Infusion Therapy Standards of Practice

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Journal of Infusion Nursing, the official publication of INS, seeks to promote excellence in infusion nursing by presenting new research, clinical reviews, case studies, and professional development information relevant to the practice of infusion therapy. Articles undergo a process of double-blind peer review. Final selections represent the broad scope of the infusion specialty and draw on the expertise of all health care providers who participate in the delivery of infusion.

Infusion Therapy Standards of Practice Reviewers

The revised *Standards*, 8th edition, was peer-reviewed by a panel of individuals across health care specialties from 17 countries around the globe. The feedback provided helped to further strengthen the recommendations outlined in this revision. The Standards of Practice Committee would like to thank the following list of reviewers:

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2021 *Infusion Therapy Standards of Practice* Updates

EDITOR'S NOTE:
INS strives to align the *Standards* with guidelines and clinical practice recommendations based on the most current evidence available. In our effort to provide consistent information and minimize confusion, this article outlines 4 corrections that will supersede recommendations published in January 2021. Please take a moment to carefully read through each item and make the appropriate updates to your clinical practice.

NEW RECOMMENDATIONS FOR FILTRATION

After publication of the 2021 *Infusion Therapy Standards of Practice* (the *Standards*) in January, the American Society for Parenteral and Enteral Nutrition (ASPEN) released new guidance on filtration of parenteral nutrition (PN). Compiled by Lisa Gorski, MS, RN, HHCNS-BC, CRNI®, FAAN, INS Standards of Practice Committee Chair, and Patricia Worthington, MSN, RN, CNSC, ASPEN Board of Director and PN Safety Committee member, this clinical practice brief outlines a history of filtration and summarizes some key information from ASPEN's 2021 recommendations that will update the recommendations in the *Standards*.[1] Clinicians are encouraged to read the ASPEN Position Paper for a thorough discussion about particulate matter and challenges and issues related to PN filtration.[2]

An abbreviated history of filtration is as follows:[2]

- Since 2004, ASPEN has recommended filtration with a 0.22-micron filter for non-lipid containing PN solutions and a 1.2-micron filter for lipid-containing solutions.[3]
- In 2014, ASPEN addressed that the problem of occluded filters may be due to use of an incorrect filter size or the presence of particulate matter in the solution. The recommendations for 0.22- and 1.2-micron filters were unchanged, and no alternative recommendation for use of a 1.2-micron filter to manage precipitation were made.[4]
- The 2021 *Standards* included the 2014 ASPEN safety recommendations, filtration of injectable lipid emulsions (ILEs), and additional evidence citations addressing particulate matter and microbubbles.[1]
- In February 2021, ASPEN published new recommendations for filtration that states: Use a 1.2-micron filter for all PN solutions including PN solutions with lipids ["total nutrient admixtures" (TNA)], dextrose-amino acid admixtures, and lipid injectable emulsions. To align with ASPEN, this new recommendation supersedes the INS Practice Recommendations for the use of 0.22-micron filtration for non-lipid solutions.
- Specifically, this revised guidance impacts Standard 35, *Filtration*, Practice Recommendation G (pS103)[1] and Standard 63, *Parenteral Nutrition,* Practice Recommendation B1 (pS190).[1]

Why is filtration of PN solutions critically important? What are the clinical consequences of particulate matter? In-line filters were initially developed for infection control purposes, but their role in protecting patients from the harmful effects of particulate matter has emerged as their primary purpose in infusion therapy. The main consequence of particulate matter is to the lungs. Symptoms may include fever, dyspnea, cough, respiratory failure, and even sudden death. Notably, when medications are co-infused with PN, there is an even greater increase in particulate matter. In 1994, the US Food and Drug Administration (FDA) issued a safety alert regarding patient deaths related to calcium-phosphate precipitation in PN solutions that led to microvascular pulmonary emboli.[5] As a result, ASPEN worked in collaboration with the FDA to develop the filtration recommendations.

Filtration poses challenges such as decreased flow rates, occlusion alarms and air locks. Cost has also been cited as a barrier to consistent use. Use of only 1.2-micron filters reduces the risk of errors associated with using 2 different types of filters not only by nurses but also by home care patients receiving PN and reduces cost. ASPEN provides procedural steps for the use of filters. In addition to the Position Paper, ASPEN has created a 2-page fact sheet that includes best practices for filter use, helpful illustrations, and guidance in trouble-shooting high-pressure/occlusion alarms and potentially occluded filters.[6] Access the fact sheet at https://www.nutritioncare.org/uploadedFiles/Documents/Guidelines_and_Clinical_Resources/IV-Filters-For%20PN-Factsheet.pdf for more detailed information.

The author has no conflicts of interest to disclose.
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REFERENCES

1. Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice. *J Infus Nurs.* 2021;44(suppl 1):S1-S224. doi:10.1097/NAN.0000000000000396
2. Worthington P, Gura KM, Kraft MD, et al. Update on the use of filters for parenteral nutrition: an ASPEN position paper. *Nutr Clin Pract*. 2021;36(1):29-39. doi:10.1002/ncp.10587
3. Mirtallo J, Canada T, Johnson D, et al. Safe practices for parenteral nutrition. *JPEN J Parenter Enteral Nutr*. 2004;28(6):S39-S69. doi:10.1177/0148607104028006s39
4. Ayers P, Adams S, Boullata J, et al. A.S.P.E.N. Parenteral nutrition safety consensus recommendations. *JPEN J Parenter Enteral Nutr*. 2014;38(3):296-333. doi:10.1177/0148607113511992
5. Lumpkin MM. Safety alert: hazards of precipitation associated with parenteral nutrition. *Am J Hosp Pharm*. 1994;51(11):1427-1428.
6. ASPEN Parenteral Nutrition Safety Committee. Update on the use of filters for parenteral nutrition. American Society for Parenteral and Enteral Nutrition; 2021. Accessed May 7, 2021. https://www.nutritioncare.org/uploadedFiles/Documents/Guidelines_and_Clinical_Resources/IV-Filters-For%20PN-Factsheet.pdf

ADDITIONAL CORRECTIONS

Abbreviations and Acronyms

ILE [Page S10]

The corrected definition for ILE should be injectable lipid emulsion.

Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*

Practice Recommendation D [Page S96]

The original statement reads:

Use a single-use sterile applicator containing sterile solution, not a multiple use product (eg, bottle of antiseptic solution).[3,5] (IV)

In the corrected statement below, the word *sterile* has been removed:

Use a single-use applicator containing antiseptic solution, not a multiple use product (eg, bottle of antiseptic solution).[3,5] (IV)

Standard 46, *Phlebitis*

Table 2. Visual Infusion Phlebitis Scale [Page S139]

The corrected scale should range from 0 to 5 as shown here:

TABLE 2

Visual Infusion Phlebitis Scale

Score	Observation
0	IV site appears healthy
1	One of the following is evident: Slight pain near IV site OR slight redness near IV site
2	Two of the following are evident: • Pain at IV site • Erythema • Swelling
3	All of the following signs are evident: • Pain along path of cannula • Induration
4	All of the following signs are evident and extensive: • Pain along path of cannula • Erythema • Induration • Palpable venous cord
5	All of the following signs are evident and extensive: • Pain along path of cannula • Erythema • Induration • Palpable venous cord • Pyrexia

Abbreviation: IV, intravenous.

Reprinted with permission from: Jackson A. Infection control–a battle in vein: infusion phlebitis. *Nurs Times.* 1998;94(4):68 -71.

REFERENCE

Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice. *J Infus Nurs*. 2021;44(suppl 1):S1-S224. doi:10.1097/NAN.0000000000000396

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The *Journal of Infusion Nursing* is a member benefit of the Infusion Nurses Society (INS). INS is a professional association dedicated to enhancing infusion practices that will improve patient outcomes. Through its many member benefits, INS offers access to the latest infusion research, technology, and education. For more information about the benefits of INS membership, visit www.ins1.org.

Foreword

The world needs infusion practice. It is a global phenomenon, benefitting millions of individuals every day. All countries are tasked with the same goal—to sustain a health system that delivers the benefits of vascular access and infusion therapy—the information gained from diagnostic tests and monitoring, the comfort of pain relief and anesthesia, therapies to manage chronic conditions, right through to life-saving resuscitation and extracorporeal membrane oxygenation. Infusion therapy provides all of this and more. Every patient who requires infusion therapy has unique circumstances, but common goals. Regardless of national identity, cultural practices, or unique characteristics, all patients desire safe, effective, and comfortable treatment, delivered in a caring and respectful way.

A global community of health professionals and supporters work tirelessly to achieve these goals. In a range of settings, with different job titles and speaking different languages, infusion and vascular access specialists have more in common than what sets them apart. As registered nurses, physicians, pharmacists, policy makers, engineers, and many others, we share a passion for providing therapy, and a hunger for up-to-date, high-quality information. We are committed to evidence-based health care—the meeting point of local circumstances (available resources and skills), patient preferences (ascertained by respectful communication), and the best available evidence. This last point challenges practitioners in the exact same way from Afghanistan to Zimbabwe and each of the 195 countries in between. How do we keep up to date when new research is published daily? How do we make sense of the varying types of research data? How do we deal with conflicting results or answering our question when no data exist? Infusion therapy gives rise to numerous questions. Some are eternal—how to access vessels without damaging them; how to balance new technologies with limited budgets—and some are new.

The recent COVID-19 pandemic has been a shared international experience that we didn't want, with large numbers of patients and what used to be unusual circumstances, such as prone position device insertions and infusion site monitoring using transmission-based precautions. Never before in our careers have we been challenged so greatly, inserting and caring for vascular devices in COVID-19 patients, at times in overwhelmed health systems where our own safety is questioned. This new disease meant we were responding with one hand tied behind our back, without previous data or research to guide us. This experience reaffirmed the perennial importance of infusion therapy, and the parallel value of highly educated, well-resourced specialists. There are always new questions and we must answer them with data and innovation. Our specialty can rise to overcome challenges, we have skilled clinicians, specialist researchers, wise experts, and quality manufacturers. All have a role in ensuring that reliable science answers clinical questions—as an international community, united in the common goal of best patient experiences and outcomes.

Fortunately, the 2021 *Infusion Therapy Standards of Practice* (the *Standards*) is here. It synthesizes specialty knowledge and provides a global focus on the shared *Standards* that we expect for our patients, and demand of each other. An international group of experts came together to critically review the evidence and updated each of the 2016 *Standards*. Two new, important *Standards* were added: Aseptic Non Touch Technique (ANTT®) and Catheter-Associated Skin Injury—both growing in focus in the literature, although already familiar to us at the bedside. The *Standards* is vital for informed decision-making and answering many infusion therapy-related questions that are about "cause and effect," such as which methods successfully prevent device infection. Such questions are best

answered by high-quality, systematic reviews and meta-analyses of randomized controlled trials since these have the least risk of bias. Yet, we must function in an imperfect world where such evidence does not always (yet) exist. To their credit, the authors have created *Standards* that reflect the best current evidence, in the context of clinical expertise, and international variation in practice settings. Level of evidence rankings have been assigned for each recommendation to indicate its strength and the likelihood that it may change as future data comes to light. For infusion therapy, our hands are not tied behind out backs, rather the *Standards* put the strength of knowledge firmly in our hands, freeing us to use them well and wisely.

As a registered nurse and nurse scientist, I am immensely proud that the *Standards* is produced by the Infusion Nurses Society and published in the *Journal of Infusion Nursing*. The contribution of nurses and midwives to infusion therapy is immense and we celebrated their role in 2020 with the World Health Organization's (WHO's) first International Year of the Nurse and Midwife. Of course, numerous professionals contribute to infusion therapy, and provide the evidence and wisdom to inform these *Standards*. Yet, it remains a notable achievement for nursing to have stewarded such a comprehensive document. Florence Nightingale, widely hailed as the first modern nurse, was a clinician, educator, and manager, but also a statistician who used data to influence the health system, including when data showed her own institution was not up to the standards of the time. In this, our time, I challenge you to read, reflect on, implement, and innovate from these important *Standards* so that your light shines within our vast global community of infusion therapy professionals.

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STANDARDS OF PRACTICE COMMITTEE

CONFLICTS OF INTEREST AND OTHER DISCLOSURES

The authors have completed and submitted a form for disclosure of potential conflicts of interest. **Lisa A. Gorski** receives book royalties from F.A. Davis and Springer publishers, owns stock in ivWatch, and has received speaker fees from 3M, BD Medical, and Genentech. **Lynn Hadaway** is a paid consultant for Atrion Corporation, Fresenus Kabi, Nexus Medical, Teleflex, and VATA. Additionally, she is a paid consultant and speaker for B Braun Medical, BD Medical, and Velano Vascular. **Mary E. Hagle** is employed by Clement J. Zablocki VA Medical Center, Milwaukee, WI. The contents do not represent the views of the US Department of Veterans Affairs or the United States Government nor does mention of trade names, commercial products, or organizations imply endorsement by the US government. **Daphne Broadhurst** receives speakers' honoraria from 3M and Baxter Canada and unrestricted research grants from 3M and BD Canada. **Tricia Kleidon** reports grants by the National Health and Medical Research Council (NHMRC), employment by Griffith University, grants by the Children's Hospital Foundation, Emergency Medicine Foundation, Association for Vascular Access Foundation, and investigator-initiated research grants and speaker fees provided to Griffith University from 3M Medical, Access Scientific, BD-Bard, Medical Specialties Australia, and Vygon. **Britt M. Meyer** is a paid researcher for Bard/BD. **Elizabeth Sharpe** reports consultation and speaker fees from Argon Medical Devices. **Mary Alexander** reports speaker fees provided to INS from BD. **Simon Clare, Barb Nickel, and Stephen Rowley** have no conflicts of interest to report.

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Preface

In a complex health care environment, it is imperative that clinicians provide safe, quality patient care. Due to the invasive nature and risks associated with infusion therapy, guidance that supports clinical practice is critical to ensure competent practice and maintain our patients' trust. The comprehensive nature of infusion therapy, including care delivery to all patient populations in all care settings, eliminating complications, promoting vein preservation, and ensuring patient satisfaction commands support for clinicians responsible for the patient outcomes. Hence, INS' commitment to developing and disseminating standards of practice. Adherence to the *Infusion Therapy Standards of Practice*, promotes consistency in patient care, guides clinical decision-making, and enhances competency.

While the *Standards* is recognized globally, it is important that the content reflects global practice. To incorporate that perspective, several members of the Standards of Practice Committee and one-third of the public comments came from reviewers who reside outside of the United States. Language within the *Standards* was carefully drafted to ensure global application.

Continuing the commitment to revising the *Standards* every 5 years, INS is proud to introduce this 8th edition. The overall format is similar to previous versions. Standards are declarative statements, an expectation of the profession by which the quality of practice, service, or education is judged. They describe the action needed to provide competent care. Each standard was reviewed and revised based on the most recent evidence and research at the time of publication with a few new standards added. To minimize redundancy and make it easier to read, some sections begin with "Section Standards," general statements that are applicable to all the standards within the section. Also, in addition to the glossary, definitions are highlighted within some specific standards for clarity.

Practice Recommendations, formerly Practice Criteria, provide guidance on how to achieve the standard. These statements are ranked according to the Strength of the Body of Evidence with references cited. Often the ranking and references are grouped at the end of the Practice Recommendation. When readers are instructed to "refer to" a particular standard, these statements are not ranked nor have references since the original standard includes both. There are also statements guiding the reader to "see" another standard for more information and these are ranked and include references.

The committee reviewed more than 2500 sources of literature for this edition. The staggering number of references cited speaks to how the science of infusion therapy and vascular access has advanced in 5 years. Since infusion therapy and vascular access management are ubiquitous in all care settings, the published evidence can justify existing practice or lead to practice changes.

Of note, this edition also addresses crisis standards of care, guidelines designed to help organizations and health care professionals deliver the best possible care in circumstances in which resources are severely limited and health care standards are compromised. They include strategies to deal with a crisis such as a pandemic when the goal is to do the greatest good for the most people–implementing the best alternative practices to ensure safe care to the patient and protection for the clinician.

As INS continues to "Set the Standard for Infusion Care", we remain focused on how best to deliver patient-centered infusion care. This comprehensive 8th edition of the *Standards* is an invaluable reference for all clinicians as we promote consistency in practice, enhance competency, and provide a guide for clinical decision-making around the globe.

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Methodology for Developing the Standards of Practice

ROLE OF THE STANDARDS OF PRACTICE COMMITTEE

The Standards of Practice Committee brought together a group of international nurses with a wealth of clinical knowledge and expertise in the domains of infusion therapy and vascular access device (VAD) planning, placement, and management. They initially met to review and agree on the evidence rating scale and to discuss methods and sources of searching for evidence. They also agreed on how to evaluate types of evidence. Throughout the *Standards* review and revision process, the committee met regularly via virtual technology, reviewed each standard in detail, and came to consensus on the final strength of the body of evidence rating for the final draft of the *Infusion Therapy Standards of Practice,* 8th edition. This draft was sent to more than 200 international, interdisciplinary reviewers who are experts in their field, comprising all aspects of infusion therapy and VAD management. A total of 120 reviewers returned critiques; 30 of these reviewers were from outside the United States. Reviewers provided comments, suggestions, references, and questions which were compiled by specific standard into a 102-page, single-spaced word document. The committee addressed every comment, revised Practice Recommendations, and sought additional evidence as needed. Each standard had a final review by the committee for consensus on the content, evidence, recommendation, and rating.

The *Standard*s is written for clinicians of multiple disciplines around the world with various educational backgrounds, training, certifications, and licensing, as infusion therapy may be provided by any one of these individuals. The premise is that patients deserve infusion therapy based on the best available evidence, irrespective of the discipline of the clinician who provides that therapy while operating within her or his scope of practice.

SEARCHING FOR BEST EVIDENCE

Each committee member conducted a literature search for their assigned standards of practice using key words and subject headings related to the standard and Practice Recommendation. Searches were limited to mainly English-language, peer-reviewed journal articles published between January 2015 and May 2020. Additional, but narrow, literature searches were conducted through August 2020 when addressing reviewers' comments or questions. Databases included, but were not limited to, Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINAHL), EMBASE, Google Scholar, Ingenta Connect, MEDLINE, PubMed, ScienceDirect, Scopus, UpToDate, and Web of Science. References of retrieved articles and select journal titles were reviewed for relevant literature.

Additional sources of evidence included, but were not limited to, the websites of professional organizations, manufacturers, pharmaceutical organizations, and the United States Pharmacopeia (USP). Clinical practice guidelines, publications, and websites of health care and professional organizations from select countries were reviewed; these were used as needed. Evidence was also included from the Association for the Advancement of Medical Instrumentation (AAMI), Institute for Safe Medication Practices, The Joint Commission, the US Department of Health and Human Services, Centers for Disease Control and Prevention, US Food and Drug Administration, National Quality Forum, and the US Department of Labor (eg, Occupational Safety and Health Administration). Other evidence came from health care-related agencies in Ireland, United Kingdom, Australia, and Canada. Classic papers were included as needed. On occasion, textbooks served as sources of evidence when clinical research and scholarship are widely accepted, such as for anatomy and physiology. Because the *Standards* is written for all health care settings and all populations, evidence was included for each of these areas as available.

EVALUATING EVIDENCE

Each item of evidence was evaluated from many perspectives, and the highest, most robust evidence relating to the Practice Recommendation was used. Research evidence was preferred over nonresearch evidence. For research evidence, the study design was the initial means for ranking. Other aspects of evaluation of quality include sufficient sample size based on a power analysis, appropriate

statistical analysis, examination of the negative cases, and consideration of threats to internal and external validity.

Research on research, such as meta-analyses and systematic reviews, is the highest level of evidence. Meta-analysis uses statistical analysis and only specific study designs to produce the most robust type of evidence. Single studies with strong research designs, such as randomized controlled trials (RCTs), form the basis for research on research or a strong body of evidence when there are several RCTs with similar findings. Other research designs are needed as well for a developing area of science and often before an RCT can be conducted. A necessary and foundational study for learning about a question or a population is the descriptive research study, but because of its lack of research controls, it is ranked at a low level of evidence for clinical practice.

Lastly, nonresearch is often the only available evidence. Nonresearch includes quality improvement projects, clinical articles, case reports, or position papers, as well as manufacturers' instructions for use and consensus guidelines. Nonresearch evidence can be extremely valuable for certain aspects of practice when it is unethical to conduct research on that question or research is impractical. Many times, quality improvements lead to a research question and subsequent study.

An evidence table was often used to synthesize multiple pieces and types of evidence for a Practice Recommendation, while some literature searches yielded very little usable evidence and a table was unnecessary. Every effort was made to be consistent throughout the *Standards* when referring to the same action (eg, disinfecting a needleless connector or measuring the circumference of an extremity).

RATING THE STRENGTH OF THE BODY OF EVIDENCE

The rating scale for the Strength of the Body of Evidence, developed in 2011 by the Standards of Practice Committee, was robustly discussed by the Committee for the 2021 *Standards*. Several changes were made. First, the Regulatory level was eliminated since it was US-centric and the *Standards* is a global document. Clinicians are now referred to the "laws, rules, and regulations established by regulatory and accrediting bodies in all patient care settings." Second, evidence from anatomy, physiology, and pathophysiology at the time the *Standards* was written is identified by "A/P" (Anatomy/Physiology) and does not have a rating level.

The rating scale provides guidance for clinicians when implementing these *Standards*. This guidance can reflect a range of evidence, from a preponderance of evidence with highly recommended specific clinician actions, to minimal evidence with actions directed by organizational preference and/or clinician judgment.

The rating scale ranges from the highest ranking of "I," representing a meta-analysis and other research on research to the lowest level of "V." For a standard of practice with a single item of evidence, such as a meta-analysis with its accepted methods, the body of evidence is within the meta-analysis and the strength of this body of evidence is I. When studies are cited within the larger work of a meta-analysis or systematic review, the individual studies are not cited separately. However, for large research-based guidelines, the level of evidence may vary based on what is cited: the whole guideline or a specific part of the guideline with its related evidence.

The A/P (Anatomy/Physiology) identification may be based on textbooks as well as published case studies. This evaluation is used in a Practice Recommendation to stop an unsafe action, such as preventing an air embolism through body positioning. It may also be used to prevent harm to the patient, such as avoiding venipuncture around dense areas of nerves. On rare occasions, there is a lack of literature or very low levels of evidence with conflicting findings. In these instances, the Standards of Practice Committee reviewed the evidence, discussed the practice, and agreed to a Practice Recommendation using the designation of "Committee Consensus." This rating was used infrequently in the Practice Recommendations.

PRACTICE RECOMMENDATIONS

When there is a large body of evidence based on robust research with consistent findings, the strength of the body of evidence reflects a high rating, such as a I or II, and the Practice Recommendation is strong. There is also the occasion when there is a systematic review, which is a robust research design, but the findings are inconclusive. Thus, there is a strong body of evidence indicating a high rating for the type of evidence cited, but there is insufficient evidence to draw conclusions. In this instance, a term is used such as "consider" and the clinician is advised to use this evidence along with her or his expertise and clinical judgment. Last, as mentioned earlier, Committee Consensus is used when there was minimal or low-rated conflicting studies but guidance is needed for clinicians to provide safe care without harm.

The *Standards* is reviewed and revised based on the best evidence every 5 years. With the rating scale, projects can be stimulated during the intervening years to address some of the gaps in evidence. However, INS and the Standards of Practice Committee are committed to bringing research-based critical changes to practice for clinicians through a variety of dissemination strategies in the time between each revision.

Abbreviations and Acronyms

AACA	authorized agent-controlled analgesia
ABHR	alcohol-based hand rub
ANTT®	Aseptic Non Touch Technique
AP	anteroposterior
APRN	advanced practice registered nurse
ASD	adhesive securement device
AST	accelerated Seldinger technique
AVF	arteriovenous fistula
AVG	arteriovenous graft
BMI	body mass index
BSI	bloodstream infection
BUD	beyond-use date
CABSI	catheter-associated bloodstream infection
CA-DVT	catheter-associated deep vein thrombosis
CAJ	cavoatrial junction
CASI	catheter-associated skin injury
CDC	Centers for Disease Control and Prevention
CFU	colony forming unit
CHG	chlorhexidine gluconate
CKD	chronic kidney disease
CLABSI	central line-associated bloodstream infection
CMV	cytomegalovirus
CNA	certified nursing assistant
CNLP	clinical nonlicensed personnel
C-PEC	containment primary engineering control
CPOE	computerized prescriber order entry
CR-BSI	catheter-related bloodstream infection
CRNI®	Certified Registered Nurse Infusion
CRS	cytokine release syndrome
CSTD	closed system transfer device
CT	computed tomography
CVAD	central vascular access device
CVP	central venous pressure
DEHP	Di[2-ethylhexyl]phthalate
DERS	dose error reduction systems
DIVA	difficult intravenous access
DME	durable medical equipment
DMSO	dimethyl sulfoxide
DTP	differential time to positivity
DVT	deep vein thrombosis
EBP	evidence-based practice
ECG	electrocardiogram
ED	emergency department
EDTA	ethylenediaminetetraacetic acid
EHR	electronic health record
EN	enrolled nurse
EPA	Environmental Protection Agency
FDA	US Food and Drug Administration
FEMA	failure mode and effects analysis
Fr	French
GFR	glomerular filtration rate
HCl	hydrochloric acid
HEPA	high-efficiency particulate air
HFMEA	Healthcare Failure Mode and Effect Analysis
Hg	mercury
HIPAA	Health Insurance Portability and Accountability Act
HIT	heparin-induced thrombocytopenia
HITT	heparin-induced thrombocytopenia and thrombosis
HLA	human leukocyte antigen
ICU	intensive care unit
IgG	immunoglobulin gamma
ILE	lipid injectable emulsion
INCC	Infusion Nurses Certification Corporation
INS	Infusion Nurses Society
IO	intraosseous
IRB	institutional review board
ISD	integrated securement device
IV	intravenous
IVC	inferior vena cava
IVIg	intravenous immunoglobulin
LMWH	low molecular weight heparin
Long PIVC	long peripheral intravenous catheter
LPN	licensed practical nurse
LVN	licensed vocational nurse
MA	medical assistant
MARSI	medical adhesive-related skin injury
MDRO	multidrug-resistant organism
MRI	magnetic resonance imaging
MST	modified Seldinger technique
NICE	National Institute for Clinical Excellence
NIOSH	National Institute for Occupational Safety and Health
nIR	near infrared
NP	nurse practitioner
NPO	nothing by mouth
OIRD	opioid-induced respiratory depression
OTC	over-the-counter
PA	physician assistant
PBM	patient blood management

PCA	patient-controlled analgesia
PICC	peripherally inserted central catheter
PIVC	peripheral intravenous catheter
PN	parenteral nutrition
PPE	personal protective equipment
PRN	as needed
QI	quality improvement
RBC	red blood cell
RCA	root cause analysis
RCT	randomized controlled trial
REMS	risk evaluation and mitigation strategies
RN	registered nurse
SASS	subcutaneous anchor securement system
SCIg	subcutaneous immunoglobulin
SDS	safety data sheet
Short PIVC	short peripheral intravenous catheter
SIRS	systemic inflammatory response syndrome
SVC	superior vena cava
TA	tissue adhesive
TNA	total nutrient admixture
tPA	tissue plasminogen activator
TSM	transparent semipermeable membrane
UAC	umbilical arterial catheter
UAP	unlicensed assistive personnel
US	ultrasound
UVC	umbilical venous catheter
VAD	vascular access device
VAT	vascular access team
VIP	visual infusion phlebitis
WHO	World Health Organization

Strength of the Body of Evidence

Evidence that is research based is preferred; however, it may come from a variety of sources as needed. The strength of evidence in this document reflects the body of evidence available and retrievable at the time of review, and thus is titled *Strength of the Body of Evidence*. The strength of the body of evidence is only as robust as the highest level of a single item of evidence. Studies and other evidence comprise similar patient populations unless otherwise noted.

Evidence Rating	Evidence Description[a]
I	Meta-analysis, systematic literature review, guideline based on randomized controlled trials (RCTs), or at least 3 well-designed RCTs.
II	Two well-designed RCTs, 2 or more well-designed, multicenter clinical trials without randomization, or systematic literature review of varied prospective study designs.
III	One well-designed RCT, several well-designed clinical trials without randomization, or several studies with quasi-experimental designs focused on the same question. Includes 2 or more well-designed laboratory studies.
IV	Well-designed quasi-experimental study, case control study, cohort study, correlational study, time series study, systematic literature review of descriptive and qualitative studies, narrative literature review, or psychometric study. Includes 1 well-designed laboratory study.
V	Clinical article, clinical/professional book, consensus report, case report, guideline based on consensus, descriptive study, well-designed quality improvement project, theoretical basis, recommendations by accrediting bodies and professional organizations, or manufacturer recommendations for products or services. This also includes a standard of practice that is generally accepted but does not have a research basis (eg, patient identification).
A/P	Evidence from anatomy, physiology, and pathophysiology as understood at the time of writing.
Committee Consensus	Review of evidence, discussion, and committee agreement for a Practice Recommendation. Used when there is insufficient or low-quality evidence to draw a conclusion.

[a]Sufficient sample size is needed with preference for power analysis adding to the strength of the evidence.

Infusion Therapy Standards of Practice

Section One: Infusion Therapy Practice

1. PATIENT CARE

Standard

1.1 The *Infusion Therapy Standards of Practice* is applicable to any patient population and any setting in which vascular, intraosseous (IO), subcutaneous, and intraspinal access devices are inserted and/or managed and where infusion therapies are administered.

1.2 Infusion therapy is provided in accordance with laws, rules, and regulations established by regulatory and accrediting bodies in each jurisdiction (eg, countries, states, provinces).

1.3 Infusion therapy practice is established in organizational policies, procedures, practice guidelines, and/or standardized written protocols/orders that describe the acceptable course of action, including performance and accountability, and provides a basis for clinical decision-making.

1.4 Infusion therapy is provided with attention to quality and patient/health care provider safety. Care is individualized, collaborative, evidence-based, culturally sensitive, and appropriate to patient/caregiver age and level of cognition.

1.5 Ethical principles are used as a foundation for decision-making. The clinician acts as a patient advocate; maintains patient confidentiality, safety, and security; and respects, promotes, and preserves human autonomy, dignity, rights, and diversity.

1.6 Clinician decisions related to infusion therapy practice, including device and/or product selection, are not influenced by commercial and/or conflicts of interest.

2. SPECIAL PATIENT POPULATIONS: NEONATAL, PEDIATRIC, PREGNANT, AND OLDER ADULTS

Standard

2.1 The needs and characteristics of special patient populations, including physiologic, developmental, communication/cognitive ability, and/or safety requirements, are identified and addressed in the planning, insertion, removal, care and management, and monitoring of vascular access devices (VADs) and with administration of infusion therapy.

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Practice Recommendations

A. Considerations for neonatal and pediatric patients:
   1. Recognize physiologic characteristics and effect of drug and nutrient selection; administration set selection (eg, free of Di[2-ethylhexyl]phthalate [DEHP]); electronic infusion pump selection; dosage, rate, and volume limitations with reference to age, height, weight, or body surface area; pharmacologic actions, interactions, side effects, and adverse effects; monitoring parameters; and response to infusion therapy.[1-4] (V)
   2. Provide education to the mother regarding the potential impact and risks/benefits of any medication use during lactation.[5,6] (IV)
   3. Provide vascular access with attention to the child's anatomical, physiological, and developmental level.
      a. Identify pediatric patients with difficult intravenous access (DIVA); utilize technology (eg, ultrasound, near infrared light) and ensure skill of clinicians to improve insertion success (see Standard 5, *Competency and Competency Assessment;* Standard 22, *Vascular Visualization;* Standard 26, *Vascular Access Device Planning*).[7-10] (V)
      b. Use nonpharmacologic measures to promote comfort and reduce pain and anxiety associated with infusion therapy procedures (see Standard 32, *Pain Management for Venipuncture and Vascular Access Procedures*).[7,11-15] (I)
   4. Assess for psychosocial and socioeconomic considerations that may affect the plan for infusion therapy.[16] (V)
   5. Identify and interact with appropriate patient caregivers (eg, parents, other family members, surrogates) as members of the patient's health care team, including provision of patient education, with attention to age, developmental level, health literacy, culture, and language preferences (see Standard 8, *Patient Education*).[8,17-19] (V)
   6. Obtain assent from the school-aged or adolescent patient as appropriate (see Standard 9, *Informed Consent*).[20] (IV)

B. Considerations in pregnancy:
   1. Recognize physiologic changes related to pregnancy and their effect on drug dosage, volume limitations, and potential impact on the fetus; pharmacologic

actions, interactions, side effects, adverse effects; monitoring parameters; and response to infusion therapy.[21] (IV, A/P)

2. Provide education to the mother and/or significant other regarding the potential impact and risks/benefits of any medication use during pregnancy.[21] (V)
3. Recognize potential risks of peripherally inserted central catheter (PICC) complications (eg, infection and thrombosis) during pregnancy.[22] (I)
    a. Enteral tube feeding (nasogastric or nasoduodenal) should be initiated as the first-line treatment to provide nutritional support to the woman with hyperemesis gravidarum who is not responsive to medical therapy and cannot maintain her weight.[23] (IV)
    b. Potential infusion therapy needs for patients with hyperemesis gravidarum include subcutaneous antiemetics, intravenous (IV) hydration solutions, and parenteral nutrition (PN).[24] (IV)

C. Considerations for the older adult patients:
1. Recognize physiologic changes associated with the aging process and its effect on immunity, drug dosage and volume limitations, pharmacologic actions, interactions, side effects, monitoring parameters, and response to infusion therapy. Anatomical changes, including loss of thickness of the dermal skin layer, thickening of the tunica intima/media, and loss of connective tissue, contribute to vein fragility and present challenges in vascular access.[25-28] (V)
2. Assess for any changes in cognitive abilities, dexterity, and ability to communicate or learn (eg, changes in vision, hearing, speech), as well as psychosocial and socioeconomic considerations that may affect the patient's ability to communicate symptoms suggestive of complications that may impact the plan for infusion therapy.[29-32] (IV)
    a. Older adults may be safely treated with antimicrobial therapy at home upon assessment of adequacy of cognition, mobility, dexterity, and ability to communicate with the health care team.[33] (IV)
3. Assess for ability to safely manage medication regimens and VADs in the presence of cognitive impairment and dexterity issues and for the presence of unsafe practices in the storage of medications in the home setting.[34] (V)
4. Identify and interact with appropriate family members, caregivers, or surrogates as members of the patient's health care team, with consent of the patient, or as necessary due to mental status.[35-39] (IV)
5. Identify potential for adverse events and significant drug interactions in older adults who may be prescribed multiple medications; work with the health care team to resolve medication issues and reduce risks.[40-43] (I)

REFERENCES

Note: All electronic references in this section were accessed between March 3, 2020, and August 10, 2020.

1. McNab S. Intravenous maintenance fluid therapy in children. *J Paediatr Child Health*. 2016;52(2):137-140. doi:10.1111/jpc.13076
2. Miller JW, Balyan R, Dong M, Mahmoud M, Lam JE, Pratap JN, et al. Does intranasal dexmedetomidine provide adequate plasma concentrations for sedation in children: a pharmacokinetic study. *Br J Anaesth*. 2018;120(5):1056-1065. doi:10.1016/j.bja.2018.01.035
3. Saha P, Beardsall K. Perioperative continuous glucose monitoring in a preterm infant. *BMJ Case Rep*. 2018;2018:bcr2018224728. doi:10.1136/bcr-2018-224728
4. Tuckwell R, Wood D, Mansfield-Sturgess S, Brierley J. A European Society of Paediatric and Neonatal Intensive Care (ESPNIC) survey of European critical care management of young people. *Eur J Pediatr*. 2017;176(2):155-161. doi:10.1007/s00431-016-2815-6
5. Mitchell J, Jones W, Winkley E, Kinsella SM. Guideline on anaesthesia and sedation in breastfeeding women 2020: guideline from the Association of Anaesthetists [published online ahead of print Aug 1, 2020]. *Anaesthesia.* 2020;10.1111/anae.15179. doi:10.1111/anae.15179
6. Verstegen RHJ, Ito S. Drugs in lactation. *J Obstet Gynaecol Res.* 2019;45(3):522-531. doi:10.1111/jog.13899
7. Cooke M, Ullman AJ, Ray-Barruel G, Wallis M, Corley A, Rickard CM. Not "just" an intravenous line: consumer perspectives on peripheral intravenous cannulation (PIVC). an international cross-sectional survey of 25 countries. *PLoS One*. 2018;13(2):e0193436. doi:10.1371/journal.pone.0193436
8. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health*. 2019;55(10):1214-1223. doi:10.1111/jpc.14384
9. Schults J, Rickard C, Kleidon T, Paterson R, Macfarlane F, Ullman A. Difficult peripheral venous access in children: an international survey and critical appraisal of assessment tools and escalation pathways. *J Nurs Scholarsh.* 2019;51(5):537-546. doi:10.1111/jnu.12505
10. Ullman A, Kleidon T. Developmental stages and clinical conditions for vascular access in pediatrics. In: Moureau NL, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access*. SpringerOpen; 2019:171-179. https://link.springer.com/content/pdf/10.1007%2F978-3-030-03149-7.pdf
11. Bergomi P, Scudeller L, Pintaldi S, Dal Molin A. Efficacy of non-pharmacological methods of pain management in children undergoing venipuncture in a pediatric outpatient clinic: a randomized controlled trial of audiovisual distraction and external cold and vibration. *J Pediatr Nurs.* 2018;42:e66-e72. doi:10.1016/j.pedn.2018.04.011
12. Birnie KA, Noel M, Chambers CT, Uman LS, Parker JA. Psychological interventions for needle-related procedural pain and distress in children and adolescents. *Cochrane Database Syst Rev*. 2018;10(10):CD005179. doi:10.1002/14651858.CD005179.pub4
13. Harrison D, Yamada J, Adams-Webber T, Ohlsson A, Beyene J, Stevens B. Sweet tasting solutions for reduction of needle-related procedural pain in children aged one to 16 years. *Cochrane Database Syst Rev*. 2015;2015(5):CD008408. doi:10.1002/14651858.CD008408.pub3
14. McMurtry CM, Pillai Riddell R, Taddio A, Racine N, Asmundson GJ, Noel M, et al. Far from "just a poke": common painful needle procedures and the development of needle fear. *Clin J Pain*. 2015;31(10 Suppl):S3-S11. doi:10.1097/AJP.0000000000000272
15. Noel M, McMurtry CM, Pavlova M, Taddio A. Brief clinical report: a systematic review and meta-analysis of pain memory-reframing interventions for children's needle procedures. *Pain Pract.* 2018;18(1):123-129. doi:10.1111/papr.12572
16. Kleidon TM, Ullman AJ. Device assessment and selection in pediatrics. In: Moureau NL, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access*. SpringerOpen; 2019:181-195. https://link.springer.com/content/pdf/10.1007%2F978-3-030-03149-7.pdf

17. Badaczewski A, Bauman LJ, Blank AE, et al. Relationship between teach-back and patient-centered communication in primary care pediatric encounters. *Patient Educ Couns.* 2017;100(7):1345-1352. doi:10.1016/j.pec.2017.02.022
18. Hill C, Knafl KA, Santacroce SJ. Family-centered care from the perspective of parents of children cared for in a pediatric intensive care unit: an integrative review. *J Pediatr Nurs.* 2017;S0882-5963(17)30531-6. doi:10.1016/j.pedn.2017.11.007
19. Smith W. Concept analysis of family-centered care of hospitalized pediatric patients. *J Pediatr Nurs.* 2018;42:57-64. doi:10.1016/j.pedn.2018.06.014
20. Heerman WJ, White RO, Barkin SL. Advancing informed consent for vulnerable populations. *Pediatrics*. 2015;135(3):e562-e56.
21. Briggs GC, Freeman RK, Towers CV, Forinahs, AB. *Drugs in Pregnancy and Lacation: A Reference Guide to Fetal and Neonatal Risk*. 11th ed. Wolters Kluwer Health; 2017.
22. Frolova AI, Shanahan MA, Tuuli MG, Simon L, Young OM. Complications of peripherally inserted central catheters in pregnancy: a systematic review and meta-analysis [published online ahead of print May 22, 2020]. *J Matern Fetal Neonatal Med.* 2020;1-8. doi:10.1080/14767058.2020.1769591
23. Committee on Practice Bulletins-Obstetrics. ACOG Practice Bulletin No. 189: nausea and vomiting of pregnancy. *Obstet Gynecol.* 2018;131(1):e15-e30. doi:10.1097/AOG.0000000000002456
24. MacGibbon KW. Hyperemesis gravidarum: strategies to improve outcomes. *J Infus Nurs*. 2020;43(2):78-96. doi:10.1097/NAN.0000000000000363
25. Kane RL, Ouslander JG, Resnick B, Malone ML. *Essentials of Clinical Geriatrics*. 8th ed. McGraw-Hill Education; 2018.
26. Smith CM, Cotter VT. Age-related changes in health. In: Botlz M, Capezuti E, Fulmer T, Zwicker D, eds. *Evidence-Based Geriatric Nursing Protocols for Best Practice.* Springer Publishing Company; 2016:chap 3.
27. Musso CG, Belloso WH, Scibona P, Bellizzi V, Macías Núñez JF. Impact of renal aging on drug therapy. *Postgrad Med*. 2015;127(6):623-629. doi:10.1080/00325481.2015.1063957
28. Coulter K. Successful infusion therapy in older adults. *J Infus Nurs.* 2016;39(6):352-358. doi:10.1097/NAN.0000000000000196
29. Wattamwar K, Qian ZJ, Otter J, et al. Increases in the rate of age-related hearing loss in the older old. *JAMA Otolaryngol Head Neck Surg*. 2017;143(1):41-45. doi:10.1001/jamaoto.2016.2661
30. Davis A, McMahon CM, Pichora-Fuller KM, et al. Aging and hearing health: the life-course approach. *Gerontologist*. 2016;56(Suppl 2): S256–S267. doi:10.1093/geront/gnw033
31. Fischer ME, Cruickshanks KJ, Schubert, CR, et al. Age-related sensory impairments and risk of cognitive impairment. *J Am Geriatr Soc*. 2016;64(10):1981-1987. doi:10.1111/jgs.14308
32. Swenor BK, Simonsick, EM, Ferrucci L, et al. Visual impairment and incident mobility limitations: the health, aging and body composition study. *J Am Geriatr Soc*. 2015; 63(1):46–54. doi:10.1111/jgs.13183
33. Norris AH, Shrestha NK, Allison GM, et al. 2018 Infectious Diseases Society of America clinical practice guideline for the management of outpatient parenteral antimicrobial therapy. *Clin Infect Dis.* 2019;68(1):1-4. doi:10.1093/cid/ciy867
34. Lang A, Macdonald M, Marck P, et al. Seniors managing multiple medications: using mixed methods to view the home care safety lens. *BMC Health Serv Res.* 2015;15:548. doi:10.1186/s12913-015-1193-5
35. Winkler M, Guenter P. Long-term home parenteral nutrition: it takes an interdisciplinary approach. *J Infus Nurs.* 2014;37(5):389-395. doi:10.1097/NAN.0000000000000068
36. Lukazewski A, Martin B, Sokhal D, et al. Screening for adverse drug events in older adults: the impact of interventions. *Consult Pharm.* 2014;7(10):689-697. doi:10.4140/TCP.n.2014.689
37. Noureldin M, Murawski MM, Mason HL, Hyner GC, Plake KS. The association between family caregivers' involvement in managing older adults' medications and caregivers' information-seeking behavior. *J Am Pharm Assoc (2003)*. 2017;57(2):170-177.e1. doi:10.1016/j.japh.2016.12.061
38. Noureldin M, Plake KS. Correlates of caregivers' involvement in the management of older adults' medications. *Res Social Adm Pharm.* 2017;13(4):840-848. doi:10.1016/j.sapharm.2016.09.009
39. Walker J, Crotty BH, O'Brien J, Dierks MM, Lipsitz L, Safran C. Addressing the challenges of aging: how elders and their care partners seek information. *Gerontologist.* 2017;57(5):955-962. doi:10.1093/geront/gnw060
40. Carmona-Torres JM, Cobo-Cuenca AI, Recio-Andrade B, Laredo-Aguilera JA, Martins MM, Rodríguez-Borrego MA. Prevalence and factors associated with polypharmacy in the older people: 2006–2014. *J Clin Nurs.* 2018;27(15-16):2942-2952. doi:10.1111/jocn.14371
41. Merel SE, Paauw DS. Common drug side effects and drug-drug interactions in elderly adults in primary care. *J Am Geriatr Soc*. 2017;65(7):1578-1585. doi:10.1111/jgs.14870
42. Rodrigues MC, Oliveira Cd. Drug-drug interactions and adverse drug reactions in polypharmacy among older adults: an integrative review. *Rev Lat Am Enfermagem*. 2016;24:e2800. doi:10.1590/1518-8345.1316.2800
43. Wimmer BC, Cross AC, Jokanovic N, et al. Clinical outcomes associated with medication regimen complexity in older people: a systematic review. *J Am Geriatr Soc*. 2017;65(4):747-753. doi:10.1111/jgs.146823.

3. SCOPE OF PRACTICE

Standard

3.1 Clinicians prescribing and/or administering infusion therapy and performing vascular access insertion and management are qualified and competent to perform these services based on their licensure and certification and practice within the boundaries of their identified scope of practice.

3.2 The role, responsibilities, and accountability for each type of clinician involved with infusion therapy prescription and administration and vascular access insertion and management are clearly defined in organizational policy according to the applicable regulatory agencies or boards.

3.3 Members of the health care team collaborate to achieve the universal goal of safe, effective, and appropriate infusion therapy.

3.4 Infusion therapy and vascular access activities, skills, or procedures are delegated from a licensed professional to others in accordance with rules and regulations established by the appropriate regulatory agency (eg, state board of nursing) and within the policies and procedures of the organization.

Practice Recommendations

A. Recognize that many clinicians require licensure (eg, registered nurse [RN], advanced practice registered nurse [APRN], physician, physician assistant [PA]) whereas others do not have licensure requirements (eg, unlicensed assistive personnel [UAP]) and still others have variable credential requirements based on the applicable regulatory agencies or boards (eg, radiologic technologists).
   1. Know the defined scope of practice for one's licensure to avoid legal and employment consequences. "Scope of practice" for licensed clinicians is not

consistently defined across all jurisdictions (eg, countries, states, provinces).[1,2] (IV)
2. Practice below one's defined scope of practice (eg, underutilization of licensed staff) causes loss of competency, whereas practice beyond or outside the defined scope results in unsafe practice.[1] (IV)
3. Clinicians who do not require licensure may have scope of practice defined through certification programs established by the respective professional organizations (eg, American Society of Radiologic Technologists [ASRT]).[3] (V)
4. Educational requirements and services provided by a UAP vary among countries, states, and health care organizations. UAPs usually do not have a regulated legal scope of practice, and the roles of this group vary extensively.[4-6] (IV)
5. Apply the 5 types of regulations that impact scope of practice including:
   a. Transnational agreements across countries.
   b. Laws, ordinances, or statutes authorized by the appropriate legislative body for each jurisdiction.
   c. Rules and regulations created by the responsible board or council in each jurisdiction.
   d. Interpretation and implementation to apply the laws as specific guidelines.
   e. Standards, guidelines, position statements, and/or competency frameworks written by professional organizations.[7] (V)
6. Accept responsibility and accountability of one's actions or inactions and those of others who are supervised by or receiving delegation from the licensed clinician.[7] (V)

B. Know the process for defining the scope of practice for one's profession and the appropriate framework for making scope of practice decisions. Governments in some jurisdictions define the scope of practice through legislation, whereas professional organizations may have this authority in other jurisdictions. Practice expansion may be required due to the complexity and costs of health care, improvement of patient outcomes, and patient satisfaction. Expansion and extension of the scope of practice (eg, RN insertion of a central vascular access device [CVAD], medication prescribed by an RN, UAP insertion of a short peripheral intravenous catheter [short PIVC]) are accompanied by necessary educational and competency requirements.[1,2,8-14] (IV)
   1. A standardized decision tree for determining nursing's scope of practice is recommended by the National Council of State Boards of Nursing and most individual US state boards of nursing. Similar tools are available from the International Council of Nurses and by other disciplines (eg, ASRT).
   2. Common questions in a decision tree include:
      a. Is the activity/intervention in accordance with laws, regulations, and policies of the governing regulatory body?
      b. Does the activity/intervention align with evidence-based practice (EBP) and other published resources?
      c. Are there established policies and procedures supporting the activity/intervention?
      d. Have educational requirements to perform the activity/intervention been completed?
      e. Have processes to assess and document competency for the activity/intervention been created?
      f. Are appropriate resources to perform the activity/intervention readily available in the setting?
      g. Is the individual prepared to accept accountability for the outcome of the activity/intervention?[3,7,15] (V)

C. Identify and collaborate with all members of the patient's health care team toward the universal goal of safe, effective, and appropriate infusion therapy and vascular access. Know the roles of all team members to improve collaboration and clinical decision-making to reach optimal performance for all clinicians.[16,17] (IV)

D. Identify which professionals are considered providers based on the scope of one's license and granted clinical privileges.
   1. Providers (eg, physician, APRN, PA) must present credentials and be granted privileges for practice in a specific venue of care before initial practice begins and periodically based on regulations of the jurisdiction.
   2. Although the legal scope of practice for a profession may be broad, the actual scope of what the individual may perform is limited to privileges granted by the organization.[18-20] (V)

E. Delegate activities, skills, or procedures related to infusion therapy administration and vascular access insertion and management based on patient needs and the documented competency of the delegatee while applying the *Five Rights of Delegation* including the right task, under the right circumstances, to the right person, with the right direction and communication, and under the right supervision and evaluation. Specific guidelines are available for the nursing profession but may be applied to others.[21] (V)
   1. Delegation within the nursing profession may occur from:
      a. APRNs to RNs, licensed practical/vocational nurse (LPN/LVNs), and UAP.
      b. RNs to LPN/LVNs and UAP.
      c. LPN/LVN to UAP, as permitted by applicable regulations.[21] (V)
   2. When employed by a physician, specific tasks may only be delegated to medical assistants (MAs) by the physician; however, MAs may be employed in other venues of care. Physicians may also delegate some medical tasks to nurse practitioners (NPs).[22,23] (IV)

3. Develop policies and procedures for which infusion and vascular access activities can and cannot be delegated, in collaboration with the designated organizational leader on delegation activities.[21,24] (V)
4. An activity requiring clinical reasoning, nursing judgment, and critical decision-making cannot be delegated.[21] (V)
5. Delegatees must accept only those delegated responsibilities for which they have documented competency (refer to Standard 5, *Competency and Competency Assessment*).
6. Every member of the health care team has responsibility for patient well-being. While the licensed nurse is accountable for the total care of the patient, the delegatee is responsible for the delegated activity, skill, or procedure.[24] (V)

F. Nursing Personnel
1. Employ the nursing process in a holistic, patient-centered approach to safely deliver infusion therapy and perform vascular access insertion and management.[25] (V)
2. Perform independent nursing interventions related to infusion therapy and vascular access using appropriate clinical reasoning, nursing judgment, and critical decision-making skills.[25] (V)
3. While establishing parameters and boundaries, the scope of nursing practice should be sufficiently broad and flexible, and focus on a combination of knowledge, judgment, and skills of direct patient care, patient advocacy, supervision, and delegation to others, as well as leadership, management, research, and health care policy development.[1,2,8] (IV)
4. Identify barriers that prevent practice to the full nursing potential, also known as practice at the top of licensure, and advocate for removing these barriers to allow practice at the full extent of one's education and competency. Barriers include administrative practices such as lack of permission to perform a specific practice and/or the absence of organizational policies, failing to include the nurse in open communications among all members of the health care team, the burden of managing non-nursing tasks in the absence of adequate staff, and workplace chaos from task switching and multitasking that can lead to errors.[1,16,26,27] (IV)
5. The scope of practice for each type of nursing personnel will overlap with some activities, but these roles are not interchangeable. Better patient outcomes are achieved when the RN is accountable for assessment, care planning, evaluation of care, and the supervisory role of the LPN/LVN and UAP.[16,28] (IV)
6. RN
   a. Participate in an organized education program, competency assessment, and documentation process for all infusion therapy and vascular access activities, skills, and procedures required in one's practice setting. The lack and/or inconsistency of infusion therapy in basic nursing curricula could lead to serious complications (refer to Standard 5, *Competency and Competency Assessment*).
   b. Do not accept assignments and/or delegated activities without adequate preparation to perform the assignment or delegation.[21,24] (V)
   c. Develop delegation skills based on rules and regulations articulated by the applicable regulatory agency or board.[21,24] (V)
7. LPN/LVN and Enrolled Nurse (EN)
   a. Complete an organized educational program, including supervised clinical practice on infusion therapy.
      i. In the United States, some state boards of nursing require completion of a postgraduate infusion therapy course with a defined curriculum.[24] (V)
      ii. In states or other jurisdictions without such requirements, completion of an educational program is recommended prior to performing infusion therapy procedures or interventions (refer to Standard 5, *Competency and Competency Assessment*).
      iii. Practice for LPN/LVN in the United States varies greatly between states but may include a broad range of infusion/vascular access-related tasks (eg, venipuncture, management of CVADs); monitoring of IV flow rates, transfusions, and pain control devices; and administration of some IV medications.[29,30] (V)
   b. Realize that the legislated scope of practice for LPNs/LVNs/ENs may include expansion of educational requirements, which may expand the scope of practice. Allow LPNs/LVNs/ENs to work at the top of their license by focusing on knowledge and responsibilities rather than tasks. There is a lack of clarity around the scope of practice for ENs, leading to role confusion and overlap with RNs.[31-33] (IV)
   c. Adhere to the rules and regulations from the appropriate regulatory organization, including the authority to delegate tasks or procedures to UAP.[21] (V)
8. Infusion Nurse Specialist (Certified Registered Nurse Infusion [CRNI®])
   a. Enhance professional growth and empowerment through specialization in infusion nursing, designated by earning board certification as an infusion nurse specialist (ie, CRNI®).[25,34,35] (V)
   b. Participate in quality improvement (QI) activities and clinical research in infusion therapy (refer to Standard 6, *Quality Improvement;* Standard 7, *Evidence-Based Practice and Research*).

c. Serve as the educator, leader, manager, consultant, and primary resource to guide policy and procedure development of infusion therapy and vascular access derived from best evidence.[36,37] (V)

9. APRN
   a. Ensure that all clinicians understand the rules and regulations governing the scope of APRN practice to make certain that all prescriptions for infusion therapy and vascular access are issued appropriately.
      i. In the United States, scope of practice differs by state, ranging from independent to restricted with and without prescription authority.[38] (V)
      ii. Advocate for the highest level of autonomy in practice decisions. Organizational bylaws (eg, hospital admitting privileges) and payer policies (eg, billing under physician's billing number) impact APRN practice.[38-42] (IV)
      iii. US hospitals credential NPs and grant privileges to practice according to the policies of the organization, which may differ from their legal scope of practice.[43,44] (IV)
      iv. The scope of practice for NPs in Australia includes both autonomy and requirements for collaboration with physicians. Regulatory and reimbursement restrictions on those working in the public sector restrict health care to rural communities.[45] (IV)
   b. Obtain and document competency to perform all VAD and IO insertions, including surgical procedures for insertion and removal (refer to Standard 5, *Competency and Competency Assessment*).
   c. Provide leadership in education, conducting research, and application of EBP according to the needs of the employing organization and/or patient populations served.[46] (V)

G. UAP
   1. UAP, also known as clinical nonlicensed personnel (CNLP), includes nursing assistants and MAs with many different job titles working under the supervision of a licensed health care professional.[47] (IV)
   2. Know the educational requirements for nursing UAP, as there is great variation between jurisdictions. Education may include an associate degree (high-skill level), a certificate or postsecondary nondegree (middle-skill level), or a high school diploma with on-the-job training (low-skill level). There are no clear and consistent educational program structures, entrance requirements, length of time needed for education, or division between classroom and clinical practice.[5,6] (IV)
   3. Assess the applicable laws and regulations in the appropriate jurisdiction for statements regarding scope of function for UAP; however, UAP do not usually have a regulated scope of practice. Nursing assistants may be included in the laws governing nursing practice, whereas MAs are usually included in the laws governing medical practice.
      a. An unofficial scope of practice for certified nursing assistants (CNAs) is derived from the US Code of Federal Regulations (42 CFR § 483), which applies to care for residents of nursing facilities. Basic nursing care tasks are included, although some states have expanded this list, along with the length of initial and ongoing education. No tasks related to VAD insertion, care, or management, or to the administration of any IV solution or medications are included.[4,48] (V)
      b. MAs are most often employed in medical offices and other outpatient care settings and primarily perform administrative and clinical tasks; however, their role is expanding (eg, phlebotomy, medical scribes). Type of school, length of training, and curriculum are highly variable. Regulations vary greatly across jurisdictions, with very few identifying any form of scope of practice. Delegation of tasks from physicians and the need for direct supervision are regulated by US state medical boards with variations among states.[49-51] (IV)
      c. Managing equipment and supplies, gathering data, and assisting licensed clinicians with invasive procedures are infusion-related tasks that may be assigned to UAP.[11] (V)
         i. Tasks performed by nursing UAP primarily include hygiene, dressing, feeding, and mobility, although advanced tasks including venipuncture have been reported. Defining the specific role of nursing UAP is difficult due to the wide variety of tasks, work settings, patient populations, and levels of autonomy. Although UAP may not be performing infusion therapy-related activities, the care provided must involve knowing how to protect the VAD dressing and attached administration sets and infusion pumps while performing other patient care activities (eg, bathing, mobility).[5,52] (IV)
      d. Include UAP in handoff communications, as their absence in this process may impact the quality and safety of patient care.[53] (V)
      e. There is much variation among jurisdictions regarding what is allowed for UAP working with dialysis patients (ie, patient care technicians) who manage CVADs for hemodialysis and IV administration of medications, such as heparin and 0.9% sodium chloride.[30,54] (V)
   4. Delegate appropriate infusion-related tasks to the UAP according to existing rules or regulations from

TABLE 1

Other Clinical Disciplines Involved With Infusion Therapy and Vascular Access

Discipline	General scope of practice	Role/responsibilities for infusion therapy/vascular access
Physician	• Licensed in the general practice of medicine without regard for specialty practice (undifferentiated license). • Exclusive rights to practice medicine; has a significant influence over the practice of other health care professionals. • State medical boards may have purview over others performing infusion therapy and vascular access including PAs, anesthesiologist assistants, respiratory therapists. • Great variation in defining scope of practice; allows for flexibility but can also cause tension with other professions. • Required to provide services within their skill and training. • Must be credentialed by the organization and receive privileges to perform a specific set of services as directed by the medical bylaws of each health care organization.[20,44,55,56] (V)	• Establishes the medical plan of care by prescribing solutions and medications. • May insert and access all types of VADs, IO devices, and intraspinal catheters. • Interprets radiology studies (eg, reading a chest radiograph) and documents final tip location for CVADs.
Physician assistant	• Licensed by the appropriate regulatory board (eg, state medical board). • Must be credentialed by the organization and receive privileges according to the policies of the organization, which may differ from their legal scope. • Practices through delegation from supervising physician and in compliance with the bylaws of each organization. • Extensive differences among states about qualifications, scope of practice, prescriptive authority, and supervision requirements.[41,44,57,58] (IV)	• May have prescriptive authority for IV solutions and medications. • May insert and access all types of VADs and IO devices.
Registered radiology assistant	• Certified and registered as an advanced level radiographer in accordance with the rules and/or laws in each jurisdiction. • Perform patient assessment, management, and selected examinations under the supervision of the radiologist.[59,60] (V)	• May insert and access all types of VADs in addition to role of medical imaging technologist below.
Medical imaging and radiation technologist	• Licensed and/or certified from a national credentialing board (eg, ARRT) as required in the jurisdiction. a. Unlicensed and/or uncertified individuals and those holding only an institutional license working in the radiology department should not have the responsibility for venipuncture or administration of any IV medication. • Adheres to recommendations, position statements, standards of practice, and other guidance documents from ASRT, ACR, and other appropriate regulatory agencies. • Uses the *ASRT Practice Standards* and *Decision Tree for Determining Scope of Practice* for specialty radiology practices involving infusion therapy and vascular access including, but not limited to, cardiovascular and interventional, computed tomography, magnetic resonance, and nuclear medicine.[3,61,62] (V)	• Perform procedures and other aspects of radiologic care as established by ASRT and other radiology organizations including: a. Basic venipuncture and peripheral catheter insertion b. Other interventional procedures as prescribed by radiologist (eg, PICC insertion) c. Accessing existing peripheral and central VADs d. Administering diagnostic contrast agents and/or IV medications when a licensed practitioner is immediately available to ensure proper diagnosis and treatment of adverse events. • Uses all flow-control devices in radiology including, but not limited to, power injectors. Ensures all attached devices are labeled for use with power injections (eg, VAD, extension set).

(*continues*)

TABLE 1

Other Clinical Disciplines Involved With Infusion Therapy and Vascular Access (Continued)

Discipline	General scope of practice	Role/responsibilities for infusion therapy/vascular access
Respiratory care practitioner	• Licensed and/or certified from national certifying board (ie, National Board for Respiratory Care). Two levels of certification are available: Certified Respiratory Therapist and Registered Respiratory Therapist. • Due to their knowledge of cardiorespiratory anatomy and physiology, the American Association for Respiratory Care holds the position that vascular catheters may be inserted by a respiratory therapist with appropriate education.[63-66] (V)	• PICC and other CVAD insertion as designated by the state regulatory board. • Arterial catheter insertion and obtaining arterial blood samples.
EMS personnel	• Know the applicable laws and regulatory agencies governing practice in one's state/province, as this varies greatly. a. In the United States, the National Highway Traffic Safety Administration issues a consensus-based practice model to enhance consistency among states. b. Canada employs a similar system, with the Paramedic Chiefs of Canada posing recommendations, with regulation coming from the provincial level. • Holds a license from the regulatory agency in the state/province, and/or certification from the national certifying board, and be authorized by a local emergency services medical director to perform the skills or role. • Provides paramedical services in a variety of settings (eg, home or work settings) prior to transporting to a facility for medical services. Interdisciplinary teamwork with nurses coordinating patient care is necessary.[67-70] (V)	• Two levels of EMS personnel are permitted to perform infusion therapy. • Advanced Emergency Medical Technicians may: a. Insert short PIVCs and IO devices in adults and children b. Infuse IV and IO solutions without added medication(s) c. Administer certain medications by the IV route. • Paramedics may: a. Insert short PIVCs and IO devices b. Access indwelling CVADs c. Administer IV solutions with and without added medications d. Administer IV medications e. Monitor infusions of blood and blood products.
Registered pharmacist	• Licensed by the appropriate regulatory board (eg, state board of pharmacy). • Primary resource in the use of medications for treatment, management, and prevention of disease. • Manages medication use systems. • May have independent provider status or prescriptive authority through collaborative practice agreements and state-based protocols after the credentialing process is complete. Many variations exist between state boards of pharmacy.[71-73] (V)	• Postdiagnosis prescription of new medications or modifying existing medications. • Prescribe laboratory tests, interpret laboratory values, and adapt medication dosage based on the values. • Administer medications.

Abbreviations: ACR, American College of Radiology; ARRT, American Registry of Radiologic Technologists; ASRT, American Society of Radiologic Technologists; CVAD, central vascular access device; EMS, emergency medical services; IO, intraosseous; IV, intravenous; PA, physician assistant; PICC, peripherally inserted central catheter; PIVC, peripheral intravenous catheter; VAD, vascular access device.

the appropriate regulatory board or council after competency has been documented. Supervise task performance according to organizational policy and procedure.

   a. Identify the professional who is allowed to delegate infusion-related tasks. Some US states may allow the physician to delegate insertion of a short PIVC to an MA in the physician's office, but delegation by the licensed nurse may not be appropriate.[22] (V)
   b. Clarify which professional holds the accountability for the outcomes produced by the UAP activities.[21,24] (V)

H. Other Clinical Disciplines Involved With Infusion Therapy and Vascular Access
   1. Table 1 is based on local and regional (eg, state/province) rules, regulations, and laws.
   2. Unless otherwise noted, the content is about scope of practice in the United States, as the comparable information for other countries was not readily found.
   3. The Infusion Nurses Society (INS) recognizes that there is great variation among countries in titles, licensure requirements, and scope of practice relative to infusion therapy and vascular access.

REFERENCES

Note: All electronic references in this section were accessed between June 4, 2020, and August 10, 2020.

1. Feringa MM, De Swardt HC, Havenga Y. Registered nurses' knowledge, attitude, practice and regulation regarding their scope of practice: a literature review. *Int J Africa Nurs Sci*. 2018;8:87-97. https://doi.org/10.1016/j.ijans.2018.04.001
2. International Council of Nurses. Scope of nursing practice [position statement]. International Council of Nurses; Updated 2013. https://www.icn.ch/sites/default/files/inline-files/B07_Scope_Nsg_Practice.pdf
3. American Society of Radiologic Technologists. ASRT professional practice resources and decision tree for determining scope of practice. American Society of Radiologic Technologists; Revised January 30, 2018. https://www.asrt.org/docs/default-source/practice-standards/asrt-practice-resources.pdf?sfvrsn=720059d0_12
4. McMullen TL, Resnick B, Hansen JC, Miller N, Rubinstein R. Certified nurse aides and scope of practice: clinical outcomes and patient safety. *J Gerontol Nurs.* 2015;41(12):32-39. doi:10.3928/00989134-20151008-58
5. Hewko SJ, Cooper SL, Huynh H, et al. Invisible no more: a scoping review of the health care aide workforce literature. *BMC Nurs.* 2015;14(1):38. doi:10.1186/s12912-015-0090-x
6. Laxer K, Jacobsen FF, Lloyd L, et al. Comparing nursing home assistive personnel in five countries. *Ageing Int.* 2016;41(1):62-78. doi:10.1007/s12126-015-9226-2
7. Morrison A. Scope of nursing practice and decision-making framework toolkit: ICN regulation series. International Council of Nurses; 2010. https://www.icn.ch/sites/default/files/inline-files/2010_ICN%20Scope%20of%20Nursing%20and%20Decision%20making%20Toolkit_eng.pdf
8. Birks M, Davis J, Smithson J, Cant R. Registered nurse scope of practice in Australia: an integrative review of the literature. *Contemp Nurse.* 2016;52(5):522-543. doi:10.1080/10376178.2016.1238773
9. Russell KA. Nurse practice acts guide and govern: update 2017. *J Nurs Regulation.* 2017;8(3):18-25. https://doi.org/10.1016/S2155-8256(17)30156-4
10. Plohal A, Dumont C, Perry C, et al. The role of the registered nurse in the insertion of nontunneled central vascular access devices [position statement]. *J Infus Nurs.* 2017;40(6):339-345. doi:10.1097/NAN.0000000000000255
11. Vizcarra C. The role of unlicensed assistive personnel in the provision of infusion therapy [position statement]. *J Infus Nurs.* 2016;39(4):196-200. doi:10.1097/NAN.0000000000000172
12. Wilson DM, Murphy J, Nam MA, Fahy A, Tella S. Nurse and midwifery prescribing in Ireland: a scope-of-practice development for worldwide consideration. *Nurs Health Sci.* 2018;20(2):264-270. doi:10.1111/nhs.12408
13. Kooienga S, Wilkinson J. RN prescribing: an expanded role for nursing. *Nurs Forum.* 2017;52(1):3-11. doi:10.1111/nuf.12159
14. Kennedy C, O'Reilly P, Fealy G, et al. Comparative analysis of nursing and midwifery regulatory and professional bodies' scope of practice and associated decision-making frameworks: a discussion paper. *J Adv Nurs.* 2015;71(8):1797-1811. doi:10.1111/jan.12660
15. Ballard K, Haagenson D, Christiansen L, et al. Scope of nursing practice decision-making framework. *J Nurs Regulation*. 2016;7(3):19-21. https://doi.org/10.1016/S2155-8256(16)32316-X
16. Aroke EN. Full nursing potential: a concept clarification. *Nurs Forum*. 2014;49(4):278-287. doi:10.1111/nuf.12096
17. Kusi-Appiah E, Dahlke S, Stahlke S. Nursing care providers' perceptions on their role contributions in patient care: an integrative review. *J Clin Nurs*. 2018;27(21-22):3830-3845. doi:10.1111/jocn.14534
18. Jalloh F, Tadlock MD, Cantwell S, Rausch T, Aksoy H, Frankel H. Credentialing and privileging of acute care nurse practitioners to do invasive procedures: a statewide survey. *Am J Crit Care*. 2016;25(4):357-361. doi:10.4037/ajcc2016118
19. Pradarelli JC, Campbell DA, Dimick JB. Hospital credentialing and privileging of surgeons: a potential safety blind spot. *JAMA.* 2015;313(13):1313-1314. doi:10.1001/jama.2015.1943
20. Patel R, Sharma S. Credentialing. In: *StatPearls* [Internet]. StatPearls Publishing; 2020. Updated Sep 11, 2019. https://www.ncbi.nlm.nih.gov/books/NBK519504/?report=classic
21. National Council of State Boards of Nursing (NCSBN), American Nurses Association. National guidelines for nursing delegation [joint statement on delegation]. NCSBN, American Nurses Association; April 29, 2019. https://www.ncsbn.org/NGND-PosPaper_06.pdf
22. Maningo MJ, Panthofer N. Appropriate delegation in ambulatory care nursing practice. *AAACN Viewpoint*. 2018;40(1):14-15. https://www.aaacn.org/sites/default/files/members/viewpoint/janfeb18.pdf
23. Niezen MG, Mathijssen JJ. Reframing professional boundaries in healthcare: a systematic review of facilitators and barriers to task reallocation from the domain of medicine to the nursing domain. *Health Policy*. 2014;117(2):151-169. doi:10.1016/j.healthpol.2014.04.016
24. National Council of State Boards of Nursing. National guidelines for nursing delegation. *J Nurs Regulation*. 2016;7(1):5-14. https://doi.org/10.1016/S2155-8256(16)31035-3
25. Fowler MDM. *Guide to the Code of Ethics for Nurses With Interpretive Statements: Development, Interpretation, and Application.* 2nd ed. American Nurses Association; 2015.
26. Ganz FD, Toren O, Fadlon Y. Factors associated with full implementation of scope of practice. *J Nurs Scholarsh*. 2016;48(3):285-293. doi:10.1111/jnu.12203
27. Buck J, Loversidge J, Chipps E, Gallagher-Ford L, Genter L, Yen PY. Top-of-license nursing practice: describing common nursing activities and nurses' experiences that hinder top-of-license practice, part 1. *J Nurs Adm*. 2018;48(5):266-271. doi:10.1097/NNA.0000000000000611
28. Mueller C, Duan Y, Vogelsmeier A, Anderson R, McConnell E, Corazzini K. Interchangeability of licensed nurses in nursing homes: perspectives of directors of nursing. *Nurs Outlook*. 2018;66(6):560-569. doi:10.1016/j.outlook.2018.09.004

29. National Council of State Boards of Nursing (NCSBN). 2018 LPN/VN practice analysis: linking the NCLEX-PN® examination to practice. *NCSBN Research Brief.* Vol 75. NCSBN; 2019. https://www.ncsbn.org/LPN_Practice_Analysis_FINAL.pdf
30. O'Keefe C. The authority for certain clinical tasks performed by unlicensed patient care technicians and LPNs/LVNs in the hemodialysis setting: a review. *Nephrol Nurs J*. 2014;41(3):247-254.
31. McKenna L, Wood P, Williams A, et al. Scope of practice and workforce issues confronting Australian enrolled nurses: a qualitative analysis. *Collegian*. 2019;26(1):80-85. https://doi.org/10.1016/j.colegn.2018.04.001
32. MacLeod ML, Stewart NJ, Kosteniuk JG, et al. Rural and remote licensed practical nurses' perceptions of working below their legislated scope of practice. *Nurs Leadersh (Tor Ont).* 2019;32(1):8-19. doi:10.12927/cjnl.2019.25852
33. Leon RJ, Tredoux JH, Foster SM. Valuing enrolled nurses – a study to better understand the investment education and training have on the retention of enrolled nurses. *Collegian.* 2019;26(1):158-164. https://doi.org/10.1016/j.colegn.2018.07.001
34. McLaughlin A, Fetzer SJ. The perceived value of certification by Magnet® and non-Magnet nurses. *J Nurs Adm*. 2015;45(4):194-199. doi:10.1097/NNA.0000000000000184
35. Chopra V, Kuhn L, Vaughn V, et al. CE: original research: does certification in vascular access matter? an analysis of the PICC1 survey. *Am J Nurs*. 2017;117(12):24-34. doi:10.1097/01.NAJ.0000527458.85599.3a
36. Meyer BM. Broadening infusion specialization as an adjunct to organizational sustainability. *J Infus Nurs*. 2014;37(1):44-54. doi:10.1097/NAN.0000000000000015
37. Corrigan A. Infusion nursing as a specialty. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. Saunders/Elsevier; 2010:1-9.
38. Park J, Athey E, Pericak A, Pulcini J, Greene J. To what extent are state scope of practice laws related to nurse practitioners' day-to-day practice autonomy? *Med Care Res Rev*. 2018;75(1):66-87. doi:10.1177/1077558716677826
39. Xue Y, Ye Z, Brewer C, Spetz J. Impact of state nurse practitioner scope-of-practice regulation on health care delivery: systematic review. *Nurs Outlook.* 2016;64(1):71-85. doi:10.1016/j.outlook.2015.08.005
40. Reed PG. Philosophical clarity and justifying the scope of advanced practice nursing. *Nurs Sci Q.* 2017;30(1):73-76. doi:10.1177/0894318416680709
41. Lofgren MA, Berends SK, Reyes J, et al. Scope of practice barriers for advanced practice registered nurses: a state task force to minimize barriers. *J Nurs Adm*. 2017;47(9):465-469. doi:10.1097/NNA.0000000000000515
42. Smith-Gagen J, White LL, Santos A, Hasty SM, Tung WC, Lu M. Scope-of-practice laws and expanded health services: the case of underserved women and advanced cervical cancer diagnoses. *J Epidemiol Community Health*. 2019;73(3):278-284. doi:10.1136/jech-2018-210709
43. Hoffman LA, Guttendorf J. Preparation and evolving role of the acute care nurse practitioner. *Chest*. 2017;152(6):1339-1345. doi:10.1016/j.chest.2017.08.007
44. Pittman P, Leach B, Everett C, Han X, McElroy D. NP and PA privileging in acute care settings: do scope of practice laws matter? *Med Care Res Rev.* 2020;77(2):112-120. doi:10.1177/1077558718760333
45. Smith T, McNeil K, Mitchell R, Boyle B, Ries N. A study of macro-, meso- and micro-barriers and enablers affecting extended scopes of practice: the case of rural nurse practitioners in Australia. *BMC Nurs*. 2019;18:14. doi:10.1186/s12912-019-0337-z
46. Ullman AJ, Kleidon T, Rickard CM. The role of the vascular access nurse practitioner in developing evidence, promoting evidence-based vascular access practice and improving health services. *Vascular Access*. 2015;1(1):10-20.
47. Pittman P, Li S, Han X, Lowe T. Clinical nonlicensed personnel in U.S. hospitals: job trends from 2010 to 2015. *Nurs Outlook*. 2018;66(1):35-45. doi:10.1016/j.outlook.2017.06.014
48. Trinkoff AM, Storr CL, Lerner NB, Yang BK, Han K. CNA training requirements and resident care outcomes in nursing homes. *Gerontologist.* 2017;57(3):501-508. doi:10.1093/geront/gnw049
49. McCarty MN. The lawful scope of practice of medical assistants–2012 update. *AMT Events*. American Medical Technologists; 2012:110-119.
50. Chapman SA, Marks A, Dower C. Positioning medical assistants for a greater role in the era of health reform. *Acad Med*. 2015;90(10):1347-1352. doi:10.1097/ACM.0000000000000775
51. Chapman SA, Blash LK. New roles for medical assistants in innovative primary care practices. *Health Serv Res*. 2017;52((Suppl 1):383-406. doi:10.1111/1475-6773.12602
52. Roche MA, Duffield C, Friedman S, Dimitrelis S, Rowbotham S. Regulated and unregulated nurses in the acute hospital setting: tasks performed, delayed or not completed. *J Clin Nurs*. 2016;25(1-2):153-162. doi:10.1111/jocn.13118
53. Glynn DM, Saint-Aine R, Gosselin MA, Quan S, Chute J. The role of unlicensed assistive personnel in patient handoff. *Nursing*. 2017;47(3):57-60. doi:10.1097/01.NURSE.0000512885.29505.73
54. Bennett PN, Dewald G. Patient care technicians managing hemodialysis central venous catheter care: pro and con. *Nephrol Nurs J.* 2017;44(5):449-454.
55. Federation of State Medical Boards. U.S. medical regulatory trends and actions 2018. Federation of State Medical Boards; 2018. https://www.fsmb.org/siteassets/advocacy/publications/us-medical-regulatory-trends-actions.pdf
56. Harper G. Trust me I'm a doctor: the struggle over scope of practice and its effect on health care fraud and abuse. *DePaul J Health Care L.* 2013;15:237. https://via.library.depaul.edu/jhcl/vol15/iss2/6
57. Wiler JL, Ginde AA. State laws governing physician assistant practice in the United States and the impact on emergency medicine. *J Emerg Med.* 2015;48(2):e49-e58. doi:10.1016/j.jemermed.2014.09.033
58. Orrantia E, Amand SS. Establishing and growing the scope of practice of physician assistants. *Can Fam Physician.* 2017;63(5):373-374.
59. American College of Radiology; Society of Interventional Radiology; Society of Neurointerventional Surgery; Society of Pediatric Radiology. Practice parameter for interventional clinical practice and management. *J Vasc Interv Radiol.* 2015;26(8):1197-1204. doi:10.1016/j.jvir.2015.05.017
60. Shay W, Silva D, Mohabir H, Erinjeri J. The effect of radiologist assistants in an interventional radiology department. *Radiol Technol.* 2017;88(3):333-338.
61. American Society of Radiologic Technologists. The ASRT practice standards for medical imaging and radiation therapy. American Society of Radiologic Technologists; 2019. https://www.asrt.org/main/standards-and-regulations/professional-practice/practice-standards-online
62. American Society of Radiologic Technologists. ASRT position statements. American Society of Radiologic Technologists; 2019. https://www.asrt.org/docs/default-source/governance/hodpositionstatements.pdf?sfvrsn=ec78dd1_41
63. Barnes TA, Kacmarek RM, Kageler WV, Morris MJ, Durbin CG Jr. Transitioning the respiratory therapy workforce for 2015 and beyond. *Respir Care.* 2011;56(5):681-690. doi:10.4187/respcare.01169
64. Barnes TA, Gale DD, Kacmarek RM, Kageler WV. Competencies needed by graduate respiratory therapists in 2015 and beyond. *Respir Care.* 2010;55(5):601-616.
65. American Association for Respiratory Care. Insertion and maintenance of vascular catheters by respiratory therapists [position statement]. American Association of Respiratory Care; 2015. http://www.aarc.org/wp-content/uploads/2017/03/statement-of-insertion-and-maintenance-of-vascular-catheters.pdf

66. American Association for Respiratory Care. Respiratory care scope of practice [position statement]. American Association for Respiratory Care; 2018. https://www.aarc.org/wp-content/uploads/2017/03/statement-of-scope-of-practice.pdf
67. Bowles RR, van Beek C, Anderson GS. Four dimensions of paramedic practice in Canada: defining and describing the profession. *Australas J Paramedicine*. 2017;14(3). http://dx.doi.org/10.33151/ajp.14.3.539
68. National Association of State EMS Officials. National EMS scope of practice model 2019. Report No. DOT HS 812-666. National Highway Traffic Safety Administration; 2019. https://www.ems.gov/pdf/National_EMS_Scope_of_Practice_Model_2019.pdf
69. Brydges M, Denton M, Agarwal G. The CHAP-EMS health promotion program: a qualitative study on participants' views of the role of paramedics. *BMC Health Serv Res*. 2016;16(1):435-435. doi:10.1186/s12913-016-1687-9
70. American Nurses Association. ANA's essentials principles for utilization of community paramedics. American Nurses Association; 2014. https://www.nursingworld.org/~4af4f2/globalassets/docs/ana/ethics/ana-essentialprinciples-utilization-of-communityparamedics.pdf
71. Jordan TA, Hennenfent JA, Lewin JJ 3rd, Nesbit TW, Weber R. Elevating pharmacists' scope of practice through a health-system clinical privileging process. *Am J Health Syst Pharm*. 2016;73(18):1395-1405. doi:10.2146/ajhp150820
72. Burns AL. Emerging developments in pharmacists' scope of practice to address unmet health care needs. *Ann Pharmacother.* 2016;50(9):785-787. doi:10.1177/1060028016655351
73. Adams A, Weaver K. Pharmacists' patient care process: a state "scope of practice" perspective. *Innov Pharm*. 2019;10(2):1-8. https://doi.org/10.24926/iip.v10i2.13894.

4. ORGANIZATION OF INFUSION AND VASCULAR ACCESS SERVICES

Standard

4.1 Infusion therapy requires interprofessional collaboration among all clinicians that prescribe, dispense, and administer a wide variety of solutions, medications, nutrition, and blood components, in addition to management and purchasing personnel.

4.2 The scope of services provided by the infusion team/vascular access team (VAT) is structured to meet patient and organizational needs for safe delivery/administration of quality infusion therapy.

4.3 Infusion and vascular access services provided in the community follow regulations applicable in each country.

Practice Recommendations

A. General
   1. Identify the deficits, challenges, clinical outcomes, and costs with delivery of infusion/vascular access within the organization.
      a. Trends show that some acute care hospitals have assigned tasks of assessment, peripheral and central VAD insertion, medication monitoring, dressing changes, and VAD removal to occupational groups with more formal education and training (ie, providers and infusion team/VATs) when compared to nonhospital organizations. However, many hospitals and nonhospital organizations have reassigned infusion-related tasks to individual RNs. As health care organizations have disbanded teams and terminated staff with infusion-related expertise and tacit knowledge, individual nurses are required to develop their own infusion/vascular access knowledge and skills without adequate employer support.[1] (V)
      b. The failure mode and effects analysis (FMEA) is commonly applied to evaluate current patient care delivery and workflow processes toward the goal of risk reduction.[2,3] (V)
      c. Lean Thinking and Six Sigma are process improvement methods used to identify inefficiencies, variables, process defects, and waste.[4,5] (IV)
   2. Assign the most knowledgeable clinicians to employ a proactive approach for assessing patient needs and selecting the most appropriate VAD, using skillful insertion techniques, managing infusion methods and vascular access care, and evaluating clinical outcomes.[6-8] (IV)
   3. Choose the name for this designated team of clinicians that reflects the services provided while allowing for expansion of the scope of service. A wide variety of names are used synonymously including, but not limited to, IV team, infusion team, VAT, and vascular resource team.[9-12] (IV)
   4. Identify the most appropriate clinician to organize and lead the team. Because of the amount of time spent with patients in all venues of care, knowledge of infusion therapies and technology, and patient education activities, nurses specializing in this practice are best suited to fill this role. Other clinicians in leadership positions include physicians, respiratory therapists, and radiographic technologists. Pharmacist involvement is also needed. Teams led by physicians and technologists are limited to VAD insertion only without reporting who is responsible for the remaining aspects of infusion therapy and VAD management. In the United Kingdom, the recommendation for hospitals is to have a lead clinician who is responsible for clinical governance, staff development, and QI activities related to IV solution infusions.[6,13-17] (IV)
   5. Master the processes required for financial management of the infusion team/VAT or service within the health care system in each jurisdiction.
      a. Know the budgetary process for the infusion team/VAT, the operational costs, and the sources of operational revenue.
      b. Establish the infusion team/VAT as a revenue and cost center in acute care hospitals, allowing the team to track and analyze services provided and document financial contributions to the organization, showing revenue to offset costs.[18] (V)

6. Initiate and/or participate in interprofessional safety programs to reduce the number, risk, and costs of adverse events related to infusion/vascular access including:
    a. Involvement with antibiotic stewardship programs.[19,20] (V)
    b. Analysis of IV-associated medication errors.[21] (V)
    c. Systemic adverse drug reactions (eg, red man's syndrome) and VAD-associated complications (eg, infiltration, extravasation).[21-23] (IV)
    d. Collaboration with acute pain teams to reduce lapses in analgesia.[22,24] (V)
    e. Collaboration with multiple disciplines and departments to reduce errors related to dose error reduction systems (DERS) in electronic infusion pumps (see Standard 24, *Flow-Control Devices*).[25,26] (IV)
    f. Coordination of product evaluation, QI, staff development, and standardized EBPs, within and between health care organizations (see Standard 6, *Quality Improvement*).[25-27] (V)
7. Encourage and support members of the team to obtain and maintain an internationally recognized board certification (see Standard 3, *Scope of Practice*).[28] (V)

B. Acute Care
1. Organize a team of clinicians dedicated exclusively to infusion and vascular access practices to provide the optimum method for infusion delivery in acute care facilities.
    a. PIVC insertion in adults by infusion/vascular access specialists produced greater first-attempt insertion success and lower rates of complications. In pediatric patients, the number of clinicians required for PIVC insertion was reduced, leading to a better use of resources and personnel.[5,10,29-31] (III)
        i. One study noted that the majority of catheters reached end of therapy with a single catheter, and costs savings were projected to be more than $2.9 million USD annually.[5] (IV)
        ii. First-attempt insertion success is correlated with greater experience and confidence in skills, without a difference in the professional discipline of the inserter, leading investigators to advocate for a team of specialists for PIVC insertion.[32] (IV)
        iii. A narrative literature review reported positive outcomes of 10 studies on short PIVC insertion by specialists; however, the methodological quality of these studies was assessed to be generally poor. Randomized controlled trials (RCTs) are needed.[33] (IV)
    b. Teams reduce the health care-acquired complications associated with CVADs, including pneumothorax, arterial puncture, and catheter-associated infections.[12,34-38] (IV)
    c. Teams reduce the need to escalate from use of peripheral VADs to more invasive CVADs; reduce costs associated with labor, devices, other supplies and equipment; and improve patient satisfaction.[10,32] (III)
2. Assess the needs of the organization to determine the appropriate hours of service to meet patient needs. Comprehensive infusion and vascular access services on a 24-hour basis, 7 days/week, insert PIVCs, PICCs, and other CVADs; assess each patient daily for VAD necessity; and manage all VAD dressing changes. Comprehensive teams administer specific types of medications (eg, antineoplastics) to inpatients and outpatients and provide support services to specialty departments (eg, emergency, critical care) on an as-needed basis. Combining small specialty groups (ie, neonatal PICC team) with the hospital VAT into a centralized service may improve patient outcomes.[9,15,37,39] (IV)
3. Promote the consultative role of the team rather than viewing team members as operators or task performers. This approach resulted in decreasing inappropriate PICC use, especially multilumen PICCs, while increasing appropriate use of midline catheters, and facilitates shared decision-making about appropriate timing of CVAD removal. Infusion/vascular access specialists functioning as valued consultants have a better relationship with physicians and other nursing staff.[8,40-42] (IV)
4. Consider expanding the services of the infusion team/VAT to include placement of all types of CVADs, use of appropriate technologies, and insertion of arterial catheters as needed in each facility. Collaborate with members of other disciplines as needed to accomplish the required steps for this expansion.[43] (V)
5. Meet urgent and emergent venipuncture needs in the emergency department (ED) with use of a team dedicated to inserting all short PIVCs and phlebotomy for blood sampling, known as a DIVA team or ED vascular access specialist team. First-attempt insertion success is associated with skill and experience of the clinician performing the procedure. Failure to successfully perform venipuncture causes significant delays in diagnostic and therapeutic infusions, thus threatening patient safety. These teams are staffed by trained technicians or nurses and employ additional skills to use near infrared light or ultrasound as needed for venipuncture.[31,44-46] (IV)

C. Alternative Sites
1. Recognize the country-based variations in the types of infusion therapies, organizational structure, and regulatory requirements for delivery in the home, outpatient, or skilled nursing facility.
    a. Adhere to the minimum threshold for operational and clinical aspects of patient safety for

in-office infusion as identified by the National Infusion Center Association (NICA).[47] (V)

2. Establish methods to communicate between acute care and community care organizations. Provide details of the specific type and management of VADs and the type and methods of delivery for the infusion therapy required to enhance care by alternative care organizations. While many advanced medical technologies are used in alternative care settings, more research is needed on user experience, training, and human factors involving their use. Standardizing practices across all organizations and sharing outcome data result in decreased community-acquired catheter-associated bloodstream infection (CABSI).[48-50] (IV)
3. Establish clear methods of communication among all disciplines (eg, nurses, pharmacists, physicians, laboratory staff) involved in patient care, as all services may be geographically separated.[51] (V)
4. As patient volumes increase at infusion clinics, appropriate use of infusion chairs, nursing staff, space planning, need for ancillary services (ie, laboratory), and other resources improves timeliness of infusion and decreases wait times. Scheduling based on duration and acuity of treatment improves operational efficiency and patient satisfaction.[52,53] (V)

See Appendix A. *Infusion Teams/Vascular Access Teams in Acute Care Facilities.*

REFERENCES

1. Pratt BR, Dunford BB, Alexander M, Morgeson FP, Vogus TJ. Trends in infusion administrative practices in US health care organizations: an exploratory analysis. *J Infus Nurs.* 2019;42(1):13-22. doi:10.1097/NAN.0000000000000308
2. Li G, Xu B, He RX, Zhang S. Using healthcare failure mode and effect analysis to reduce intravenous chemotherapy errors in Chinese hospitalized patients. *Cancer Nurs.* 2017;40(2):88-93. doi:10.1097/NCC.0000000000000348
3. Polancich S, Rue L, Poe T, Miltner R. Proactive risk mitigation: using failure modes and effects analysis for evaluating vascular access. *J Healthc Qual.* 2018;40(1):58-65. doi:10.1097/JHQ.0000000000000125
4. Steere L, Rousseau M, Durland L. Lean Six Sigma for intravenous therapy optimization: a hospital use of lean thinking to improve occlusion management. *J Assoc Vasc Access.* 2018;23(1):42-50. https://doi.org/10.1016/j.java.2018.01.002
5. Steere L, Ficara C, Davis M, Moureau N. Reaching one peripheral intravenous catheter (PIVC) per patient visit with lean multimodal strategy: the PIV5Rights™ bundle. *J Assoc Vasc Access.* 2019;24(3):31-43. https://doi.org/10.2309/j.java.2019.003.004
6. Fiorini J, Venturini G, Conti F, et al. Vessel health and preservation: an integrative review. *J Clin Nurs.* 2019;28(7-8):1039-1049. doi:10.1111/jocn.14707
7. Moureau NL, Carr PJ. Vessel health and preservation: a model and clinical pathway for using vascular access devices. *Br J Nurs.* 2018;27(8):S28-S35. doi:10.12968/bjon.2018.27.8.S28
8. DeVries M, Lee J, Hoffman L. Infection free midline catheter implementation at a community hospital (2 years). *Am J Infect Control.* 2019;47(9):1118-1121. doi:10.1016/j.ajic.2019.03.001
9. Crowell J, O'Neil K, Drager L. Project HANDS: a bundled approach to increase short peripheral catheter dwell time. *J Infus Nurs.* 2017;40(5):274-280. doi:10.1097/NAN.0000000000000237
10. Hartman JH, Bena JF, Morrison SL, Albert NM. Effect of adding a pediatric vascular access team component to a pediatric peripheral vascular access algorithm. *J Pediatr Health Care.* 2020;34(1):4-9. doi:10.1016/j.pedhc.2019.06.004
11. Harpel J. Best practices for vascular resource teams. *J Infus Nurs.* 2013;36(1):46-50. doi:10.1097/NAN.0b013e3182798862
12. Carr PJ, Higgins NS, Cooke ML, Mihala G, Rickard CM. Vascular access specialist teams for device insertion and prevention of failure. *Cochrane Database Syst Rev.* 2018;3(3):CD011429. doi:10.1002/14651858.CD011429.pub2
13. Youngmann TE, Barnes RE. Nursing-constructed central venous catheter program: a six-step guide to implementation. *J Radiol Nurs.* 2016;35(1):19-23.
14. Pernar LI, Wolf LL, Seshadri A, Patel V. Impact of a surgeon-led peripherally inserted central venous catheter team on peripherally inserted central venous catheter-related complications and costs. *Surg Infect (Larchmt).* 2016;17(3):352-356. doi:10.1089/sur.2015.093
15. Johnson D, Snyder T, Strader D, Zamora A. Positive influence of a dedicated vascular access team in an acute care hospital. *J Assoc Vasc Access.* 2017;22(1):35-37. https://doi.org/10.1016/j.java.2016.12.002
16. Chasseigne V, Larbi A, Goupil J, et al. PICC management led by technicians: establishment of a cooperation program with radiologists and evaluation of complications. *Diagn Interv Imaging.* 2020;101(1):7-14. doi:10.1016/j.diii.2019.06.010
17. Styslinger E, Nguyen H, Hess O, et al. Central line-associated bloodstream infections and completion of the central line insertion checklist: a descriptive analysis comparing a dedicated procedure team to other providers. *Am J Infect Control.* 2019;47(11):1400-1402. doi:10.1016/j.ajic.2019.05.030
18. Hadaway L, Wise M, Orr M, Bayless A, Dalton L, Guerin G. Making the business case for infusion teams: the purpose, people, and process. *J Infus Nurs.* 2014;37(5):321-346. doi:10.1097/NAN.0000000000000062
19. Carrico R, Wiemken T. Antimicrobial stewardship: the role of vascular access teams. *J Assoc Vasc Access.* 2016;21(2):83-86. https://doi.org/10.1016/j.java.2016.02.001
20 Nori P, Guo Y, Ostrowsky B. Creative collaborations in antimicrobial stewardship: using the Centers for Disease Control and Prevention's core elements as your guide. *Med Clin North Am.* 2018;102(5):845-854. doi:10.1016/j.mcna.2018.05.001
21. Wolf ZR. Medication errors involving the intravenous administration route: characteristics of voluntarily reported medication errors. *J Infus Nurs.* 2016;39(4):235-248. doi:10.1097/NAN.0000000000000178
22. Mohanty M, Lawal OD, Skeer M, Lanier R, Erpelding N, Katz N. Medication errors involving intravenous patient-controlled analgesia: results from the 2005–2015 MEDMARX database. *Ther Adv Drug Saf.* 2018;9(8):389-404. doi:10.1177/2042098618773013
23. Guérin A, Tourel J, Delage E, et al. Accidents and incidents related to intravenous drug administration: a pre–post study following implementation of smart pumps in a teaching hospital. *Drug Saf.* 2015;38(8):729-736. doi:10.1007/s40264-015-0308-6
24. Lee Y, Kim K, Kim M. CE: original research: errors in postoperative administration of intravenous patient-controlled analgesia: a retrospective study. *Am J Nurs.* 2019;119(4):22-27. doi:10.1097/01.NAJ.0000554523.94502.4c
25. Marwitz KK, Giuliano KK, Su WT, Degnan D, Zink RJ, DeLaurentis P. High-alert medication administration and intravenous smart pumps: a descriptive analysis of clinical practice. *Res Social Adm Pharm.* 2019;15(7):889-894. doi:10.1016/j.sapharm.2019.02.007
26. Giuliano KK, Su WT, Degnan DD, Fitzgerald K, Zink RJ, DeLaurentis P. Intravenous smart pump drug library compliance: a descriptive study of 44 hospitals. *J Patient Saf.* 2018;14(4):e76-e82. doi:10.1097/PTS.0000000000000383
27. Falder-Saeed K, McClain K, Patton L, Langford M, Marusich J, Flom L. Teaming up to take down community-acquired bloodstream infections: a program aimed at educating and training nurses in the community. *J Assoc Vasc Access.* 2016;21(4):217-222. https://doi.org/10.1016/j.java.2016.05.003

28. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines.* Pappin Communications; 2019.
29. Wallis MC, McGrail M, Webster J, et al. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from a randomized controlled trial. *Infect Control Hosp Epidemiol.* 2014;35(1):63-68. doi:10.1086/674398
30. Legemaat M, Carr PJ, van Rens RM, van Dijk M, Poslawsky IE, van den Hoogen A. Peripheral intravenous cannulation: complication rates in the neonatal population: a multicenter observational study. *J Vasc Access.* 2016;17(4):360-365. doi:10.5301/jva.5000558
31. Marsh N, Webster J, Larsen E, et al. Expert versus generalist inserters for peripheral intravenous catheter insertion: a pilot randomised controlled trial. *Trials.* 2018;19(1):1-10. doi:10.1186/s13063-018-2946-3
32. Carr PJ, Rippey JC, Cooke ML, et al. Factors associated with peripheral intravenous cannulation first-time insertion success in the emergency department. a multicentre prospective cohort analysis of patient, clinician and product characteristics. *BMJ Open.* 2019;9(4):e022278. doi:10.1136/bmjopen-2018-022278
33. Marsh N, Larsen E, Webster J, Cooke M, Rickard CM. The benefit of a vascular access specialist placing a peripheral intravenous catheter: a narrative review of the literature. *Vasc Access.* 2020;6(1):10-15.
34. Krein SL, Kuhn L, Ratz D, Chopra V. Use of designated nurse PICC teams and CLABSI prevention practices among US hospitals: a survey-based study. *J Patient Saf.* 2015;15(4):293-295. doi:10.1097/PTS.0000000000000246
35. Rupp ME, Majorant D. Prevention of vascular catheter-related bloodstream infections. *Infect Dis Clin North Am.* 2016;30(4):853-868. doi:10.1016/j.idc.2016.07.001
36. Savage TJ, Lynch AD, Oddera SE. Implementation of a vascular access team to reduce central line usage and prevent central line-associated bloodstream infections. *J Infus Nurs.* 2019;42(4):193-196. doi:10.1097/NAN.0000000000000328
37. Legemaat MM, Jongerden IP, van Rens RM, Zielman M, van den Hoogen A. Effect of a vascular access team on central line-associated bloodstream infections in infants admitted to a neonatal intensive care unit: a systematic review. *Int J Nurs Stud.* 2015;52(5):1003-1010. doi:10.1016/j.ijnurstu.2014.11.010
38. Martillo M, Zarbiv S, Gupta R, Brito A, Shittu A, Kohli-Seth R. A comprehensive vascular access service can reduce catheter-associated bloodstream infections and promote the appropriate use of vascular access devices. *Am J Infect Control.* 2020;48(4):460-464. doi:10.1016/j.ajic.2019.08.019
39. deCastro MVA, Eades LJ, Rineair SA, Schoettker PJ. Proactive planning for vascular access therapy: one hospital's plan for success. *J Assoc Vasc Access.* 2014;19(4):238-243. https://doi.org/10.1016/j.java.2014.07.005
40. Krein SL, Kuhn L, Ratz D, Winter S, Vaughn VM, Chopra V. The relationship between perceived role and appropriate use of peripherally inserted central catheters: a survey of vascular access nurses in the United States. *Int J Nurs Stud.* 2017;71:28-33. doi:10.1016/j.ijnurstu.2017.03.001
41. Swaminathan L, Flanders S, Rogers M, et al. Improving PICC use and outcomes in hospitalised patients: an interrupted time series study using MAGIC criteria. *BMJ Qual Saf.* 2018;27(4):271-278. doi:10.1136/bmjqs-2017-007342
42. Kim-Saechao SJ, Almario E, Rubin ZA. A novel infection prevention approach: leveraging a mandatory electronic communication tool to decrease peripherally inserted central catheter infections, complications, and cost. *Am J Infect Control.* 2016;44(11):1335-1345. doi:10.1016/j.ajic.2016.03.023
43. Plohal A, Dumont C, Perry C, et al. The role of the registered nurse in the insertion of nontunneled central vascular access devices [position statement]. *J Infus Nurs.* 2017;40(6):339-345. doi:10.1097/NAN.0000000000000255
44. Whalen M, Maliszewski B, Baptiste DL. Establishing a dedicated difficult vascular access team in the emergency department: a needs assessment. *J Infus Nurs.* 2017;40(3);149-154. doi:10.1097/NAN.0000000000000218
45. Whalen M, Maliszewski B, Sheinfeld R, Gardner H, Baptiste D. Outcomes of an innovative evidence-based practice project: building a difficult-access team in the emergency department. *J Emerg Nurs*. 2018;44(5):478-482. doi:10.1016/j.jen.2018.03.011
46. Bell JA, Spencer TR. Implementing an emergency department vascular access team: a quality review of training, competency, and outcomes [published online ahead of print Jun 2, 2020]. *J Vasc Access.* 2020;1129729820924554. doi:10.1177/1129729820924554
47. Fisher S, Martin-Lester MJ, Munden M, Nyquist B, VanHoose T, Williams J, eds. *NICA Minimum Standards for In-Office Infusion: A Threshold for Minimum Standards in Infusion Practice and Quality of Care.* National Infusion Center Association; 2019:13.
48. Patton LJ, Cardwell DL, Falder-Saeed K. Standardize, engage, and collaborate: an initiative to reduce community acquired central line blood stream infections across the continuum of care. *J Pediatr Nurs.* 2019;49:37-42. doi:10.1016/j.pedn.2019.08.018
49. Harrod M, Montoya A, Mody L, McGuirk H, Winter S, Chopra V. Challenges for nurses caring for individuals with peripherally inserted central catheters in skilled nursing facilities. *J Am Geriatr Soc.* 2016;64(10):2059-2064. doi:10.1111/jgs.14341
50. Ten Haken I, Ben Allouch S, van Harten WH. The use of advanced medical technologies at home: a systematic review of the literature. *BMC Public Health.* 2018;18(1):284-233. doi:10.1186/s12889-018-5123-4
51. Goldspiel B, Hoffman JM, Griffith NL, et al. ASHP guidelines on preventing medication errors with chemotherapy and biotherapy. *Am J Health Syst Pharm.* 2015;72(8):e6-e35. doi:10.2146/sp150001
52. Edwards L, Hermis K, LeGette CR, Lujan LA, Scarlett C. Acuity-based scheduling: outcomes in ambulatory oncology centers. *Clin J Oncol Nurs.* 2017;21(2):250-253. doi:10.1188/17.CJON.250-253
53. Slocum RF, Jones HL, Fletcher MT, et al. Improving chemotherapy infusion operations through the simulation of scheduling heuristics: a case study. *Health Systems.* Published online Feb 2, 2020. doi:10.1080/20476965.2019.17099085.

5. COMPETENCY AND COMPETENCY ASSESSMENT

Standard

5.1 To provide for patient safety and public protection, clinicians meet licensing requirements and core competencies according to their specific profession.

5.2 Due to its invasive, high-risk nature, the clinician with responsibility for the safe delivery of infusion therapy and VAD insertion and/or management demonstrates competency with this role.

5.3 Initial competency is assessed and documented before the task or skill is performed without supervision.

5.4 Ongoing competency assessment and documentation is a continuous process driven by patient and organizational outcomes.

Practice Recommendations

A. Provide education and skills development opportunities for newly graduated clinicians (eg, nurse residency programs) early in their employment to close the gap between preparation and practice and improve the confidence of newly graduated clinicians.[1,2] (V)

1. Recognize that each clinician has many variations in prelicensure education, experiences, and previous methods for assessing individual competence. The type and amount of support and feedback and the functionality of coworkers influence the transition to practice.[3,4] (IV)
2. There are significant preparation–practice gaps in knowledge and skills for infusion therapy and vascular access insertion and management for medical and nursing professions. Although regulatory organizations may require competence with certain procedures (eg, CVAD insertion), there are no consistent guidelines for how to provide training and measure its outcomes.[5-11] (IV)

B. Acknowledge that the length of clinical experience and passive recurrent performance are not surrogates for clinical knowledge and procedural competence for experienced clinicians. The absence of appropriate evidence-based education and skill development among clinicians with all levels of experience are 2 factors among many that lead to premature failure and high complication rates of short PIVCs. Variations in performance of CVAD insertion in a simulation laboratory emphasize the need for ongoing competency assessment. Experienced clinicians may not recognize their need for reconstruction of knowledge and skills to correct inaccuracies and improve techniques.[12-16] (IV)

C. Accept individual responsibility for developing and maintaining clinical competency with infusion therapy and vascular access practices as defined by the clinician's legal scope of practice and the requirements of the specific clinical practice venue and/or patient population.[3,17,18] (IV)

D. Plan interprofessional education for competency assessment programs as appropriate due to the need for a high level of interprofessional collaboration with infusion and vascular access practices.[18-22] (IV)

E. Empower clinicians for lifelong professional growth and development by incorporating multiple methods into the competency framework. Options include acknowledging participation in continuing professional education, achieving and maintaining board certification (eg, CRNI®) from a national certifying body (eg, Infusion Nurses Certification Corporation [INCC]), serving as faculty at seminars and conferences, conducting clinical research, publishing in a scholarly journal, and completion of an accredited academic study program in a related field.[3,23-25] (IV)

F. Collaborate with staff development personnel to identify infusion and vascular access knowledge, skills, and attitudes that require competency assessment including technical and nontechnical skills. Use standards, guidelines, and published evidence to create the competency assessment process.[26-30] (V)
1. Incorporate adult learning principles and practices by using appropriate teaching methods for adults as learners, their motivations and characteristics as learners, and methods to overcome obstacles to adult learning.[31,32] (IV)
2. Identify the services provided by the infusion/VAT vs those provided by other clinicians and identify the competencies associated with each role. Some skills may apply to all (eg, monitoring outcome data, use of information technology, interprofessional teamwork), whereas some will be very specific for the team members (eg, use of vascular visualization technology, insertion of midline catheters and CVADs, accessing implanted ports, catheter clearance procedures). Some professionals may use the term *entrustable professional activities* for specific tasks, indicating the learner has reached the point of being trusted to perform the skill without supervision.[33,34] (V)
3. Employ a systems-based approach to infusion and vascular access competencies centered on standardized policies and procedures applied across the entire organization (eg, hospital, ambulatory infusion centers, and radiology and emergency services).[35,36] (V)
4. Consider implementing assessment methods to identify the clinical skills specific to individual nursing units or a specialty. This method is reported to produce greater clinician satisfaction, improve confidence, and increase independence.[37-39] (V)
5. Consider implementing skills fairs for learning needs assessment and to identify additional interventions for competency development. Skills fairs may be better designed for systemwide core competencies.[37,40] (V)

G. Manage competency assessment and validation in 2 phases, initial and ongoing competency.
1. Perform initial competency assessment when:
   a. Orienting newly hired clinicians, both new graduates and clinicians re-entering the workforce
   b. An experienced clinician moves into a position requiring infusion/vascular access skills
   c. Practice expansion occurs (eg, insertion of CVADs, administration of hazardous drugs)
   d. Introducing new policies, practices, and products.[26] (V)
2. Perform ongoing or continuing competency assessment and validation as directed by regulatory and accreditation requirements and organizational safety and quality indicators.
   a. Follow regulatory and accreditation standards to create a competency assessment plan. Periodic competency assessment is required by accreditation organizations, but the frequency of ongoing assessments is defined by the organization.
   b. Identify the interventions, actions, and skills requiring ongoing assessment by using clinical

outcome data; safety and quality indicators such as adverse events, serious safety events, and sentinel events; changing patient populations served; and patient satisfaction data.

c. Determine the root cause and appropriate methods for improvement of identified practice gaps through a learning needs assessment. Competency assessment processes may not be the appropriate methods to improve some practice gaps (eg, lack of appropriate supplies or equipment) and may be detrimental when used inappropriately.

d. Build alliances with all stakeholders (eg, staff or management) to increase their interest and participation in the needs assessment process.[26,41,42] (V)

H. Employ a blended learning approach by combining a variety of methods to deliver education and training. This will improve learning outcomes, maximize use of resources, and allow flexibility.

1. For knowledge acquisition and critical thinking skills, choose instructor-led delivery or electronic-based delivery of content. Electronic delivery allows for synchronous delivery at a scheduled time for all learners or asynchronous delivery, which allows the learners to access the content at a time and place that is convenient for their schedule. Assigned reading, self-directed study, large and small group discussions, and lectures are additional teaching strategies for knowledge acquisition.[14,43-46] (III)
2. For psychomotor skill acquisition, employ simulation-based experiences.[45] (III)
3. For patient assessment skills, use web-based, multimedia technology for simulation of scenarios or standardized patients.[47,48] (III)

I. Use learner-centered, experiential methods to assess competency for psychomotor skills development in 4 consecutive phases including knowledge acquisition, observation, simulation, and clinical performance. Choose the most appropriate teaching and evaluation strategies for each phase.[10,31,45,49-52] (II)

J. Use simulation method(s) most suitable to develop and refine technical and nontechnical skills using high-fidelity methods (ie, those with greatest degree of realism possible).[51,53-56] (IV)

K. Do not perform invasive procedures (eg, venipuncture, catheter insertion) on human volunteers for training purposes.

1. Learning a skill is not complete until it has been successfully performed on patients under supervision. Use of human volunteers is a form of simulation and does not replace supervised performance on patients.[57,58] (IV)
2. The risk of performing invasive procedures on human volunteers outweighs the benefits. The human volunteer will be exposed to physical health risk for infection, thrombosis, and vessel/tissue damage plus emotional stress.[59,60] (III)
3. Skill acquisition outcomes for PIVC cannulation are equivalent with use of anatomical training models compared to human volunteers. An RCT teaching IV cannulation to military LPNs reported no statistical significance with first-attempt success in patients between the groups trained on human volunteers vs anatomical training arms.[60] (III)
4. Use of human volunteers requires constant supervision from an instructor to protect the volunteer. This form of simulation becomes instructor-centered interaction resulting in fewer learning actions taken by the students. Simulation on anatomical models is learner-centered with a greater number of learning actions taken (eg, checking available printed guidelines, repetitive skill performance) and a higher level of learner engagement.[58] (V)
5. Practice noninvasive steps of a skill on human volunteers including tourniquet application and removal, vein palpation, and vascular visualization using electronic devices such as near infrared light and ultrasound, because these steps do not involve skin puncture. Invasive procedures require use of anatomical models, task trainers, or virtual reality to allow for repetitive practice.[14,60] (IV)

L. Measure competency by performance and not by a time or a predetermined number of procedures. There is no established number of procedures performed that will ensure competency for any skill.

1. Repetition of the skill in the simulation phase demonstrates that the learner can show how the skill is performed. Repetition in clinical practice demonstrates that the learner can actually perform the complete skill from initial patient assessment through documentation.
2. Performing greater numbers of CVAD insertion procedures is associated with lower rates of complications; however, the number of procedures performed is not an adequate surrogate for competency.
3. Success rates with ultrasound-guided PIVC insertions usually improves with greater number of procedures performed. Examples of inconsistency among studies includes studies from the emergency department. Ten supervised insertions were not sufficient to produce 80% success rates and required 25 successful supervised insertions in 1 study, whereas another study reported 81% success rate with the first 10 insertions, and success rates exceeded 90% after 20 attempts.[49,61,62] (V)

M. Employ a variety of perspectives to assess competency, including self-assessment, peer-assisted learning, and assessment by others, such as an instructor or preceptor.[38,63-65] (III)

N. Designate qualified instructors and assessors to develop and implement all phases of the competency assessment process for infusion and vascular access competencies in an unbiased, objective manner. Instructors and assessors should understand and apply

the principles of adults as learners, choose appropriate teaching strategies, use appropriate evaluation tools and processes, and provide positive feedback and suggestions for improvement. Instructors and assessors should have documented competency with the skill being assessed.[1,36,42,45,64,66-70] (III)

O. Address ongoing competency for low-frequency, high-risk skills by using realistic simulation to practice these skills on a frequent basis.[42,49,57,71] (III)

P. Use a skills checklist, a global rating scale, or both to assess and document performance in an objective, measurable manner. The tool should reflect real clinical practice and be tested for reliability and validity in the planning process.[72-78] (II)

Q. Use a consistent process to manage and monitor outcomes produced by contracted consultants (eg, VAD insertion). Performance expectations for competency for all contracted clinicians include documentation of licensure, competency, and compliance with the organization's requirements for staff qualifications, personnel practices, and clinical policies and procedures. When contractors are acquiring initial competency of a new skill, the organization's management should be knowledgeable of the status of these contractors; that these contracted clinicians are adequately supervised while obtaining competency; and that final documentation of competency is provided to the organization.[79,80] (V)

R. Enhance cultural competency by incorporating respect for all racial, ethnic, and linguistic groups, as well as geographical, religious/spiritual, biological, and sociological characteristics into infusion and vascular access practices. Identify and address the needs of diverse patient populations and validate clinician competency to meet those needs.[81-83] (II)

S. Evaluate the competency assessment program based on learner satisfaction, degree of knowledge acquisition, behavioral changes, changes in patient indicators, and the program's return on investment.[42,84] (IV)

REFERENCES

Note: All electronic references in this section were accessed between March 6, 2020, and August 7, 2020.

1. Hulse AL. Designing and evaluating vascular access training using educational theory. *Br J Nurs.* 2018;27(2):S27-S33. doi:10.12968/bjon.2018.27.2.S27
2. Hollingshead L, Ventura V, Ochinero C, Parson M, Brown S, Dickerson PS. Adult learning. In: Dickerson PS, ed. *Core Curriculum for Nursing Professional Development.* 5th ed. Association for Nursing Professional Development; 2017:28-37.
3. Vernon R, Chiarella M, Papps E, Lark A. Assuring competence or ensuring performance. *Collegian.* 2019;26(3):399-406. https://doi.org/10.1016/j.colegn.2018.10.004
4. Lima S, Jordan HL, Kinney S, Hamilton B, Newall F. Empirical evolution of a framework that supports the development of nursing competence. *J Adv Nurs.* 2016;72(4):889-899. doi:10.1111/jan.12872
5. Brydges R, Stroud L, Wong BM, Holmboe ES, Imrie K, Hatala R. Core competencies or a competent core? A scoping review and realist synthesis of invasive bedside procedural skills training in internal medicine. *Acad Med.* 2017;92(11):1632-1643. doi:10.1097/ACM.0000000000001726
6. Cho EE, Bevilacqua E, Brewer J, Hassett J, Guo WA. Variation in the practice of central venous catheter and chest tube insertions among surgery residents. *J Emerg Trauma Shock.* 2018;11(1):47-52. doi:10.4103/JETS.JETS_124_15
7. Hulse A, Cochrane J. Impact of educational leadership and interprofessional learning on vascular access training. *Br J Nurs.* 2018;27(19):S4-S18. doi:10.12968/bjon.2018.27.19.S4
8. Simonetti V, Comparcini D, Miniscalco D, Tirabassi R, Di Giovanni P, Cicolini G. Assessing nursing students' knowledge of evidence-based guidelines on the management of peripheral venous catheters: a multicentre cross-sectional study. *Nurse Educ Today.* 2019;73:77-82. doi:10.1016/j.nedt.2018.11.023
9. Ahlin C, Klang-Söderkvist B, Johansson E, Björkholm M, Löfmark A. Assessing nursing students' knowledge and skills in performing venepuncture and inserting peripheral venous catheters. *Nurse Educ Pract.* 2017;23:8-14. doi:10.1016/j.nepr.2017.01.003
10. Hunter MR, Vandenhouten C, Raynak A, Owens AK, Thompson J. Addressing the silence: a need for peripheral intravenous education in North America. *J Assoc Vasc Access.* 2018;23(3):157-165. https://doi.org/10.1016/j.java.2018.06.001
11. Sawyer T, French H, Ades A, Johnston L. Neonatal-perinatal medicine fellow procedural experience and competency determination: results of a national survey. *J Perinatol.* 2016;36(7):570-574. doi:10.1038/jp.2016.19
12. Barsuk JH, Cohen ER, Nguyen D, et al. Attending physician adherence to a 29-component central venous catheter bundle checklist during simulated procedures. *Crit Care Med.*2016;44(10):1871-1881. doi:10.1097/CCM.0000000000001831
13. Helm RE, Klausner JD, Klemperer JD, Flint LM, Huang E. Accepted but unacceptable: peripheral iv catheter failure. *J Infus Nurs.* 2015;38(3):189-203. doi:10.1097/NAN.0000000000000100
14. Glover KR, Stahl BR, Murray C, et al. A simulation-based blended curriculum for short peripheral intravenous catheter insertion: an industry-practice collaboration. *J Contin Educ Nurs.* 2017;48(9):397-406. doi:10.3928/00220124-20170816-05
15. Schuster C, Stahl B, Murray C, Glover K. Development and testing of an instrument to measure short peripheral catheter insertion confidence. *J Infus Nurs.* 2016;39(3):159-165. doi:10.1097/NAN.0000000000000166
16. Spencer TR, Bardin-Spencer AJ. Pre- and post-review of a standardized ultrasound-guided central venous catheterization curriculum evaluating procedural skills acquisition and clinician confidence. *J Vasc Access.* 2020;21(4):440-448. doi:10.1177/1129729819882602
17. Liu Y, Aungsuroch Y. Current literature review of registered nurses' competency in the global community: nursing competency in global community. *J Nurs Scholarsh.* 2018;50(2):191-199. doi:10.1111/jnu.12361
18. Decker SI, Anderson M, Boese T, et al. Standards of best practice: simulation standard VIII: Simulation-enhanced Interprofessional Education (Sim-IPE). *Clin Simul Nurs.* 2015;11(6):293-297. https://doi.org/10.1016/j.ecns.2015.03.010
19. Brem BG, Schaffner N, Schlegel CA, Fritschi V, Schnabel KP. The conversion of a peer teaching course in the puncture of peripheral veins for medical students into an interprofessional course. *GMS J Med Educ.* 2016;33(2):Doc21. doi:10.3205/zma001020
20. Conte H, Scheja M, Hjelmqvist H, Jirwe M. Exploring teams of learners becoming "WE" in the intensive care unit–a focused ethnographic study. *BMC Med Educ.* 2015;15(1):131. doi:10.1186/s12909-015-0414-2
21. Interprofessional Education Collaborative. Core competencies for interprofessional collaborative practice: 2016 update.

Interprofessional Education Collaborative (IPEC); 2016. https://hsc.unm.edu/ipe/resources/ipec-2016-core-competencies.pdf

22. Chappell K, Travlos D, Regnier K. Interprofessional continuing education. In: Dickerson PS, ed. *Core Curriculum for Nursing Professional Development.* 5th ed. Association for Nursing Professional Development; 2017:58-71.
23. Martin LC, Arenas-Montoya NM, Barnett TO. Impact of nurse certification rates on patient satisfaction and outcomes: a literature review. *J Contin Educ Nurs.* 2015;46(12):549-556. doi:10.3928/00220124-20151112-06
24. Chopra V, Kuhn L, Ratz D, et al. Vascular access specialist training, experience, and practice in the United States: results from the national PICC1 survey. *J Infus Nurs.* 2017;40(1):15-25. doi:10.1097/NAN.0000000000000203
25. Youngmann TE, Barnes RE. Nursing-constructed central venous catheter program: a six-step guide to implementation. *J Radiol Nurs.* 2016;35(1):19-23. https://doi.org/10.1016/j.jradnu.2015.12.006
26. Wahl S. Competency management. In: Dickerson PS, ed. *Core Curriculum for Nursing Professional Development.* 5th ed. Association for Nursing Professional Development; 2017:308-317.
27. O'Byrne N, Kozub EI, Fields W. Reducing continuous intravenous medication errors in an intensive care unit. *J Nurs Care Qual.* 2016;31(1):13-16. doi:10.1097/NCQ.0000000000000144
28. Di Simone E, Tartaglini D, Fiorini S, Petriglieri S, Plocco C, Di Muzio M. Medication errors in intensive care units: nurses' training needs. *Emerg Nurse.* 2016;24(4):24-29. doi:10.7748/en.2016.11577
29. Romøren M, Gjelstad S, Lindbaek M. A structured training program for health workers in intravenous treatment with fluids and antibiotics in nursing homes: a modified stepped-wedge cluster-randomised trial to reduce hospital admissions. *PLoS One.* 2017;12(9):e0182619. doi:10.1371/journal.pone.0182619
30. Soffler MI, Hayes MM, Smith CC. Central venous catheterization training: current perspectives on the role of simulation. *Adv Med Educ Pract.* 2018;9:395-403. doi:10.2147/AMEP.S142605
31. Moureau N, Lamperti M, Kelly LJ, et al. Evidence-based consensus on the insertion of central venous access devices: definition of minimal requirements for training. *Br J Anaesth.* 2013;110(3):347-356. doi:10.1093/bja/aes499
32. Wenger B. Development of an intravenous skills module for graduate nurses. *J Infus Nurs.* 2015;38(2):135-139. doi:10.1097/NAN.0000000000000094
33. Dhaliwal U, Gupta P, Singh T. Entrustable professional activities: teaching and assessing clinical competence. *Indian Pediatr.* 2015;52(7):591-597. doi:10.1007/s13312-015-0681-3
34. Cate OT. A primer on entrustable professional activities. *Korean J Med Educ.* 2018;30(1):1-10. doi:10.3946/kjme.2018.76
35. Carreon N, Sugarman C, Beener E, Agan D. Creating and standardizing annual chemotherapy competencies throughout a healthcare system. *J Nurses Prof Dev.* 2015;31(1):35-39. doi:10.1097/NND.0000000000000131
36. Beaver C, Magnan MA, Henderson D, DeRose P, Carolin K, Bepler G. Standardizing assessment of competences and competencies of oncology nurses working in ambulatory care. *J Nurses Prof Dev.* 2016;32(2):64-73. doi:10.1097/NND.0000000000000250
37. Figueroa S, Bowling J, Cummings JL, Laporte RLR, Cohn T, Irizarry J. Nurses' perception of unit-based competency assessment compared to traditional skills fair. *Medsurg Nurs.* 2018;27(6):373-378.
38. Mangold K, Tyler B, Velez L, Clark C. Peer-review competency assessment engages staff and influences patient outcomes. *J Contin Educ Nurs.* 2018;49(3):119-126. doi:10.3928/00220124-20180219-06
39. Schanne LC, Stern S, Hand C, et al. From chaos to competency: implementing a new competency model in a multihospital system. *J Contin Educ Nurs.* 2016;47(3):111-119. doi:10.3928/00220124-20160218-06
40. Saleh U, O'Connor T, Afaneh T, Moore Z, Patton D, Derwin R. The use of a competence fair to validate nursing competence. *Nurse Educ Today.* 2017;57:1-7. doi:10.1016/j.nedt.2017.06.007
41. Gooding N. Gaps in professional practice/learning needs assessment. In: Dickerson, PS, ed. *Core Curriculum for Nursing Professional Development.* 5th ed. Association for Nursing Professional Development; 2017:94-113.
42. Wright D. *Competency Assessment Field Guide: A Real World Guide for Implementation and Application.* Creative Health Care Management; 2015.
43. Hainey K, Kelly LJ, Green A. A blended learning approach to teaching CVAD care and maintenance. *Br J Nurs.* 2017;26(2):S4-S12. doi:10.12968/bjon.2017.26.2.S4
44. Purran A, Weller G, Kerr C. Evaluation of a PICC care training programme. *Nurs Stand.* 2016;30(20):45-50. doi:10.7748/ns.30.20.45.s47
45. Keleekai NL, Schuster CA, Murray CL, et al. Improving nurses' peripheral intravenous catheter insertion knowledge, confidence, and skills using a simulation-based blended learning program: a randomized trial. *Simul Healthc.* 2016;11(6):376-384. doi:10.1097/SIH.0000000000000186
46. Parchen DA, Phelps SE, Johnson EM, Fisher CA. Improving efficiency using a hybrid approach: revising an intravenous/blood workshop in a clinical research environment. *J Nurses Prof Dev.* 2016;32(3):144-149. doi:10.1097/NND.0000000000000252
47. Liaw SY, Wong LF, Chan SW, et al. Designing and evaluating an interactive multimedia Web-based simulation for developing nurses' competencies in acute nursing care: randomized controlled trial. *J Med Internet Res.* 2015;17(1):e5. doi:10.2196/jmir.3853
48. Holtschneider ME. Standardized patients: infusing realism into simulation scenarios. *J Nurses Prof Dev.* 2016;32(6):321-322. doi:10.1097/NND.0000000000000304
49. Sawyer T, White M, Zaveri P, et al. Learn, see, practice, prove, do, maintain: an evidence-based pedagogical framework for procedural skill training in medicine. *Acad Med.* 2015;90(8):1025-1033. doi:10.1097/ACM.0000000000000734
50. O'Regan S, Molloy E, Watterson L, Nestel D. Observer roles that optimise learning in healthcare simulation education: a systematic review. *Adv Simul (Lond).* 2016;1(1):4. doi:10.1186/s41077-015-0004-8
51. Chee J. Clinical simulation using deliberate practice in nursing education: a Wilsonian concept analysis. *Nurse Educ Pract.* 2014;14(3):247-252. doi:10.1016/j.nepr.2013.09.001
52. Harris KR, Eccles DW, Shatzer JH. Team deliberate practice in medicine and related domains: a consideration of the issues. *Adv Health Sci Educ Theory Pract.* 2017;22(1):209-220. doi:10.1007/s10459-016-9696-3
53. INACSL Standards Committee. INACSL standards of best practice: Simulation^{SM} simulation design. *Clin Simul Nurs.* 2016;12(S):S5-S12. http://dx.doi.org/10.1016/j.ecns.2016.09.005
54. Terry VR, Moloney C, Bowtell L, Terry PC. Online intravenous pump emulator: as effective as face-to-face simulation for training nursing students. *Nurse Educ Today.* 2016;40:198-203. doi:10.1016/j.nedt.2016.03.004
55. McWilliams LA, Malecha A. Comparing intravenous insertion instructional methods with haptic simulators. *Nurs Res Pract.* 2017;2017:4685157.
56. Rivière E, Saucier D, Lafleur A, Lacasse M, Chiniara G. Twelve tips for efficient procedural simulation. *Med Teach.* 2018;40(7):743-751. doi:10.1080/0142159X.2017.1391375
57. Aldridge MD. Nursing students' perceptions of learning psychomotor skills: a literature review. *Teach Learn Nurs.* 2017;12(1):21-27. https://doi.org/10.1016/j.teln.2016.09.002
58. Ravik M, Havnes A, Bjørk IT. Defining and comparing learning actions in two simulation modalities: students training on a latex

arm and each other's arms. *J Clin Nurs.* 2017;26(23-24):4255-4266. doi:10.1111/jocn.13748

59. Sarid O, Anson O, Schwartz D, Yaari A. Undergoing venipuncture in health-care education: the psycho-biological effect on students. *Internet J Allied Health Sci Pract.* 2008;6(4). https://nsuworks.nova.edu/ijahsp/vol6/iss4/8/
60. Jones RS, Simmons A, Boykin GL, Stamper D, Thompson JC. Measuring intravenous cannulation skills of practical nursing students using rubber mannequin intravenous training arms. *Mil Med.* 2014;179(11):1361-1367. doi:10.7205/MILMED-D-13-00576
61. Feinsmith S, Huebinger R, Pitts M, Baran E, Haas S. Outcomes of a simplified ultrasound-guided intravenous training course for emergency nurses. *J Emerg Nurs.* 2018;44(2):169-175.e162. doi:10.1016/j.jen.2017.10.001
62. Smith C. Should nurses be trained to use ultrasound for intravenous access to patients with difficult veins? *Emerg Nurse.* 2018;26(2):18-24. doi:10.7748/en.2018.e1733
63. Hadid S. Factors influencing nursing student self-assessment in relation to instructor assessment. *J Nurs Educ.* 2017;56(2):70-76. doi:10.3928/01484834-20170123-03
64. Takase M, Yamamoto M, Sato Y. The factors related to self-other agreement/disagreement in nursing competence assessment: comparative and correlational study. *Int J Nurs Stud.* 2018;80:147-154. doi:10.1016/j.ijnurstu.2018.01.011
65. Pelloux S, Grégoire A, Kirmizigul P, et al. Peripheral venous catheter insertion simulation training: a randomized controlled trial comparing performance after instructor-led teaching versus peer-assisted learning. *Anaesth Crit Care Pain Med.* 2017;36(6):397-402. doi:10.1016/j.accpm.2016.11.007
66. McSparron JI, Ricotta DN, Moskowitz A, et al. The PrOSTE: identifying key components of effective procedural teaching. *Ann Am Thorac Soc.* 2015;12(2):230-234.
67. Aldridge MD. How can nurse educators perform patient simulation efficiently? *Teach Learn Nurs.* 2016;11(1):8-14. https://doi.org/10.1016/j.teln.2015.09.001
68. McPhee K. Teaching new graduate nurses about infusion therapy in a nurse residency program. *J Infus Nurs.* 2015;38(1):57-61. doi:10.1097/NAN.0000000000000084
69. Rosa W, Santos S. Introduction of the engaged feedback reflective inventory during a preceptor training program. *J Nurses Prof Dev.* 2016;32(4):E1-E7. doi:10.1097/NND.0000000000000280
70. Ke YT, Kuo CC, Hung CH. The effects of nursing preceptorship on new nurses' competence, professional socialization, job satisfaction and retention: a systematic review. *J Adv Nurs.* 2017;73(10):2296-2305. doi:10.1111/jan.13317
71. Hebbar KB, Cunningham C, McCracken C, Kamat P, Fortenberry JD. Simulation-based paediatric intensive care unit central venous line maintenance bundle training. *Intensive Crit Care Nurs.*2015;31(1):44-50. doi:10.1016/j.iccn.2014.10.003
72. Riggle JD, Wadman MC, McCrory B, et al. Task analysis method for procedural training curriculum development. *Perspect Med Educ.* 2014;3(3):204-218. doi:10.1007/s40037-013-0100-1
73. Schuster C, Stahl B, Murray C, Keleekai NL, Glover K. Development and testing of a short peripheral intravenous catheter insertion skills checklist. *J Assoc Vasc Access.* 2016;21(4):196-204. https://doi.org/10.1016/j.java.2016.08.003
74. Fleming GM, Mink RB, Hornik C, et al. Developing a tool to assess placement of central venous catheters in pediatrics patients. *J Grad Med Educ.* 2016;8(3):346-352. doi:10.4300/JGME-D-15-00365.1
75. Hartman N, Wittler M, Askew K, Manthey D. Delphi method validation of a procedural performance checklist for insertion of an ultrasound-guided internal jugular central line. *Am J Med Qual.* 2016;31(1):81-85. doi:10.1177/1062860614549762
76. Primdahl SC, Weile J, Clemmesen L, et al. Validation of the peripheral ultrasound-guided vascular access rating scale. *Medicine (Baltimore).* 2018;97(2):e9576. doi:10.1097/MD.0000000000009576
77. Franklin N, Melville P. Competency assessment tools: an exploration of the pedagogical issues facing competency assessment for nurses in the clinical environment. *Collegian.* 2015;22(1):25-31. doi:10.1016/j.colegn.2013.10.005
78. Ma IW, Brindle ME, Ronksley PE, Lorenzetti DL, Sauve RS, Ghali WA. Use of simulation-based education to improve outcomes of central venous catheterization: a systematic review and meta-analysis. *Acad Med.* 2011;86(9):1137-1147. doi:10.1097/ACM.0b013e318226a204
79. The Joint Commission. Contracted services - organization's responsibilities. Jointcommission.org. Updated May 21, 2020. https://www.jointcommission.org/en/standards/standard-faqs/laboratory/leadership-ld/000001470/
80. The Joint Commission. Contract staff - applicability of human resource standards (HAP, CAH, AMB, OBS, NCC). Jointcommission.org. Updated April 26, 2017. https://www.jointcommission.org/en/standards/standard-faqs/ambulatory/human-resources-hr/000001417/
81. US Department of Health and Human Services; Office of Minority Health. The national CLAS standards. HHS.gov. Updated October 2, 2018. https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=2&lvlid=53
82. Govere L, Govere EM. How effective is cultural competence training of healthcare providers on improving patient satisfaction of minority groups? A systematic review of literature. *Worldviews Evid Based Nurs.* 2016;13(6):402-410. doi:10.1111/wvn.12176
83. Jongen C, McCalman J, Bainbridge R, Clifford A. *Cultural Competence in Health: A Review of The Evidence.* Springer; 2018.
84. Pepsnik D. Measuring outcomes at the activity level. In: Dickerson PS, ed. *Core Curriculum for Nursing Professional Development.* 5th ed. Association for Nursing Professional Development; 2017: 198-206.

6. QUALITY IMPROVEMENT

Standard

6.1 Quality improvement (QI) activities are implemented to advance safety and excellence in infusion administration and VAD insertion and management.

6.2 QI programs incorporate surveillance, aggregation, analysis, and reporting of patient quality indicators and adverse events with clinicians taking action as needed to improve practice, processes, and/or systems.

Practice Recommendations

A. Foster a just culture and individual accountability through a focus on improving systems and processes by clinicians and leaders.[1-6] (V)

B. Identify and prioritize organizational objectives for QI initiatives and incorporate a variety of strategies as part of a QI program.
   1. Engage the interprofessional team in development of a QI plan; include leadership and local champions (eg, infusion team/VAT, infection preventionists); (see Standard 4, *Organization of Infusion and Vascular Access Services*).[7-11] (II)
   2. Assess current gaps in practice and identify, minimize, and/or eliminate barriers to change and improvement; consider potential barriers including attitudes, time, and financial and physical resources.[9-10] (IV)

3. Evaluate quality and safety indicator outcomes, including close calls (ie, good catches), errors, and adverse events to identify areas for improvement (refer to Standard 11, *Adverse and Serious Adverse Events*).
4. Use systematic methods and tools to guide activities such as Model for Improvement (Plan-Do-Check-Act), Lean Six Sigma, continuous quality improvement (CQI), root cause analysis (RCA), and Healthcare Failure Mode and Effect Analysis (HFMEA); (see Standard 11, *Adverse and Serious Adverse Events*).[12-19] (IV)
5. Plan for sustainability of QI at the onset; integrate changes into the organization through staff engagement, education, and leadership, as well as through organizational infrastructure and culture; consider issues such as transparency, simplicity, and actionability of the plan.[20-21] (V)
6. Use audit and feedback when implementing changes in practice.
    a. Include rationale for practice changes and for audit activities; ensure that there is a link between audit criteria and patient outcomes (eg, disinfection of needleless connector and catheter-associated bloodstream infection [CABSI]); provide both written and verbal feedback; translate feedback into goals and action plans.[22-28] (II)
7. Provide education as part of a QI strategy.
    a. Recognize that education alone is not enough to improve clinical outcomes and clinical practice.[7-10] (II)
    b. Employ a blended learning approach by combining a variety of methods to deliver education and training (refer to Standard 5, *Competency and Competency Assessment*).
8. Recognize that patient education may improve professional practice by increasing clinician adherence to recommended clinical practice and improve patient outcomes (see Standard 8, *Patient Education*).[29] (II)
9. Share improvements gained through these processes internally and externally.[7-11,20-28] (II)

C. Evaluate adverse events from CVADs for complications (eg, CABSI, reasons for removal, unnecessary CVAD placements, occlusions, venous thrombosis).
1. Use surveillance methods and definitions that are consistent and allow comparison to benchmark data, as well as reviewing for root cause (eg, CABSI).
2. Collect data; analyze and evaluate outcomes against benchmarks for areas of improvement.
3. Compare rates to historical internal data and external data (eg, publicly reported outcomes).
4. Use a standard formula to calculate complication rates.
5. Report as mandated by local/national requirements to external quality initiatives or programs.[30-40] (IV)

D. Evaluate adverse events from peripheral/arterial catheters for complications (eg, bloodstream infection [BSI], infiltration, phlebitis) through incidence, point prevalence, reports from patient health records, or International Classification of Diseases (ICD) codes.
1. Use surveillance methods and definitions that are consistent and permit comparison to benchmark data.
2. Collect data; analyze and evaluate outcomes against benchmarks for areas of improvement.
3. Compare rates to historical internal data and when possible to external national rates.
4. Report as mandated by local/national requirements to external quality initiatives or programs.[30,38-46] (II)

E. Monitor and evaluate medication adverse reactions and errors.
1. Establish a strong just culture that strengthens safety and creates an environment that raises the level of transparency and encourages reporting of medication errors (see Standard 11, *Adverse and Serious Adverse Events*).[1-5,47,48] (IV)
2. Establish a system that supports the reporting of close calls (ie, good catches).[49,50] (V)
3. Identify infusion medication safety risk factors.[51,52] (III)
4. Analyze technology analytics, such as smart pumps and barcode medication administration, for errors, overrides, and other alerts so that improvements may be made.[53-57] (IV)

REFERENCES

Note: All electronic references in this section were accessed between May 7, 2020, and July 30, 2020.

1. Stawicki SP, Firstenberg MS. Introductory chapter: the decades long quest continues toward better, safer healthcare systems. In: Firstenberg MS, Stawicki SP, eds. *Vignettes in Patient Safety: Volume 1*. IntechOpen Limited; 2017. doi:10.5772/intechopen.69354
2. Mathews SC, Demski R, Pronovost PJ. Redefining accountability in quality and safety at academic medical centers. *Qual Manag Health Care.* 2016;25(4):244-247. doi:10.1097/QMH.0000000000000107
3. Ghaferi AA, Dimick JB. Understanding failure to rescue and improving safety culture. *Ann Surg*. 2015;261(5):839-840. doi:10.1097/SLA.0000000000001135.
4. Aveling EL, Parker M, Dixon-Woods M. What is the role of individual accountability in patient safety? A multi-site ethnographic study. *Sociol Health Illn*. 2016;38(2):216-232. doi:10.1111/1467-9566.12370
5. Frankel A, Haraden C, Federico F, Lenoci-Edwards J. A framework for safe, reliable, and effective care [white paper]. Institute for Healthcare Improvement and Safe & Reliable Healthcare; 2017. http://www.ihi.org/resources/Pages/IHIWhitePapers/Framework-Safe-Reliable-Effective-Care.aspx
6. Armstrong G. QSEN safety competency: the key ingredient is just culture. *J Contin Educ Nurs*. 2019;50(10):444-447. doi:10.3928/00220124-20190917-05
7. Flodgren G, Conterno LO, Mayhew A, Omar O, Pereira CR, Shepperd S. Interventions to improve professional adherence to guidelines for prevention of device-related infections. *Cochrane Database Syst Rev*. 2013;(3):CD006559. doi:10.1002/14651858.CD006559.pub2
8. Marschall J, Mermel LA, Fakih M, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(7):753-771. doi:10.1086/676533

9. Owings A, Graves J, Johnson S, Gilliam C, Gipson M, Hakim H. Leadership line care rounds: application of the engage, educate, execute, and evaluate improvement model for the prevention of central line-associated bloodstream infections in children with cancer. *Am J Infect Control*. 2018;46(2):229-231. doi:10.1016/j.ajic.2017.08.032
10. Registered Nurses Association of Ontario. Toolkit: implementation of best practice guidelines. 2nd ed. Registered Nurses Association of Ontario; 2012. https://rnao.ca/sites/rnao-ca/files/RNAO_ToolKit_2012_rev4_FA.pdf
11. Ratner S, Pignone M. Quality improvement principles and practice. *Prim Care*. 2019;46(4):505-514. doi:10.1016/j.pop.2019.07.008
12. Li X, He M, Wang H. Application of failure mode and effect analysis in managing catheter-related blood stream infection in intensive care unit. *Medicine (Baltimore)*. 2017;96(51):e9339. doi:10.1097/MD.0000000000009339
13. Johnson JK, Sollecito WA, eds. *McLaughlin and Kaluzny's Continuous Quality Improvement in Healthcare*. 5th ed. Jones & Bartlett Learning; 2020.
14. Franklin BD, Panesar SS, Vincent C, Donaldson LJ. Identifying systems failures in the pathway to a catastrophic event: an analysis of national incident report data relating to vinca alkaloids. *BMJ Qual Saf*. 2014;23(9):765-772. doi:10.1136/bmjqs-2013-002572
15. Barlow M, Dickie R, Morse C, Bonney D, Simon R. Documentation framework for healthcare simulation quality improvement activities. *Adv Simul (Lond).* 2017;2:19. doi:10.1186/s41077-017-0053-2
16. Ogrinc GS, Headrick LA, Barton AJ, Dolansky MA, Madigosky WS, Miltner RS. *Fundamentals of Health Care Improvement: A Guide to Improving Your Patients' Care*. 3rd ed. The Joint Commission and The Institute for Healthcare Improvement; 2018.
17. Dehnavieh R, Ebrahimipour H, Molavi-Taleghani Y, Vafaee-Najar A, Noori Hekmat S, Esmailzdeh H. Proactive risk assessment of blood transfusion process, in pediatric emergency, using the Health Care Failure Mode and Effects Analysis (HFMEA). *Glob J Health Sci.* 2014;7(1):322-331. doi:10.5539/gjhs.v7n1p322
18. Faiella G, Parand A, Franklin BD, et al. Expanding healthcare failure mode and effect analysis: a composite proactive risk analysis approach. *Reliability Engineering & System Safety*. 2018;169:117-126. https://doi.org/10.1016/j.ress.2017.08.003
19. Liu H, You X, Tsung F, Ji P. An improved approach for failure mode and effect analysis involving large group of experts: an application to the healthcare field. *Qual Eng*. 2018;30(4):762-775. https://doi.org/10.1080/08982112.2018.1448089
20. Silver SA, McQuillan R, Harel Z, et al. How to sustain change and support continuous quality improvement. *Clin J Am Soc Nephrol*. 2016;11(5):916-924. doi:10.2215/CJN.11501015
21. Minnier TE. How to build sustainability into the improvement process. Agency for Healthcare Research and Quality; 2014. https://innovations.ahrq.gov/perspectives/how-build-sustainability-innovation-process
22. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev*. 2012;(6):CD000259. doi:10.1002/14651858.CD000259.pub3
23. Ivers NM, Grimshaw JM, Jamtvedt G, et al. Growing literature, stagnant science? Systematic review, meta-regression and cumulative analysis of audit and feedback interventions in health care. *J Gen Intern Med*. 2014;29(11):1534-1541. doi:10.1007/s11606-014-2913-y
24. Ullman AJ, Ray-Barruel G, Rickard CM, Cooke M. Clinical audits to improve critical care: part 1 prepare and collect data. *Aust Crit Care*. 2018;31(2):101-105. doi:10.1016/j.aucc.2017.04.003
25. Ray-Barruel G, Ullman AJ, Rickard CM, Cooke M. Clinical audits to improve critical care: part 2: analyse, benchmark and feedback. *Aust Crit Care*. 2018;31(2):106-109. doi:10.1016/j.aucc.2017.04.002
26. Borgert M, Binnekade J, Paulus F, Goossens A, Vroom M, Dongelmans D. Timely individual audit and feedback significantly improves transfusion bundle compliance-a comparative study. *Int J Qual Health Care*. 2016;28(5):601-607. doi:10.1093/intqhc/mzw071
27. Morrison T, Raffaele J, Brennaman L. Impact of personalized report cards on nurses managing central lines. *Am J Infect Control*. 2017;45(1):24-28. doi:10.1016/j.ajic.2016.09.020
28. Christina V, Baldwin K, Biron A, Emed J, Lepage K. Factors influencing the effectiveness of audit and feedback: nurses' perceptions. *J Nurs Manag*. 2016;24(8):1080-1087. doi:10.1111/jonm.12409
29. Fønhus MS, Dalsbø TK, Johansen M, Fretheim A, Skirbekk H, Flottorp SA. Patient-mediated interventions to improve professional practice. *Cochrane Database Syst Rev*. 2018;9(9):CD012472. doi:10.1002/14651858.CD012472.pub2
30. Schults JA, Rickard CM, Kleidon T, et al. Building a global, pediatric vascular access registry: a scoping review of trial outcomes and quality indicators to inform evidence-based practice. *Worldviews Evid Based Nurs*. 2019;16(1):51-59. doi:10.1111/wvn.12339
31. Keller SC, Alexander M, Williams D, et al. Perspectives on central-line-associated bloodstream infection surveillance in home infusion therapy. *Infect Control Hosp Epidemiol*. 2019;40(6):729-731. doi:10.1017/ice.2019.90
32. Keller SC, Williams D, Rock C, Deol S, Trexler P, Cosgrove SE. A new frontier: central line-associated bloodstream infection surveillance in home infusion therapy. *Am J Infect Control*. 2018;46(12):1419-1421. doi:10.1016/j.ajic.2018.05.016
33. Centers for Disease Control and Prevention. Bloodstream infection event (central line-associated bloodstream infection and non-central line-associated bloodstream infection). In: *National Healthcare Safety Network (NHSN) Patient Safety Component Manual.* National Healthcare Safety Network; 2020:chap 4. https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf
34. Larsen EN, Gavin N, Marsh N, Rickard CM, Runnegar N, Webster J. A systematic review of central-line-associated bloodstream infection (CLABSI) diagnostic reliability and error. *Infect Control Hosp Epidemiol*. 2019;40(10):1100-1106. doi:10.1017/ice.2019.205
35. Hallam C, Jackson T, Rajgopal A, Russell B. Establishing catheter-related bloodstream infection surveillance to drive improvement. *J Infect Prev*. 2018;19(4):160-166. doi:10.1177/1757177418767759
36. Xiong Z, Chen H. Interventions to reduce unnecessary central venous catheter use to prevent central-line-associated bloodstream infections in adults: a systematic review. *Infect Control Hosp Epidemiol*. 2018;39(12):1442-1448. doi:10.1017/ice.2018.250
37. Australian Commission on Safety and Quality in Health Care. Preventing and controlling healthcare-associated infection standard. In: *The National Safety and Quality Health Service Standards.* 2nd ed. Australian Commission on Safety and Quality in Health Care; 2017:chap 3. https://www.safetyandquality.gov.au/sites/default/files/2019-04/National-Safety-and-Quality-Health-Service-Standards-second-edition.pdf
38. National Quality Forum. The ABCs of measurement. www.qualityforum.org/Measuring_Performance/ABCs_of_Measurement.aspx
39. Institute for Healthcare Improvement. Measures. ihi.org. http://www.ihi.org/resources/Pages/Measures/default.aspx
40. Schults J, Kleidon T, Chopra V, et al. International recommendations for a vascular access minimum data set: a Delphi consensus-building study. *BMJ Qual Saf.* 2020; Sep 22:bmjqs-2020-011274. Published online ahead of print. doi:0.1136/bmjqs-2020-011274
41. Helm RE, Klausner JD, Klemperer JD, Flint LM, Huang E. Accepted but unacceptable: peripheral IV catheter failure. *J Infus Nurs*. 2015;38(3):189-203. doi:10.1097/NAN.0000000000000100
42. Alexandrou E, Ray-Barruel G, Carr PJ, et al. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *J Hosp Med*. 2018;13(5):10.12788/jhm.3039. doi:10.12788/jhm.3039
43. Mermel LA. Short-term peripheral venous catheter–related bloodstream infections: a systematic review. *Clin Infect Dis.*2017;65(10):1757-1762. doi:10.1093/cid/cix562

44. Miliani K, Taravella R, Thillard D, et al. Peripheral venous catheter-related adverse events: evaluation from a multicentre epidemiological study in France (the CATHEVAL project). *PLoS One*. 2017;12(1):e0168637. doi:10.1371/journal.pone.0168637
45. Sato A, Nakamura I, Fujita H, et al. Peripheral venous catheter-related bloodstream infection is associated with severe complications and potential death: a retrospective observational study. *BMC Infect Dis*. 2017;17(1):434. doi:10.1186/s12879-017-2536-0
46. Blauw M, Foxman B, Wu J, Rey J, Kothari N, Malani AN. Risk factors and outcomes associated with hospital-onset peripheral intravenous catheter-associated *Staphylococcus aureus* bacteremia. *Open Forum Infect Dis*. 2019;6(4):ofz111. doi:10.1093/ofid/ofz111
47. Dirik HF, Samur M, Seren Intepeler S, Hewison A. Nurses' identification and reporting of medication errors. *J Clin Nurs*. 2019;28(5-6):931-938. doi:10.1111/jocn.14716
48. Rutledge DN, Retrosi T, Ostrowski G. Barriers to medication error reporting among hospital nurses. *J Clin Nurs*. 2018;27(9-10):1941-1949. doi:10.1111/jocn.14335
49. Speroni KG, Fisher J, Dennis M, Daniel M. What causes near-misses and how are they mitigated? *Nursing*. 2013;43(4):19-24. doi:10.1097/01.NURSE.0000427995.92553.ef
50. Urich B. Near misses and close calls: what they are and why you should report them. *Nephrol Nurs J*. 2015;42(3):205-208.
51. Krukas A, Franklin ES, Bonk C, et al. Identifying safety hazards associated with intravenous vancomycin through the analysis of patient safety event reports. *Patient Safety.* 2020;2(1):17. doi:10.33940/data/2020.3.3
52. Kavanagh C. Medication governance: preventing errors and promoting patient safety. *Br J Nurs*. 2017;26(3):159-165. doi:10.12968/bjon.2017.26.3.159
53. Lehr J, Vitoux RR, Evanovich Zavotsky K, Pontieri-Lewis V, Colineri L. Achieving outcomes with innovative smart pump technology: partnership, planning, and quality improvement. *J Nurs Care Qual*. 2019;34(1):9-15. doi:10.1097/NCQ.0000000000000326
54. Catlin AC, Malloy WX, Arthur KJ, et al. Comparative analytics of infusion pump data across multiple hospital systems. *Am J Health Syst Pharm*. 2015;72(4):317-324. doi:10.2146/ajhp140424
55. Institute for Safe Medication Practices. Guidelines for optimizing safe implementation and use of smart infusion pumps. Published February 10, 2020. https://www.ismp.org/guidelines/safe-implementationand-use-smart-pumps. https://www.ismp.org/guidelines/safe-implementation-and-use-smart-pumps
56. Walroth TA, Smallwood S, Arthur K, et al. Development of a standardized, citywide process for managing smart-pump drug libraries. *Am J Health Syst Pharm*. 2018;75(12):893-900. doi:10.2146/ajhp170262
57. DeLaurentis P, Walroth TA, Fritschle AC, et al. Stakeholder perceptions of smart infusion pumps and drug library updates: A multisite, interdisciplinary study. *Am J Health Syst Pharm*. 2019;76(17):1281-1287. doi:10.1093/ajhp/zxz135

7. EVIDENCE-BASED PRACTICE AND RESEARCH

Standard

7.1 The clinician integrates evidence-based knowledge with clinical expertise and the patient's preferences and values in the current context when providing safe, effective, and patient-centered infusion therapy.

7.2 The clinician uses the highest level of research findings and current best evidence to expand knowledge in infusion therapy, validate and improve practice, advance professional accountability, and enhance evidence-based decision-making.

7.3 The clinician conducts or participates in research studies that generate new knowledge about the environment and processes of, products for, or the care of patients receiving infusion therapy.

7.4 The clinician shares innovations, knowledge gained, and outcomes about infusion therapy with other clinicians internally and externally to improve care globally.

7.5 Organizational policies, procedures, and/or practice guidelines are based on current research findings and best evidence with regular review and revisions as needed and when new guidelines/findings are published.

7.6 The clinician obtains approval for research activities in accordance with local/national laws and organizational policy.

Practice Recommendations

A. Collaborate with health care team members and leadership to support a culture of EBP and research that advances safe and effective infusion therapy.[1-14] (IV)
B. Participate in critically evaluating, interpreting, and synthesizing research findings and current best evidence into practice through implementation and sustainment, considering the clinician's education and position, and through a collaborative decision-making framework. This includes, but is not limited to, policy and procedure development or revision; product technology selection; practice guideline implementation; and evidence-based QI.[15-19] (I)
C. Participate in infusion therapy research activities that advance knowledge, considering the clinician's education, experience, and position; this includes activities such as participating on a research team or journal club, piloting new products within a research framework and Institutional Review Board (IRB) approval, and disseminating research findings to support EBP initiatives.[20-25] (III)

REFERENCES

Note: All electronic references in this section were accessed May 21, 2020.

1. Copeland D, Miller K, Clanton C. The creation of an interprofessional evidence-based practice council. *J Nurs Adm.* 2020;50(1):12-15. doi:10.1097/NNA.0000000000000832
2. Cullen L, Hanrahan K, Farrington M, DeBerg J, Tucker S, Kleiber C. *Evidence-Based Practice in Action: Comprehensive Strategies, Tools, and Tips From the University of Iowa Hospitals and Clinics*. Sigma Theta Tau International; 2018.
3. Dang D, Dearholt SL. *Johns Hopkins Nursing Evidence-Based Practice: Model and Guidelines.* 3rd ed. Sigma Theta Tau International; 2018.
4. DeGrazia M, Difazio RL, Connor JA, Hickey PA. Building and sustaining a culture of clinical inquiry in a pediatric quaternary hospital. *J Nurs Adm.* 2019;49(1):28-34. doi:10.1097/NNA.0000000000000704
5. Hagle M, Dwyer D, Gettrust L, Lusk D, Peterson K, Tennies S. Development and implementation of a model for research, evidence-based practice, quality improvement, and innovation. *J Nurs Care Qual.* 2020;35(2):102-107. doi:10.1097/NCQ.0000000000000422
6. Halm MA, Alway A, Bunn S, et al. Intersecting evidence-based practice with a lean improvement model. *J Nurs Care Qual.* 2018;33(4):309-315. doi:10.1097/NCQ.0000000000000313

7. Harvey G, Kitson A. PARIHS revisited: from heuristic to integrated framework for the successful implementation of knowledge into practice. *Implement Sci.* 2016;11:33. doi:10.1186/s13012-016-0398-2
8. Jordan Z, Lockwood C, Munn Z, Aromataris E. The updated Joanna Briggs Institute model of evidence-based healthcare. *Int J Evid Based Healthc.* 2019;17(1):58-71. doi:10.1097/XEB.0000000000000155
9. McCarron TL, Noseworthy T, Moffat K, et al. A co-designed framework to support and sustain patient and family engagement in health-care decision making. *Health Expect.* 2020;23(4):825-836. doi:10.1111/hex.13054
10. Melnyk BM, Fineout-Overholt E, Giggleman M, Choy K. A test of the ARCC© model improves implementation of evidence-based practice, healthcare culture, and patient outcomes. *Worldviews Evid Based Nurs*. 2017;14(1):5-9. doi:10.1111/wvn.12188
11. Cochrane Interactive Learning. Interactive learning: conducting an intervention review. The Cochrane Collaboration website. Published 2020. https://training.cochrane.org/interactivelearning
12. Pratt BR, Dunford BB, Alexander M, Morgeson FP, Vogus TJ. Trends in infusion administrative practices in US health care organizations: an exploratory analysis. *J Infus Nurs.* 2019;42(1):13-22. doi:10.1097/NAN.0000000000000308
13. Scott RD 2nd, Culler SD, Rask KJ. Understanding the economic impact of health care-associated infections: a cost perspective analysis. *J Infus Nurs.* 2019;42(2):61-69. doi:10.1097/NAN.0000000000000313
14. Whalen M, Baptiste DL, Maliszewski B. Increasing nursing scholarship through dedicated human resources: creating a culture of nursing inquiry. *J Nurs Adm*. 2020;50(2):90-94. doi:10.1097/NNA.0000000000000847
15. Blandford A, Dykes PC, Franklin BD, et al. Intravenous infusion administration: a comparative study of practices and errors between the United States and England and their implications for patient safety. *Drug Saf.* 2019;42(10):1157-1165. doi:10.1007/s40264-019-00841-2
16. Boord C. Pulsatile flushing: a review of the literature. *J Infus Nurs*. 2019;42(1):37-43. doi:10.1097/NAN.0000000000000311
17. Degnan DD, Bullard TN, Davis MBH. Risk of patient harm related to unnecessary dilution of ready-to-administer prefilled syringes: a literature review. *J Infus Nurs.* 2020;43(3):146-154. doi:10.1097/NAN.0000000000000366
18. Koyama AK, Maddox CS, Li L, Bucknall T, Westbrook JI. Effectiveness of double checking to reduce medication administration errors: a systematic review. *BMJ Qual Saf.* 2020;29(7):595-603. doi:10.1136/bmjqs-2019-009552
19. Wu S, Li W, Zhang Q, Li S, Wang L. Comparison of complications between peripheral arm ports and central chest ports: a meta-analysis. *J Adv Nurs.* 2018;74(11):2484-2496. doi:10.1111/jan.13766
20. Fujioka G, Newcomb P, Hunchusky C, Myers H, Behan D. Pain perception of a structured vascular access team approach to short peripheral catheter (SPC) placement compared to SPC placement by bedside nurses. *J Infus Nurs.* 2020;43(1):33-38. doi:10.1097/NAN.0000000000000352
21. Harding M, Stefka S, Bailey M, Morgan D, Anderson A. Best practice for delivering small-volume intermittent intravenous infusions. *J Infus Nurs.* 2020;43(1):47-52. doi:10.1097/NAN.0000000000000355
22. Lyons I, Furniss D, Blandford A, et al. Errors and discrepancies in the administration of intravenous infusions: a mixed methods multihospital observational study. *BMJ Qual Saf*. 2018;27(11):892-901. doi:10.1136/bmjqs-2017-007476
23. Tancredi TS, Kissane JL, Lynch FC, Li M, Kong L, Waybill PN. The effect of immediate versus delayed port access on 30-day infection rate. *J Infus Nurs.* 2020;43(3):167-171. doi:10.1097/NAN.0000000000000370
24. Twibell KR, Hofstetter P, Siela D, Brown D, Jones HM. A comparative study of blood sampling from venipuncture and short peripheral catheters in pediatric inpatients. *J Infus Nurs.* 2019;42(5):237-247. doi:10.1097/NAN.0000000000000338
25. Vos J, Franklin BD, Chumbley G, Galal-Edeen GH, Furniss D, Blandford A. Nurses as a source of system-level resilience: secondary analysis of qualitative data from a study of intravenous infusion safety in English hospitals. *Int J Nurs Stud.* 2020;102:103468. doi:10.1016/j.ijnurstu.2019.103468

8. PATIENT EDUCATION

Standard

8.1 The patient/caregiver is educated about the prescribed infusion therapy and plan of care including, but not limited to, the purpose and expected outcome(s) and/or goal(s) of treatment, expected duration of therapy, risks and benefits, infusion therapy administration, VAD options and expected care, potential complications, adverse effects associated with treatment or therapy, and how to access health care services as needed.

8.2 Teaching strategies and learning materials are congruent with the knowledge and skills being taught and encompass patient/caregiver learning needs, abilities, and resources.

Practice Recommendations

A. Develop an effective and mutually agreed upon educational plan based on identified goals to ensure the safe delivery of infusion therapy and reduce the risk of infusion therapy-related complications.
   1. Establish specific, achievable, and measurable goals.
   2. Engage the patient/caregiver/surrogate in the development of and commitment to these goals.
   3. Select effective ways to validate appropriate knowledge and skill acquisition for all aspects of infusion delivery that the patient/caregiver will be performing.
   4. Communicate the educational plan and the patient's progress as the patient transitions to other health care settings.[1-4] (V)

B. Select teaching methods based on an assessment of age, developmental and cognitive level, health literacy, access to educational resources and technology, preferred learning style, cultural influences, and language preference. Also assess additional factors affecting the patient's/caregiver's readiness to learn (eg, current stressors, sensory deficits, functional limitations, and relationship with the clinician).[5-11] (V)
   1. Employ strategies to address issues relative to health literacy when conducting patient teaching to ensure communication is simplified, comprehension is confirmed, and misinformation is minimized.
      a. Recognize populations more likely to have low health literacy: older adults, minorities, and those with limited English proficiency and/or digital literacy. Use teaching strategies that acknowledge that all patients and caregivers may experience difficulty comprehending health-related information. Communication should be simplified, encouraging questions,

and providing resources to readily address ongoing learning needs.

b. Provide training for clinicians on the impact of clinician/patient relationship on effectiveness of education, the utilization of resources to evaluate health literacy, and how to create and/or customize patient education materials that meets cultural needs and accessibility/usability guidelines.

c. Use educational resources that are understandable and actionable. These elements include consideration of health literacy levels (written, verbal, and numeracy), cultural congruence, primary language, and instructional methods. Avoid medical jargon and use plain language.[1,3,7,10,12-27] (II)

2. Consider the impact of home infusion therapy upon caregivers who are required to learn or participate in infusion administration; caregivers as well as patients may experience anxiety, depression, and social restrictions when participating in more complex home infusion therapy such as PN, analgesic infusions, and chemotherapy.[28] (V)
3. Ensure that websites (if used/available for patient/caregiver education) are reputable, usable, and accessible to the learner and incorporate national accessibility standards (eg, meets US Federal Section 508 accessibility and usability guidelines), such as effective use of text and page layout, clear navigation, user experience optimization, and accessibility statement.[29-31] (IV)
4. Consider use of well-designed printed information and technology, such as electronic tablets and educational videos, to enable self-paced and repetitive learning in the patient's home environment and to enhance retention of self-care practices.[6,32-33] (III)
5. Consider providing a bundled approach to patient teaching at home, using printed and audio/visual materials.[34] (IV)
6. Advise the patient/caregiver/surrogate about the benefits and challenges associated with the use of social media (ie, YouTube, Twitter, Facebook, blogs) to obtain health advice and information and to seek social support. Limited research has shown benefits of patient engagement; however, there are challenges that include safety, privacy, and risk of misinformation.[35] (IV)

C. Evaluate patient/caregiver/surrogate learning outcomes with methods that directly measure knowledge, such as demonstration/return demonstration for psychomotor skills, verbal feedback for cognitive knowledge (teach-back), and reports of feelings and beliefs for the affective domain.[3,12,36-38] (II)
D. Educate patients/caregivers about infusion therapy to include, but not limited to:
   1. The right for information about risks, benefits, and consideration for alternative treatment options if available.
   2. VAD options; proper care of the VAD.
   3. Precautions for preventing infection and other complications, including aseptic technique and hand hygiene.
   4. Self-monitoring for signs and symptoms of VAD/infusion-related complications/adverse reactions/side effects, including those that may occur after the infusion device is removed and after the patient leaves the health care setting (eg, signs of postinfusion phlebitis, fever) and how/where to report them.
   5. For outpatients and those receiving home infusion therapy, additional education should also include:
      a. Safe storage, maintenance, and disposal of solutions, supplies, and equipment.
         i. Hazardous medication handling, storage, and management of a potential hazardous spill.
      b. Infusion administration procedures as appropriate.
      c. Use and troubleshooting of the infusion administration method (eg, electronic infusion pump).
      d. Living with an access device, including activity limitations and protecting the device while performing activities of daily living.[6,8,39-41] (V)
E. Evaluate patient/caregiver comprehension and performance at the beginning of infusion therapy and periodically thereafter at established intervals.[41] (V)

REFERENCES

Note: All electronic references in this section were accessed between March 6, 2020, and July 29, 2020.

1. National Network of Libraries of Medicine. Health literacy definition. http://nnlm.gov/outreach/consumer/hlthlit.html
2. Weingart SN, Hsieh C, Lane S, Cleary AM. Standardizing central venous catheter care by using observations from patients with cancer. *Clin J Oncol Nurs.* 2014;18(3):321-326. doi:10.1188/14.CJON.321-326
3. Barton AJ, Allen PE, Boyle DK, Loan LA, Stichler JF, Parnell TA. Health literacy: essential for a culture of health. *J Cont Educ Nurs.* 2018;49(2):73-78. doi:10.3928/00220124-20180116-06
4. Shepherd HL, Barratt A, Jones A, et al. Can consumers learn to ask three questions to improve SDM? A feasibility study of the ASK (AskSHareKnow) patient-clinician communication model intervention in primary health care setting. *Health Expect.* 2016;19(5):1160-1168. doi:10.1111/hex.12409
5. Weiss B. Elder care interprofessional provider sheets: health literacy. University of Arizona Health Sciences. Arizona Center on Aging. Published August 2019. https://www.uofazcenteronaging.com/care-sheet/providers/health-literacy
6. Petroulias PL. Use of electronic tablets for patient education on flushing peripherally inserted central catheters. *J Infus Nurs.* 2017;40(5):298-304. doi:10.1097/NAN.0000000000000239
7. Abu Abed M, Himmel W, Vormfelde S, Koschack J. Video assisted patient education to modify behavior: a systematic review. *Patient Educ Couns.* 2014;97(1):16-22. doi:10.1016/j.pec.2014.06.015
8. Cabrerra MA, Marshall CN, Sadler KA, Murea M. Vascular access: HD patients' perceived knowledge and practices. *Nurs Manage.* 2018;49(11):31-36. doi:10.1097/01.NUMA.0000547260.22709.0f
9. Fisher KA, Tan ASL, Matlock DD, Saver B, Mazor KM, Pieterse AH. Keeping the patient in the center: common challenges in the practice

of shared decision making. *Patient Educ Couns.* 2018;101(12):2195-2201. doi:10.1016/j.pec.2018.08.007

10. Hawley ST, Morris AM. Cultural challenges to engaging patients in shared decision making. *Patient Educ Couns.* 2017;100(1):18-24. doi:10.1016/j.pec.2016.07.008
11. Joseph-Williams N, Elwyn G, Edwards A. Knowledge is not power for patients: a systematic review and thematic synthesis of patient-reported barriers and facilitators to shared decision making. *Patient Educ Couns.* 2014;94(3):291-309. doi:10.1016/j.pec.2013.10.031
12. Brega AG, Barnard J, Mabachi NM, et al. *AHRQ Health Literacy Universal Precautions Toolkit.* 2nd ed. Agency for Healthcare Research and Quality; 2015. AHRQ Publication No. 15-0023-EF. https://www.ahrq.gov/sites/default/files/publications/files/healthlittoolkit2_4.pdf
13. Loan LA, Parnell TA, Stichler JF, et al. Call for action: nurses must play a critical role to enhance health literacy. *Nurs Outlook.* 2018;66(1):91-100. doi:10.1016/j.outlook.2017.11.003
14. Chesser AK, Keene Woods N, Smothers K, Rogers N. Health literacy and older adults: a systematic review. *Gerontol Geriatr Med*. March 15, 2016. doi:10.1177/2333721416630492
15. Perez-Stable EJ, El-Toukhy S. Communicating with diverse patients: how patient and clinician factors affect disparities. *Patient Educ Couns.* 2018;101(12):2186-2194. doi:10.1016/j.pec.2018.08.021
16. Agarwal N, Hansberry DR, Sabourin V, Tomei KL, Prestigiacomo CJ. A comparative analysis of the quality of patient education materials from medical specialties. *JAMA Intern Med.* 2013;173(13):1257-1259. doi:10.1001/jamainternmed.2013.6060
17. Sadigh G, Hawkins CM, O'Keefe JJ, Khan R, Duszak R Jr. Can patients comprehend the educational materials that hospitals provide about common IR procedures? *J Vasc Interv Radiol.* 2015;26(8):1156-1161. doi:10.1016/j.jvir.2015.04.029
18. Foster J, Idossa L, Mau L, Murphy E. Applying health literacy principles: strategies and tools to develop easy-to-read patient education resources. *Clin J Oncol Nurs.* 2016;20(4):433-436.
19. Hansberry DR, Kraus C, Agarwal N, Baker SR, Gonzales SF. Health literacy in vascular and interventional radiology: a comparative analysis of on-line patient education resources. *Cardiovasc Intervent Radiol.* 2014;37(4):1034-1040. doi:10.1007/s00270-013-0752-6
20. Shoemaker SJ, Wolf MS, Brach C. The Patient Education Materials Assessment Tool (PEMAT) and user's guide: an instrument to assess the understandability and actionability of print and audiovisual education materials (version 1.0). Agency for Healthcare Research and Quality; 2013. AHRQ Publication No. 14-0002-EF. Updated August 2014. https://www.ahrq.gov/sites/default/files/publications2/files/pemat_guide_0.pdf
21. Pilcher J, Flanders S. Who is Billy Ruben? Health literacy and patient education. *Neonatal Netw.* 2014;33(3):150-154. doi:10.1891/0730-0832.33.3.150
22. Marcus C. Strategies for improving the quality of verbal patient and family education: a review of the literature and creation of the EDUCATE model. *Health Psychol Behav Med.* 2014;2(1):482-495. doi:10.1080/21642850.2014.900450
23. Büchter RB, Fechtelpeter D, Knelangen M, Ehrlich M, Waltering A. Words or numbers? Communicating risk of adverse effects in written consumer health information: a systematic review and meta-analysis. *BMC Med Inform Decis Mak*. Aug 2014;14:76. doi:10.1186/1472-6947-14-76
24. Zellmer C, Zimdars P, Safdar M. Usefulness of patient education materials for central line associated blood stream infection prevention. *Int J Infect Control.* 2016;12(1):1-5. doi:10.3396/IJIC.v12i1.003.16
25. Dahodwala M, Geransar R, Babion J, de Grood J, Sargious P. The impact of the use of video-based educational interventions on patient outcomes in hospital settings: a scoping review. *Patient Educ Couns*. 2018;101(12):2116–2124. doi:10.1016/j.pec.2018.06.018
26. Schweier R, Romppel M, Richter C, Grande G. Dissemination strategies and adherence predictors for web-based interventions–how efficient are patient education sessions and email reminders? *Health Educ Res*. 2016;31(3):384–394. doi:10.1093/her/cyw019
27. Stacey D, Légaré F, Lewis K, et al. Decision aids for people facing health treatment or screening decisions. *Cochrane Database Syst Rev.* Apr 2017;4:CD001431. doi:10.1002/14651858.CD001431.pub5
28. Gorski LA. The impact of home infusion therapies on caregivers. *Semin Oncol Nurs*. 2019;35(4):370–373. doi:10.1016/j.soncn.2019.06.010
29. Yadrich D, Fitzgerald SA, Werkowitch M, Smith CE. Creating patient and family education websites. *Comput Inform Nurs*. 2012;30(1):46-54. doi:10.1097/NCN.0b013e3182343eac
30. Bailey SC, O'Conor R, Bojarski EA, et al. Literacy disparities in patient access and health-related use of Internet and mobile technologies. *Health Expect*. 2015;18(6):3079–3087. doi:10.1111/hex.12294
31. Hur I, Schmidt JJ, Lee RM. How healthcare technology shapes health literacy: a systematic review. Paper presented at 21st Americas Conference on Information Systems (AMCIS); August 13-15, 2015; Puerto Rico. https://pdfs.semanticscholar.org/0b8d/92a0b60e49157886384e07eccf4efe824b52.pdf
32. Piredda M, Biagioli V, Giannarelli D, et al. Improving cancer patients' knowledge about totally implantable access port: a randomized controlled trial. *Support Care Cancer*. 2016;24(2):833–841. doi:10.1007/s00520-015-2851-1
33. Piredda M, Migliozzi A, Biagioli V, Carassiti M, De Marinis MG. Written information improves patient knowledge about implanted ports. *Clin J Oncol Nurs*. 2016;20(2):E28–E33. doi:10.1188/16.CJON.E28-E33
34. Emery D, Pearson A, Lopez R, Hamilton C, Albert NM. Voiceover interactive powerpoint catheter care education for home parenteral nutrition. *Nutr Clin Pract*. 2015;30(5):714–719. doi:10.1177/0884533615584391
35. Househ M, Borycki E, Kushniruk A. Empowering patients through social media: the benefits and challenges. *Health Informatics J*. 2014;20(1):50–58. doi:10.1177/1460458213476969
36. Peter D, Robinson P, Jordan M, Lawrence S, Casey K, Salas-Lopez D. Reducing readmissions using teach-back: enhancing patient and family education. *J Nurs Adm*. 2015;45(1):35–42. doi:10.1097/NNA.0000000000000155
37. Ha Dinh TT, Bonner A, Clark R, Ramsbotham J, Hines S. The effectiveness of the teach-back method on adherence and self-management in health education for people with chronic disease: a systematic review. *JBI Database System Rev Implement Rep*. 2016;14(1):210–247. doi:10.11124/jbisrir-2016-2296
38. Centrella-Nigro AM, Alexander C. Using the teach-back method in patient education to improve patient satisfaction. *J Contin Educ Nurs*. 2017;48(1):47–52. doi:10.3928/00220124-20170110-10
39. Romyn A, Rush KL, Hole R. Vascular access transition: experiences of patients on hemodialysis. *Nephrol Nurs J*. 2015;42(5):445–454.
40. Vizcarra C, Cassutt C, Corbitt N, Richardson D, Runde D, Stafford K. Recommendations for improving safety practices with short peripheral catheters. *J Infus Nurs*. 2014;37(2):121–124. doi:10.1097/NAN.0000000000000028
41. Gorski LA. *Fast Facts for Nurses About Home Infusion Therapy: The Expert's Best Practice Guide in a Nutshell.* Springer Publishing Company; 2017.

9. INFORMED CONSENT

Standard

9.1 Informed consent is obtained for all infusion/vascular access-related procedures and treatments in accordance with local/national laws, rules and regulations, and organizational policy.

9.2 The clinician performing the invasive procedure (eg, CVAD insertion) facilitates the process and ensures informed consent is obtained.
9.3 The patient or surrogate has the right to accept or refuse treatment.
9.4 Informed consent is required for human subject participation in research in accordance with local/national laws, rules and regulations, and organizational policy.

Practice Recommendations

A. Recognize that obtaining informed consent is an educational process involving the patient in shared decision-making.
   1. The process begins with dialogue between the patient/surrogate and the provider or qualified clinician performing the procedure; however, other clinicians have a significant role in the complete process.
   2. The process concludes with the patient/surrogate signing a consent document or providing verbal consent according to organizational policy (eg, via phone conversation). Organizational policy should outline a process for identifying surrogate decision-makers.
   3. Continued confirmation of informed consent may be necessary for ongoing treatments (eg, hemodialysis or antineoplastic administration).[1-6] (IV)

B. Follow requirements for obtaining informed consent from the patient/surrogate as regulations vary across jurisdictions. Differences include documentation, the professional performing the consent process, procedures/treatments requiring informed consent, and variations in the legal approach to evaluation of informed consent.
   1. Recognize that there could be condition-based exceptions to requirements for informed consent (eg, emergency/life-threatening situations, patient incapacitation without surrogate decision-maker) and adhere to the organizational policy for managing these situations.[4,7] (V)

C. Ensure that the process for informed consent includes these required elements:
   1. Consent is voluntarily given and is free from coercion or persuasion.
   2. The patient/surrogate is capable of comprehending relevant information, appreciates the situation and its consequences, and is able to make choices.
   3. The patient/surrogate has received the necessary information to understand the procedure/treatment, its purpose, risks, potential benefits, alternative procedures/treatments, common complications, and potentially serious or irreversible risks.
   4. Formal interpreter services are used to ensure understanding.
   5. The decision is authorized by the patient/surrogate and documented on the signed form as appropriate.[1,2,4-8] (IV)

D. Facilitate the informed consent process by choosing learning methods most appropriate for the patient's age, relational abilities, and level of health literacy (see Standard 8, *Patient Education*).[9-19] (IV)
   1. Document the informed consent process by serving as a witness to the patient/surrogate signature on an informed consent document, if written consent is required.[13] (V)

E. For research-informed consent, provide explanations and a consent document that begins with a clear, concise, and an accurate representation of the research purpose(s). Use extended dialogue and simplified consent documents with a clear layout and text styling to improve the patient's ability to understand the information. In addition to the standard components of informed consent, the research-informed consent document includes additional components, such as:
   1. The anticipated length of participation in the research.
   2. Identification of procedures that are experimental.
   3. Management processes for confidential patient information and their identity.
   4. Compensation for participation, if any.
   5. Risks and benefits of participation.
   6. Availability of medical treatments if injury occurs.[20-22] (V)

F. Recognize that photographs and/or videotaping of patients may or may not require informed consent.
   1. In the United States, unless the photograph is for treatment purposes, payment for services, or health care operations, written informed consent is required under Health Insurance Portability and Accountability Act (HIPAA) rules when the patient is identifiable by inclusion of the patient's face or other identifiable features, such as jewelry, tattoos, or other anatomically notable scars or lesions. This consent includes how the images will be obtained, managed, stored, and shared.
   2. A photograph that does not identify the patient would not require informed consent under HIPAA rules; however, health care facilities may have policies that go beyond these rules (eg, social media policies).
   3. Unidentifiable photographs have benefits for educational purposes; however, there are challenges with adequate security for storage and use and other legal issues such as copyright ownership.[23-25] (V)

G. Recognize cultural differences that may affect the process of informed consent. The foundation of informed consent is self-determination, which may not fit with cultures where medical treatment choices are a family decision rather than an individual decision.[4,10,14,26] (V)

H. Assess patients with age-, trauma-, or disease-related alterations in cognitive capacity for their ability to consent by using tools to evaluate cognitive status or asking

probing questions to evaluate language comprehension, memory, and ability to reason. When the patient does not have the necessary cognitive capacity, obtain informed consent from a surrogate.[9] (II)

I. For neonatal, pediatric, and adolescent patients, verify that informed consent was obtained for the procedure/treatment from the parent or legal guardian. From the patient, verify assent (ie, agreement) to the procedure/treatment using language and learning methods appropriate for the age and/or cognitive stage of the individual. While there is a lack of consensus over the age of assent, this is generally considered 7 years old or school age.[11,27] (V)

J. Define circumstances (eg, emergent and time-sensitive situations) when exemption from obtaining informed consent is allowed. Document details of information provided, method of discussion (eg, telephone), to whom it was given, and the patient or surrogate response in the patient's health record.[1,2] (V)

REFERENCES

Note: All references in this section were accessed between March 6, 2020, and July 20, 2020.

1. Shah P, Thornton I, Turrin D, Hipskin JE. In: StatPearls [Internet]. Updated June 1, 2020. StatPearls Publishing; 2020. https://www.ncbi.nlm.nih.gov/books/NBK430827/
2. Lindsley KA. Improving quality of the informed consent process: developing an easy-to-read, multimodal, patient-centered format in a real-world setting. *Patient Educ Couns*. 2019;102(5):944-951. https://doi.org/10.1016/j.pec.2018.12.022
3. Raj M, Choi SW, Platt J. A qualitative exploration of the informed consent process in hematopoietic cell transplantation clinical research and opportunities for improvement. *Bone Marrow Transplant*. 2017;52(2):292-298. doi:10.1038/bmt.2016.252
4. Cook WE. "Sign here": nursing value and the process of informed consent. *Plast Surg Nurs.* 2014;34(1):29-33. doi:10.1097/PSN.0000000000000030
5. Brennan F, Stewart C, Burgess H, et al. Time to improve informed consent for dialysis: an international perspective. *Clin J Am SocNephrol.* 2017;12(6):1001-1009. doi:10.2215/CJN.09740916
6. Kerber A. Ethical and legal issues. In: Olsen M, LeFebvre K, Brassil K, eds. *Chemotherapy and Immunotherapy Guidelines.* Oncology Nurses Society; 2019:28.
7. The Joint Commission. Informed consent: more than getting a signature. *Quick Safety*. Issue 21. Published February 2016. https://www.jointcommission.org/-/media/deprecated-unorganized/imported-assets/tjc/system-folders/joint-commission-online/quick_safety_issue_twenty-one_february_2016pdf.pdf?db=web&hash=5944307ED39088503A008A70D2C768AA
8. Cocanour CS. Informed consent-it's more than a signature on a piece of paper. *Am J Surg*. 2017;214(6):993-997.doi:10.1016/j.amjsurg.2017.09.015
9. Fields LM, Calvert JD. Informed consent procedures with cognitively impaired patients: a review of ethics and best practices. *Psychiatry Clin Neurosci*. 2015;69(8):462-71. doi:10.1111/pcn.12289
10. Grady C. Enduring and emerging challenges of informed consent. *N Engl J Med.* 2015;372(22):2172. doi:10.1056/NEJMc1503813
11. Jeremic V, Senecal K, Borry P, Chokoshvilli D, Vears DF. Participation of children in medical decision-making: challenges and potential solutions. *J Bioeth Inq*. 2016;13(4):525-534. doi:10.1007/s11673-016-9747-8
12. Eltorai AEM, Naqvi SS, Ghanian S, et al. Readability of invasive procedure consent forms. *Clin Transl Sci.* 2015;8(6):830-833. doi:10.1111/cts.12364
13. Lee JC, Thorn SH, Chong JW. Patient consent and genuine understanding. *Intern Med J*. 2017;47(6):714-715. doi:10.1111/imj.13448
14. Simkulet W. Informed consent and nudging. *Bioethics.* 2019;33(1):169-184. doi:10.1111/bioe.12449
15. Lee JS, Perez-Stable EJ, Gregorich SE, et al. Increased access to professional interpreters in the hospital improves informed consent for patients with limited English proficiency. *J Gen Intern Med.* 2017;32(8):863-870. doi:10.1007/s11606-017-3983-4
16. Morris SE, Heinssen RK. Informed consent in the psychosis prodrome: ethical, procedural and cultural considerations. *Philos Ethics Humanit Med.* 2014;9:1-9. doi:10.1186/1747-5341-9-19
17. Farrell TW, Widera E, Rosenberg L, et al. AGS position statement: making medical treatment decisions for unbefriended older adults. *J Am Geriatr Soc.* 2017;65(1):14-15. doi:10.1111/jgs.14586
18. Kraft SA, Constantine M, Magnus D, et al. A randomized study of multimedia informational aids for research on medical practices: implications for informed consent. *Clin Trials.* 2017;14(1):94-102. doi:10.1177/1740774516669352
19. Sowan AK, Beraya AR, Carrola A, Reed CC, Matthews SV, Moodley T. Developing, implementing, and evaluating a multimedia patient decision aid program to reform the informed consent process of a peripherally inserted central venous catheter procedure: protocol for quality improvement. *JMIR Res Protoc.* 2018;7(12):e10709. doi:10.2196/10709
20. US Food and Drug Administration. A guide to informed consent: guidance for institutional review boards and clinical investigators. Published January 1998. Updated June 10, 2019. https://www.fda.gov/regulatory-information/search-fda-guidance-documents/guide-informed-consent
21. US Department of Health and Human Services. Meeting new challenges in informed consent in clinical research: an exploratory workshop. Office for Human Research Protections. Published September 7, 2018. https://www.hhs.gov/ohrp/sites/default/files/meeting-new-challenges.pdf
22. US Food and Drug Administration. Protection of human subjects. 21 CFR 50. Updated April 1, 2019. http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=50&showFR=1&subpartNode=21:1.0.1.1.20.2
23. Butler DJ. A review of published guidance for video recording in medical education. *Fam Syst Health*. 2018;36(1):4-16.
24. American Nurses Association. ANA's principles for social networking and the nurse: guidance for registered nurses. American Nurses Association; 2011. https://www.nursingworld.org/~4af4f2/globalassets/docs/ana/ethics/social-networking.pdf
25. Dumestre DO, Fraulin FOG. Balancing the need for clinical photography with patient privacy issues: the search for a secure smartphone application to take and store clinical photographs. *Plast Surg (Oakv).* 2017; 25(4): 255-260. doi:10.1177/2292550317731761
26. Kumar A, Mullick P, Prakesh S, Bharadwaj A. Consent and the Indian medical practitioner. *Indian J Anaesth.* 2015;59(11):695-700.
27. Waligora M, Dranseika V, Piasecki J. Child's assent in research: age threshold or personalisation? *BMC Med Ethics*. 2014;15(1):44.

10. DOCUMENTATION IN THE HEALTH RECORD

Standard

10.1 Clinicians record their initial and ongoing assessments or collection of data, diagnosis or problem, intervention

and monitoring, the patient's response to that intervention, and plan of care for infusion therapy and vascular access in a patient-specific physical (ie, paper) or electronic/digital document. Expected side effects and unexpected adverse events that occur, with actions taken and patient response, are documented.

10.2 Documentation contains accurate, complete, chronological, and objective information in the patient's health record regarding the patient's infusion therapy and vascular access with the clinician's name, licensure or credential to practice, date, and time.

10.3 Documentation is legible, timely, accessible to authorized personnel, efficiently retrievable, and promotes communication with the health care team.

10.4 Documentation reflects the continuity, quality, and safety of care for all patient interactions.

10.5 Documentation guidelines and the policies for confidentiality and privacy of the patient's health care information and personal data are established in organizational policies, procedures, and/or practice guidelines according to the scope of practice for individuals with specific licensure or credentials, standards of care, accrediting bodies, and local/national laws.

Practice Recommendations

A. Documentation includes patient, caregiver, or surrogate's consent or assent to VAD insertion, as appropriate, and their participation in or understanding of VAD-related procedures but not limited to the following:
   1. Patient responses to VAD insertion and removal procedures.
   2. Patient responses to VAD access and/or infusion therapy, including symptoms, side effects, or adverse events.
   3. Patient, caregiver, or surrogate understanding of VAD- and infusion therapy-related education or barriers to that education.[1-5] (I)

B. Include the following in documentation for vascular access and/or VAD-related procedures:
   1. A standardized tool for documenting adherence to recommended practices, such as specific site preparation, infection prevention, and safety precautions taken.[6-12] (IV)
   2. Related to VAD insertion: indication for use, date and time of insertion, number of attempts; type, length, and gauge/size of VAD inserted; functionality of device, identification of the insertion site by anatomical descriptors, laterality, landmarks, or appropriately marked drawings; lot number for all CVADs and implanted devices; type of anesthetic (if used); and the insertion methodology, including visualization and guidance technologies.[10,11,13-16] (V)
   3. Related to each regular assessment of the access site or VAD: condition of the site, dressing, type of catheter securement, dressing change, site care, patient report of discomfort/pain, and changes related to the VAD or access site.[5,16] (V)
   4. A standardized assessment for signs and symptoms of phlebitis, infiltration, and extravasation that is appropriate for the specific patient (eg, age or cognitive ability) with photography as needed and in accordance with organizational policy. This also allows for accurate and reliable evaluation on initial identification and with each subsequent site assessment (see Standard 9, *Informed Consent*).[3,5,14-18] (IV)
   5. Type of therapy, including flushing or locking, drug, dose, rate, time, route, and method of administration, including vital signs and laboratory test results as appropriate; condition of the venipuncture or VAD site prior to and after infusion therapy.[2,10] (V)
   6. Findings of assessment for VAD functionality including patency, absence of signs and symptoms of complications, lack of resistance when flushing, and presence of a blood return upon aspiration.[5,10,17](V)
   7. Type of equipment used for infusion therapy administration; depending on the venue of care, accountability for maintenance, and replacement of administration sets/add-on devices, as well as identification of caregiver or surrogate for patient support and their ability to provide this care.[19] (V)
   8. Clear indication of solutions and medications being infused through each device or lumen when multiple VADs or catheter lumens are used. (Committee Consensus)
   9. Regular assessment is completed of the need for continuation of the VAD:
      a. Daily for acute inpatient settings.[5,12,13] (V)
      b. During regular assessment visits in other settings, such as in the home, outpatient facility, or skilled nursing facility.[20] (V)
   10. Upon removal: condition of site; condition of the VAD, such as length of the catheter compared to length documented at insertion; reason for device removal, interventions during removal, dressing applied, date/time of removal, any necessary continuing management for complications; and, if cultures are obtained, source of culture(s).[5,10,15] (V)

C. Additional documentation related to midline catheters and PICCs includes:
   1. External catheter length and length of catheter inserted.[19] (V)
   2. Circumference of the extremity: at time of insertion and when clinically indicated to assess the presence of edema and possible deep vein thrombosis. Note where the measurement is taken and if it is the same area each time. Note presence of pitting or nonpitting edema.[21,22] (IV)

D. Documentation includes confirmation of the anatomical location of the catheter tip for all CVADs prior to initial use and as needed for evaluation of catheter dysfunction or changes in external length of catheter.[7] (V)

E. Documentation of required elements of care using standardized templates or tools should be used (eg, for

VAD insertion and infusion therapy), without limiting further description as needed.[3,17,23] (V)

F. Complete all documentation in an electronic health record (EHR) or other electronic health information system, if available, using standardized terminologies and promoting communication among the health care team.[1,24-27] (I)
   1. Electronic entries should reflect current patient status, even when an entry is pulled from another location in the health record.[3,28] (V)
   2. The EHR should capture data for QI of patient vascular access without additional documentation from clinicians.[3,29-35] (I)

REFERENCES

Note: All references in this section were accessed between March 6, 2020, and August 10, 2020.

1. DeGroot K, Triemstra M, Paans W, Francke AL. Quality criteria, instruments, and requirements for nursing documentation: a systematic review of systematic reviews. *J Adv Nurs*. 2019;75(7):1379-1393. doi:10.1111/jan.13919
2. Furniss D, Lyons I, Franklin BD, et al. Procedural and documentation variations in intravenous infusion administration: a mixed methods study of policy and practice across 16 hospital trusts in England. *BMC Health Serv Res.* 2018;18(1):270. doi:10.1186/s12913-018-3025-x
3. Kuhn T, Basch P, Barr M, Yackel T; Medical Informatics Committee of the American College of Physicians. Clinical documentation in the 21st century: executive summary of a policy position paper from the American College of Physicians. *Ann Intern Med*. 2015;162(4):301-303.
4. Ozkaynak M, Reeder B, Hoffecker L, Makic MB, Sousa K. Use of electronic health records by nurses for symptom management in inpatient settings: a systematic review. *Comput Inform Nurs*. 2017;35(9):465-472. doi:10.1097/CIN.0000000000000329
5. Ray-Barruel G, Cooke M, Chopra V, Mitchell M, Rickard CM. The I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: a clinimetric evaluation. *BMJ Open*. 2020;10(1):e035239. doi:10.1136/bmjopen-2019-035239
6. Chen W, Yang Y, Li H, Huang X, Zhang W. Adherence to central-line insertion practices (CLIP) with peripherally inserted central catheters (PICC) and central venous catheters (CVC): a prospective study of 50 hospitals in China. *Infect Control Hosp Epidemiol.* 2018;39(1):122123. doi:10.1017/ice.2017.259
7. Hade AD, Beckmann LA, Basappa BK. A checklist to improve the quality of central venous catheter tip positioning. *Anaesthesia.* 2019;74(7):896-903. doi:10.1111/anae.14679
8. O'Grady NP, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. *Am J Infect Control.* 2011;39(4 Suppl 1):S23. doi:10.1016/j.ajic.2011.01.003
9. Taylor JE, McDonald SJ, Earnest A, et al. A quality improvement initiative to reduce central line infection in neonates using checklists. *Eur J Pediatr.* 2017;176(5):639–646. doi:10.1007/s00431-017-2888-x
10. Thate J, Rossetti SC, McDermott-Levy R, Moriarty H. Identifying best practices in electronic health record documentation to support interprofessional communication for the prevention of central line-associated bloodstream infections. *Am J Infect Control.* 2020;48(2):124–131. doi:10.1016/j.ajic.2019.07.027
11. Upadhyaya K, Hendra H, Wilson N. A high impact intervention for a high impact intervention: improving documentation of peripheral venous access insertion in theatre. *J Infect Prev.* 2018;19(1):43–45. doi:10.1177/1757177417724881
12. Yagnik L, Graves A, Thong K. Plastic in patient study: prospective audit of adherence to peripheral intravenous cannula monitoring and documentation guidelines, with the aim of reducing future rates of intravenous cannula-related complications. *Am J Infect Control.* 2017;45(1):34–38. doi:10.1016/j.ajic.2016.09.008
13. Alexandrou E, Ray-Barruel G, Carr PJ, et al. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *J Hosp Med.* 2018;13(5):10.12788/jhm.3039. doi:10.12788/jhm.3039
14. Brady T, Bruno F, Marchionni C, Paquet F. Prevalence and maintenance practices of peripheral intravenous catheters. *Vascular Access.* 2016;10(2):11-19.
15. DeVries M, Strimbu K. Short peripheral catheter performance following adoption of clinical indication removal. *J Infus Nurs.* 2019;42(2):81-90. doi:10.1097/NAN.0000000000000318
16. Høvik LH, Gjeilo KH, Lydersen S, et al. Monitoring quality of care for peripheral intravenous catheters; feasibility and reliability of the peripheral intravenous catheters mini questionnaire (PIVC-miniQ). *BMC Health Serv Res.* 2019;19(1):636. doi:10.1186/s12913-019-4497-z
17. Carry-Littles K, Nguyen K, Rowe T, Johnston PA, Brassil K. Symptom word documentation: a novel approach to identifying and managing hospital-acquired infections. *Am J Infect Control*. 2016;44(11):1424-1426. doi:10.1016/j.ajic.2016.03.004
18. Park SM, Jeong IS, Kim KL, Park KJ, Jung MJ, Jun SS. The effect of intravenous infiltration management program for hospitalized children. *J Pediatr Nurs.* 2016;31(2):172-178. doi:10.1016/j.pedn.2015.10.013
19. Gorski LA. *Phillips's Manual of I.V. Therapeutics: Evidence-Based Practice for Infusion Therapy.* 7th ed. F.A. Davis; 2018:1-39;392.
20. Gorski LA, Hallock D, Kuehn SC, Morris P, Russell JM, Skala LC. Recommendations for frequency of assessment of the short peripheral catheter site. *J Infus Nur.* 2012;35(5):290-292. doi:10.1097/NAN.0b013e318267f636
21. Maneval RE, Clemence BJ. Risk factors associated with catheter-related upper extremity deep vein thrombosis in patients with peripherally inserted central venous catheters: a prospective observational cohort study: part 2. *J Infus Nurs*. 2014;37(4):260-268. doi:10.1097/NAN.0000000000000042
22. Bahl A, Karabon P, Chu D. Comparison of venous thrombosis complications in midlines versus peripherally inserted central catheters: are midlines the safer option? *Clin Appl Thromb Hemost*. 2019;25:1076029619839150. doi:10.1177/1076029619839150
23. Reimschissel E, Dela Cruz B, Gonzalez M, Buitrago J, Goodman C, Johnston PA. Immunotherapy toxicities: a new electronic documentation template to improve patient care. *Clin J Oncol Nurs*. 2017;21(2 Suppl):41-44. doi:10.1188/17.CJON.S2.41-44
24. DeGroot K, De Veer AJE, Paans W, Francke AL. Use of electronic health records and standardized terminologies: a nationwide survey of nursing staff experiences. *Int J Nurs Stud.* 2020;104:103523. doi:10.1016/j.ijnurstu.2020.103523
25. Ibrahim S, Donelle L, Regan S, Sidani S. A qualitative content analysis of nurses' comfort and employment of workarounds with electronic documentation systems in home care practice. *Can J Nurs Res.* 2020;52(1):31-44. doi:10.1177/0844562119855509
26. Perotti S, Ritchie A. The impact of hybridisation on the accuracy of fluid balance documentation: a retrospective cross-sectional analysis of intravenous fluid order and administration documentation using a partly-computerized medical record in an Australian tertiary teaching hospital. *Stud Health Technol Inform*. 2019;264:1751-1752. doi:10.3233/SHTI190630
27. Saranto K, Kinnunen UM, Kivekas E, et al. Impacts of structuring nursing records: a systematic review. *Scand J Caring Sci*. 2014;28(4):629-647. doi:10.1111/scs.12094
28. Patterson ES, Sillars DM, Staggers N, et al. Safe practice recommendations for the use of copy-forward with nursing flow sheets in

hospital settings. *Jt Comm J Qual Patient Saf*. 2017;43(8):375-385. doi:10.1016/j.jcjq.2017.02.009

29. Classen D, Li M, Miller S, Ladner D. An electronic health record-based real-time analytics program for patient safety surveillance and improvement. *Health Aff (Millwood).* 2018;37(11):1805-1812. doi:10.1377/hlthaff.2018.0728
30. Hyman D, Neiman J, Rannie M, Allen R, Swietlik M, Balzer A. Innovative use of the electronic health record to support harm reduction efforts. *Pediatrics*. 2017;139(5):e20153410. doi:10.1542/peds.2015-3410
31. McCarthy B, Fitzgerald S, O'Shea M, et al. Electronic nursing documentation interventions to promote or improve patient safety and quality care: a systematic review. *J Nurs Manag*. 2019;27(3):491-501. doi:10.1111/jonm.12727
32. Quan KA, Cousins SM, Porter DD, et al. Electronic health record solutions to reduce central line-associated bloodstream infections by enhancing documentation of central line insertion practices, line days, and daily line necessity. *Am J Infect Control.* 2016;44(4):438–443. doi:10.1016/j.ajic.2015.10.036
33. Sittig DF, Singh H. Toward more proactive approaches to safety in the electronic health record era. *Jt Comm J Qual Patient Saf*. 2017;43(10):540–547. doi:10.1016/j.jcjq.2017.06.005
34. Strudwick G, Booth R. Quality improvement in vascular access care through the use of electronic health records. *J Assoc Vasc Access*. 2016;21(1):30-34. doi:10.1016/j.java.2015.11.004
35. Zanaboni P, Kummervold PE, Sørensen T, Johansen MA. Patient use and experience with online access to electronic health records in Norway: results from an online survey. *J Med Internet Res*. 2020;22(2):e16144. doi:10.2196/16144

Section Two: Patient and Clinician Safety

11. ADVERSE AND SERIOUS ADVERSE EVENTS

Standard

11.1 Adverse events, serious adverse events (eg, sentinel events), or close calls associated with infusion therapy and/or vascular access devices (VADs) are documented and reported within the health care organization and to the appropriate regulatory body when required.

11.2 The science of safety, which includes human errors and system failures, along with reporting of adverse events and serious adverse events, is defined in organizational policies, procedures, and/or practice guidelines.

Practice Recommendations

A. Use standardized tools to identify, document, and track adverse events in accordance with organization policy. Use documents and tools developed by legal and risk management personnel, providing objective and specific facts about the adverse event. Document adverse events in the patient's health record and incident report system as defined in organizational policy.[1-5] (V)

B. Educate the patient and caregivers about signs and symptoms of complications, reactions, or any untoward event that could be an adverse event and how to contact the appropriate clinician (eg, home care nurse, ambulatory clinic staff) for timely management.[6,7] (II)

C. Report adverse events or serious adverse events or the risk thereof (ie, close calls or good catches) associated with VADs and/or infusion products/devices and the administration of drugs, biologics, and/or infusates to the appropriate individuals and organizations:[1-4,8-13] (V)
   1. Provider and other essential health care team members.
   2. Organization's designated management personnel.
   3. Organizational department(s) (eg, risk management, quality improvement [QI]).
   4. Advisory organizations (eg, Institute for Safe Medication Practices [ISMP]).
   5. Regulatory organizations (eg, US Food and Drug Administration [FDA], Health Protection Branch of the Canada Department of National Health and Welfare [HPB], Federal Institute for Drugs and Medical Devices [BfArM], Medicines and Healthcare products Regulatory Agency [MHRA], Swissmedic).
   6. Accreditation organizations (eg, The Joint Commission, Joint Commission International).
   7. Drug and/or device manufacturers (when possible, retain defective device and return to manufacturer as part of the product incident report).[4,10-13] (V)

D. Investigate serious adverse events immediately to ensure prompt action and improve safety. The process includes a root cause analysis (RCA) or other systematic investigation and analysis to improve quality and safety. Organizations must have a process to determine which serious events require an RCA.[1-3,10,14-17] (V)
   1. Describe and analyze the event and contributing factors to discern the cause(s) of the event.[16,17] (V)
   2. Implement specific strategies and/or actions for improvements that protect patients. An interprofessional approach to patient safety is comprehensive and focuses on systems issues, procedures, human resources, peer and/or clinical review, products/equipment, processes, and training gaps.[1] (V)
   3. Participate in the development, implementation, and evaluation of the improvement plan.[1,10] (V)
   4. Consider using an RCA or other systematic investigation or analysis for complex and/or recurrent problems and for close calls.[15,17] (V)

E. Improve safety within the organization through a prevention-focused approach by:
   1. Developing a culture of safety, shared learning, and high reliability.[18-24] (V)
   2. Focusing on correction of the system(s) and processes rather than blaming the clinician.[19-21] (V)
   3. Examining at-risk behaviors and coaching individuals to make safe behavioral choices according to the precepts of a just culture.[19,21] (V)
   4. Advocating for teamwork interventions, including training and education (eg, focus on communication and leadership); work redesign (eg, change interactions such as interprofessional rounds or local team "huddles"); and use of structured tools and protocols (eg, handoff communication tools and checklists).[23-25] (V)
   5. Standardizing and simplifying the reporting processes throughout the organization as practicable.[26] (IV)
   6. Using a systematic method to guide safety initiatives such as Healthcare Failure Mode and Effect Analysis (HFMEA); (see Standard 6, *Quality Improvement*).[27-30] (IV)

F. Establish a strong just culture that continuously strengthens safety and creates an environment that raises the level of transparency, promotes shared learning, encourages reporting, empowers the clinician to identify and implement appropriate actions to prevent adverse events and close calls, and promotes quality patient outcomes (see Standard 6, *Quality Improvement*).[19-21,31] (V)

G. Promote organizational learning and communicate necessary practice changes to staff at all levels.[16,25,32,33] (V)

H. Ensure responsible disclosure of errors to patients; promote interprofessional collaboration in planning and discussing information with the team responsible for disclosing information about the adverse event to the patient, caregiver, or surrogate.[10,34,35] (V)

I. Include patients in adverse event review when appropriate.[8,9,36] (V)

J. Identify levels of clinical knowledge and skills necessary to reduce adverse events. Fewer adverse events are documented when the skill mix of clinicians is higher.[10] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 30, 2020, and September 11, 2020.

1. The Joint Commission. Sentinel event policy and procedures. Updated January 2020. http://www.jointcommission.org/sentinel_event_policy_and_procedures/
2. The Joint Commission. Patient safety systems (PS) chapter. In: *2020 Comprehensive Accreditation Manuals.* The Joint Commission; 2019. https://www.jointcommission.org/en/standards/patient-safety-systems-ps-chapter/
3. American Nurses Association. *Code of Ethics for Nurses With Interpretive Statements*. 2nd ed. American Nurses Association; 2015:11-12.
4. Institute for Safe Medication Practices. Report an error. https://www.ismp.org/report-error/merp
5. Bolcato M, Fassina G, Rodriguez D, Russo M, Aprile A. The contribution of legal medicine in clinical risk management. *BMC Health Serv Res*. 2019;19(1):85. doi:10.1186/s12913-018-3846-7
6. Harrison R, Walton M, Manias E, et al. The missing evidence: a systematic review of patients' experiences of adverse events in health care. *Int J Qual Health Care*. 2015;27(6):424-442. doi:10.1093/intqhc/mzv075
7. Fønhus MS, Dalsbø TK, Johansen M, et al. Patient-mediated interventions to improve professional practice. *Cochrane Database Syst Rev.* 2018;9(9):CD012472. doi:10.1002/14651858.CD012472.pub2
8. Institute for Safe Medication Practices. ISMP survey helps define near miss and close call. Published September 9, 2009. https://www.ismp.org/resources/ismp-survey-helps-define-near-miss-and-close-call
9. Agency for Healthcare Research and Quality. Patient safety network glossary. https://psnet.ahrq.gov/glossary
10. National Quality Forum. *Patient Safety 2015: Final Technical Report.* US Department of Health and Human Services, National Quality Forum; February 12, 2016. http://www.qualityforum.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=81724
11. US Food and Drug Administration. MedWatch: the FDA safety information and adverse event reporting program. Updated August 1, 2020. https://www.fda.gov/safety/medwatch-fda-safety-information-and-adverse-event-reporting-program
12. US Food and Drug Administration. Sentinel initiative: final assessment report. US Food and Drug Administration; 2017. https://www.fda.gov/media/107850/download
13. US Food and Drug Administration. Sentinel system: five year strategy 2019-2023. US Food and Drug Administration; 2019. https://www.fda.gov/media/120333/download
14. Zastrow RL. Root cause analysis in infusion nursing: applying quality improvement tools for adverse events. *J Infus Nurs*. 2015;38(3):225-231. doi:10.1097/NAN.0000000000000104
15. Brook OR, Kruskal JB, Eisenberg RL, Larson DB. Root cause analysis: learning from adverse safety events. *Radiographics*. 2015;35(6):1655-1667. doi:10.1148/rg.2015150067
16. Hooker AB, Etman A, Westra M, Van der Kam WJ. Aggregate analysis of sentinel events as a strategic tool in safety management can contribute to the improvement of healthcare safety. *Int J Qual Health Care*. 2019;31(2):110-116. doi:10.1093/intqhc/mzy116
17. National Patient Safety Foundation, Institute for Healthcare Improvement. RCA^2: improving root cause analyses and actions to prevent harm. National Patient Safety Foundation; 2015. http://www.ihi.org/resources/Pages/Tools/RCA2-Improving-Root-Cause-Analyses-and-Actions-to-Prevent-Harm.aspx
18. Desmedt M, Bergs J, Vertriest S, et al. Systematic psychometric review of self-reported instruments to assess patient safety culture in primary care. *J Adv Nurs*. 2018;74(3):539-549. doi:10.1111/jan.13464
19. Adelman J. High-reliability healthcare: building safer systems through just culture and technology. *J Healthc Manag.* 2019;64(3):137-141. doi:10.1097/JHM-D-19-00069
20. Armstrong G. QSEN safety competency: the key ingredient is just culture. *J Contin Educ Nurs.* 2019;50(10):444-447. doi:10.3928/00220124-20190917-05
21. DeSocio PA, Garzon MP, Hicks MR. Building a culture of safety: relearning organizational behavior. *Int Anesthesiol Clin*. 2019;57(3):12-24. doi:10.1097/AIA.0000000000000242
22. DiCuccio MH. The relationship between patient safety culture and patient outcomes: a systematic review. *J Patient Saf*. 2015;11(3):135-142. doi:10.1097/PTS.0000000000000058
23. Guttman OT, Lazzara EH, Keebler JR, Webster KLW, Gisick LM, Baker AL. Dissecting communication barriers in healthcare: a path to enhancing communication resiliency, reliability, and patient safety [published online ahead of print Nov 9, 2018]. *J Patient Saf*. 2018;10.1097/PTS.0000000000000541
24. Sim MA, Ti LK, Mujumdar S, et al. Sustaining the gains: a 7-year follow-through of a hospital-wide patient safety improvement project on hospital-wide adverse event outcomes and patient safety culture [published online ahead of print May 9, 2020]. *J Patient Saf*. 2020;10.1097/PTS.0000000000000725
25. Lee W, Kim SY, Lee SI, Lee SG, Kim HC, Kim I. Barriers to reporting of patient safety incidents in tertiary hospitals: a qualitative study of nurses and resident physicians in South Korea. *Int J Health Plann Manage*. 2018;33(4):1178-1188. doi:10.1002/hpm.2616
26. Tevis SE, Schmocker RK, Wetterneck TB. Adverse event reporting: harnessing residents to improve patient safety [published online ahead of print Oct 13, 2017]. *J Patient Saf*. 2017;10.1097/PTS.0000000000000333
27. Li X, He M, Wang H. Application of failure mode and effect analysis in managing catheter-related blood stream infection in intensive care unit. *Medicine (Baltimore).* 2017;96(51):e9339. doi:10.1097/MD.0000000000009339
28. Dehnavieh R, Ebrahimipour H, Molavi-Taleghani Y, Vafaee-Najar A, Noori Hekmat S, Esmailzdeh H. Proactive risk assessment of blood transfusion process, in pediatric emergency, using the Health Care Failure Mode and Effects Analysis (HFMEA). *Glob J Health Sci.* 2014;7(1):322-331. doi:10.5539/gjhs.v7n1p322
29. Faiella G, Parand A, Franklin BD, et al. Expanding healthcare failure mode and effect analysis: a composite proactive risk analysis approach. *Reliability Engineering & System Safety*. 2018;169:117-126. https://doi.org/10.1016/j.ress.2017.08.003

30. Liu HC, You XY, Tsung F, Ji P. An improved approach for failure mode and effect analysis involving large group of experts: an application to the healthcare field. *Qual Eng*. 2018;30(4):762-775. https://doi.org/10.1080/08982112.2018.1448089
31. Paradiso L, Sweeney N. Just culture: it's more than policy. *Nurs Manage*. 2019;50(6):38-45. doi:10.1097/01.NUMA.0000558482.07815.ae
32. Bos K, Dongelmans DA, Greuters S, Kamps GJ, van der Laan MJ. The next step in learning from sentinel events in healthcare. *BMJ Open Qual*. 2020;9(1):e000739. doi:10.1136/bmjoq-2019-000739
33. McFarland DM, Doucette JN. Impact of high-reliability education on adverse event reporting by registered nurses. *J Nurs Care Qual*. 2018;33(3):285-290. doi:10.1097/NCQ.0000000000000291
34. Mira JJ, Lorenzo S, Carrillo I, et al. Lessons learned for reducing the negative impact of adverse events on patients, health professionals and healthcare organizations. *Int J Qual Health Care*. 2017;29(4):450-460. doi:10.1093/intqhc/mzx056
35. Liang SY, Taylor M, Waterman AD. Disclosure of adverse events and medical errors: supporting the patient, the family, and the provider. In: Fondahn E, Lane MA, Vannucci A, De Fer TM, eds. *Washington Manual of Patient Safety and Quality Improvement*. Wolters Kluwer; 2016:151-162.
36. Etchegaray JM, Ottosen MJ, Aigbe A, et al. Patients as partners in learning from unexpected events. *Health Serv Res*. 2016;51(Suppl 3):2600-2614. doi:10.1111/1475-6773.12593

12. PRODUCT EVALUATION, INTEGRITY, AND DEFECT REPORTING

Standard

12.1 Clinician end users are involved in the evaluation of VAD and/or infusion products, equipment, and technologies, including clinical application, performance, infection/complication prevention, safety, efficacy, acceptability, reliability, and cost.

12.2 Clinician end users attain and maintain knowledge about developments and technologies relating to VADs, infusion products, and equipment to meet evidence-based standards.

12.3 Infusion equipment and supplies are inspected for product integrity and function before, during, and after use; product(s) are visually inspected for damage before use; packaging is clean, dry, and intact; product expiration date is verified.

12.4 Expired/defective products are removed from patient use and labeled as such; the problem is reported to the appropriate department within the organization, to the manufacturer, and/or to authoritative reporting organizations as required.

Practice Recommendations

A. Select VADs and infusion-related products/equipment for evaluation based upon factors including, but not limited to, organizational quality indicators, internally and externally reported incident/occurrence/adverse event reports, availability of new/safer products, current/new evidence, and emerging technology.
   1. Include an interprofessional group of direct and indirect clinician end users (eg, staff with human factors training, nurses, infection preventionists, physicians, biomedical engineers, information technologists, pharmacists, and patient representatives) in the product evaluation process.
   2. Assess the following when evaluating products for use in the home: Is the device designed for the unique home environment? Can it be cleaned/disinfected properly between each use? Does it provide feedback to assist the patient/caregiver to identify and troubleshoot problems? Will the product/technology improve communication between the home care patient and the health care team?
   3. Establish clear goals of what is to be measured and evaluated during the process of product evaluation (eg, enhance continuity of care, reduce a complication, improve clinician compliance, save time, and standardize use) and define in advance the minimum parameters that must be met for evaluation to be considered successful.
   4. Evaluate the intended organizational use of the product (eg, reduction of infection, occlusion, or thrombosis) against the manufacturers' directions for use and indications for the product.
   5. Develop data collection tools for analysis and ongoing monitoring.
   6. Provide education and training for use of the product/equipment selected for evaluation; consider support/involvement by the manufacturer in product education.[1-3] (V)

B. Report problems associated with use of any product; remove from use and follow organizational policies and procedures for reporting.
   1. Monitor for product recalls and hazard alerts.
   2. Use a structured and objective approach when investigating problems associated with medical devices, which may include issues such as device malfunction and user error; identify the need for additional clinician education.
   3. Develop an organizational environment conducive to reporting.
      a. Recognize that clinicians may switch to different devices or develop work-around strategies to continue to use problematic products and may be uncertain regarding what to report and be fearful of incident reporting.
      b. Explore systems to facilitate the ease of reporting.
   4. Instruct home care patients/caregivers to promptly report any problems related to the use of products/technology; recognize that infusion pumps in particular are associated with numerous incidents including malfunction, programming errors, incorrect setup, equipment damage, and degradation (refer to Standard 24, *Flow-Control Devices*).
   5. Report adverse events or serious adverse events (eg, sentinel events), or the risk thereof (ie, close calls) associated with VADs and/or infusion products/equipment and the administration of drugs and biologics, to

the appropriate department(s) within the organization (eg, risk management, QI) and authoritative reporting organizations as required (see Standard 11, *Adverse and Serious Adverse Events*).[2,4-10] (IV)

REFERENCES

Note: All electronic references in this section were accessed between March 6, 2020, and August 4, 2020.

1. Kelly LJ. Right evaluation of products and compliance measures. In: Moureau NL, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access.* SpringerOpen; 2019:285-292. https://link.springer.com/book/10.1007/978-3-030-03149-7
2. Weick-Brady M. From hospital to home: a process map for successful infusion therapy transition. AAMI Foundation; 2018. https://www.aamifoundation.org/wp-content/uploads/dlm_uploads/2018/12/AAMI_HospitaltoHomeGuide_8.5x11_FINAL0918-002.pdf
3. Lyons I, Blandford A. Safer healthcare at home: detecting, correcting and learning from incidents involving infusion devices. *Appl Ergon.* 2018;67:104-114. doi:10.1016/j.apergo.2017.09.010
4. US Food and Drug Administration. MedWatch: the FDA safety information and adverse event reporting program. Updated August 1, 2020. https://www.fda.gov/safety/medwatch-fda-safety-information-and-adverse-event-reporting-program
5. Gagliardi AR, Ducey A, Lehoux P, et al. Factors influencing the reporting of adverse medical device events: qualitative interviews with physicians about higher risk implantable devices. *BMJ Qual Saf.* 2018;27(3):190-198. doi:10.1136/bmjqs-2017-006481
6. Amoore JN. A structured approach for investigating the causes of medical device adverse events. *J Med Eng.* 2014;2014:314138. doi:10.1155/2014/314138
7. Almadi MA, Alsohaibani FI. Reporting adverse medical device events is an obligation and not a "fashion." *Obes Surg.* 2019;29(9):2974-2975. doi:10.1007/s11695-019-03974-6
8. US Food and Drug Administration. Infusion pump risk reduction strategies. Updated August 22, 2018. https://www.fda.gov/medical-devices/infusion-pumps/infusion-pump-risk-reduction-strategies
9. Polisena J, Gagliardi A, Clifford T. How can we improve the recognition, reporting and resolution of medical device-related incidents in hospitals? A qualitative study of physicians and registered nurses. *BMC Health Serv Res.* 2015;15:220. doi:10.1186/s12913-015-0886-0
10. Polisena J, Gagliardi A, Urbach D, Clifford T, Fiander M. Factors that influence the recognition, reporting and resolution of incidents related to medical devices and other healthcare technologies: a systematic review. *Syst Rev.* 2015;4:37. doi:10.1186/s13643-015-0028-013.

13. MEDICATION VERIFICATION

Standard

13.1 Medications and infusion solutions are identified, compared against the medication order and infusion control device (if applicable), and verified by reviewing the label for the name (brand and generic), dosage and concentration, total volume, beyond-use/expiration date, route of administration, frequency, rate of administration, and any other special instructions.

13.2 At least 2 patient identifiers, including patient's full name (or distinct methods of identification for infants), are used to ensure accurate patient identification when administering medications.

Practice Recommendations

A. Perform a medication reconciliation at each care transition and when a new medication(s) is ordered (eg, admission, transfers to different levels of care, discharge to new health care setting). Include verification of discontinued medications to reduce the risk of medication errors, including omissions, duplications, dosing errors, and drug interactions.[1–7] (III)

B. Confirm the "rights" for safe medication administration (eg, right patient, drug, dose, route, time, reason), including expiration dates and patient allergy status.[8–15] (V)
   1. Perform a cognitive review of all components of the medication assessment, beyond the medication rights (eg, appropriateness of drug, dose, route, compatibility of multiple drugs, monitoring test results, flow-control device settings, correct infusion is activated).[12,14–16] (V)
   2. Use critical reasoning and situational awareness when verifying medication, as well as recognizing limitations of technology if used.[9,17] (V)
   3. Teach patients/caregivers who self-administer medications to confirm the medication rights.[18] (V)

C. Avoid interruptions during all phases of medication administration and educate staff, patients, and families, as there is a significant association between medication errors and interruptions.[19-21] (IV)

D. Implement safeguards to reduce the risk of medication errors with high-alert medications, such as:
   1. Standardize storage, preparation, and administration (eg, standard order sets, standardized drug concentrations and dosing units); improve access to drug information; limit access (eg, stored securely, limited quantities); use supplementary labels and automated alerts.[22-24] (IV)
   2. Perform an independent double check by 2 clinicians for the organization's selected high-alert medications that pose the greatest risk of harm (eg, opioids, insulin, heparin, chemotherapy).[12,25-27] (V)
      a. Develop a standard process and educate staff in how to perform the double check. Consider the use of a checklist.[4,6,8,10,12,28-34] (III)
      b. Monitor compliance with use of independent double checks.[12] (V)

E. Trace all catheters/administration sets/add-on devices between the patient's access device and the solution container before connecting or reconnecting any infusion/device, at each care transition to a new setting or service, and as part of the handoff process.[13,35,36] (V)

F. Minimize errors related to multiple infusions (refer to Standard 24, *Flow-Control Devices*; Standard 59, *Infusion Medication and Solution Administration*).

G. Use approved, standardized nomenclature for communication of medication information. Use a list of error-prone drug names, abbreviations, symbols, and dose

designations (eg, sound-alike, look-alike drugs) to implement safeguards to reduce the risk for medication errors, such as using both generic and brand names; including reason for medication on label; and changing the appearance of look-alike names by using approved, bolded, tall man (mixed case) lettering.[6,35-36] (V)

H. Use technology when available to verify medications prior to administration as one of multiple infusion safety strategies. Analyze effectiveness and limitations related to technology through organizational QI processes.[4,37-41] (IV)
   1. Use barcode scanning (preferred) or similar technology immediately prior to the administration of medication (unless its use would result in a clinically significant delay and potential patient harm, such as in cardiac arrest). Barcode scanning is associated with decreased risk of medication errors and is increasingly common among acute care organizations, and there is emerging research supporting its use in long-term care settings. Studies have reported that errors still occur as staff may create "work-arounds" that bypass safety mechanisms with barcode technology.[6,18,30,38,39,42-44] (IV)
   2. Use electronic infusion pumps that include dose error reduction systems ([DERS] ie, smart pumps) with current and relevant drug libraries, as these are associated with reduced risk for infusion-related medication errors, including error interceptions (eg, wrong rate) and reduced adverse drug events.[6,45,46] (II)
      a. Provide regular education and training, including usability issues and avoidance of work-arounds, and assessment of use for both routine users and new staff members; failure to comply with appropriate use, overriding of alerts, and use of the wrong drug library contribute to the risks associated with smart pumps and high-risk medications.[15,22,30,37,39,46-48] (II)
   3. Consider implementation of interoperable infusion systems, incorporating medication orders, a drug library, electronic health record (EHR), barcode medication administration, and reporting to satisfy the rights of medication safety.[22,39] (V)
   4. Encourage use of medication labels consistent in format and content from the electronic infusion pump drug library to the infusion reservoir (eg, bag labels) to the health record documentation.[39] (V)

I. Do not use color differentiation or color matching as the sole cue for product or medication identification. Color coding can lead users to rely on the color coding rather than ensuring a clear understanding of which administration sets and VADs are connected.[49,50] (IV)

J. Ensure standardized, facility-approved resources are readily available at the point of care to guide the safe practice of intravenous (IV) medication administration.[36] (V)

K. Report adverse events/medication discrepancies associated with medications and biologic agents to the appropriate department within the organization and authoritative reporting organizations. Medication errors should be regularly monitored and results communicated to staff as a means of prevention (see Standard 11, *Adverse and Serious Adverse Events*).[43,51] (V)

REFERENCES

Note: All electronic references in this section were accessed between April 6, 2020, and August 3, 2020

1. Institute for Healthcare Improvement. Reconcile medications at all transition points. http://www.ihi.org/resources/Pages/Changes/ReconcileMedicationsatAllTransitionPoints.aspx
2. Almanasreh E, Moles R, Chen TF. The medication reconciliation process and classification of discrepancies: a systematic review. *Br J Clin Pharmacol.* 2016;82:645-658. doi:10.1111/bcp.13017
3. Bosma LBE, Hunfeld NGM, Quax RAM, et al. The effect of a medication reconciliation program in two intensive care units in the Netherlands: a prospective intervention study with a before and after design. *Ann Intensive Care*. 2018;8(1):19. doi:10.1186/s13613-018-0361-2
4. Baldwin A, Rodriguez ES. Improving patient safety with error identification in chemotherapy orders by verification nurses. *Clin J Oncol Nurs.* 2016;20(1):59-65. doi:10.1188/16.CJON.59-65
5. Cheema E, Alhomoud FK, Kinsara ASA, et al. The impact of pharmacists-led medicines reconciliation on healthcare outcomes in secondary care: a systematic review and meta-analysis of randomized controlled trials. *PLoS One.* 2018;13(3):e0193510. doi:10.1371/journal.pone.0193510
6. Kane-Gill SL, Dasta JF, Buckley MS, et al. Clinical practice guideline: safe medication use in the ICU. *Crit Care Med*. 2017;45(9):e877-e915. doi:10.1097/ccm.0000000000002533
7. Redmond P, Grimes T, McDonnell R, Boland F, Hughes C, Fahey T. Impact of medication reconciliation for improving transitions of care. *Cochrane Database Syst Rev.* 2018;8(8):CD010791. doi:10.1002/14651858.CD010791.pub2
8. Kellett P, Gottwald M. Double-checking high risk medications in acute settings: a safer process. *Nurs Manage (Harrow).* 2015;21(9):16-22. doi:10.7748/nm.21.9.16.e1310
9. Martyn J, Paliadelis P, Perry C. The safe administration of medication: nursing behaviours beyond the five-rights. *Nurse Educ Pract*. 2019;37:109-114. doi:10.1016/j.nepr.2019.05.006
10. Furniss D, Lyons I, Franklin BD, et al. Procedural and documentation variations in intravenous infusion administration: a mixed methods study of policy and practice across 16 hospital trusts in England. *BMC Health Serv Res.* 2018;18(1):270. doi:10.1186/s12913-018-3025-x
11. Schiff G, Volk LA, Wright A, et al. Enhancing medication CPOE safety and quality by indications-based prescribing (Massachusetts): final report. Agency for Healthcare Research and Quality; 2018. https://digital.ahrq.gov/sites/default/files/docs/citation/r01hs023694-schiff-final-report-2018.pdf
12. Institute for Safe Medication Practices. Independent double checks: worth the effort if used judiciously and properly. Published June 6, 2019. https://www.ismp.org/resources/independent-double-checks-worth-effort-if-used-judiciously-and-properly
13. Grissinger M. Using a saline flush "site unseen" could lead to a wrong-route error. *P T.* 2016;41(11):665-666.
14. US Food and Drug Administration. Infusion pump risk reduction strategies for home health nurses. Updated February 2, 2018. https://www.fda.gov/medical-devices/infusion-pumps/infusion-pump-risk-reduction-strategies-home-health-nurses
15. Giuliano KK, Ruppel H. Are smart pumps smart enough? *Nursing (Lond).* 2017;47(3):64-66. doi:10.1097/01.NURSE.0000512888.75246.88

16. ECRI Institute. Top 10 health technology hazards for 2017: a report from *Health Devices* November 2016 [executive brief]. ECRI Institute; 2017. https://www.ecri.org/Resources/Whitepapers_and_reports/Haz17.pdf
17. Furniss D, Franklin BD, Blandford A. The devil is in the detail: how a closed-loop documentation system for IV infusion administration contributes to and compromises patient safety [published online ahead of print Apr 15, 2019]. *Health Informatics J.* 2019;1460458219839574. doi:10.1177/1460458219839574
18. Goldspiel B, Hoffman J, Griffith N, et al. ASHP guidelines on preventing medication errors with chemotherapy and biotherapy. *Am J Health Syst Pharm*. 2015;72(8):e6-e35. doi:10.2146/sp150001
19. Campoe KR, Giuliano KK. Impact of frequent interruption on nurses' patient-controlled analgesia programming performance. *Hum Factors.* 2017;59(8):1204-1243. doi:10.1177/0018720817732605
20. Raja, Badil, Ali S, Sherali S. Association of medication administration errors with interruption among nurses in public sector tertiary care hospitals. *Pak J Med Sci.* 2019;35(5):1318-1321. doi:10.12669/pjms.35.5.287
21. Dall'Oglio I, Fiori M, Di Ciommo V, et al. Effectiveness of an improvement programme to prevent interruptions during medication administration in a paediatric hospital: a preintervention – postintervention study. *BMJ Open*. 2017;7(1):e013285. doi:10.1136/bmjopen-2016-013285
22. Canadian Agency for Drugs and Technologies in Health (CADTH). Smart infusion pump use in hospitalized patients: clinical safety and guidelines. *Rapid Response Report: Summary of Abstracts.* CADTH; 2014. https://www.cadth.ca/sites/default/files/pdf/htis/feb-2014/RB0640%20Smart%20Pumps%20Final.pdf
23. DeLaurentis PC, Hsu KY, De la Armenta AI, Bitan Y. Investigating delays in updates to infusion pump drug limit libraries. *AMIA Annu Symp Proc*. 2017;2016:490-495.
24. Kanjia MK, Adler AC, Buck D, Varughese AM. Increasing compliance of safe medication administration in pediatric anesthesia by use of a standardized checklist. *Pediatr Anesth.* 2019;29(3):258-264. doi:10.1111/pan.13578
25. Institute for Safe Medication Practices. ISMP list of high-alert medications in community/ambulatory healthcare. Published 2011. https://www.ismp.org/sites/default/files/attachments/2017-11/highAlert-community.pdf
26. Institute for Safe Medication Practices. ISMP list of high-alert medications in long-term care (LTC) settings. Published 2016. https://www.ismp.org/sites/default/files/attachments/2017-11/LTC-High-Alert-List.pdf
27. Institute for Safe Medication Practices. ISMP list of high-alert medications in acute care settings. Published 2018. https://www.ismp.org/sites/default/files/attachments/2018-10/highAlert-2018new-Oct2018-v1.pdf
28. Douglass AM, Elder J, Watson R, Kallay T, Kirsh D. A Randomized controlled trial on the effect of a double check on the detection of medication errors. *Ann Emerg Med.* 2018;71(1):74-82.e1. doi:10.1016/j.annemergmed.2017.03.022
29. Koyama AK, Maddox CS, Li L, Bucknall T, Westbrook JI. Effectiveness of double checking to reduce medication administration errors: a systematic review. *BMJ Qual Saf*. 2020;29(7):595-603. doi:10.1136/bmjqs-2019-009552
30. Lapkin S, Levett-Jones T, Chenoweth L, Johnson M. The effectiveness of interventions designed to reduce medication administration errors: a synthesis of findings from systematic reviews. *J Nurs Manag.* 2016;24(7):845-858. doi:10.1111/jonm.12390
31. Schutijser B, Klopotowska JE, Jongerden I, Spreeuwenberg P, Wagner C, de Bruijne M. Nurse compliance with a protocol for safe injectable medication administration: comparison of two multicentre observational studies. *BMJ Open.* 2018;8(1):e019648. doi:10.1136/bmjopen-2017-019648
32. Schwappach DLB, Taxis K, Pfeiffer Y. Oncology nurses' beliefs and attitudes towards the double-check of chemotherapy medications: a cross-sectional survey study. *BMC Health Serv Res*. 2018;18(1):123.
33. Ibeas-lopez J. New technology: heparin and antimicrobial-coated catheters. *J Vasc Access*. 2015;16(Suppl 9):S48-S53. doi:10.5301/jva.5000376
34. Subramanyam R, Mahmoud M, Buck D, Varughese A. Infusion medication error reduction by two-person verification: a quality improvement initiative. *Pediatrics.* 2016;138(6):e20154413. doi:10.1542/peds.2015-4413
35. Institute for Safe Medication Practices. ISMP guidelines for safe electronic communication of medication information. Published January 16, 2019. https://www.ismp.org/resources/guidelines-safe-electronic-communication-medication-information
36. Institute for Safe Medication Practices. FDA and ISMP lists of look-alike drug names with recommended tall man letters. Published November 20, 2016. https://www.ismp.org/recommendations/tall-man-letters-list
37. Giuliano KK, Su WT, Degnan DD, Fitzgerald K, Zink RJ, DeLaurentis P. Intravenous smart pump drug library compliance: a descriptive study of 44 hospitals. *J Patient Saf.* 2018;14(4):e76–e82.doi:10.1097/pts.0000000000000383
38. Marwitz K, Giuliano K, Su W, Degnan D, Zink R, DeLaurentis P. High-alert medication administration and intravenous smart pumps: a descriptive analysis of clinical practice. *Res Soc Adm Pharm*. 2019;15(7):889-894. doi:10.1016/j.sapharm.2019.02.007
39. Association for the Advancement of Medical Instrumentation, US Food and Drug Administration. Infusing patients safely: priority issues from the AAMI/FDA Infusion Device Summit. October 5-6, 2010. https://www.aami.org/docs/default-source/reports/aami_fda_summit_report.pdf
40. Schnock KO, Dykes PC, Albert J, et al. The frequency of intravenous medication administration errors related to smart infusion pumps: a multihospital observational study. *BMJ Qual Saf.* 2017;26(2):131-140. doi:10.1136/bmjqs-2015-004465
41. Institute for Safe Medication Practices. 2018-2019 targeted medication safety best practices for hospitals. Institute for Safe Medication Practices; 2019. https://www.ismp.org/sites/default/files/attachments/2019-01/TMSBP-for-Hospitalsv2.pdf
42. Shah K, Lo C, Babich M, Tsao NW, Bansback NJ. Bar Code medication administration technology: a systematic review of impact on patient safety when used with computerized prescriber order entry and automated dispensing devices. *Can J Hosp Pharm.* 2016;69(5):394-402. doi:10.4212/cjhp.v69i5.1594
43. Institute for Safe Medication Practices. ISMP safe practice guidelines for adult IV push medications: a compilation of safe practices from the ISMP Adult IV Push Medication Safety Summit. Institute for Safe Medication Practices; 2015. https://www.ismp.org/sites/default/files/attachments/2017-11/ISMP97-Guidelines-071415-3.%20FINAL.pdf
44. Institute for Safe Medication Practices. Guidelines for optimizing safe implementation and use of smart infusion pumps. Published February 10, 2020. https://www.ismp.org/guidelines/safe-implementation-and-use-smart-pumps
45. Ibarra-Perez R, Puertolas-Balint F, Lozano-Cruz E, Zamora-Gomez SE, Castro-Pastrana LI. Intravenous administration errors intercepted by smart infusion technology in an adult intensive care unit [published online ahead of print Apr 1, 2017] *J Patient Saf*. 2017;10.1097/PTS.0000000000000374. doi:10.1097/pts.0000000000000374
46. Ohashi K, Dalleur O, Dykes PC, Bates DW. Benefits and risks of using smart pumps to reduce medication error rates: a systematic review. *Drug Saf.* 2014;37(12):1011-1020. doi:10.1007/s40264-014-0232-1
47. Shah PK, Irizarry J, O'Neill S. Strategies for managing smart pump alarm and alert fatigue: a narrative review. *Pharmacotherapy.* 2018;38(8):842-850. doi:10.1002/phar.2153
48. Dunford BB, Perrigino M, Tucker SJ, et al. Organizational, cultural, and psychological determinants of smart infusion pump work arounds:

a study of 3 U.S. health systems. *J Patient Saf.* 2017;13(3):162-168. doi:10.1097/pts.0000000000000137

49. Wolf ZR. Medication errors involving the intravenous administration route. *J Infus Nurs*. 2016;39(4):235-248. doi:10.1097/NAN.0000000000000178
50. Simmons D, Symes L, Guenter P, Graves K. Tubing misconnections: normalization of deviance. *Nutr Clin Pract.* 2011;26(3):286-293.
51. El Meneza S, Habib A, Mohamed R. Analysis and identifying risk profile for medication errors in the neonatal intensive care units. *EC Paediatr.* 2018;7(7):669-684.

14. LATEX SENSITIVITY OR ALLERGY

Standard

14.1 Exposure to latex in the environment is minimized.

14.2 Latex-free personal protective equipment (PPE), patient care equipment, and other supplies are provided to latex-sensitive or latex-allergic clinicians and patients and are used during patient care.

Practice Recommendations

A. Identify health care providers with latex allergy/sensitivity; exposure to latex gloves is the most common cause of latex allergy/sensitivity.[1-6] (IV)

B. Identify patients at increased risk for or with known latex allergy/sensitivity.
   1. Children with birth defects/diseases requiring multiple surgeries/indwelling urinary catheters.
   2. Patients with myelomeningocele; an important risk factor for these patients is having more than 5 surgeries.
   3. Patients with allergy to tropical fruits (eg, avocado, banana, chestnut, kiwi) have a high cross-reactivity to latex as such fruits contain proteins with allergenic similarities to latex.[3,5,7,8] (IV)

C. Document and communicate the positive screen for latex sensitivity or allergy in the patient's health record so all health care providers involved in the patient's care can incorporate into the patient's plan of care.[4,9] (V)

D. Distinguish between the signs and symptoms associated with latex sensitivity vs latex allergy:
   1. Latex sensitivity/allergic contact dermatitis: type IV immunologic reaction/delayed T-cell–mediated reaction to chemicals used in latex manufacturing; begins with an acute eczema-like skin rash, vesicles, and pruritus, erythema, or hives. With continued exposure to latex, sensitivity can become latex allergy.
   2. Latex allergy: type I immunoglobulin E (IgE)–mediated hypersensitivity reactions occur within minutes of exposure to latex; reactions range from mild (eg, urticaria, rhinoconjunctivitis) to severe (eg, bronchospasm, hypotension, anaphylaxis).[4,5] (IV)

E. Recognize potential exposure routes to latex including direct skin contact, airborne exposure (largely reduced with powder-free gloves), and food/medicine contamination (medical devices, vials).[5,10] (V)

F. Use nonpowdered, nonlatex gloves; a change to nonpowdered latex and synthetic gloves has resulted in dramatic reduction in sensitization.
   1. The FDA has banned the use of powdered surgeon's gloves, powdered patient examination gloves, and absorbable powder for lubricating a surgeon's glove.[11] (IV)

G. Minimize exposure to latex for those at risk or with known latex allergy/sensitivity as frequent exposure to latex remains the primary cause of sensitization.
   1. Review the label on medical devices, equipment, and supplies prior to use for the presence of latex, which is a component of product labeling required by the FDA.
   2. Remove latex-containing products from the patient care setting to reduce the exposure to latex.
   3. Recognize that latex products are ubiquitous and that prevention of contact with latex is challenging; examples of items within homes include balloons, baby bottle nipples/pacifiers, and toys; refer to available lists of products that contain latex.
   4. Access medication vials with latex stoppers only once; most multidose vials no longer contain latex; the Centers for Disease Control and Prevention (CDC) provides a list of vaccines indicating presence or absence of latex in the packaging (eg, syringe/vial).
   5. Provide patient education regarding how to avoid latex exposure.[12-14] (V)

H. Instruct patients/clinicians with latex allergy to wear a medical alert bracelet/necklace, inform all health care providers and caregivers (eg, teachers, babysitters) about latex allergies, carry an epinephrine auto-injector and ensure patient/caregivers are competent to use it.[7,14] (V)

REFERENCES

Note: All electronic references in this section were accessed between March 6, 2020, and August 4, 2020.

1. US Department of Labor. Potential for sensitization and possible allergic reaction to natural rubber latex gloves and other natural rubber products. Occupational Safety and Health Administration. *Safety and Health Information Bulletin.* SHIB 01-28-2008. Published January 28, 2008. https://www.osha.gov/dts/shib/shib012808.html
2. Buss ZS, Kupek E, Frode TS. Screening for latex sensitization by questionnaire: diagnostic performance in health care workers. *J Investig Allergol Clin Immunol.* 2008;18(1):12-16.
3. Kelly KJ, Sussman G. Latex allergy: where are we now and how did we get there? *J Allergy Clin Immunol Pract.* 2017;5(5):1212-1216. doi:10.1016/j.jaip.2017.05.029
4. Kahn SL, Podjasek JO, Dimitropoulos VA, Brown CW. Natural rubber latex allergy. *Dis Mon*. 2016;62(1):5-17. doi:10.1016/j.disamonth.2015.11.002
5. Wu M, McIntosh J, Liu J. Current prevalence of latex allergy: why it remains a problem? *J Occup Health.* 2016;58(2):138-144. doi:10.1539/joh.15-0275-RA
6. Köse S, Mandiracioğlu A, Tatar B, Güi S, Erdem. Prevalence of latex allergy among healthcare workers in Izmir (Turkey). *Cent Eur J Public Health.* 2014;22(4):262-265. doi:10.21101/cejph.a3912

7. Hohler SE. Keeping children with latex allergies safe. *Nursing.* 2017;47(10):1-5. doi:10.1097/01.NURSE.0000524760.51000.bd
8. Parisi CA, Petriz NA, Busaniche JN, et al. Prevalence of latex allergy in a population of patients diagnosed with myelomeningocele. *Arch Argent Pediatr.* 2016;114(1):30-35. doi:10.5546/aap.2016.eng.30
9. Minami CA, Barnard C, Bilmoria KY. Management of a patient with a latex allergy. *JAMA.* 2017;317(3):309-310. doi:10.1001/jama.2016.20034
10. Johnson C, Zumwalt M, Anderson N. Latex hypersensitivity to injection devices for biologic therapies in psoriasis patients. *Cutis.* 2018;102(2):116-118.
11. US Food and Drug Administration. Banned devices; powdered surgeon's gloves, powdered patient examination gloves, and absorbable powder for lubricating a surgeon's glove. US Dept of Health and Human Services. *Federal Register.* Vol. 81. No. 24. December 19, 2016. https://www.federalregister.gov/documents/2016/12/19/2016-30382/banned-devices-powdered-surgeons-gloves-powdered-patient-examination-gloves-and-absorbable-powder
12. US Department of Health and Human Services. NIOSH fast facts: home healthcare workers: how to prevent latex allergies. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; February 2012. Publication No. 2012-119. https://www.cdc.gov/niosh/docs/2012-119/pdfs/2012-119.pdf
13. Centers for Disease Control and Prevention. Epidemiology and prevention of vaccine-preventable diseases; appendix B: latex in vaccine packaging. Updated February 2020. https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/appendices/b/latex-table.pdf
14. US National Library of Medicine. Managing latex allergies at home. Updated February 10, 2020. https://medlineplus.gov/ency/patientinstructions/000500.htm

15. HAZARDOUS DRUGS AND WASTE

Standard

15.1 Safe handling of hazardous drugs, appropriate use of PPE, exposure risk reduction, and safe handling of waste, including spills, is addressed in accordance with local/national laws, rules, and regulations as well as organizational policies, procedures and/or practice guidelines.

15.2 Safe handling practices are required during preparation, administration, and disposal of all hazardous drugs.

15.3 All hazardous waste is discarded in appropriate containers and disposed of according to regulations in each jurisdiction.

Practice Recommendations

A. Recognize the applicable guidelines for handling hazardous drugs in the jurisdiction and if those guidelines are voluntary or mandatory compliance.[1-3] (II)

B. Identify hazardous drugs used in the health care setting and revise as needed. The National Institute for Occupational Safety and Health (NIOSH) provides a list of antineoplastic, nonantineoplastic, other drug categories, and biologic agents that meet the definition of hazardous drugs. The most recent list should be used as this list is updated periodically based on new drug information. Health care organizations in the United States are required to review this list annually and to review new drugs and agents as their use begins.
   1. Additional resources used to evaluate the hazard potential of a drug include safety data sheets (SDSs), drug package inserts and special health warnings from drug manufacturers, professional groups' and organizations' evidence-based recommendations, and online resources including:
      a. Drugbank (http://drugbank.ca).
      b. Daily Med (http://dailymed.nlm.nih.gov/dailymed).
      c. International Agency for Research on Cancer (IARC), (http://www.iarc.fr).
      d. National Toxicology Program (https://ntp.niehs.nih.gov).
      e. The drug regulatory agency in each country (eg, US FDA, http://www.fda.gov/drugs/default.htm).[4,5] (V)

C. Recognize that no safe levels of exposure to hazardous drugs have been determined, thus driving the need for a comprehensive hazardous drug control program. Exposure may occur at all points including receipt of drug shipments, compounding and all steps in preparation, administration in all venues of care (eg, home, ambulatory clinic), and during patient care activities, spills, transportation, and waste disposal.[3,6-10] (II)

D. Recognize that hazardous drugs are not limited to oncology settings as there are infusion drugs from other categories classified as hazardous. Certain antineoplastic drugs are administered for many autoimmune conditions in multiple clinical settings. Clinicians in all settings who administer hazardous drugs should be provided appropriate PPE and engineering controls to reduce exposure (see Standard 60, *Antineoplastic Therapy*).[5,11] (V)

E. Use appropriate engineering controls within the organization during receipt and unpacking, storage, sterile compounding (eg, containment primary engineering control [C-PEC]), and containment supplemental devices such as closed system transfer devices (CSTDs).[3,5,8,12,13] (II)

F. Participate in environmental wipe sampling to identify surface residue of hazardous drugs in the areas where compounding, preparation, and administration are conducted. Identify and contain the cause of contamination and deactivate, decontaminate, and improve engineering controls to reduce contamination.[3,8,14,15] (II)

G. Use appropriate PPE during all stages of handling hazardous drugs including receipt and storage, compounding and preparation, administration, spill control, and waste disposal. Ensure appropriate steps are used to don and doff PPE. Appropriate PPE varies depending upon the activity being performed and the risk of splashing, including:
   1. Use of head/hair and shoe covers.
   2. Face and eye protective covers, such as goggles and shields.
   3. Fit-tested N95 respirator or powered air-purifying respirator if drug inhalation is possible. Filtration designed for gases or vapors may be required for certain situations (eg, unpacking hazardous drugs on arrival, cleaning large spills). Surgical masks do

not provide respiratory protection, and N95 respirators may not protect against direct liquid splashes.
4. Disposable gowns shown to resist permeability with solid front, long sleeves, tight cuffs, and back closure. Remove and discard gown when it is contaminated, before leaving the area where the hazardous drug is handled, and after handling all hazardous drugs. Gowns are single-use only.
5. Two pairs of powder-free gloves that have been tested for hazardous drug use, removed, and discarded after each use or after 30 minutes of wear. Wear 1 pair under the gown cuff and 1 pair over the cuff.[3,5,7,8,12,13,16] (II)

H. Ensure all containers of hazardous drugs are labeled or marked with the drug identity and the appropriate hazard warning.[3,7,8] (II)

I. Provide training and document competency for all personnel who handle hazardous drugs at any stage. Education and training alone are not sufficient to reduce health care personnel exposure and must be combined with other administrative and engineering controls. Training should be based on the individual's job description and be provided before handling any hazardous drugs. At a minimum, this training should include the list of hazardous drugs and their associated risk, review of all policies and procedures, appropriate use of PPE and other equipment or devices, management of known or suspected exposure, spill management, and proper disposal.[3,8,13,17] (II)

J. Allow clinicians who are actively trying to conceive, are pregnant, or are breastfeeding to refrain from exposure to hazardous drugs and waste. Guidelines from some countries suggest that avoidance of handling chemotherapy drugs is needed only for those trying to conceive and during the first trimester of pregnancy.[7,12] (V)

K. Apply the appropriate processes for all personnel preparing sterile hazardous drugs within a C-PEC, including hand hygiene, PPE use, decontamination, and disinfection. C-PECs are located in an area that has negative pressure to an adjacent ante area, are designed for high-efficiency particulate air (HEPA)-filtered air flow, and have exhaust vented to the outside.[7,18] (V)

L. Use protective devices and techniques for administration of all hazardous drugs, including use of CSTDs and inserting the IV administration set spike into the container and priming while inside the C-PEC and before adding the hazardous drug. If this step must be done outside the C-PEC, attach the unprimed set to the primary solution infusion and backprime to move the air into the secondary solution container.[3,12,13,16] (V)

M. Avoid spills of hazardous drugs through appropriate handling of all drug containers, administration sets, and other supplies used. Inadvertent punctures of solution bags, inadequate connections between the solution container and the administration set, loose connections along the administration set, and improper use of CSTDs are common causes of spills. Immediately contain, deactivate, and decontaminate the surface, followed by cleaning the spill using appropriate PPE.
1. Ensure that a spill kit is available where hazardous drugs are prepared and administered and follow directions for use in the event of a hazardous drug leak or spill. Cleaning processes for hard surfaces, carpet, and the C-PEC will vary.
2. Report such spills as an occurrence according to organizational procedures.
3. Large spills should be handled by health care workers who are trained in hazardous waste handling.
4. After any exposure to hazardous drugs, perform thorough hand washing with soap and water, as alcoholic hand gel is not sufficient to remove the drug from skin.
5. Do not transport parenteral hazardous drugs in a pneumatic tube system.
6. Spill kits should be easily accessible for anyone transporting hazardous drugs.[3,7,10,17,19] (IV)

N. Immediately apply appropriate measures for exposure to hazardous drugs. Participate in a program of medical surveillance if handling hazardous drugs is a regular part of the job assignment.
1. Immediately following skin exposure, remove contaminated clothing and wash skin with soap and water.
2. For eye exposure, flush the eye with saline or water for at least 15 minutes and obtain emergency treatment.
3. For inhalation, move away from the area and obtain emergency treatment if symptoms are severe.
4. Report employee exposure to the organization's occupational health and safety department. Follow organizational policy for reporting patient exposure.[3,7,8,13] (II)

O. Safely dispose of hazardous waste and materials used in the preparation and administration of hazardous drugs.
1. The World Health Organization (WHO) identifies cytotoxic waste as 1 of the 7 categories of hospital waste. Segregation of types and source of waste, while necessary for proper disposal, may not be performed in some countries.
2. Color-coded waste containers are used to separate the source of waste. Do not place hazardous drug waste in containers used for other types of medical waste because medical waste disposal is handled differently from hazardous waste (see Standard 21, *Medical Waste and Sharps Safety*).
3. Place contaminated materials, including empty ampoules/vials/syringes/solution containers, and administration sets, gloves, and gowns into sealable, leakproof bags. Needles and other sharps are placed in a puncture-proof container. All containers are clearly labeled for hazardous waste.
4. Refer to organizational policy and procedure for disposal of unused hazardous drug if infusion is interrupted.
5. In the home setting, dispose of all hazardous waste in a separate container labeled for this purpose. Place this container in an area away from pregnant women, children, and pets.[3,7,20-22] (IV)

P. Handle patient body fluids safely for at least 48 hours after receiving a hazardous drug and instruct the patient/caregiver/surrogate in safe handling. Employ these practices for the known excretion time, as some hazardous drugs (eg, cyclophosphamide) may be present in urine for longer than 48 hours.
   1. Close toilet lid or cover with a plastic-backed pad and flush twice after use, especially with toilets that have low volume for flushing.
   2. Wear 2 pairs of powder-free, chemotherapy-tested gloves and a gown shown to resist permeability when handling patient emesis or excretions. Wear a face shield if splashing is anticipated.
   3. Use disposable linens and leakproof pads to contain contaminated body fluids if possible. Washable linens should be placed in a leakproof bag and handled as contaminated.
   4. In the home setting:
      a. Place contaminated linens and clothing in a washable pillowcase separate from other items and machine wash twice with regular detergent.
      b. Discard disposable diapers in plastic bags and discard used gloves in hazardous waste containers if available.[3,7] (V)

REFERENCES

Note: All electronic references in this section were accessed between March 6, 2020, and August 4, 2020.

1. Mathias PI, MacKenzie BA, Toennis CA, Connor TH. Survey of guidelines and current practices for safe handling of antineoplastic and other hazardous drugs used in 24 countries. *J Oncol Pharm Pract*. 2019;25(1):148-162. doi:10.1177/1078155217726160
2. Bernabeu-Martinez MA, Ramos Merino M, Santos Gago JM, Alvarez Sabucedo LM, Wanden-Berghe C, Sanz-Valero J. Guidelines for safe handling of hazardous drugs: a systematic review. *PLoS One*. 2018;13(5):e0197172. doi:10.1371/journal.pone.0197172
3. United States Pharmacopeial Convention. USP general chapter ＜800＞ hazardous drugs - handling in healthcare settings. United States Pharmacopeial Convention; 2020. https://www.usp.org/compounding/general-chapter-hazardous-drugs-handling-healthcare
4. Connor T, MacKenzie B, DeBord D, Trout D, O'Callaghan J, Cincinnati O. NIOSH list of antineoplastic and other hazardous drugs in healthcare settings. Department of Health and Human Services, Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health; 2016. DHHS (NIOSH) Publication No. 2016-161. https://www.cdc.gov/niosh/docs/2016-161/pdfs/2016-161.pdf
5. Kienle PC. Unforeseen dangers: drugs that are hazardous to health care personnel. *J Infus Nurs*. 2019;42(1):44-48. doi:10.1097/NAN.0000000000000309
6. Meade E. Avoiding accidental exposure to intravenous cytotoxic drugs. *Br J Nurs*. 2014;23(16):S34, S36-39. doi:10.12968/bjon.2014.23.Sup16.S34
7. Olsen MM, LeFebvre KB, Brassil KJ. *Chemotherapy and Immunotherapy Guidelines and Recommendations for Practice*. Oncology Nursing Society; 2019.
8. Crickman R, Finnell D. Systematic review of control measures to reduce hazardous drug exposure for health care workers. *J Nurs Care Qual.* 2016;31(2):183-190. doi:10.1097/NCQ.0000000000000155
9. Huff C. Hazardous drug residues in the home setting: worker safety concerns. *J Infus Nurs*. 2020;43(1):15-18. doi:10.1097/NAN.0000000000000354
10. Friese CR, Wong M, Fauer A, Mendelsohn-Victor K, Polovich M, McCullagh MC. Hazardous drug exposure: case report analysis from a prospective, multisite study of oncology nurses' exposure in ambulatory settings. *Clin J Oncol Nurs*. 2020;24(3):249-255.
11. Redmond M. Chemotherapy and biotherapy: what nurses need to know when administering to nononcologic patients. *J Contin Educ Nurs.* 2016;47(2):52-54. doi:10.1188/20.CJON.249-255
12. Kanda K, Hirai K, Iino K, et al. Salient features and outline of the joint Japanese Guidelines for safe handling of cancer chemotherapy drugs. *Asia Pac J Oncol Nurs*. 2017;4(4):304-312. doi:10.4103/apjon.apjon_30_17
13. Eisenberg S. Hazardous drugs and USP ＜800＞: implications for nurses. *Clin J Oncol Nurs.* 2017;21(2):179-187. doi:10.1188/17.CJON.179-187
14. Graeve C, McGovern PM, Arnold S, Polovich M. Testing an intervention to decrease healthcare workers' exposure to antineoplastic agents. *Oncol Nurs Forum*. 2017;44(1):E10-E19. doi:10.1188/17.ONF.E10-E19
15. Chauchat L, Tanguay C, Caron NJ, Gagné S, Labrèche F, Bussières. Surface contamination with ten antineoplastic drugs in 83 Canadian centers. *J Oncol Pharm Pract*. 2019;25(5):1089-1098. doi:10.1177/1078155218773862
16. Kwon JH, Burnham CD, Reske KA, et al. Assessment of healthcare worker protocol deviations and self-contamination during personal protective equipment donning and doffing. *Infect Control Hosp Epidemiol.* 2017;38(9):1077-1083. doi:10.1017/ice.2017.121
17. Friese CR, Yang J, Mendelsohn-Victor K, McCullagh M. Randomized controlled trial of an intervention to improve nurses' hazardous drug handling. *Oncol Nurs Forum*. 2019;46(2):248-256. doi:10.1188/19.ONF.248-256
18. Power LA, Coyne JW. ASHP guidelines on handling hazardous drugs. *Am J Health Syst Pharm.* 2018;75(24):1996-2031. doi:10.2146/ajhp180564
19. Hon CY, Abusitta D. Causes of health care workers' exposure to antineoplastic drugs: an exploratory study. *Can J Hosp Pharm*. 2016;69(3):216-223. doi:10.4212/cjhp.v69i3.1558
20. Ali M, Wang W, Chaudhry N, Geng Y. Hospital waste management in developing countries: a mini review. *Waste Manag Res*. 2017;35(6):581-592. doi:10.1177/0734242X17691344
21. da Conceicao AV, Bernardo D, Lopes LV, et al. Oncology pharmacy units: a safety policy for handling hazardous drugs and related waste in low- and middle-income African countries-Angolan experience. *Ecancermedicalscience*. 2015;9:575. doi:10.3332/ecancer.2015.575
22. Friese CR, McArdle C, Zhau T, et al. Antineoplastic drug exposure in an ambulatory setting: a pilot study. *Cancer Nurs.* 2015;38(2):111-117. doi:10.1097/NCC.0000000000000143

Section Three: Infection Prevention and Control

16. HAND HYGIENE

Standard

16.1 Hand hygiene is performed routinely during patient care activities.

Practice Recommendations

A. Mitigate the transfer of microorganisms by performing hand hygiene:
   1. Before and after having direct contact with the patient.
   2. After contact with body fluids or excretions, mucous membranes, and wound dressings.
   3. After touching the patient's surroundings.
   4. Before donning gloves.
   5. After removing gloves.
   6. Before, during as required, and after all clinical procedures requiring Aseptic Non Touch Technique (ANTT®), including:
      a. Insertion and removal of indwelling invasive medical devices including all vascular access devices (VADs).
      b. Ongoing management and manipulation of indwelling medical devices.
      c. Infusion administration.
   7. Before/after eating and after using a restroom.
   8. Before moving from work on a soiled body site to a clean body site on the same patient.[1-7] (I)

B. Use an alcohol-based hand rub (ABHR), containing at least 60% ethanol or 70% isopropyl alcohol, routinely for hand hygiene unless the hands are visibly soiled, or if the patient is suspected of having/or there is an outbreak of a spore-forming pathogen or norovirus gastroenteritis.[1-6] (I)
   1. Unless hands are visibly soiled, an ABHR is preferred over soap and water in most clinical situations due to evidence of better compliance compared to soap and water. Hand rubs are generally less irritating to hands and are effective in the absence of a sink.[1-6] (II)
   2. Perform hand hygiene using an ABHR for at least 20 seconds.[1-6] (I)

C. Use either a nonantimicrobial or antimicrobial soap and water for hand hygiene and wash hands for at least 20 seconds:
   1. When the hands are visibly contaminated with blood and or other body fluids.
   2. After providing care or having contact with patients suspected or confirmed of being infected with norovirus/rotavirus gastroenteritis or a spore-forming pathogen during an outbreak (eg, *Clostridioides difficile*).[1-6,8] (II)

D. Ensure that supplies necessary for adherence to hand hygiene are readily accessible in all areas where patient care is being delivered.[1-6] (IV)

E. Keep nails clean and nail length short.
   1. Do not wear artificial fingernails or extenders; artificial or false nails have been associated with higher levels of infectious agents, especially Gram-negative bacilli and yeasts, than natural nails.
   2. Avoid wearing nail polish; if organizational policy permits, nail polish should not be chipped as chipped nail polish may support the growth of microorganisms.[1,3-6] (IV)

F. Educate the patient/caregivers on when and how to perform hand hygiene and to ask the clinician to perform hand hygiene before having direct contact with the patient if it was not observed.[1,2,4-6] (IV)

G. Implement organizational strategies to improve hand hygiene compliance.
   1. Use a systematic, multistep approach.[7,9] (III)
      a. A drastic increase in hand hygiene compliance in a low-resource setting was associated with activities such as visual demonstration of bacterial contamination, leader engagement, testing knowledge, and sharing progress during regular staff meetings.[10] (IV)
   2. Implement multimodal strategies including performance feedback to improve hand hygiene compliance and to reduce infection and colonization rates.[11-15] (I)
   3. Involve the clinician with the evaluation of hand hygiene products to assess for product feel, fragrance, and skin irritation. Provide alternatives for clinicians who have sensitivity to a particular product. Other products for skin care such as gloves, lotions, and moisturizers should be assessed for compatibility with hand antisepsis products.[1] (IV)

4. Provide the clinician with education on hand hygiene, monitor hand hygiene performance, and provide feedback regarding hand hygiene performance.[1,3,5,11-15] (III)

REFERENCES

Note: All references in this section were accessed between March 18, 2020, and August 11, 2020.

1. World Health Organization. WHO guidelines on hand hygiene in health care: a summary; first global patient safety challenge clean care is safer care. World Health Organization; 2009:11-23. http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf
2. Healthcare Infection Control Practices Advisory Committee (HICPAC). Core infection prevention and control practices for safe healthcare delivery in all settings–recommendations of the Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention, HICPAC; Updated March 15, 2017. https://www.cdc.gov/hicpac/pdf/core-practices.pdf
3. Centers for Disease Control and Prevention. Hand hygiene recommendations: guidance for healthcare providers about hand hygiene and COVID-19. Updated May 17, 2020. https://www.cdc.gov/coronavirus/2019-ncov/hcp/hand-hygiene.html
4. Centers for Disease Control and Prevention. Guideline for hand hygiene in health-care settings. Recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. *Morb Mortal Wkly Rep*. Vol 51. No. RR-16. Published October 25, 2002. https://www.cdc.gov/mmwr/PDF/rr/rr5116.pdf
5. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect.* 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2
6. Australian Commission on Safety and Quality in Healthcare. Australian guidelines for the prevention and control of infection in healthcare. National Health and Medical Research Council; 2019. https://www.nhmrc.gov.au/about-us/publications/australian-guidelines-prevention-and-control-infection-healthcare-2019
7. Rowley S, Clare S, Macqueen S, Molyneux R. ANTT v2: an updated practice framework for aseptic technique. *Br J Nurs*. 2010;19(Suppl 1):S5-S11. https://doi.org/10.12968/bjon.2010.19.Sup1.47079
8. MacCannell T, Umscheid CA, Agarwal RK, et al. Guideline for the prevention and control of norovirus gastroenteritis outbreaks in healthcare settings. *Infect Control Hosp Epidemiol*. 2011;32(10):939-969.
9. Ellingson K, Haas JP, Aiello AE, et al. Strategies to prevent healthcare-associated infections through hand hygiene. *Infect Control Hosp Epidemiol*. 2014;35(8):937-960. doi:10.1086/677145
10. Kallam B, Pettitt-Schieber C, Owen M, Agyare Asante R, Darko E, Ramaswamy R. Implementation science in low-resource settings: using the interactive systems framework to improve hand hygiene in a tertiary hospital in Ghana. *Int J Qual Health Care.* 2018;30(9):724-730. doi:10.1093/intqhc/mzy111
11. Clare S, Rowley S. Implementing the Aseptic Non Touch Technique (ANTT®) clinical practice framework for aseptic technique: a pragmatic evaluation using a mixed methods approach in two London hospitals. *J Infect Prev*. 2018;19(1):6-15. doi:10.1177/1757177417720996
12. Doronina O, Jones D, Martello M, Biron A, Lavoie-Tremblay M. A systematic review on the effectiveness of interventions to improve hand hygiene compliance of nurses in the hospital setting. *J Nurs Scholarsh*. 2017;49(2):143-152. doi:10.1111/jnu.12274
13. Gould DJ, Moralejo D, Drey N, Chudleigh JH, Taljaard M. Interventions to improve hand hygiene compliance in patient care. *Cochrane Database Syst Rev*. 2017;9(9):CD005186. doi:10.1002/14651858.CD005186.pub4
14. Luangasanatip N, Hongsuwan M, Limmathurotsakul D, et al. Comparative efficacy of interventions to promote hand hygiene in hospital: systematic review and network meta-analysis. *BMJ*. 2015;351:h3728. doi:10.1136/bmj.h3728
15. Staines A, Vanderavero P, Duvillard B, et al. Sustained improvement in hand hygiene compliance using a multi-modal improvement programme at a Swiss multi-site regional hospital. *J Hosp Infect.* 2018;100(2):176-182. doi:10.1016/j.jhin.2018.04.010

17. STANDARD PRECAUTIONS

Standard

17.1 Standard Precautions are used during all patient care procedures and in all clinical settings that potentially expose the clinician to blood and body fluids, secretions, excretions (except sweat), nonintact skin, and mucous membranes and may contain transmissible infectious agents.

17.2 Personal protective equipment (PPE) is selected and worn based on the nature of the patient interaction and potential for exposure to blood, body fluids, or infectious agents, and based upon Transmission-Based Precautions in effect at the time of the patient encounter for specific communicable diseases and for patients who may be immunocompromised.

17.3 Surfaces that are in close proximity to the patient and frequently touched surfaces in the patient care environment are cleaned and disinfected more frequently than other surfaces.

17.4 Spills of blood or other potentially infectious materials are promptly cleaned and decontaminated.

17.5 Durable medical equipment ([DME] eg, electronic infusion pumps, vascular visualization devices) is cleaned and disinfected before and after each patient use with disinfectants that have microcidal activity against pathogens likely to contaminate the equipment and in accordance with manufacturers' directions for use for cleaning and disinfecting.

Practice Recommendations

A. Perform hand hygiene as it is a major component of Standard Precautions.
   1. Ensure access to hand hygiene facilities and appropriate hand antiseptic cleansers (liquid soap and water and ABHR). Refer to Standard 16, *Hand Hygiene*.

B. Ensure that sufficient and appropriate PPE is available and readily accessible at the point of care; when wearing any type of PPE, remove at the end of the procedure before leaving the patient care space.[1-6] (V)

C. Perform hand hygiene immediately in between each step of removing PPE if the hands become contaminated, immediately after removing all PPE, and before leaving the patient's environment.[1-7] (III)

D. Wear gloves that fit appropriately and extend to cover the wrist of an isolation gown (if worn) when there is potential contact with blood (eg, during phlebotomy, venipuncture), body fluids, mucous membranes, nonintact skin, or contaminated equipment.

1. Change gloves during patient care when torn, when heavily contaminated, or if moving from a contaminated body site to a clean body site within the same patient.
2. Do not reuse gloves or use for more than 1 patient. Gloves are single-use.
3. Gloves should not be considered as a substitute for hand hygiene.[1-8] (III)

E. Wear a single-use disposable gown or apron to protect skin and clothing during procedures or activities in which contact with blood or body fluids is anticipated.
   1. Do not wear the same gown/apron when caring for more than 1 patient.[1-6] (III)

F. Wear eye protection, which may include goggles with a face mask, or face shield alone, to prevent the potential splash or spray of blood, respiratory secretions, or other body fluids from the mouth, nose, and eyes.[1-6] (III)

G. Educate the clinician to implement respiratory hygiene/cough etiquette by covering the mouth/nose with a tissue when coughing, promptly disposing of used tissues, and performing hand hygiene; educate the clinician to stay home when ill.[1,3,4] (III)

H. Educate the patient and caregiver to implement respiratory hygiene/cough etiquette by placing a face mask on the coughing person if tolerated and appropriate or covering the mouth/nose with a tissue when coughing, promptly disposing of used tissues, and performing hand hygiene; educate visitors/family about need for other PPE when near the patient.[1,3,4] (III)

I. Clean and disinfect DME (eg, intravenous [IV] poles, flow-control devices, vascular visualization devices) using an appropriate disinfectant (eg, Environmental Protection Agency [EPA]–registered disinfectant) before and after each use.
   1. Develop organizational procedures based upon manufacturers' instructions for cleaning and disinfection.
   2. Maintain separation between clean and soiled equipment to prevent cross contamination.[9] (IV)

J. Employ practices to reduce the risk for transmission of microorganisms from home to home when providing care in the home setting.
   1. Clean the inside and the outside of the clinical bag carried from home to home by home care clinicians. One study found that the inside/outside of the clinical bag and equipment within the bag are frequently contaminated with human pathogens, including multidrug resistant organisms (MDROs).[10-11] (IV)
   2. Perform hand hygiene before opening the clinical bag to retrieve needed supplies and equipment, after removing supplies and before direct patient contact, after contact with the patient's intact skin (eg, taking blood pressure), and after contact with inanimate objects in the patient's vicinity.[10-11] (IV)
   3. Limit reusable patient care equipment and leave in the home until discharged when caring for a patient with an MDRO. Clean and disinfect before removing from the home or transport in a container (eg, plastic bag) to an appropriate site for cleaning and disinfection.[11-12] (IV)

K. Use a multimodal approach to Standard Precaution education and training.[13] (III)

REFERENCES

Note: All electronic references in this section were accessed between March 6, 2020, and August 11, 2020.

1. Healthcare Infection Control Practices Advisory Committee (HICPAC). Core infection prevention and control practices for safe healthcare delivery in all settings–recommendations of the Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention, HICPAC; Updated March 15, 2017. https://www.cdc.gov/hicpac/pdf/core-practices.pdf
2. US Department of Labor. Occupational Safety and Health Administration. Bloodborne pathogens. Standard 29 CFR 1910.1030. https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030
3. Centers for Disease Control and Prevention. Guide to infection prevention in outpatient settings: minimum expectations for safe care. National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Healthcare Quality Promotion (DHQP); 2016. https://www.cdc.gov/infectioncontrol/pdf/outpatient/guide.pdf
4. World Health Organization. Standard precautions in health care. *Epidemic and Pandemic Alert and Response Aide-Memoire*. Published October 2007. https://www.who.int/csr/resources/publications/EPR_AM2_E7.pdf
5. Centers for Disease Control and Prevention. Sequence for donning and removing personal protective equipment. https://www.cdc.gov/hai/pdfs/ppe/PPE-Sequence.pdf
6. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect*. 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2
7. World Health Organization. WHO guidelines on hand hygiene in health care: first global patient safety challenge clean care is safer care. World Health Organization; 2009. http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf?ua=1
8. World Health Organization. Glove use information leaflet. Revised August 2009. https://www.who.int/gpsc/5may/Glove_Use_Information_Leaflet.pdf
9. Rutala WA, Weber DJ, Healthcare Infection Control Practices Advisory Committee. Guideline for disinfection and sterilization in healthcare facilities, 2008. Centers for Disease Control and Prevention; Updated May 2019. https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines-H.pdf
10. Bakunas-Kenneley I, Madigan EA. Infection prevention and control in home health care: the nurse's bag. *Am J Infect Control*. 2009;37(8):687-688. doi:10.1016/j.ajic.2009.03.004
11. McGoldrick M. Best practices for home care "bag technique" and the use of surface barriers. *Home Healthc Now*. 2017;35(9):478-484. doi:10.1097/NHH.0000000000000611
12. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. Centers for Disease Control and Prevention; 2007. Updated July 2019. https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines-H.pdf
13. Moralejo D, El Dib R, Prata RA, Barretti P, Corrêa I, Cochrane Effective Practice and Organisation of Care Group. Improving adherence to standard precautions for the control of health care-associated infections. *Cochrane Database Syst Rev*. 2018;(2):CD010768. doi:10.1002/14651858.CD010768.pub2

KEY DEFINITIONS

Aseptic Technique: A set of infection prevention actions aimed at protecting patients from infection during invasive clinical procedures and management of indwelling medical devices; notably, it is a generic term that is variously defined, interpreted, and used interchangeably with other practice terms, such as *clean*, *sterile*, and *non-touch technique*.

Aseptic Non Touch Technique (ANTT®): A specific and comprehensively defined type of aseptic technique with a unique theory-practice framework based on an original concept of Key-Part and Key-Site Protection; achieved by integrating Standard Precautions such as hand hygiene and personal protective equipment with appropriate aseptic field management, non-touch technique, and sterilized supplies. It is designed for all invasive clinical procedures and management of invasive medical devices. In the context of infusion therapy, this includes vascular access device (VAD) placement and management and infusion administration.

The 5 practice terms to using ANTT:

- **Key-Site:** Any portal of entry into the patient (eg, VAD site, injection site, open wound).
- **Key-Part:** The part of the procedure equipment that, if contaminated, is likely to contaminate the patient (eg, syringe tip, male luer end/spike of administration set, injection needle).
- **General Aseptic Field:** A decontaminated and disinfected procedure tray or single-use procedure kit/barrier. Used to promote, but not ensure, asepsis.
- **Critical Aseptic Field:** A sterile drape/barrier. Used to ensure asepsis; all procedure equipment is placed upon the drape and managed collectively.
- **Micro Critical Aseptic Field:** A small protective sterile surface/housing (eg, sterile caps, covers, and the inside of recently opened sterile equipment packaging) that protect Key-Parts individually.

Standard-ANTT: A combination of Standard Precautions and an approach of protecting Key-Parts and Key-Sites individually, using non-touch technique and Micro Critical Aseptic Fields within a General Aseptic Field. Used for clinical procedures where achieving asepsis and protecting Key-Parts and Key-Sites is straightforward and short in duration, such as VAD flushing and locking, administration set preparation and change, intravenous medication administration, and simple wound care. In the event of Key-Parts or Key-Sites requiring direct touch, then sterile gloves must be used.

Surgical-ANTT: A combination of Standard Precautions and an approach of protecting Key-Sites and Key-Parts collectively using a sterile drape(s) and barrier precautions. Used for clinically invasive procedures where achieving asepsis and protecting Key-Parts and Key-Sites are difficult and/or procedures are long in duration, such as surgery and central vascular access device insertion.

Standard

18.1 Aseptic Non Touch Technique (ANTT®) is applied to all infusion-related procedures, including vascular and other infusion access device insertion and management, and administration of infusion medications and solutions, as a critical aspect of infection prevention.

18.2 Clinicians and patients/caregivers who administer infusions and manage vascular access and other infusion devices are educated in ANTT.

Practice Recommendations

A. Standardize the use of aseptic technique with the international standard approach of ANTT for all invasive clinical procedures.[1-3] (V)

B. Document the clinical competency of ANTT as a core competency for all clinicians. This encompasses all aspects of infusion therapy, including but not limited to, preparation and administration of infusion solutions and medications and insertion and management of VADs and other infusion devices (see Standard 5, *Competency and Competency Assessment*).[1-7] (V)

1. Recognize that clinicians are ultimately responsible for ensuring the safe and consistent application of the components of ANTT for each and every clinical intervention requiring aseptic technique (refer to Standard 5, *Competency and Competency Assessment*).
2. Ensure standardized practice through incorporation of ANTT within the organization that includes ANTT education, initial/ongoing competency assessment, and monitoring of practice standards through audit.[1,2,5,6,8] (V)
3. Use multimodal standardized resources for clinician education and training as outlined in the ANTT® Clinical Practice Framework.[4,6,9,10] (III)

C. Employ ANTT through Key-Part and Key-Site Protection, routine integration of Standard Precautions, and appropriate use of aseptic fields and non-touch technique. Hand hygiene is a fundamental component of ANTT (see Standard 16, *Hand Hygiene*; Standard 17, *Standard Precautions*).[1-3,5,8,11-13] (III)

D. Select either Standard-ANTT or Surgical-ANTT for the procedure as determined by organizational policy or clinician risk assessment using the defined ANTT risk assessment. The decision is guided as follows:

1. For this procedure, is the clinician able to protect all Key-Parts individually?
    a. If yes, then Standard-ANTT is used. If no, then select Surgical-ANTT.
    b. The clinician considers a number of practice variables, including:
        i. The number and size of Key-Parts and Key-Sites.
        ii. The invasiveness of the procedure.
        iii. The duration of the procedure.
        iv. The environment within which the procedure will take place.
        v. The level of PPE required.[5] (V)
2. Use Standard-ANTT for simple procedures of short duration, involving few and small Key-Parts (easily and readily protected by Micro Critical Aseptic Fields and non-touch technique). Examples include infusion of medications, phlebotomy, and short peripheral intravenous catheter (PIVC) placement; if gloves are indicated, nonsterile gloves are typically worn; in the event that Key-Parts or Key-Sites require direct touch, sterile gloves are worn.[1,4,5,14-16] (V)
3. Use Surgical-ANTT for longer, complex procedures, involving multiple or large Key-Parts (eg, central vascular access device [CVAD] insertion, CVAD exchange), while employing barrier precautions and appropriate use of PPE.[1,4,5,17] (I)
    a. For Surgical-ANTT, sterile gloves are worn; however, still employ a non-touch technique of Key-Parts whenever practical to do so.[1,2,5,8] (V)

E. Ensure the aseptic state of Key-Parts and Key-Sites by appropriate device disinfection and skin antisepsis (refer to Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*; Standard 34, *Vascular Access Device Placement*; Standard 36, *Needleless Connectors*; Standard 44, *Blood Sampling*).

F. Maintain asepsis during VAD dwell time by the use and management of sterile dressings and appropriate securement devices, applied and maintained using ANTT (refer to Standard 38, *Vascular Access Device Securement;* Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes).*

G. Ensure effective management of the patient care setting prior to clinical procedures, including purposeful decontamination to help reduce the transmission of pathogenic microorganisms.[8,10-12,18-19] (I)
    1. Perform appropriate decontamination and disinfection (before, during, and after clinical intervention) of DME used with an ANTT procedure (eg, ultrasound, electronic infusion pump). See Standard 17, *Standard Precautions;* refer to Section Four: *Infusion Equipment*.[5] (V)

REFERENCES

Note: All electronic references in this section were accessed between June 3, 2020, and August 11, 2020.

1. Rowley S, Clare S. Standardizing the critical clinical competency of aseptic, sterile, and clean techniques with a single international standard: Aseptic Non Touch Technique (ANTT). *J Assoc Vasc Access.* 2019;24(4):12-17. https://doi.org/10.2309/j.java.2019.004.003
2. Australian Commission on Safety and Quality in Healthcare. Australian guidelines for the prevention and control of infection in healthcare. National Health and Medical Research Council; 2019. https://www.nhmrc.gov.au/about-us/publications/australian-guidelines-prevention-and-control-infection-healthcare-2019
3. Welsh Government. Aseptic Non Touch Technique (ANTT): implementation of a national standardised approach. *Welsh Health Circular*. WHC/2015/026. Published June 5, 2015. http://www.primarycareservices.wales.nhs.uk/sitesplus/documents/1150/WHC%202015.026.pdf
4. Clare S, Rowley S. Implementing the Aseptic Non Touch Technique (ANTT®) clinical practice framework for aseptic technique: a pragmatic evaluation using a mixed methods approach in two London hospitals. *J Infect Prev.* 2018;19(1):6-15. doi:10.1177/1757177417720996
5. Rowley S, Clare S, Macqueen S, Molyneux R. ANTT v2: an updated practice framework for aseptic technique. *Br J Nurs.* 2010;19(Suppl 1):S5-S11. https://doi.org/10.12968/bjon.2010.19.Sup1.47079
6. Rowley S, Clare S. Improving standards of aseptic practice through an ANTT trust-wide implementation process: a matter of prioritization and care. *J Infect Prev*. 2009;10(Suppl 1):S18-S23. https://doi.org/10.1177/1757177409342140
7. Moureau N, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access*. SpringerOpen; 2019. https://link.springer.com/book/10.1007/978-3-030-03149-7
8. Rowley S, Clare S. Right asepsis with ANTT® for infection prevention. In: Moureau N, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access*. SpringerOpen; 2019:147-162. https://link.springer.com/book/10.1007/978-3-030-03149-7
9. Beaumont K, Wyland M, Lee D. A multi-disciplinary approach to ANTT implementation: what can be achieved in 6 months. *Infect Dis Health*. 2016;21(2):67-71. https://doi.org/10.1016/j.idh.2016.06.002
10. Khurana S, Saini SS, Sundaram VA, Dutta S, Kumar P. Reducing healthcare-associated infections in neonates by standardizing and improving compliance to aseptic non-touch techniques: a quality improvement approach. *Indian Pediatr.* 2018; 55(9):748-752.
11. World Health Organization. Evidence of hand hygiene as the building block for infection prevention and control. World Health Organization; 2017. https://apps.who.int/iris/bitstream/handle/10665/330079/WHO-HIS-SDS-2017.7-eng.pdf?sequence=1&isAllowed=y
12. Doll M, Stevens M, Bearman G. Environmental cleaning and disinfection of patient areas. *Int J Infect Dis*. 2018;67:52-57. doi:10.1016/j.ijid.2017.10.014
13. Kramer A, Schwebke I, Kampf G. How long do nosocomial pathogens persist on inanimate surfaces? a systematic review. *BMC Infect Dis.* 2006;6:130. doi:10.1186/1471-2334-6-130
14. Mutalib M, Evans V, Hughes A, Hill S. Aseptic non-touch technique and catheter-related bloodstream infection in children receiving parenteral nutrition at home. *United European Gastroenterol J.* 2015;3(4):393-398. doi:10.1177/2050640615576444
15. Flynn JM, Keogh SJ, Gavin NC. Sterile v aseptic non-touch technique for needle-less connector care on central venous access devices in a bone marrow transplant population: a comparative study. *Eur J Oncol Nurs*. 2015;19(6):694-700. doi:10.1016/j.ejon.2015.05.003
16. Larwood KA, Anstey CM, Dunn SV. Managing central venous catheters: a prospective randomised trial of two methods. *Aust Crit Care*. 2000;13(2);44-50. doi:10.1016/s1036-7314(00)70621-7
17. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: National evidence-based guidelines for preventing healthcare-associated infections in NHS

hospitals in England. *J Hosp Infect.* 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2

18. Weber DJ, Anderson D, Rutala WA. The role of the surface environment in healthcare-associated infections. *Curr Opin Infect Dis.* 2013;26(4):338-344. doi:10.1097/QCO.0b013e3283630f04
19. Mitchell BG, Dancer SJ, Anderson M, Dehn E. Risk of organism acquisition from prior room occupants: a systematic review and meta-analysis.*J Hosp Infect*. 2015;91(3):211-217. doi:10.1016/j.jhin.2015.08.005

See Appendix B, *Aseptic Non Touch Technique (ANTT®) Clinical Practice Framework*.

19. TRANSMISSION-BASED PRECAUTIONS

Standard

19.1 Transmission-Based Precautions, including Airborne Precautions, Droplet Precautions, and/or Contact Precautions, are implemented when strategies, in addition to Standard Precautions, are required to reduce the risk for transmission of infectious agents.

19.2 Airborne Precautions are implemented to prevent the transmission of infectious agents that remain infectious when suspended in the air over long distances.

19.3 Droplet Precautions are implemented to prevent transmission of pathogens spread through close respiratory or mucous membrane contact with respiratory secretions.

19.4 Contact Precautions are implemented to prevent the transmission of infectious agents, which are spread by direct or indirect contact with the patient or the environment, including when there are excessive bodily discharges, such as wound drainage.

19.5 Transmission-Based Precautions are adapted and applied as appropriate for nonacute care settings where infusion therapy is provided, including long-term care facilities, home care, ambulatory, and other settings.

19.6 Transmission-Based Precautions are adapted and modified to deal with infectious disease crises, such as pandemics, under the direction of organizations including the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO).

Practice Recommendations

A. Select and use PPE for Transmission-Based Precautions based on the nature of the patient interaction and potential for exposure to blood, body fluids, or infectious agents and isolation precaution guidelines in effect at the time of the patient encounter for specific communicable diseases.[1-5] (III)
B. Observe Droplet Precautions, in addition to Standard Precautions, when there is potential contact with respiratory secretions and sprays of blood or body fluids; wear a face mask, eye protection, and fluid repellent gown, when there is potential contact with respiratory secretions and sprays of blood or body fluids.[1-4] (III)
C. Perform hand hygiene before donning PPE, immediately in between each step of removing PPE if the hands become contaminated, immediately after removing all PPE, and before leaving the patient's environment.[1-6] (III)
D. Wear a fit-tested, certified, N95-or-higher respirator and observe Airborne Precautions, in addition to Standard Precautions, if an infection spread by airborne route is suspected or confirmed, or when microbial agents become airborne transmissible, during unexpected aerosol-generating procedures (eg, intubation) to prevent the potential exposure to infectious agents. Perform fit testing prior to initial respirator use and repeat if there are significant changes to facial structures and at least annually thereafter.[1,2,4,6,7] (III)
    1. Instruct clinicians to perform a seal check every time the respirator is worn and adjust as needed.[7] (V)
E. Establish and maintain a Respiratory Protection Program.[8-10] (IV)
F. Maintain Transmission-Based Precautions until it is determined that the cause of the symptoms is not due to an infectious agent or the duration of the recommended isolation precautions has been met.[1] (III)
G. Employ "enhanced barrier precautions," a specific strategy required for US nursing homes (skilled nursing facilities) when performing high-contact resident care activities that provide opportunities for transfer of MDROs to staff hands and clothing.
    1. Wear gloves and gown when performing any high-contact care activity in a nursing home, which includes care required for wounds and/or indwelling medical devices (eg, CVAD, urinary catheter, feeding tube, tracheostomy/ventilator) for those who reside on a unit or wing where a resident known to be infected or colonized with a novel or targeted MDRO resides.[11] (V)
H. Implement strategies to deal with crises such as pandemics by reducing health care facility risk (eg, limit visitors, cancel elective procedures), isolating symptomatic patients, and protecting clinicians (eg, barriers at triage; limit number of staff caring for patient; ensure availability of PPE where most needed, eg, N95 respirators in the presence of aerosol-generating procedures; and adoption of technology, eg, wireless probes, electrocardiogram [ECG] technology to minimize the need for radiological confirmation of device tip location).
    1. Understand that care decisions in a crisis are necessarily constrained by specific conditions under a crisis, such as a pandemic.
    2. Implementation of crisis standards of care are done within the health care organization and in collaboration with health care professionals, policy makers, and the community.[12-14] (V)
I. Notify accepting facilities and transporting agencies about suspected infections and the need for Transmission-Based Precautions when patients are transferred.[4] (V)
J. In the home setting, when caring for a patient with an MDRO or on Transmission-Based Precautions, limit

reusable patient care equipment and leave in the home until no longer necessary. Clean and disinfect equipment before removing from the home and place in a container (eg, plastic bag) or transport to an appropriate site for cleaning and disinfection.[1,15-17] (IV)

REFERENCES

Note: All electronic references in this section were accessed between March 14, 2020, and August 12, 2020.

1. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. Centers for Disease Control and Prevention; Updated July 2019. https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines-H.pdf
2. Healthcare Infection Control Practices Advisory Committee (HICPAC). Core infection prevention and control practices for safe healthcare delivery in all settings–recommendations of the Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention, HICPAC; Updated March 15, 2017. https://www.cdc.gov/hicpac/pdf/core-practices.pdf
3. US Department of Labor. Occupational Safety and Health Administration. Bloodborne pathogens. Standard 29 CFR 1910.1030. https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030
4. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect*. 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2.
5. Centers for Disease Control and Prevention. Sequence for donning and removing personal protective equipment. https://www.cdc.gov/hai/pdfs/ppe/PPE-Sequence.pdf
6. Centers for Disease Control and Prevention. Guideline for hand hygiene in health-care settings. Recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. *Morb Mortal Wkly Rep*. Vol 51. No. RR-16. Published October 25, 2002. https://www.cdc.gov/mmwr/PDF/rr/rr5116.pdf
7. Centers for Disease Control and Prevention, The National Personal Protective Technology Laboratory (NPPTL), The National Institute for Occupational Safety and Health (NIOSH). Filtering out confusion: frequently asked questions about respiratory protection. Updated April 2018. https://www.cdc.gov/niosh/npptl/FilteringOutConfusion.html
8. US Department of Labor. Occupational Safety and Health Administration. Respiratory protection. Standard 29 CFR 1910.134. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=12716&p_table=standards
9. The Joint Commission. Implementing hospital respiratory protection programs: strategies from the field. The Joint Commission; 2014. https://www.jointcommission.org/assets/1/18/Implementing_Hospital_RPP_2-19-15.pdf
10. Centers for Disease Control and Prevention. Hospital respiratory protection program toolkit: resources for respirator program administrators. National Institute for Occupational Safety and Health; 2015. Publication No. 2015-117. https://www.cdc.gov/niosh/docs/2015-117/pdfs/2015-117.pdf?id=10.26616/NIOSHPUB2015117
11. Centers for Disease Control and Prevention. Implementation of personal protective equipment (PPE) in nursing homes to prevent spread of novel or targeted multidrug-resistant organisms (MDROs). Dept of Health and Human Services, Centers for Disease Control and Prevention; Updated July 29, 2019. https://www.cdc.gov/hai/pdfs/containment/PPE-Nursing-Homes-H.pdf
12. Centers for Disease Control and Prevention. Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID -19) in healthcare settings. Updated July 15, 2020. https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html
13. American Nurses Association. Crisis standard of care – COVID-19 pandemic. Published April 2020. https://www.nursingworld.org/~496044/globalassets/practiceandpolicy/work-environment/health–safety/coronavirus/crisis-standards-of-care.pdf
14. Scoppettuolo G, Biasucci DG, Pittiruti M. Vascular access in COVID-19 patients: smart decisions for maximal safety. *J Vasc Access*. 2020;21(4):408-410. doi:10.1177/1129729820923935
15. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. Management of multidrug-resistant organisms in healthcare settings, 2006. Dept of Health and Human Services, Centers for Disease Control and Prevention; Updated February 15, 2017. https://www.cdc.gov/infectioncontrol/pdf/guidelines/mdro-guidelines.pdf
16. McGoldrick M. Core and supplementary contents in the home care nursing bag. *Home Healthc Now*. 2016;34(8):457. doi:10.1097/NHH.0000000000000431
17. McGoldrick M. Best practices for home care "bag technique" and the use of surface barriers. *Home Healthc Now*. 2017;35(9):478-484. doi:10.1097/NHH.0000000000000611

20. COMPOUNDING AND PREPARATION OF PARENTERAL SOLUTIONS AND MEDICATIONS

Standard

20.1 Parenteral solutions and medications are compounded in accordance with laws, rules, and regulations established by regulatory and accrediting bodies in each jurisdiction (eg, countries, states, provinces).

20.2 Parenteral solutions and medications are compounded and/or prepared following processes to create a sterile product.

Practice Recommendations

A. Administer, whenever possible, medications that have been compounded (prepared, mixed, packaged, and labeled) in a pharmacy that complies with compounding standards and regulations.[1-3] (II)

B. Adhere to safe injection practices when preparing parenteral medications and solutions outside of the pharmacy environment; improper infusion and injection practices have resulted in transmission of bloodborne viruses and other microbial pathogens.
   1. Adhere to ANTT when preparing medications (refer to Standard 18, *Aseptic Non Touch Technique*).
   2. Use medications packaged as single-dose or single-use for only 1 patient.
   3. Discard a single-dose vial after a single entry.
   4. Dedicate a multidose vial for a single patient.
   5. Use a multidose vial for up to a maximum of 28 days of opening or puncture unless there is a specified expiration date labeled by the manufacturer.
      a. Label a multidose vial with the beyond-use date (BUD) and store the vial according to the manufacturer's recommendations. Discard if

the vial lacks a BUD, the sterility is compromised or questionable, and after the BUD has been met.

6. Disinfect the vial septum before each entry and the neck of a glass ampoule with 70% alcohol prior to vial access or breaking of the ampoule; allow the disinfectant to dry prior to entry.
   a. Use a blunt fill needle with filter or filter straw to withdraw medication from an ampoule and discard any leftover medication; do not infuse or inject medication through a filter needle.
7. Use a new needle and syringe for every injection.
8. Never use the same syringe to administer medication to more than 1 patient.[4-6] (IV)

C. Use single-use, commercially prepared, prefilled syringe of appropriate solution to flush and lock VADs to reduce the risk of catheter-associated bloodstream infection (CABSI) and save time for syringe preparation (refer to Standard 41, *Flushing and Locking*).

D. Do not use IV solutions in containers intended for infusion, including minibags, as common-source containers (multidose product) to dilute or reconstitute medications.[4-6] (IV)

E. Prepare a single-dose medication for an individual patient in accordance with labeling provided by the manufacturer.
   1. Prepare medications and assemble needed supplies in a clean area using a General Aseptic Field/Micro Critical Aseptic Fields in accordance with ANTT (refer to Standard 18, *Aseptic Non Touch Technique*).
   2. Use IV push medications for adults in a ready-to-administer form to minimize the need for manipulation outside the pharmacy sterile compounding area; only dilute when recommended by the manufacturer or in accordance with organizational policies, procedures, or practice guidelines.
      a. Do not use prefilled flush syringes for dilution of medications. Differences in gradation markings, an unchangeable label on prefilled syringes, partial loss of the drug dose, and possible contamination increase the risk of serious medication errors with syringe-to-syringe drug transfer (refer to Standard 41, *Flushing and Locking*).
   3. Prepare medications immediately prior to administration; if not immediately administered, label all clinician-prepared medications at the location of preparation without any break in the procedure (refer to Standard 59, *Infusion Medication and Solution Administration*).
   4. Limit preparation to the pharmacy, whenever possible, when it is necessary to combine more than 1 medication in a single syringe for IV push administration.
   5. Use a syringe appropriately sized for the medication being injected after confirmation of VAD patency by detecting no resistance and the presence of a blood return during the flushing procedure.
      a. Do not withdraw IV push medications from commercially available, cartridge-type syringes into another syringe for administration.
      b. Do not transfer the medication to a larger syringe.[4-8] (IV)

F. Provide education and competency assessment; nurse medication administration skills were found to need improvement, particularly in the areas of medication preparation and administration.[9] (I)

REFERENCES

Note: All electronic references in this section were accessed between April 17, 2020, and August 18, 2020.

1. United States Pharmacopeial Convention. USP general chapter <797> pharmaceutical compounding – sterile preparations. United States Pharmacopeial Convention; 2020. https://www.uspnf.com/sites/default/files/usp_pdf/EN/USPNF/revisions/gc-797-rb-notice-20200424.pdf
2. Petroff BJ, Filibeck D, Nowobilski-Vasilios A, Olsen RS, Rollins CJ, Johnson C. ASHP guidelines on home infusion pharmacy services. *Am J Health Syst Pharm*. 2014;71(4):325-341. doi:10.2146/sp140004
3. Petroff B, Johnson C. ASHP Guidelines on evaluating and using home or alternate-site infusion service providers. *Am J Health Syst Pharm*. 2016;73(12):922-926. doi:10.2146/ajhp151013
4. Dolan S, Arias KM, Felizardo G, et al. APIC position paper: safe injection, infusion, and medication vial practices in health care. *Am J Infect Control*. 2016;44(7);750-757. https://www.apic.org/Resource_/TinyMceFileManager/Position_Statements/2016APICSIPPositionPaper.pdf
5. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. Centers for Disease Control and Prevention. Published 2007. Updated July 2019. https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines-H.pdf
6. Centers for Disease Control and Prevention. Safe injection practices to prevent transmission of infections to patients. Published April 1, 2011. https://www.cdc.gov/injectionsafety/ip07_standardprecaution.html
7. Centers for Disease Control and Prevention. Guide to infection prevention for outpatient settings: minimum expectations for safe care. Centers for Disease Control and Prevention; 2016. https://www.cdc.gov/infectioncontrol/pdf/outpatient/guide.pdf
8. Institute for Safe Medication Practices. ISMP safe practice guidelines for adult IV push medications: a compilation of safe practices from the ISMP Adult IV Push Medication Safety Summit. Institute for Safe Medication Practices; 2015. https://www.ismp.org/sites/default/files/attachments/2017-11/ISMP97-Guidelines-071415-3.%20FINAL.pdf
9. Luokkamäki S, Härkänen M, Saano S, Vehviläinen-Julkunen K. Registered nurses' medication administration skills: a systematic review [published online ahead of print Mar 13, 2020]. *Scand J Caring Sci*. 2020;10.1111/scs.12835. doi:10.1111/scs.12835

21. MEDICAL WASTE AND SHARPS SAFETY

Standard

21.1 Safe handling and disposal of regulated medical waste are based on laws, rules, and regulations established in each jurisdiction (eg, countries, states, provinces) and

defined in organizational policies, procedures, and/or practice guidelines.

21.2 Risk reduction for clinician exposure to potentially infectious materials and for needlestick injuries is included in an organization's quality improvement (QI) program.

21.3 Contaminated sharps are discarded in a nonpermeable, puncture-resistant, tamperproof, biohazard container that is easily accessible and located in the immediate area where sharps are used.

21.4 Safety-engineered devices that isolate or remove the bloodborne pathogens hazard are available in the workplace and, when used, are consistently activated and used in accordance with manufacturers' directions for use.

Practice Recommendations

A. Reduce the risk of needlestick injury associated with parenteral injections, VADs, and blood sampling procedures.
   1. Use safety-engineered devices to prevent needlestick injury.[1-14] (I)
   2. Consider the use of passive safety-engineered devices.[12-14] (I)
   3. Do not recap, break, or bend sharps; discard directly into sharps container.
      a. Activate built-in safety controls during use, and discard as a single unit after use.[1-5] (I)
   4. Dispose of sharps in a sharps container that is closable, puncture-resistant, leakproof, appropriately labeled or color-coded, and large enough to accommodate disposal of the entire blood collection assembly (ie, holder and needle).[1-11] (I)
      a. Consider additional or enhanced security measures where a higher risk of tampering is possible (eg, pediatric or mental health units, correctional facilities).[15] (V)

B. Educate clinicians in safe practices relative to handling of sharps, medical waste disposal, and use of safety-engineered devices; the risk of needlestick injury is reduced when education is combined with implementation of sharps safety products.
   1. Address the importance of reporting needlestick injuries and exposure to bloodborne pathogens; needlestick injuries are prevalent and underreported in a number of countries.[7,16-24] (I)
   2. Involve clinician end users in evaluation of safety-engineered devices (see Standard 12, *Product Evaluation, Integrity, and Defect Reporting*).[1,2,4] (V)

C. Identify, report, and document exposure to potentially infectious materials or injury from sharps; follow organizational protocol for postexposure follow-up.
   1. Monitor and analyze data for trends and implement appropriate QI activities (see Standard 6, *Quality Improvement*).[6-12] (I)

D. Consider use of a checklist as a guideline for handling medical waste.[25] (V)

REFERENCES

Note: All electronic references in this section were accessed between April 22, 2020, and August 12, 2020.

1. US Department of Labor. Occupational Safety and Health Administration. Bloodborne pathogens. Standard 29 CFR 1910.1030. https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030
2. US Department of Labor. Occupational Safety and Health Administration. Occupational exposure to blood borne pathogens: needlestick and other sharps injuries; final rule. Standard 29 CFR Part 1910. Fed Register No. 66:5317-5325. Published January 18, 2001. https://www.osha.gov/laws-regs/federalregister/2001-01-18
3. US Department of Labor. Occupational Safety and Health Administration. Disposal of contaminated needles and blood tube holders used for phlebotomy. Published March 10, 2015. https://www.osha.gov/dts/shib/shib101503.html
4. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect*. 2014;86(suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2
5. European Agency for Safety and Health at Work. Directive 2010/32/EU - prevention from sharp injuries in the hospital and healthcare sector. Published May 10, 2010. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0032
6. Ghanei Gheshlagh R, Aslani M, Shabani F, Dalvand S, Parizad N. Prevalence of needlestick and sharps injuries in the healthcare workers of Iranian hospitals: an updated meta-analysis. *Environ Health Prev Med*. 2018;23(1):44. doi:10.1186/s12199-018-0734-z
7. Harb AC, Tarabay R, Diab B, Ballout RA, Khamassi S, Akl EA. Safety engineered injection devices for intramuscular, subcutaneous and intradermal injections in healthcare delivery settings: a systematic review and meta-analysis. *BMC Nurs*. 2015;14:71. doi:10.1186/s12912-015-0119-1
8. Ballout RA, Diab B, Harb AC, Tarabay R, Khamassi S, Akl EA. Use of safety-engineered devices by healthcare workers for intravenous and/or phlebotomy procedures in healthcare settings: a systematic review and meta-analysis. *BMC Health Serv Res*. 2016;16:458. doi:10.1186/s12913-016-1705-y
9. Schuurmans J, Lutgens SP, Groen L, Schneeberger PM. Do safety engineered devices reduce needlestick injuries? *J Hosp Infect*. 2018;100(1):99-104. doi:10.1016/j.jhin.2018.04.026
10. Perry J, Jagger J, Parker G, Phillips EK, Gomaa A. Disposal of sharps medical waste in the United States: impact of recommendations and regulations, 1987-2007. *Am J Infect Control*. 2012;40(4):354-358. doi:10.1016/j.ajic.2011.04.328
11. Grimmond T, Good L. EXPO-S.T.O.P. 2016 and 2017 blood exposure surveys: an alarming rise. *Am J Infect Control*. 2019;47(12):1465-1470. doi:10.1016/j.ajic.2019.07.004
12. Reddy VK, Lavoie MC, Verbeek JH, Pahwa M. Devices for preventing percutaneous exposure injuries caused by needles in healthcare personnel. *Cochrane Database Syst Rev*. 2017;11(11):CD009740. doi:10.1002/14651858.CD009740.pub3
13. Ottino MC, Argentero A, Argentero PA, Garzaro G, Zotti CM. Needlestick prevention devices: data from hospital surveillance in Piedmont, Italy-comprehensive analysis on needlestick injuries between healthcare workers after the introduction of safety devices. *BMJ Open*. 2019;9(11):e030576. doi:10.1136/bmjopen-2019-030576
14. Tosini W, Ciotti C, Goyer F, et al. Needlestick injury rates according to different types of safety-engineered devices: results of a French multicenter study. *Infect Control Hosp Epidemiol*. 2010;31(4):402-407. doi:10.1086/651301
15. Centers for Disease Control and Prevention. Selecting, evaluating and using sharps disposal containers. US Dept of Health and Human Services, National Institute for Occupational Safety; January 1998.

Updated June 6, 2014. DHHS (NIOSH) Publication No. 97-111. https://www.cdc.gov/niosh/docs/97-111/pdfs/97-111.pdf?id=10.26616/NIOSHPUB97111

16. Tarigan LH, Cifuentes M, Quinn M, Kriebel D. Prevention of needlestick injuries in healthcare facilities: a meta-analysis. *Infect Control Hosp Epidemiol*. 2015;36(7):823-829. doi:10.1017/ice.2015.50
17. Dulon M, Lisiak B, Wendeler D, Nienhaus A. Causes of needlestick injuries in three healthcare settings: analysis of accident notifications registered six months after the implementation of EU Directive 2010/32/EU in Germany. *J Hosp Infect*. 2017;95(3):306-311. doi:10.1016/j.jhin.2016.11.015
18. Motaarefi H, Mahmoudi H, Mohammadi E, Hasanpour-Dehkordi A. Factors associated with needlestick injuries in health care occupations: a systematic review. *J Clin Diagn Res*. 2016;10(8):IE01-IE04. doi:10.7860/JCDR/2016/17973.8221
19. Rezaei S, Hajizadeh M, Zandian H, Fathi A, Nouri B. Period prevalence and reporting rate of needlestick injuries to nurses in Iran: a systematic review and meta-analysis. *Res Nurs Health*. 2017;40(4):311-322. doi:10.1002/nur.21801
20. Yazie TD, Chufa KA, Tebeje MG. Prevalence of needlestick injury among healthcare workers in Ethiopia: a systematic review and meta-analysis. *Environ Health Prev Med*. 2019;24(1):52. doi:10.1186/s12199-019-0807-7
21. Brouillette NM, Quinn MM, Kriebel D. Risk of sharps injuries to home care nurses and aides: a systematic review and meta-analysis. *J Occup Environ Med*. 2017;59(11):1072-1077. doi:10.1097/JOM.0000000000001160
22. Mossburg S, Agore A, Nkimbeng M, Commodore-Mensah Y. Occupational hazards among healthcare workers in Africa: a systematic review. *Ann Glob Health*. 2019;85(1):78. doi:10.5334/aogh.2434
23. Aziz AM. Do training and needle-safety devices prevent needlestick injuries? A systematised review of the literature. *Br J Nurs*. 2018;27(16):944-952. doi:10.12968/bjon.2018.27.16.944
24. Grimmond T. UK safety-engineered device use: changes since the 2013 sharps regulations. *Occup Med (Lond)*. 2019;69(5):352-358. doi:10.1093/occmed/kqz087
25. Centers for Disease Control and Prevention. Regulated medical waste-self inspection checklist. National Institute for Occupational Safety and Health; October 2003. Updated June 6, 2014. DHHS (NIOSH) Publication No. 2004-101. https://www.cdc.gov/niosh/docs/2004-101/chklists/r1n79m~1.htm

Section Four: Infusion Equipment

Section Standards

I. To ensure patient safety, the clinician is competent in the use of infusion equipment, including knowledge of appropriate indications, contraindications, and manufacturers' directions for use.

II. The use and maintenance of infusion equipment is established in organizational policies, procedures, and/or practice guidelines.

III. Infusion equipment is cleaned and disinfected after each patient use with disinfectants that have antimicrobial activity against pathogens likely to contaminate the equipment and in accordance with manufacturers' directions for cleaning and disinfecting.

22. VASCULAR VISUALIZATION

Standard

22.1 Vascular visualization technology is employed to increase insertion success of the most appropriate, least invasive vascular access device (VAD), minimizing the need to escalate to an unnecessary, more invasive device and to reduce insertion-related complications.

Practice Recommendations

A. Assess the patient's medical history for conditions that may affect the peripheral vasculature and increase the need for visualization technology to assist in locating appropriate venous or arterial insertion sites. Factors that increase difficulty with locating veins by observation and palpation (known as landmark techniques) include, but are not limited to:
   1. Disease processes that result in structural vessel changes (eg, diabetes mellitus, hypertension).
   2. History of frequent venipuncture and/or lengthy courses of infusion therapy.
   3. Variations in skin between patient populations, such as darker skin tones and excessive hair on the skin.
   4. Skin alterations, such as the presence of scars or tattoos.
   5. Patient's age (both neonates and the elderly).
   6. Obesity.
   7. Fluid volume deficit.[1-5] (I)

B. Assess the anatomy prior to insertion when using ultrasound to identify vascular anomalies (eg, occlusion or thrombosis) and to assess vessel diameter.
   1. Select the most appropriate vessel to cannulate based on vessel size, shape, depth, flow, and patency; identification of potential structures to avoid (eg, nerves, arteries) within the vicinity of insertion; respiratory variation; catheter-to-vein ratio; and operator experience.
   2. Minimize damage to surrounding structures; identify vessels in the short (transverse) axis and proceed with insertion, or, alternatively, if the long (longitudinal) axis for needle insertion is preferred for adult patients redirect the probe to this plane upon completion of initial assessment.[6-10] (I)

C. Consider the use of visible light devices that provide transillumination of the peripheral veins.
   1. Visible light devices aid in locating superficial veins in neonates; however, their usefulness in infants, older children, and adults is limited due to the thickness of subcutaneous tissue and size of the arm circumference.[11-15] (II)
   2. Use only cold light sources in devices designed for vascular visualization. Thermal burns have been reported due to close contact between skin and the light source when the device emits heat (eg, traditional flashlights).[15] (V)

D. Use near infrared (nIR) light technology to aid in locating viable superficial peripheral venous sites and decreasing procedure time for peripheral intravenous catheter (PIVC) insertion.
   1. Available technology includes hands-free devices that capture an image of the veins and reflect it back to the skin's surface or to a screen.
   2. Use nIR light technology to assess peripheral venous sites and facilitate more informed decisions about vein selection (ie, bifurcating veins, tortuosity of veins, palpable but nonvisible veins, location of venous valves). The use of nIR technology has been associated with enhanced first-time insertion success and decreased procedural time compared to traditional visual assessment and palpation in some populations, such as neonates.[12-14] (II)

E. Measure the catheter-to-vessel ratio prior to insertion of an upper extremity VAD; ensure a catheter-to-vessel ratio of less than 45%; while research is focused on peripherally inserted central catheter (PICC) insertion, this ratio can be applied to midline catheters as well, as they are placed in the same veins (see Standard 34, *Vascular Access Device Placement;* Standard 53, *Catheter-Associated Deep Vein Thrombosis*).[6,16,17] (A/P)

F. Use ultrasound for PIVC and midline catheter insertion.
   1. Adults: studies report fewer venipuncture attempts and decreased escalation to central vascular access device (CVAD) insertion.[5,18-23] (I)
      a. Short PIVC: use ultrasound in adult patients with difficult intravenous access (DIVA).[5,6,8,10,24-27] (I)
      b. Long PIVC: insertion with ultrasound may reduce failure due to an increased ratio of catheter within the vessel; 1 study demonstrated a reduction in catheter failure rate (when ≥65% of the catheter resided within the vein).[28] (IV)
   2. Pediatric patients:
      a. Some small randomized controlled trials (RCTs) and prospective observational studies have demonstrated improved, first-time PIVC insertion success; reduced number of attempts; and shorter procedural time with use of ultrasound; however, more large, well-designed RCTs are needed to confirm these results in various pediatric populations and settings.[13,29-35] (II)
      b. Consider use of short axis (out of plane view) vs long axis (in plane view) for PIVC insertion; this technique has shown improved insertion success in pediatric patients.[29,36] (IV)

G. Use real-time ultrasound guidance and a systematic approach to insertion of CVADs in adults and children to improve insertion success rates, reduce number of needle punctures, and decrease insertion complication rates.[9,10,37-39] (I)

H. Use ultrasound guidance for arterial puncture and catheter insertion in adults and children.
   1. Ultrasound-guided insertion of the radial artery has been associated with higher first-attempt success and lower failure rate compared to palpation, with no significant difference in time to insertion or hematoma formation in adult and pediatric patients.[24,37,40-42] (I)
   2. Use real-time, ultrasound-guided femoral arterial line insertion, as it has been associated with reduced hematoma formation and vascular complications.[10,24,37,43] (I)

I. Use a sterile single-use gel packet and a sterile sheath over the probe and disinfect before and after each use to reduce the risk for ultrasound probe contamination and subsequent risk for infection; refer to manufacturers' directions for use.[6,7,44] (V)

J. Assess and document clinician competency in the use of vascular visualization technology for insertion of VADs. This knowledge includes, but is not limited to, assessment of vessels, size, depth, location, potential complications, and adherence to and awareness of Aseptic Non Touch Technique (ANTT). See Standard 5, *Competency and Competency Assessment;* Standard 18, *Aseptic Non Touch Technique*.[45] (V)

REFERENCES

Note: All electronic references in this section were accessed between April 28, 2020, and August 20, 2020.

1. Marsh N, Webster J, Larson E, Cooke M, Mihala G, Rickard CM. Observational study of peripheral intravenous catheter outcomes in adult hospitalized patients: a multivariable analysis of peripheral intravenous catheter failure. *J Hosp Med*. 2018;13(2):83-89. doi:10.12788/jhm.2867
2. Whalen M, Maliszewski B, Baptiste DL. Establishing a dedicated difficult vascular access team in the emergency department: a needs assessment. *J Infus Nurs.* 2017;40(3):149-154. doi:10.1097/NAN.0000000000000218
3. Riker MW, Kennedy C, Winfrey BS, Yen K, Dowd MD. Validation and refinement of the difficult intravenous access score: a clinical prediction rule for identifying children with difficult intravenous access. *Acad Emerg Med*. 2011;18(11):1129-1134. doi:10.1111/j.1553-2712.2011.01205.x
4. Yen K, Riegert A, Gorelick MH. Derivation of the DIVA score: a clinical prediction rule for the identification of children with difficult intravenous access. *Pediatr Emerg Care.* 2008;24(3):143-147. doi:10.1097/PEC.0b013e3181666f32
5. van Loon FHJ, Buise MP, Claassen JJF, Dierick-van Daele ATM, Bouwman ARA. Comparison of ultrasound guidance with palpation and direct visualisation for peripheral vein cannulation in adult patients: a systematic review and meta-analysis. *Br J Anaesth*. 2018;121(2):358-366. doi:10.1016/j.bja.2018.04.047
6. Association for Vascular Access. *Resource Guide for Vascular Access: Recommended Study Guide for Vascular Access Board Certification*. Association for Vascular Access; 2019.
7. Gottlieb M, Sundaram T, Holladay D, Nakitende D. Ultrasound-guided peripheral intravenous line placement: a narrative review of evidence-based best practices. *West J Emerg Med.* 2017;18(6):1047-1054. doi:10.5811/westjem.2017.7.34610
8. AIUM practice parameter for the performance of a peripheral venous ultrasound examination. *J Ultrasound Med*. 2020;39(5):E49-E56. doi:10.1002/jum.15263
9. Alexandrou E. Right assessment and vein selection. In: Moureau N ed. *Vessel Health and Preservation: The Right Approach for Vascular Access.* SpringerOpen; 2019:9-22. https://link.springer.com/content/pdf/10.1007%2F978-3-030-03149-7.pdf
10. Schmidt GA, Blaivas M, Conrad SA, et al. Ultrasound-guided vascular access in critical illness. *Intensive Care Med*. 2019;45(4):434-446. doi:10.1007/s00134-019-05564-7
11. Gümüş M, Basbakkal Z. Efficacy of veinlite PEDI in pediatric peripheral intravenous access: a randomized controlled trial [published online ahead of print May 23, 2018]. *Pediatr Emerg Care*. 2018;10.1097/PEC.0000000000001515. doi:10.1097/PEC.0000000000001515
12. Çağlar S, Büyükyılmaz F, Bakoğlu İ, İnal S, Salihoğlu Ö. Efficacy of vein visualization devices for peripheral intravenous catheter placement in preterm infants: a randomized clinical trial. *J Perinat Neonatal Nurs*. 2019;33(1):61-67. doi:10.1097/JPN.0000000000000385
13. Heinrichs J, Fritze Z, Klassen T, Curtis S. A systematic review and meta-analysis of new interventions for peripheral intravenous cannulation of children. *Pediatr Emerg Care.* 2013;29(7):858-866. doi:10.1097/PEC.0b013e3182999bcd
14. Pitts P, Ostroff M. The use of visualization technology for the insertion of peripheral intravenous catheters. *J Assoc Vasc Access*. 2019;24(3):10-14. https://doi.org/10.2309/j.java.2019.003.007
15. Ramasethu J, Seo S. *MacDonald's Atlas of Procedures in Neonatology*. 6th ed. Wolters Kluwer; 2020.
16. Sharp R, Cummings M, Fielder A, Mikocka-Walus A, Grech C, Esterman A. The catheter to vein ratio and rates of symptomatic venous

thromboembolism in patients with a peripherally inserted central catheter (PICC): a prospective cohort study. *Int J Nurs Stud.* 2015;52(3):677-685. doi:10.1016/j.ijnurstu.2014.12.002

17. Spencer TR, Mahoney KJ. Reducing catheter-related thrombosis using a risk reduction tool centered on catheter to vessel ratio. *J Thromb Thrombolysis.* 2017;44(4):427-434. doi:10.1007/s11239-017-1569-y
18. Galen B, Baron S, Young S, Hall A, Berger-Spivack L, Southern W. Reducing peripherally inserted central catheters and midline catheters by training nurses in ultrasound-guided peripheral intravenous catheter placement. *BMJ Qual Saf*. 2020;29(3):245-249. doi:10.1136/bmjqs-2019-009923
19. Morata L, Ogilvie C, Yon J, Johnson A. Decreasing peripherally inserted central catheter use with ultrasound-guided peripheral intravenous lines: a quality improvement project in the acute care setting. *J Nurs Adm*. 2017;47(6):338-344. doi:10.1097/NNA.0000000000000489
20. Pare JR, Pollock SE, Liu JH, Leo MM, Nelson KP. Central venous catheter placement after ultrasound guided peripheral IV placement for difficult vascular access patients. *Am J Emerg Med.* 2019;37(2):317-320. doi:10.1016/j.ajem.2018.11.021
21. Deutsch GB, Sathyanarayana SA, Singh N, Nicastro J. Ultrasound-guided placement of midline catheters in the surgical intensive care unit: a cost-effective proposal for timely central line removal. *J Surg Res*. 2014;191(1):1-5.
22. Adams DZ, Little A, Vinsant C, Khandelwal S. The midline catheter: a clinical review. 2016;51(3):252-258. doi:10.1016/j.jemermed.2016.05.029
23. Scoppettuolo G, Pittiruti M, Pitoni S, et al. Ultrasound-guided "short" midline catheters for difficult venous access in the emergency department: a retrospective analysis. *Int J Emerg Med.* 2016;9(1):3. doi:10.1186/s12245-016-0100-0.
24. Oliver LA, Oliver JA, Ohanyan S, Park W, Benelyahoo A, Vadivelu N. Ultrasound for peripheral and arterial access. *Best Pract Res Clin Anaesthesiol.* 2019;33(4):523-537. doi:10.1016/j.bpa.2019.10.002
25. Millington SJ, Hendin A, Shiloh AL, Koenig S. Better with ultrasound: peripheral intravenous catheter insertion. 2020;157(2):369-375. doi:10.1016/j.chest.2019.04.139
26. Horigan A, Vanhoy M, Kaiser J, et al. *Clinical Practice Guideline: Difficult Intravenous Access.* Emergency Nurses Association; 2018.
27. Stolz LA, Stolz U, Howe C, Farrell IJ, Adhikari S. Ultrasound-guided peripheral venous access: a meta-analysis and systematic review. *J Vasc Access*. 2015;16(4):321-326. doi:10.5301/jva.5000346
28. Pandurangadu AV, Tucker J, Brackney AR, Bahl A. Ultrasound-guided intravenous catheter survival impacted by amount of catheter residing in the vein. *Emerg Med J*. 2018;35(9):550-555. doi:10.1136/emermed-2017-206803
29. Munshey F, Parra DA, McDonnell C, Matava C. Ultrasound-guided techniques for peripheral intravenous placement in children with difficult venous access. *Paediatr Anaesth*. 2020;30(2):108-115. doi:10.1111/pan.13780.
30. Hanada S, Van Winkle MT, Subramani S, Ueda K. Dynamic ultrasound-guided short-axis needle tip navigation technique vs. landmark technique for difficult saphenous vein access in children: a randomised study. *Anaesthesia*. 2017;72(12):1508-1515. doi:10.1111/anae.14082
31. Vinograd AM, Chen AE, Woodford AL, et al. Ultrasonographic guidance to improve first-attempt success in children with predicted difficult intravenous access in the emergency department: a randomized controlled trial. *Ann Emerg Med*. 2019;74(1):19-27. doi:10.1016/j.annemergmed.2019.02.019
32. Vinograd AM, Zorc JJ, Dean AJ, Abbadessa MKF, Chen AE. First-attempt success, longevity, and complication rates of ultrasound-guided peripheral intravenous catheters in children. *Pediatr Emerg Care*. 2018;34(6):376-380. doi:10.1097/PEC.0000000000001063
33. Goel D, Smitthimedhin A, Yadav B, et al. Ultrasound-detected venous changes associated with peripheral intravenous placement in children. *Br J Nurs.* 2020;29(8):S44-S49. doi:10.12968/bjon.2020.29.8.S44
34. Ares G, Hunter CJ. Central venous access in children: indications, devices, and risks. *Curr Opin Pediatr*. 2017;29(3):340-346. doi:10.1097/MOP.0000000000000485
35. Curtis SJ, Craig WR, Logue E, Vandermeer B, Hanson A, Klassen T. Ultrasound or near-infrared vascular imaging to guide peripheral intravenous catheterization in children: a pragmatic randomized controlled trial. *CMAJ*. 2015;187(8):563-570. doi:10.1503/cmaj.141012
36. Paladini A, Chiaretti A, Sellasie KW, Pittiruti M, Vento G. Ultrasound-guided placement of long peripheral cannulas in children over the age of 10 years admitted to the emergency department: a pilot study. *BMJ Paediatr Open.* 2018;2(1):e000244. doi:10.1136/bmjpo-2017-000244
37. Franco-Sadud R, Schnobrich D, Mathews BK, et al. Recommendations on the use of ultrasound guidance for central and peripheral vascular access in adults: a position statement of the Society of Hospital Medicine. *J Hosp Med*. 2019;14:E1-E22. doi:10.12788/jhm.3287
38. Saugel B, Scheeren TWL, Teboul JL. Ultrasound-guided central venous catheter placement: a structured review and recommendations for clinical practice. *Crit Care*. 2017;21(1):225. doi:10.1186/s13054-017-1814-y
39. Lalu MM, Fayad A, Ahmed O, et al. Ultrasound-guided subclavian vein catheterization: a systematic review and meta-analysis. *Crit Care Med.* 2015;43(7):1498-1507. doi:10.1097/CCM.0000000000000973
40. Moussa Pacha H, Alahdab F, Al-Khadra Y, et al. Ultrasound-guided versus palpation-guided radial artery catheterization in adult population: a systematic review and meta-analysis of randomized controlled trials. *Am Heart J.* 2018;204:1-8. doi:10.1016/j.ahj.2018.06.007
41. Zhang W, Li K, Xu H, et al. Efficacy of ultrasound-guided technique for radial artery catheterization in pediatric populations: a systematic review and meta-analysis of randomized controlled trials. *Crit Care.* 2020;24(1):197. doi:10.1186/s13054-020-02920-8
42. Bhattacharjee S, Maitra S, Baidya DK. Comparison between ultrasound guided technique and digital palpation technique for radial artery cannulation in adult patients: an updated meta-analysis of randomized controlled trials. *J Clin Anesth*. 2018;47:54-59. doi:10.1016/j.jclinane.2018.03.019
43. Sobolev M, Shiloh AL, Di Biase L, Slovut DP. Ultrasound-guided cannulation of the femoral vein in electrophysiological procedures: a systematic review and meta-analysis. *Europace*. 2017;19(5):850-855. doi:10.1093/europace/euw113
44. Rutala WA, Weber DJ. Disinfection, sterilization, and antisepsis: an overview. *Am J Infect Control*. 2016;44(5 Suppl):e1-e6. doi:10.1016/j.ajic.2015.10.038
45. Spencer TR, Bardin-Spencer A. Ultrasound guidance for vascular access procedures by qualified vascular access specialists or other applicable healthcare clinicians. *J Assoc Vasc Access.* 2019;24(4):18-22. https://doi.org/10.2309/j.java.2019.004.00223.

23. CENTRAL VASCULAR ACCESS DEVICE TIP LOCATION

Standard

23.1 Tip location of a CVAD is determined radiographically or by other imaging technologies prior to initiation of infusion therapy or when clinical signs and symptoms suggest tip malposition.

23.2 The original tip location is documented in the patient's health record and made available to other organizations involved with the patient's care.

23.3 The CVAD tip location with the greatest safety profile in adults and children is the cavoatrial junction (CAJ).

Practice Recommendations

A. Determine the desired catheter length for insertion by anthropometric measurement including, but not limited to, external measurement from the planned insertion site to the third intercostal space, use of formulas

to calculate length based on body surface area, or measurement from preprocedural chest radiographs.[1-4] (IV)

B. Position the tip of a CVAD in the lower third of the superior vena cava (SVC) at or near the CAJ for adults and children.
   1. For upper body insertion sites, respiratory variation, arm movement, and changes in body position will cause the CVAD tip to move above or below the CAJ, indicating excursion into the upper right atrium. Tip location deeper in the right atrium near the tricuspid valve or in the right ventricle is associated with cardiac arrhythmias (see Standard 54, *Central Vascular Access Device Malposition*).[5-11] (II)
   2. For lower body insertion sites, the CVAD tip should be positioned in the inferior vena cava (IVC) above the level of the diaphragm.[4,12,13] (IV)
   3. For hemodialysis CVADs, proper location of the CVAD tip is at the mid-right atrium to avoid vessel and right atrial trauma and consequent complications.[14] (IV)

C. Avoid placing tip of the CVAD outside the SVC or IVC (eg, innominate, brachiocephalic, subclavian, external, or common iliac veins), as this is associated with higher rates of complications. In rare circumstances including anatomical or pathophysiological changes, these less-than-ideal tip positions might be clinically indicated.[5,6,11,15-21] (III)

D. Avoid intracardiac tip location in neonates and infants less than 1 year of age as this tip location has been associated with vessel erosion and cardiac tamponade. This complication has been described in the literature with particular reference to the use of small-gauge catheters typically less than 3 French (Fr).[2,12,22-37] (II)

E. Use methods for identifying CVAD tip location during the insertion procedure (ie, "real-time") due to greater accuracy, more rapid initiation of infusion therapy, and reduced costs.[38-47] (III)
   1. Use electrocardiogram (ECG) methods with either a metal guidewire or a column of normal saline inside the catheter lumen and observe the ECG tracing to place the CVAD tip at the CAJ. Follow manufacturers' directions for use with other ECG-based technology using a changing light pattern to detect tip location.[1,2,4,11,23,24,26,27,43,44,48-61] (II)
   2. Assess patient for known history of cardiac dysrhythmias and the presence of a P wave on ECG (if available) before planning to use ECG technology for placement. Contraindications to the use of ECG technology include patients with an abnormal ECG rhythm with an absence or alteration in the P wave (eg, presence of pacemakers, extreme tachycardia). Recent prospective observational studies have demonstrated safety and efficiency of using ECG to confirm catheter tip position in patients with atrial fibrillation.[1,51,62] (IV)
   3. Consider the use of ultrasound for CVAD tip location. The clinical applicability of this is currently limited by the small sample sizes used to demonstrate its efficacy as a reliable and safe method to replace chest radiographs in all ages, and its usefulness is limited by the knowledge, skill, and experience of the operator.[36,43,44,46,63-65] (III)
      a. The addition of agitated saline to enhance transthoracic echocardiography has been shown to be effective in detecting catheter tip position in the lower third of the SVC, as well as detecting catheter malposition through delayed opacification and reduced echogenicity.[66-68] (IV)
   4. Consider the use of ultrasound to confirm catheter tip position in neonates due to the relative ease of visualizing the catheter tip in this age group, as well as in the emergency department or other critical care environments where immediate confirmation of tip location is time critical.[46,69] (IV)
   5. Avoid fluoroscopy except where CVAD placement is difficult or has failed at the bedside, as it requires exposure to ionizing radiation.[4,53,62,70] (IV)
   6. Postprocedure radiograph imaging is not necessary if alternative tip location technology confirms proper tip placement.[46,50,71] (II)

F. Confirmation of tip location by postprocedure chest radiograph remains acceptable practice and is required in the absence of technology used during the procedure. This method is less accurate because the CAJ cannot be seen on the radiograph, requiring identification of tip location by measurement from the carina, trachea-bronchial angle, or thoracic vertebral bodies. Patient repositioning or movement results in distal or proximal migration of the catheter tip by as much as 2 cm dependent on the movement.[4,12,69,72-75] (II)

G. Recognize that radiographic or ECG tip location technology does not differentiate between venous and arterial placement. If arterial placement is suspected, use other methods to confirm or refute arterial placement.
   1. Re-evaluate CVAD tip position if there are signs and symptoms of malposition (refer to Standard 54, *Central Vascular Access Device Malposition*).

H. Immediately post-CVAD insertion and prior to initiating infusion therapy, a clinician with documented competency must verify the CVAD tip position by using ECG or assessing the postprocedure chest radiograph. [2,21,76,77] (V)

I. Assess the catheter tip position when a patient is transferred from an external health care facility; if all the following criteria are met, it is appropriate to use the catheter without additional tip confirmation:
   1. Documentation exists confirming catheter tip position at the CAJ on insertion.
   2. Ability to aspirate blood and flush the catheter without resistance.
   3. External catheter length remains the same as documented upon insertion.

4. When any of these criteria are not met, catheter tip placement should be confirmed with a chest radiograph. (Committee Consensus)

J. Document the time of insertion and CVAD tip location by including a copy of the ECG tracing, chest radiograph note, or other appropriate report in the patient's health record (refer to Standard 10, *Documentation in the Health Record*).

REFERENCES

Note: All electronic references in this section were accessed between April 28, 2020, and August 20, 2020.

1. Albertini F, Struglia M, Faraone V, Fioravanti R, Boursier Niutta S. Effectiveness of the ECG method in the correct positioning of PICC type central venous catheters in patients with atrial fibrillation. *Minerva Cardioangiol.* 2019;67(3):207-213. doi:10.23736/S0026-4725.19.04915-6
2. Ling Q, Chen H, Tang M, Qu Y, Tang B. Accuracy and safety study of intracavitary electrocardiographic guidance for peripherally inserted central catheter placement in neonates. *J Perinat Neonatal Nurs.* 2019;33(1):89-95. doi:10.1097/JPN.0000000000000389
3. Stroud A, Zalieckas J, Tan C, Tracy S, Zurakowski D, Mooney DP. Simple formulas to determine optimal subclavian central venous catheter tip placement in infants and children. *J Pediatr Surg.* 2014;49(7):1109-1112. doi:10.1016/j.jpedsurg.2013.12.024
4. Perin G, Scarpa MG. Defining central venous line position in children: tips for the tip. *J Vasc Access*. 2015;16(2):77-86. doi:10.5301/jva.5000285
5. Paterson R, Chopra V, Brown E, et al. Selection and insertion of vascular access devices in pediatrics: a systematic review. *Pediatrics*. 2020;145(Suppl 3):S243-S268. doi:10.1542/peds.2019-3474H
6. Ullman AJ, Bernstein SJ, Brown E, et al. The Michigan Appropriateness Guide for Intravenous Catheters in Pediatrics: miniMAGIC. *Pediatrics.* 2020;145(Suppl 3):S269-S284. doi:10.1542/peds.2019-3474I
7. Pittiruti M, Lamperti M. Late cardiac tamponade in adults secondary to tip position in the right atrium: an urban legend? a systematic review of the literature. *J Cardiothorac Vasc Anesth*. 2015;29(2):491-495. doi:10.1053/j.jvca.2014.05.020
8. Chopra V, Flanders SA, Saint S, et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Ann Intern Med.* 2015;163(6 Suppl):S1-S40. doi:10.7326/M15-0744
9. Connolly B, Amaral J, Walsh S, Temple M, Chait P, Stephens D. Influence of arm movement on central tip location of peripherally inserted central catheters (PICCs). *Pediatr Radiol*. 2006;36(8):845-850. doi:10.1007/s00247-006-0172-8
10. Gnannt R, Connolly BL, Parra DA, Amaral J, Moineddin R, Thakor AS. Variables decreasing tip movement of peripherally inserted central catheters in pediatric patients. *Pediatr Radiol*. 2016;46(11):1532-1538. doi:10.1007/s00247-016-3648-1
11. Kleidon TM, Horowitz J, Rickard CM, et al. Peripherally inserted central catheter thrombosis after placement via electrocardiography vs traditional methods [published online ahead of print Jul 14, 2020]. *Am J Med.* 2020;S0002-9343(20)30557-X. doi:10.1016/j.amjmed.2020.06.010
12. Guimaraes AF, Souza AA, Bouzada MC, Meira ZM. Accuracy of chest radiography for positioning of the umbilical venous catheter. *J Pediatr (Rio J).* 2017;93(2):172-178. doi:10.1016/j.jped.2016.05.004
13. Lachowska M, Lachowski K, Królak-Olejnik B. Parenteral nutrition solution in cerebrospinal fluid in preterm newborn - a case report and review of the literature. *J Vasc Access.* 2016;17(4):e82-e84. doi:10.5301/jva.5000552
14. Lok CE, Huber TS, Lee T, et al. KDOQI clinical practice guideline for vascular access: 2019 update. *Am J Kidney Dis.* 2020;75(4S2):S1-S164. doi:10.1053/j.ajkd.2019.12.001
15. Ballard DH, Samra NS, Gifford KM, Roller R, Wolfe BM, Owings JT. Distance of the internal central venous catheter tip from the right atrium is positively correlated with central venous thrombosis. *Emerg Radiol.* 2016;23(3):269-273. doi:10.1007/s10140-016-1393-2
16. Cleff C, Boensch M, Eifinger F, Hinkelbein J. Correct positioning of central venous catheters in pediatrics : are current formulae really useful? [article in German]. *Anaesthesist.* 2018;67(7):519-524. doi:10.1007/s00101-018-0446-1
17. Kumar M, Singh A, Sidhu KS, Kaur A. Malposition of subclavian venous catheter leading to chest complications. *J Clin Diagn Res.* 2016;10(5):PD16-PD18. doi:10.7860/JCDR/2016/19399.7860
18. Wang K, Sun W, Shi X. Upper extremity deep vein thrombosis after migration of peripherally inserted central catheter (PICC): a case report. *Medicine (Baltimore).* 2017;96(51):e9222. doi:10.1097/MD.0000000000009222
19. Chopra V, Kaatz S, Conlon A, et al. The Michigan Risk Score to predict peripherally inserted central catheter-associated thrombosis. *J Thromb Haemost.* 2017;15(10):1951-1962. doi:10.1111/jth.13794
20. Chopra V, Ratz D, Kuhn L, Lopus T, Lee A, Krein S. Peripherally inserted central catheter-related deep vein thrombosis: contemporary patterns and predictors. *J Thromb Haemost*. 2014;12(6):847-854. doi:10.1111/jth.12549
21. Kleidon T, Ullman AJ, Zhang L, et al. How does your PICCOMPARE? a pilot randomized controlled trial comparing various picc materials in pediatrics. *J Hosp Med.* 2018;13(8):517-525. doi:10.12788/jhm.2911
22. Arunoday A, Zipitis C. Confirming longline position in neonates–survey of practice in England and Wales. *World J Clin Pediatr.* 2017;6(3):149-153. doi:10.5409/wjcp.v6.i3.149
23. Ling QY, Chen H, Tang M, Qu Y, Tang BZ. Efficiency of electrocardiogram monitor for positioning the catheter tip in peripherally inserted central catheter placement in neonates [article in Chinese]. *Zhongguo Dang Dai Er Ke Za Zhi [Chin J Contemp Pediatr].* 2018;20(5):363-367. doi:10.7499/j.issn.1008-8830.2018.05.005
24. Xiao AQ, Sun J, Zhu LH, et al. Effectiveness of intracavitary electrocardiogram-guided peripherally inserted central catheter tip placement in premature infants: a multicentre pre-post intervention study. *Eur J Pediatr*. 2020;179(3):439-446. doi:10.1007/s00431-019-03524-3
25. Yu X, Yue S, Wang M, et al. Risk factors related to peripherally inserted central venous catheter nonselective removal in neonates. *Biomed Res Int.* 2018;2018:3769376. doi:10.1155/2018/3769376
26. Zhou L, Xu H, Liang J, Xu M, Yu J. Effectiveness of intracavitary electrocardiogram guidance in peripherally inserted central catheter tip placement in neonates. *J Perinat Neonatal Nurs*. 2017;31(4):326-331. doi:10.1097/JPN.0000000000000264
27. Zhou LJ, Xua HZ, Xu MF, Hu Y, Lou XF. An accuracy study of the intracavitary electrocardiogram (IC-ECG) guided peripherally inserted central catheter tip placement among neonates. *Open Med (Wars)*. 2017;12:125-130. doi:10.1515/med-2017-0019
28. Abiramalatha T, Kumar M, Shabeer MP, Thomas N. Advantages of being diligent: lessons learnt from umbilical venous catheterisation in neonates. *BMJ Case Rep.* 2016;2016:bcr2015214073. doi:10.1136/bcr-2015-214073
29. Ainsworth S, McGuire W. Percutaneous central venous catheters versus peripheral cannulae for delivery of parenteral nutrition in neonates. *Cochrane Database Syst Rev*. 2015;(10):CD004219. doi:10.1002/14651858.CD004219.pub4
30. Atmawidjaja RW, Azri M, Ismail IH. Cardiac tamponade: a rare but preventable complication of central venous catheter in neonates. *Med J Malaysia.* 2016;71(3):147-148.
31. Barreiros LL, Andrade FM, Torres RA, Magalhaes LVB, Farnetano BDS, Fiorelli RKA. Cardiac tamponade by peripherally inserted

central catheter in preterm infants: role of bedside ultrasonography and therapeutic approach. *Rev Col Bras Cir*. 2018;45(3):e1818. doi:10.1590/0100-6991e-20181818

32. Chioukh FZ, Ameur KB, Hmida HB, Monastiri K. Pericardial effusion with cardiac tamponade caused by a central venous catheter in a very low birth weight infant. *Pan Afr Med J*. 2016;25:13. doi:10.11604/pamj.2016.25.13.8731
33. Elbatreek M, Shehata NB, Abu-Shaheen A, Almatary A. Neonatal pericardial effusion and tamponade after umbilical venous catheter insertion and the use of saline contrast echo as a diagnostic tool. *Am J Case Rep*. 2019;20:1382-1386. doi:10.12659/AJCR.917723
34. Galvez-Cancino F, de la Luz Sánchez-Tirado M. Cardiac tamponade associated with umbilical venous catheter (UVC) placed in inappropriate position [article in Spanish]. *Gac Med Mex.* 2015;151(3):396-398.
35. Minghui Z, Hujun C, Li M, Weidan C, Yanqin C, Xinxin C. Iatrogenic acute cardiac tamponade during percutaneous removal of a fractured peripherally inserted central catheter in a premature neonate. *Heart Lung.* 2015;44(6):517-520. doi:10.1016/j.hrtlng.2015.05.009
36. Oh C, Lee S, Seo JM, Lee SK. Ultrasound guided percutaneous internal jugular vein access in neonatal intensive care unit patients. *J Pediatr Surg.* 2016;51(4):570-572. doi:10.1016/j.jpedsurg.2015.09.019
37. Blackwood BP, Farrow KN, Kim S, Hunter CJ. Peripherally inserted central catheters complicated by vascular erosion in neonates. *JPEN J Parenter Enteral Nutr.* 2016;40(6):890-895. doi:10.1177/0148607115574000
38. Adrian M, Borgquist O, Bentzer P, et al. Research protocol for mechanical complications after central venous catheterisation: a prospective controlled multicentre observational study to determine incidence and risk factors of mechanical complications within 24 hours after cannulation. *BMJ Open*. 2019;9(10):e029301. doi:10.1136/bmjopen-2019-029301
39. Ahn JH, Kim IS, Yang JH, Lee IG, Seo DH, Kim SP. Transoesophageal echocardiographic evaluation of central venous catheter positioning using Peres' formula or a radiological landmark-based approach: a prospective randomized single-centre study. *Br J Anaesth.* 2017;118(2):215-222. doi:10.1093/bja/aew430
40. Czarnik T, Gawda R, Nowotarski J. Real-time, ultrasound-guided infraclavicular axillary vein cannulation for renal replacement therapy in the critical care unit-a prospective intervention study. *J Crit Care.* 2015;30(3):624-628. doi:10.1016/j.jcrc.2015.01.002
41. Fleming GM, Mink RB, Hornik C, et al. Developing a tool to assess placement of central venous catheters in pediatrics patients. *J Grad Med Educ.* 2016;8(3):346-352. doi:10.4300/JGME-D-15-00365.1
42. Gurien LA, Blakely ML, Russell RT, et al. Real-time ultrasonography for placement of central venous catheters in children: a multi-institutional study. *Surgery.* 2016;160(6):1605-1611. doi:10.1016/j.surg.2016.05.019
43. Kim SC, Heinze I, Schmiedel A, et al. Ultrasound confirmation of central venous catheter position via a right supraclavicular fossa view using a microconvex probe: an observational pilot study. *Eur J Anaesthesiol.* 2015;32(1):29-36. doi:10.1097/EJA.0000000000000042
44. Kim SC, Klebach C, Heinze I, Hoeft A, Baumgarten G, Weber S. The supraclavicular fossa ultrasound view for central venous catheter placement and catheter change over guidewire. *J Vis Exp.* 2014;(94):52160. doi:10.3791/52160.
45. Li XY, Ye JB, Zhang LG, Jia YZ, Zhou RM, Pai P. Misplacement of tunneled hemodialysis catheter into azygos vein: left or right jugular insertion has similar susceptibility. *Blood Purif.* 2019;48(1):1-9. doi:10.1159/000497231
46. Oleti T, Jeeva Sankar M, Thukral A, et al. Does ultrasound guidance for peripherally inserted central catheter (PICC) insertion reduce the incidence of tip malposition? - a randomized trial. *J Perinatol.* 2019;39(1):95-101. doi:10.1038/s41372-018-0249-x
47. Tomaszewski KJ, Ferko N, Hollmann SS, et al. Time and resources of peripherally inserted central catheter insertion procedures: a comparison between blind insertion/chest X-ray and a real time tip navigation and confirmation system. *Clinicoecon Outcomes Res.* 2017;9:115-125. doi:10.2147/CEOR.S121230
48. Baldinelli F, Capozzoli G, Pedrazzoli R, Marzano N. Evaluation of the correct position of peripherally inserted central catheters: anatomical landmark vs. electrocardiographic technique. *J Vasc Access.* 2015;16(5):394-398. doi:10.5301/jva.5000431
49. Dale M, Higgins A, Carolan-Rees G. Sherlock 3CG(®) tip confirmation system for placement of peripherally inserted central catheters: a NICE medical technology guidance. *Appl Health Econ Health Policy.* 2016;14(1):41-49. doi:10.1007/s40258-015-0192-3
50. Elli S, Cannizzo L, Marini A, et al. Evaluation of tip location reliability of intraprocedural ECG vs. chest xrays in PICC placement [article in Italian]. *Assist Inferm Ric*. 2016;35(4):174-179. doi:10.1702/2621.26950
51. Gao Y, Liu Y, Zhang H, Fang F, Song L. The safety and accuracy of ECG-guided PICC tip position verification applied in patients with atrial fibrillation. *Ther Clin Risk Manag*. 2018;14:1075-1081. doi:10.2147/TCRM.S156468
52. Jayaraman J, Shah V. Bedside prediction of the central venous catheter insertion depth - comparison of different techniques. *J Anaesthesiol Clin Pharmacol*. 2019;35(2):197-201. doi:10.4103/joacp.JOACP_125_16
53. Li A, Jiao J, Zhang Y, et al. A randomized controlled study of bedside electrocardiograph-guided tip location technique & the traditional chest radiography tip location technique for peripherally inserted central venous catheter in cancer patients. *Indian J Med Res.* 2018;147(5):477-483. doi:10.4103/ijmr.IJMR_1120_16
54. Li W, Xu R, Fan D. Clinical application of electrocardiogram-guided tip positioning in peripheral inserted central catheters placement. *J Cancer Res Ther.* 2018;14(4):887-891. doi:10.4103/jcrt.JCRT_46_18
55. Liu G, Hou W, Zhou C, et al. Meta-analysis of intracavitary electrocardiogram guidance for peripherally inserted central catheter placement. *J Vasc Access.* 2019;20(6):577-582. doi:10.1177/1129729819826028
56. Liu YJ, Dong L, Lou XP, et al. Evaluating ECG-aided tip localization of peripherally inserted central catheter in patients with cancer. *Int J Clin Exp Med*. 2015;8(8):14127-14129.
57. Oliver G, Jones M. ECG or X-ray as the 'gold standard' for establishing PICC-tip location? *Br J Nurs.* 2014;23(suppl 19):S10-S16. doi:10.12968/bjon.2014.23.Sup19.S10
58. Rossetti F, Pittiruti M, Lamperti M, Graziano U, Celentano D, Capozzoli G. The intracavitary ECG method for positioning the tip of central venous access devices in pediatric patients: results of an Italian multicenter study. *J Vasc Access.* 2015;16(2):137-143. doi:10.5301/jva.5000281
59. Santacruz E, Mateo-Lobo R, Vega-Pinero B, et al. Intracavitary electrocardiogram (IC-ECG) guidance for peripherally inserted central catheter (PICC) placement [article in Spanish]. *Nutr Hosp.* 2018;35(5):1005-1008. doi:10.20960/nh.1847
60. Yang L, Bing X, Song L, Na C, Minghong D, Annuo L. Intracavitary electrocardiogram guidance for placement of peripherally inserted central catheters in premature infants. *Medicine (Baltimore)*. 2019;98(50):e18368. doi:10.1097/MD.0000000000018368
61. Yuan L, Li R, Meng A, et al. Superior success rate of intracavitary electrocardiogram guidance for peripherally inserted central catheter placement in patients with cancer: a randomized open-label controlled multicenter study. *PLoS One*. 2017;12(3):e0171630. doi:10.1371/journal.pone.0171630
62. Steinhagen F, Kanthak M, Kukuk G, et al. Electrocardiography-controlled central venous catheter tip positioning in patients with atrial fibrillation. *J Vasc Access.* 2018;19(6):528-534. doi:10.1177/1129729818757976
63. Bortman J, Knio Z, Amir R, Hamid K, Mahmood F, Matyal R. Perioperative surface ultrasound for placement and confirmation of central venous access: a case report. *A A Case Rep.* 2017;8(8):197-199. doi:10.1213/XAA.0000000000000463

64. Kim SC, Gräff I, Sommer A, Hoeft A, Weber S. Ultrasound-guided supraclavicular central venous catheter tip positioning via the right subclavian vein using a microconvex probe. *J Vasc Access*. 2016;17(5):435-439. doi:10.5301/jva.5000518
65. Ablordeppey EA, Drewry AM, Beyer AB, et al. Diagnostic accuracy of central venous catheter confirmation by bedside ultrasound versus chest radiography in critically ill patients: a systematic review and meta-analysis. *Crit Care Med.* 2017;45(4):715-724. doi:10.1097/CCM.0000000000002188
66. Franco-Sadud R, Schnobrich D, Mathews BK, et al. Recommendations on the use of ultrasound guidance for central and peripheral vascular access in adults: a position statement of the Society of Hospital Medicine. *J Hosp Med.* 2019;14:E1-E22. doi:10.12788/jhm.3287
67. Upadhyay J, Basu S, Srivastava Y, et al. Agitated saline contrast to delineate central venous catheter position in neonates. [published online ahead of print Jul 29, 2020]. *J Perinatol.* 2020;10.1038/s41372-020-0761-7. doi:10.1038/s41372-020-0761-7
68. Wen M, Stock K, Heemann U, Aussieker M, Küchle C. Agitated saline bubble-enhanced transthoracic echocardiography: a novel method to visualize the position of central venous catheter. *Crit Care Med*. 2014;42(3):e231-e233. doi:10.1097/CCM.0000000000000130
69. Alonso-Quintela P, Oulego-Erroz I, Rodriguez-Blanco S, Muniz-Fontan M, Lapena-Lopez-de Armentia S, Rodriguez-Nunez A. Location of the central venous catheter tip with bedside ultrasound in young children: can we eliminate the need for chest radiography? *Pediatr Crit Care Med.* 2015;16(9):e340-e345. doi:10.1097/PCC.0000000000000491
70. Sainathan S, Hempstead M, Andaz S. A single institution experience of seven hundred consecutively placed peripherally inserted central venous catheters. *J Vasc Access.* 2014;15(6):498-502. doi:10.5301/jva.5000248
71. Bidgood C. Improving the patient experience with real-time PICC placement confirmation. *Br J Nurs.* 2016;25(10):539-543. doi:10.12968/bjon.2016.25.10.539
72. Song YG, Byun JH, Hwang SY, Kim CW, Shim SG. Use of vertebral body units to locate the cavoatrial junction for optimum central venous catheter tip positioning. *Br J Anaesth*. 2015;115(2):252-257. doi:10.1093/bja/aev218
73. De Carvalho BR, Eagar GM. Immediate post-insertion tip migration of peripherally inserted central catheters dependent on arm position and depth of inspiration. *J Med Imaging Radiat Oncol*. 2018;62(3):324-329. doi:10.1111/1754-9485.12698
74. Gnannt R, Connolly BL, Parra DA, Amaral J, Moineddin R, Thakor AS. Variables decreasing tip movement of peripherally inserted central catheters in pediatric patients. *Pediatr Radiol*. 2016;46(11):1532-1538. doi:10.1007/s00247-016-3648-1
75. Chaskar V, Karnik PP, Dave NM, Garasia M. Comparative study of three methods for depth of central venous catheter placement in children: an observational pilot study. *Turk J Anaesthesiol Reanim*. 2018;46(2):116-120. doi:10.5152/TJAR.2018.32748
76. Hanekom H. Chest radiograph interpretation for critical care nurses. *Prof Nurs Today.* 2018;22(3):25-33. http://hdl.handle.net/2263/67239
77. Royer T, Earhart A. Taking the leap from PICC placement to tip placement. *J Assoc Vasc Access.* 2007;12(3):148-155. https://doi.org/10.2309/java.12-3-1124.

24. FLOW-CONTROL DEVICES

Standard

24.1 The selection of a flow-control device(s) is based upon factors including the prescribed infusion therapy, rate control requirements, infusion-related risks, patient care setting, and available resources within the organization.

24.2 Administration sets with anti–free-flow mechanisms are used with electronic infusion pumps.

Practice Recommendations

A. Choose a method for flow-control based upon factors such as age, condition, mobility, self-administration ability, preference, and lifestyle of the patient; type of VAD; type of therapy, frequency, dosing, drug stability, and rate of infusion; the potential for side effects or adverse effects of the therapy; health care setting; and reimbursement.[1–10] (IV)
   1. Use nonelectronic, flow-control devices for low-risk infusions where some variation in flow rate is not critical. These may include gravity infusion sets, mechanical pumps such as elastomeric balloon pumps, spring-based pumps, and negative-pressure pumps.
      a. Choose gravity infusions for small-volume, high-risk infusions administered through a peripheral vein when clinically applicable (eg, vesicant agents). See Standard 60, *Antineoplastic Therapy*.[5,11] (V)
      b. Consider the use of a manual flow regulator in lieu of the roller clamp (eg, allows for setting the infusion rate in mLs per hour) to allow for easier regulation and more consistent flow; there are also electronic drip monitors that can be used with a gravity administration set that provide more accurate rate monitoring.[1,7,9,12-16] (IV)
   2. Use electronic infusion pumps for infusion therapies that require precise flow-control for safe infusate administration.[2,7,8,17,18] (IV)
      a. Ensure safe and consistent use of electronic infusion pumps by using anti–free-flow protection, air-in-line detection, and pressure and occlusion alarms.[8,9,19,20] (V)
      b. Consider the use of electronic infusion pumps with dose-error reduction systems ([DERS] ie, smart pumps) for intravenous (IV) administration of medication and solutions (eg, continuous, intermittent, secondary infusions, patient-controlled analgesia [PCA], and epidural, spinal, and nerve block infusions) throughout the acute care setting, including ambulatory settings such as perioperative/procedural/radiology care areas, emergency departments, and infusion centers, as they are associated with reduced risk for infusion-related medication errors including error interceptions (eg, wrong rate) and reduced adverse drug events (see Standard 13, *Medication Verification*).[4,11,21-25] (IV)
         i. Use the drug library in accordance with organizational policy, avoiding manual programming and overrides of drug library alerts.[4,11,21-27] (IV)
         ii. Update drug libraries regularly (to address new drugs, new drug protocols, and drug shortages) to avoid unnecessary alerts, and

involve end users in the design of the library.[11,21,22,25-32] (IV)

iii. Consider use of smart pumps with electronic health record (EHR) interoperability to further reduce manual programming errors.[11,33,34] (V)

c. Use multichannel infusion pumps only for a single patient for the simultaneous delivery of therapies by the same route (eg, IV and epidural infusions are not infused on the same individual pump).[11] (V)

B. Monitor flow-control devices during the administration of infusion therapy to ensure safe and accurate delivery of the prescribed infusion rate and volume.[9] (V)

1. Identify medications that should be administered as uninterrupted primary infusions (eg, rapid infusion, critical medications).[11] (V)
2. Confirm safe infusion of all secondary or piggyback medications.
   a. Know the capabilities of the electronic infusion pump in use regarding flow rate and volume control for secondary medications.
   b. When attaching a secondary set above the electronic infusion pump, use only a primary set that contains a back-check valve or use a dedicated pump set with integrated mechanisms to prevent retrograde flow of the secondary medication into the primary solution container.
   c. Follow the manufacturers' directions for correctly positioning primary and secondary solution containers and the needed height differences between these containers (ie, head height differential). Incorrect head height differential can lead to unintended flow rates. Alterations in flow rate may occur due to differences in the level of solution in each container (eg, bag, glass bottle), the height of the IV pole, and the position of the pump. When high-risk medications are given through the primary infusion system concurrently with the primary infusion, attach the administration set below the electronic infusion pump controlling the primary fluid flow and use a separate electronic infusion pump to control the rate of the high-risk medication.[29,35-37] (V)
3. Use only accessory devices (eg, administration sets, syringes, filters) that are designed to work with the flow-control device according to the manufacturers' directions for use (refer to Standard 35, *Filtration*).
   a. If using syringe pumps for delivery of small volume infusions, use accessory devices that offer the smallest internal volume (eg, microbore tubing, shorter length) to minimize residual volume.[38] (V)
4. Assess manually regulated infusion sets at regular intervals; verify flow by counting drops and monitoring the infusion volume infused.[16] (V)
5. Routinely assess the VAD site to detect infiltration or extravasation, as electronic infusion pumps do not detect infiltration or extravasation.[9,10] (V)

C. Standardize the types of pumps used in an organization to promote user familiarity with its operation.[9,11.32] (V)

1. Use separate, designated pumps for epidural infusions, enteral infusions, and irrigations and to differentiate from vascular access infusions.[11,39] (V)
2. Ensure pumps follow and stay with patients to help minimize the need to re-establish infusions after patient transfers.[35] (V)
3. Collaborate with the health care team, including end users, in the evaluation, selection, and launch of flow-control devices (see Standard 12, *Product Evaluation, Integrity, and Defect Reporting*).[10,20,23,35] (IV)

D. Recognize the problem of alarm and alert fatigue with multiple electronic monitoring and therapeutic devices. Implement evidence-based recommendations (eg, alarm parameter settings, pump/infusate height) from professional agencies and device manufacturers through collaboration with the health care team.[23-25,32,40,41] (IV)

E. Follow organizational policy regarding use of a flow-control device during care transitions (eg, hospital admission of patient with an insulin pump).[42,43] (V)

F. Teach patients and/or caregivers in the home care setting about safe and effective use of flow-control devices and the back-up plan for pump malfunction/failure, identification of potential problems, and available resources (see Standard 8, *Patient Education*).[9,20,21,26,27] (IV)

REFERENCES

Note: All electronic references in this section were accessed between April 28, 2020, and August 20, 2020.

1. Buonora MJE. Management of gravity intravenous infusions in an austere environment using the DripAssist infusion rate monitor. *AANA J.* 2019;87(1):65-70.
2. Centrella-Nigro A, Scarano J, Ramraj N. Does the use of an infusion pump for red blood cells increase hemolysis? *J Infus Nurs.* 2018;41(6):372-374. doi:10.1097/NAN.0000000000000305
3. Meess A. Platelet transfusion in chemotherapy patients: comparison of the effect of intravenous infusion pumps versus gravity transfusion. *Br J Biomed Sci.* 2015;72(3):111-114. doi:10.1080/09674845.2015.11666806
4. Kane-Gill SL, Dasta JF, Buckley MS, et al. Clinical practice guideline: safe medication use in the ICU. *Crit Care Med*. 2017;45(9):e877-e915. doi:10.1097/ccm.0000000000002533
5. Institute for Safe Medication Practices. 2018-2019 targeted medication safety best practices for hospitals. Institute for Safe Medication Practices; 2019. https://www.ismp.org/sites/default/files/attachments/2019-01/TMSBP-for-Hospitalsv2.pdf
6. Goldspiel B, Hoffman JM, Griffith NL, et al. ASHP guidelines on preventing medication errors with chemotherapy and biotherapy. *Am J Health Syst Pharm*. 2015;72(8):e6-e35. doi:10.2146/sp150001
7. Choi GJ, Yoon IJ, Lee OH, Kang H. Accuracy of an automatic infusion controller (AutoClamp) for intravenous fluid administration. *Open Anesthesiol J*. 2015;9:23-28. doi:10.2174/1874321801509010023
8. Blandford A, Dykes PC, Franklin BD, et al. Intravenous infusion administration: a comparative study of practices and errors between the

United States and England and their implications for patient safety. *Drug Saf*. 2019;42(10):1157-1165. doi:10.1007/s40264-019-00841-2

9. Gorski LA. *Phillips's Manual of I.V. Therapeutics: Evidence-Based Practice for Infusion Therapy*. 7th ed. F.A. Davis Company; 2018.
10. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines*. Pappin Communications; 2019.
11. Institute for Safe Medication Practices. Guidelines for optimizing safe implementation and use of smart infusion pumps. Published February 10, 2020. https://www.ismp.org/guidelines/safe-implementation-and-use-smart-pumps. https://www.ismp.org/guidelines/safe-implementation-and-use-smart-pumps
12. Kim UR, Peterfreund RA, Lovich MA. Drug infusion systems: technologies, performance, and pitfalls. *Anesth Analg*. 2017;124(5):1493-1505. doi:10.1213/ane.0000000000001707
13. Oliver G. Optimising patient safety when using elastomeric pumps to administer outpatient parenteral antibiotic therapy. *Br J Nurs*. 2016;25(19):S22-S27.
14. Villalba J, Peñalver J, Torner P, Serra M, Planell J. Home-based intravenous analgesia with elastomeric pump as an outpatient procedure for pain control after anterior cruciate ligament repair. *Rev Esp Cir Ortop Traumatol*. 2018;62(1):65-70. doi:10.1016/j.recot.2017.07.005
15. Voumard R, Gardiol C, André P, et al. Efficacy and safety of continuous infusions with elastomeric pumps for outpatient parenteral antimicrobial therapy (OPAT): an observational study. *J Antimicrob Chemother*. 2018;73(9):2540-2545. doi:10.1093/jac/dky224
16. Gorski LA. *Fast Facts for Nurses About Home Infusion Therapy: The Expert's Best Practice Guide in a Nutshell.* Springer Publishing Company; 2017.
17. Association for the Advancement of Medical Instrumentation, US Food and Drug Administration. Infusing patients safely: priority issues from the AAMI/FDA Infusion Device Summit. October 5-6, 2010. https://www.aami.org/docs/default-source/reports/aami_fda_summit_report.pdf
18. Poder TG, Boileau JC, Lafreniere R, et al. Quantitative assessment of haemolysis secondary to modern infusion pumps. *Vox Sang*. 2017;112(3):201-209. doi:10.1111/vox.12486
19. ECRI Institute. Top 10 health technology hazards for 2017: a report from *Health Devices* November 2016 [executive brief]. ECRI Institute; 2017. https://www.ecri.org/Resources/Whitepapers_and_reports/Haz17.pdf
20. US Food and Drug Administration. Infusion pump risk reduction strategies for facility administrators and managers. Updated February 2, 2018. https://www.fda.gov/medical-devices/infusion-pumps/infusion-pump-risk-reduction-strategies-facility-administrators-and-managers
21. Bergon-Sendin E, Perez-Grande C, Lora-Pablos D, et al. Smart pumps and random safety audits in a neonatal intensive care unit: a new challenge for patient safety. *BMC Pediatr*. 2015;15:206. doi:10.1186/s12887-015-0521-6
22. Schnock KO, Dykes PC, Albert J, et al. A multi-hospital before-after observational study using a point- prevalence approach with an infusion safety intervention bundle to reduce intravenous medication administration errors. *Drug Saf*. 2018;41(6):591-602. doi:10.1007/s40264-018-0637-3
23. Shah PK, Irizarry J, O'Neill S. Strategies for managing smart pump alarm and alert fatigue: a narrative review. *Pharmacotherapy*. 2018;38(8):842-850. doi:10.1002/phar.2153
24. Lapkin S, Levett-Jones T, Chenoweth L, Johnson M. The effectiveness of interventions designed to reduce medication administration error: a synthesis of findings from systematic reviews. *J Nurs Manag*. 2016;24(7):845-858. doi:10.1111/jonm.12390
25. Melton KR, TImmons K, Walsh KE, Meinzen-Derr JK, Kirkendall E. Smart pumpts improve medication safety but increase alert burden in neonatal care. *BMC Med Inform Decis Mak*. 2019;19(1):213. doi:10.1186/s12911-019-0945-2
26. US Food and Drug Administration. Infusion pump risk reduction strategies for home health nurses. Updated February 2, 2018. https://www.fda.gov/medical-devices/infusion-pumps/infusion-pump-risk-reduction-strategies-home-health-nurses
27. US Food and Drug Administration. Infusion pump risk reduction strategies for pharmacists. Updated February 2, 2018. https://www.fda.gov/medical-devices/infusion-pumps/infusion-pump-risk-reduction-strategies-pharmacists
28. Dunford BB, Perrigino M, Tucker SJ, et al. Organizational, cultural, and psychological determinants of smart infusion pump work arounds: a study of 3 U.S. health systems. *J Patient Saf*. 2017;13(3):162-168. doi:10.1097/pts.0000000000000137
29. Giuliano KK, Ruppel H. Are smart pumps smart enough? *Nursing*. 2017;47(3):64-66. doi:10.1097/01.nurse.0000512888.75246.88
30. Giuliano KK, Su WT, Degnan DD, Fitzgerald K, Zink RJ, DeLaurentis P. Intravenous smart pump drug library compliance: a descriptive study of 44 hospitals. *J Patient Saf*. 2018;14(4):e76-e82. doi:10.1097/pts.0000000000000383
31. Ibarra-Perez R, Puertolas-Balint F, Lozano-Cruz E, Zamora-Gomez SE, Castro-Pastrana LI. Intravenous administration errors intercepted by smart infusion technology in an adult intensive care unit. *J Patient Saf*. 2017;10.1097/PTS.0000000000000374. doi:10.1097/pts.0000000000000374
32. Carlson R, Johnson B, Ensign RH 2nd. Development of an "infusion pump safety score." *Am J Health Syst Pharm*. 2015;72(10):777-779. doi:10.2146/ajhp140421
33. Biltoft J, Finneman L. Clinical and financial effects of smart pump-electronic medical record interoperability at a hospital in a regional health system. *Am J Health Syst Pharm*. 2018;75(14):1064-1068. doi:10.2146/ajhp161058
34. Suess TM, Beard JW, Trohimovich B. Impact of patient-controlled analgesia (PCA) smart pump-electronic health record (EHR) interoperability with auto-documentation on chart completion in a community hospital setting. *Pain Ther*. 2019;8(2):261-269. doi:10.1007/s40122-019-0132-2
35. AAMI Foundation. Quick guide: improving the safe use of multiple IV infusions. AAMI Foundation; 2016. https://www.aami.org/docs/default-source/foundation/infusion/infusion_therapy_quick_guide2.pdf
36. Bianchi P, Ranucci M. Unintentional boluses during drug infusions: pump up the volume! *Minerva Anestesiol*. 2014;80(5):626-627.
37. van der Eijk AC, van Rens RM, Dankelman J, Smit BJ. A literature review on flow-rate variability in neonatal IV therapy. *Paediatr Anaesth*. 2013;23(1):9-21. doi:10.1111/pan.12039
38. US Food and Drug Administration. Syringe pump problems with fluid flow continuity at low infusion rates can result in serious clinical consequences: FDA safety communication. August 25, 2016. https://www.fdanews.com/ext/resources/files/2016/08/08-25-16-pumpsafetynotice.pdf?1480880246
39. The Joint Commission. Managing risk during transition to new ISO tubing connector standards. *Sentinel Event Alert*. Issue 53. August 20, 2014. https://www.jointcommission.org/-/media/deprecated-unorganized/imported-assets/tjc/system-folders/assetmanager/sea_53_connectors_8_19_14_finalpdf.pdf?db=web&hash=5259E85202D5CE621294E9C46E8ED86C
40. Matocha D. Reducing infusion pump alarms through structured interventions. *J Assoc Vasc Access.* 2018;23(2):87-95. https://doi.org/10.1016/j.java.2018.03.002
41. The Joint Commission. *2020 National Patient Safety Goals.* The Joint Commission; 2020. https://www.jointcommission.org/en/standards/national-patient-safety-goals/

42. Paparella SF. Ambulatory infusion pumps: coming to an emergency department near you. *J Emerg Nurs*. 2018;44(5):517-519. doi:10.1016/j.jen.2018.05.016
43. Institute for Safe Medication Practices. Recommendations for the safe management of patients with an external subcutaneous insulin pump during hospitalization. *Acute Care ISMP Medication Safety Alert!* 2016;21(21):1-5. https://www.ismp.org/sites/default/files/attachments/2018-05/Insulin%20Pump%20Recommendations%2010-20-2016_0.pdf

25. BLOOD AND FLUID WARMING

Standard

25.1 Blood and fluid warming are performed only with devices specifically designed for that purpose.
25.2 Blood is warmed in a manner to avoid hemolysis.

Practice Recommendations

A. Use blood and fluid warmers when warranted by patient history, clinical condition, and prescribed therapy including, but not limited to, avoiding or treating intraoperative hypothermia, during treatment of trauma or from exposure, during plasma exchange for therapeutic apheresis, for patients known to have clinically significant cold agglutinins, for neonate exchange transfusions, or during replacement of large blood volumes.[1-21] (I)
   1. The risk for clinically important hypothermia is increased when blood is transfused through a CVAD.[3] (V)
   2. Warmed IV fluids can reduce the incidence of postoperative shivering.[4,10,12,14,21] (I)
   3. Warmed IV fluids may enhance a patient's thermal comfort.[6,22] (II)

B. Use only a blood or fluid warming device that is indicated for this purpose in accordance with the manufacturers' directions for use; is equipped with warning systems, including audible alarms and visual temperature gauges; and is within the maintenance date.[2,8,23,24] (V)
   1. Assure that equipment used to warm blood, IV fluids, contrast media, and irrigation solutions (eg, infusion device, warming cabinet) are monitored for proper function, including consistent temperature and alarm function. Remove from service if malfunction is suspected.[1-4,23,25] (I)
   2. Never use warming methods where temperature and infection risks cannot be controlled (eg, microwave oven, hot water bath).[1-3,13,23,24] (IV)

C. Do not warm solutions and blood above a set temperature recommended by the manufacturer of the warming device.[15,24,26] (I)
   1. Monitor the patient's temperature with a device that accurately estimates core temperature to assure that desired temperature goal is reached.[6,10,14,19,27] (I)
   2. Several factors may impact the ability to accurately infuse blood/fluids at the set temperature including, but not limited to, infusion flow rate, length of tubing, presence of add-on devices that may restrict flow rate (eg, needleless connectors), interruptions in administration, initial temperature of blood/fluid, total volume infused, environmental conditions, and other warming methods used (eg, forced air or radiant warming).[4,6,7,9-11,16,18,20,23,28-31] (I)
   3. Consider insulating the administration set to reduce heat loss if longer tubing is used and if environmental conditions warrant.[7,9,18] (I)
   4. Shield the blood component and tubing from phototherapy source (eg, ultraviolet) when administering warmed (or any) blood to an infant; inappropriate warming by exposure of blood to heat lamps or phototherapy lights may produce hemolysis.[3] (V)

D. Consider warming contrast media to reduce the viscosity. This may help to reduce extravasation in the following: high-viscosity contrast media, flow rates greater than 5 mL/s, and some arterial infusions. When contrast media is warmed, use a temperature log for the warmer and follow the device manufacturers' guidelines for maintenance of the warming device. Consult the manufacturers' package insert for the specific contrast agent regarding whether warming is contraindicated.[25,32] (V)

REFERENCES

Note: All electronic references in this section were accessed between April 5, 2019, and August 20, 2020.

1. AABB. *Primer on Blood Administration*. AABB; 2018:72-74.
2. Hrovat T, Passwater M, Palmer R, eds. *Guidelines for the Use of Blood Warming Devices*. AABB; 2002.
3. Ramasethu J, Seo S. *MacDonald's Atlas of Procedures in Neonatology*. 6th ed. Wolters Kluwer; 2020.
4. Campbell G, Alderson P, Smith A, Warttig S. Warming of intravenous and irrigation fluids for preventing inadvertent perioperative hypothermia. *Cochrane Database Syst Rev*. 2015;(4):CD009891. doi:10.1002/14651858.CD009891.pub2
5. Chebbout R, Newton RS, Walters M, Wrench IJ, Woolnough M. Does the addition of active body warming to in-line intravenous fluid warming prevent maternal hypothermia during elective caesarean section? a randomized controlled trial. *Int J Obstet Anesth*. 2017;31:37-44. doi:10.1016/j.ijoa.2017.04.008
6. Cobb B, Cho Y, Hilton G, Ting V, Carvalho B. Active warming utilizing combined IV fluid and forced-air warming decreases hypothermia and improves maternal comfort during cesarean delivery: a randomized control trial. *Anesth Analg*. 2016;122(5):1490-1497. doi:10.1213/ANE.0000000000001181
7. DeClerck MP, Lipman GS, Grahn DA, et al. A chemical heat pack-based method for consistent heating of intravenous fluids. *Wilderness Environ Med*. 2015;26(3):412-416. doi:10.1016/j.wem.2015.02.004
8. ECRI Institute. Medical device safety reports (MDSR). Suggested guidelines for blood warmer use. ECRI.org. http://www.mdsr.ecri.org/summary/detail.aspx?doc_id=8269
9. Haverkamp FJC, Giesbrecht GG, Tan ECTH. The prehospital management of hypothermia—an up-to-date overview. *Injury*. 2018;49(2):149-164. doi:10.1016/j.injury.2017.11.001
10. Kim G, Kim MH, Lee SM, Choi SJ, Shin YH, Jeong HJ. Effect of prewarmed intravenous fluids on peri-operative hypothermia and shivering after ambulatory surgery under monitored and anesthesia care. *J Anesth*. 2014;28(6):880-885. doi:10.1007/s00540-014-1820-z

11. Lehavi A, Yitzhak A, Jarassy R, Heizler R, Katz YS, Raz A. Comparison of the performance of battery-operated fluid warmers. *Emerg Med J*. 2018;35(9):564-570. doi:10.1136/emermed-2017-207112
12. Ma H, Lai B, Dong S, et al. Warming infusion improves perioperative outcomes of elderly patients who underwent bilateral hip replacement. *Medicine (Baltimore)*. 2017;96(13):e6490. doi:10.1097/MD.0000000000006490
13. Milligan J, Lee A, Gill M, Weatherall A, Tetlow C, Garner AA. Performance comparison of improvised prehospital blood warming techniques and a commercial blood warmer. *Injury*. 2016;47(8):1824-1827. doi:10.1016/j.injury.2016.05.038
14. Munday J, Hines S, Wallace K, Chang AM, Gibbons K, Yates P. A systematic review of the effectiveness of warming interventions for women undergoing cesarean section. *Worldviews Evid Based Nurs*. 2014;11(6):383-393. doi:10.1111/wvn.12067
15. Poder TG, Pruneau D, Dorval J, et al. Effect of warming and flow rate conditions of blood warmers on red blood cell integrity. *Vox Sang*. 2016;111(4):341-349. doi:10.1111/vox.12423
16. Poder TG, Pruneau D, Dorval J, et al. Pressure infusion cuff and blood warmer during massive transfusion: an experimental study about hemolysis and hypothermia. *PLoS One*. 2016;11(10):e0163429. doi:10.1371/journal.pone.0163429
17. Shen J, Wang Q, Zhang Y, Wang X, Shi P. Combination of warming blanket and prewarmed intravenous infusion is effective for rewarming in infants with postoperative hypothermia in China. *Paediatr Anaesth*. 2015;25(11):1139-1143. doi:10.1111/pan.12733
18. Singleton W, McLean M, Smale M, et al. An analysis of the temperature change in warmed intravenous fluids during administration in cold environments. *Air Med J*. 2017;36(3):127-130. doi:10.1016/j.amj.2016.07.032
19. Søreide K. Clinical and translational aspects of hypothermia in major trauma patients: from pathophysiology to prevention, prognosis and potential preservation. *Injury*. 2014;45(4):647-654. doi:10.1016/j.injury.2012.12.027
20. Thongsukh V, Kositratana C, Jandonpai A. Effect of fluid flow rate on efficacy of fluid warmer: an in vitro experimental study. *Anesthesiol Res Pract*. 2018;2018:8792125. doi:10.1155/2018/8792125
21. Zaman SS, Rahmani F, Majedi MA, Roshani D, Valiee S. A clinical trial of the effect of warm intravenous fluids on core temperature and shivering in patients undergoing abdominal surgery. *J Perianesth Nurs*. 2018;33(5):616-625. doi:10.1016/j.jopan.2016.12.010
22. Hausfeld K, Baker RB, Boettcher-Prior P, et al. Randomized prospective clinical trial comparing room temperature and warmed intravenous fluid boluses on pediatric patients' comfort. *J Pediatr Nurs*. 2015;30(6):e3-e9. doi:10.1016/j.pedn.2015.07.006
23. US Food and Drug Administration. Intravascular air-in-line and air embolism risks associated with infusion pumps, fluid warmers, and rapid infusers. *FDA Safety Communication*. Published January 31, 2019. https://www.fda.gov/medical-devices/safety-communications/intravascular-air-line-and-air-embolism-risks-associated-infusion-pumps-fluid-warmers-and-rapid
24. AABB. *Standards for Blood Banks and Transfusion Services*. 31st ed. AABB; 2018.
25. Studer KC. Does warming intravenous contrast media improve patient safety? *Radiol Technol*. 2018;89(4):407-408.
26. Poder TG, Nonkani WK, Tsakeu Leponkouo É. Blood warming and hemolysis: a systematic review with meta-analysis. *Transfus Med Rev*. 2015;29(3):172-180. doi:10.1016/j.tmrv.2015.03.002
27. National Institute for Health and Care Excellence. Inadvertent perioperative hypothermia overview. *NICE Pathways*. Updated August 19, 2020. https://pathways.nice.org.uk/pathways/inadvertent-perioperative-hypothermia/inadvertent-perioperative-hypothermia-overview.pdf
28. Lehn RA, Gross JB, McIsaac JH, Gipson KE. Needleless connectors substantially reduce flow of crystalloid and red blood cells during rapid infusion. *Anesth Analg*. 2015;120(4):801-804. doi:10.1213/ANE.0000000000000630
29. Seo HJ, Kim SH, An TH, Kim DJ. Experimental comparison of performances of Mega Acer Kit, Ranger and ThermoSens according to flow rates and distances. *J Clin Monit Comput*. 2018;32(6):1127-1134. doi:10.1007/s10877-017-9995-0
30. Zoremba N, Bruells C, Rossiant R, Bruer T. Heating capabilities of small fluid warming systems. *BMC Anesthesiol*. 2018;18(1):98. doi:10.1186/s12871-018-0565-x
31. Kim HJ, Yoo SM, Son HS, et al. Evaluation of the performance and safety of a newly developed intravenous fluid warmer. *Artif Organs*. 2015;39(7):591-596. doi:10.1111/aor.12441
32. ACR Committee on Drugs and Contrast Media. *ACR Manual on Contrast Media*. American College of Radiology; 2020. https://www.acr.org/Clinical-Resources/Contrast-Manual

Section Five: Vascular Access Device Selection and Placement

Section Standards

I. Insertion and removal of vascular access devices (VADs) are performed by providers/clinicians within the boundaries of their identified scope of practice, based on their licensure, upon documented competency, and in accordance with organizational policies, procedures, and/or practice guidelines.

II. Indications and protocols for VAD selection and insertion are established in organizational policies, procedures, and/or practice guidelines and according to manufacturers' directions for use.

KEY DEFINITIONS

Peripheral intravenous catheters (PIVCs): are inserted into and reside in veins of the periphery that includes all extremities, the external jugular vein, and scalp veins in neonates. PIVCs are inserted into superficial veins located just under the skin in the superficial tissue, as well as deep veins located under the muscle tissue.

INS categorizes 3 types of PIVCs:

Short peripheral intravenous catheter (short PIVC): an over-the-needle catheter with a hollow metal stylet (needle) positioned inside the catheter, generally inserted in superficial veins.

Long peripheral intravenous catheter (long PIVC): inserted in either superficial or deep peripheral veins and offers an option when a short PIVC is not long enough to adequately cannulate the available vein. A long PIVC can be inserted via traditional over-the-needle technique or with more advanced procedures, such as Seldinger and accelerated Seldinger techniques.

Midline catheter: inserted into a peripheral vein of the upper arm via the basilic, cephalic, or brachial vein with the terminal tip located at the level of the axilla in children and adults; for neonates, in addition to arm veins, midline catheters may be inserted via a scalp vein with the distal tip located in the jugular vein above the clavicle or in the lower extremity with the distal tip located below the inguinal crease.

26. VASCULAR ACCESS DEVICE PLANNING

Standard

26.1 Infusion therapy is initiated based on the patient's diagnosis, review of alternative routes of therapy, and consideration of the risks versus the benefits of various treatment modalities.

26.2 The appropriate type of VAD, peripheral or central, is selected to accommodate the patient's vascular access needs based on the prescribed therapy or treatment regimen, including anticipated duration of therapy, vascular characteristics, patient's age, comorbidities, history of infusion therapy, preference for VAD type and location, and ability and resources available to care for the device.

26.3 Selection of the most appropriate VAD occurs at the earliest opportunity and is a collaborative process among the health care team, the patient, and the patient's caregiver(s).

26.4 The least invasive VAD with the smallest outer diameter and fewest number of lumens needed for the prescribed therapy is selected.

26.5 Vessel health and preservation are prioritized when planning vascular access.

Practice Recommendations

I. General

A. Collaborate with an interprofessional team to identify medications that should and should not be given through peripheral veins. Peripheral parenteral therapy should ideally be isotonic and of physiological pH. When this is not achievable, peripheral intravenous (IV) infusion of extremes of pH and osmolarity should be avoided to reduce vascular endothelial damage. In clinical practice, many parameters, including administration site, number of infusion therapies, vein selected, related venous blood flow, infusion volume, infusion time, and planned duration of therapy, contribute to vessel damage. There is no well-defined and generally recognized pH or osmolarity limit. Factors to consider include, but are not limited to[1-6]: (A/P)

1. Diluent used to dilute medications to provide the final osmolarity of IV infusion
2. pH of infusate
3. Method of administration (eg, continuous or intermittent infusion or manual injection [ie, IV push])

4. Infusion rate
5. Number of infusion therapies (single vs multiple)
6. Anticipated duration of therapy (as a guide see below):
   a. (<4 days): Insert a peripheral intravenous catheter (PIVC) when all the above elements indicate peripherally compatible therapy.
   b. (5–14 days): Insert a midline catheter in hospitalized adult patients when all the above elements indicate peripherally compatible therapy. A long PIVC may remain appropriate if patient's vasculature, patient's preference, and local health care outcomes support this practice. More high-quality clinical trials are needed to confirm the safety and efficacy of midline catheter use in neonates and infants.
   c. (>15 days): Consider insertion of a central vascular access device (CVAD). For single, peripherally compatible therapies, midline catheters or long PIVCs may remain appropriate depending on patient's vasculature, patient preference, and documented outcome data for the health care organization. More high-quality clinical trials are needed to confirm the appropriate use and duration of these catheters.[1,2,7] (A/P)

B. Do not insert a PIVC or midline catheter as a central line-associated bloodstream infection (CLABSI) prevention strategy. (Committee Consensus)
C. Use a patient's port, unless contraindicated (eg, existing complication) as the preferred IV route in preference to insertion of an additional VAD. (Committee Consensus)

II. Short Peripheral Intravenous Catheters

A. Consider establishing criteria for short peripheral intravenous catheter (short PIVC) insertion to reduce the insertion of catheters that are idle. Recent studies indicate that as many as 50% of short PIVCs are in situ with no orders for infusion therapy.[8-12] (III)
B. Choose a short PIVC as follows:
   1. Evaluate the infusate characteristics in conjunction with limited duration of infusion therapy and availability of peripheral vascular access sites.[1,2,13,14] (I)
   2. Use vascular visualization technology (eg, near infrared, ultrasound) to increase success for patients with difficult intravenous access (DIVA). See Standard 22, *Vascular Visualization*.[2,15-20] (I)
   3. Avoid use for continuous infusion of medication with irritant or vesicant properties.[1-3,13,21-23] (I)
      a. For time-critical infusions of lifesaving therapies, such as vasopressors, begin the infusion through a PIVC until a CVAD can be safely inserted. Insert CVAD as soon as possible and within 24 to 48 hours.[24-26] (I)
   4. Use a restricted dextrose and protein concentration (≤10% and/or 5%, respectively) if it is medically necessary to administer parenteral nutrition (PN) through a peripheral device (see Standard 63, *Parenteral Nutrition*).[13,27] (II)
   5. Do not use a short PIVC when the vein lies deep in subcutaneous tissue or for veins classified as deep veins (lying underneath muscle), thus restricting the proportion of catheter that will be located within the vein. At least two-thirds of the PIVC should reside within the vessel to reduce the risk of PIVC failure.[28-34] (II)
C. Select the smallest-gauge PIVC that will accommodate the prescribed therapy and patient need.[22,35] (IV)
   1. Use a 20- to 24-gauge PIVC for most infusion therapies. Peripheral catheters larger than 20-gauge are more likely to cause phlebitis.[29,36-38] (IV)
   2. Use a 22- to 26-gauge catheter for neonates, pediatric patients, older adults, and patients with limited venous options to minimize insertion-related trauma.[29,36,39-41] (III)
   3. Balance the increased risk of infiltration against reducing venous trauma when choosing a 22-gauge short PIVC in adult patients. In a prospective observational trial, the risk of infiltration increased when a 22-gauge short PIVC was inserted compared to a 20-gauge short PIVC.[37,42] (IV)
   4. Consider a large-gauge PIVC for adult and pediatric patients when rapid fluid replacement is required, such as with trauma patients, or a fenestrated catheter for a contrast-based radiographic study.[35,43-46] (IV)
   5. Use a 20- to 24-gauge PIVC based on vein size for blood transfusion. A large-gauge PIVC is recommended when rapid transfusion is required (see Standard 64, *Blood Administration*).[35,43-45] (IV)
   6. Use steel-winged devices only for single-dose administration. Do not leave the device in situ.[36,47-49] (IV)

III. Long Peripheral Intravenous Catheters

A. Choose a long peripheral intravenous catheter (long PIVC) as follows:
   1. When all aspects of a short PIVC are met, but the vessel is difficult to palpate or visualize with the naked eye; ultrasound guidance/near infrared technology is recommended.[1,2,28,29,47] (III)
   2. Evaluate depth of vessel when choosing a long PIVC to ensure two-thirds of catheter lies within vein.[28-32] (I)
   3. Choose the smallest-gauge PIVC based on vein size to complete therapy.[27,29,43] (IV)

IV. Midline Catheters

A. Choose a midline catheter as follows:
   1. Assess infusate characteristics and planned duration of infusion therapy for tolerability by peripheral veins.[1,2,35,49-58] (I)
      a. Variation in the category and number of therapies infused through midline catheters exists. More studies are needed to guide clinical decision-making on appropriate type and number of therapies. One small retrospective cohort study and 1 ovine randomized controlled trial (RCT) report increased failure when multiple therapies, infused through dual lumen catheters and infusions of extreme pH and osmolarity, respectively, were used.[59,60] (IV)

2. Use a midline catheter for medications and solutions such as antimicrobials, fluid replacement, and analgesics with characteristics that are well-tolerated by peripheral veins.[1,2,52] (I)
3. Assess the clinical benefit of using a midline catheter that inhibits bacterial attachment and biofilm formation.[61,62] (IV)
4. Do not use midline catheters for continuous vesicant therapy, PN, or infusates with extremes of pH or osmolarity (see Standard 63, *Parenteral Nutrition*).[2,13,51,52,63] (I)
5. Increase catheter site surveillance when administering intermittent infusions of known irritants and vesicants due to increased risk of phlebitis or extravasation.[52,64,65] (III)
   a. Evaluate the risk and benefit of intermittently infusing vesicant medication for more than 6 days.[59,60,66] (IV)
   b. Further research is needed to establish the safety of using midline catheters for intermittent vesicant therapy and as a strategy for reducing catheter-associated bloodstream infection (CABSI). Some midline catheters have been associated with bloodstream infection (BSI) rates similar to those of central venous catheters.[67,68] (IV)
6. Avoid the use of a midline catheter when the patient has a history of thrombosis, hypercoagulability, decreased venous flow to the extremities, or end-stage renal disease requiring vein preservation.[7,52,53,69] (III)

V. CVADs (PICCs; Nontunneled Catheters; Tunneled, Cuffed Catheters; Implanted Vascular Access Ports)

A. Select a CVAD to administer any type of infusion therapy in which the benefit outweighs the risk.[1,2,13,35,47] (I)
B. To minimize unnecessary CVAD insertion, use an evidence-based list of indications for CVAD use, including, but not limited to:
   1. Clinical instability of the patient and/or complexity of infusion regimen (multiple infusates).
   2. Episodic chemotherapy treatment where insufficient peripheral venous access is anticipated.
   3. Prescribed continuous infusion therapy inappropriate for peripheral infusion (eg, vesicant, PN, electrolytes, and other medications).
   4. Invasive hemodynamic monitoring.
   5. Long-term intermittent infusion therapy (eg, any medication including anti-infectives in patients with a known or suspected infection or IV therapy for chronic disease, such as cystic fibrosis).
   6. History of failed or difficult peripheral IV access when use of ultrasound guidance has failed.[1,2,13,47,70] (I)
C. Recognize risks associated with CVADs, including venous thrombosis and an increased risk for CLABSIs in hospitalized patients (see Standard 53, *Catheter-Associated Deep Vein Thrombosis*).[1,2,43,71-83] (I)
   1. Balance the treatment benefit against the risk of venous thrombosis and infection for patients who have cancer or are critically ill when choosing a PICC; use smaller diameter and single-lumen PICCs to mitigate the risk for thrombosis (see Standard 53, *Catheter-Associated Deep Vein Thrombosis*).[1,2,13,71,74,76,77,84-90] (I)
   2. Choose a catheter appropriate to the patients' vasculature and therapy requirements (refer to Standard 34, *Vascular Access Device Placement*).
   3. Consider use of an antithrombogenic PICC to reduce thrombosis risk.[91-94] (III)
   4. Use a CVAD with the least number of lumens to reduce the risk of thrombosis, infection, and occlusion.[1,86,95-98] (I)
   5. Use insertion techniques including, but not limited to, ultrasound, catheter-to-vein ratio, and optimal catheter tip placement at the cavoatrial junction ([CAJ] tip location technology) to reduce catheter complications such as deep vein thrombosis (DVT).[90,99-101] (II)
D. Avoid PICCs in patients with chronic kidney disease (CKD). See Standard 29, *Vascular Access and Hemodialysis*.[102-104] (II)
E. Collaborate with the health care team to consider the use of anti-infective CVADs as they have shown a decrease in colonization and/or CABSI in some settings.
   1. Consider use in the following circumstances:
      a. Expected dwell of more than 5 days.
      b. CABSI rate remains high even after employing other preventive strategies.
      c. Patients with enhanced risk of infection (ie, neutropenic, transplant, burn, or critically ill patients).
      d. Emergency insertions.
      e. For patients at risk of developing CABSI, do not use anti-infective CVADs in patients with allergies to the anti-infective substances, such as chlorhexidine, silver sulfadiazine, rifampin, or minocycline.[48,70,96,105,106] (I)
   2. Do not use a PICC as an infection prevention strategy.[35,70,107] (III)
F. Plan proactively for an arteriovenous fistula (AVF) or an arteriovenous graft (AVG) for patients with CKD as a permanent access for dialysis; this includes restriction of device insertion that might compromise future fistula sites (see Standard 29, *Vascular Access and Hemodialysis*).[35,71,108,109] (I)
   1. PICC placement before or after hemodialysis initiation is associated with failure to transition to a working fistula; before PICC placement, consult with the nephrology team when available.[102-104,110-113] (IV)
G. Consider use of an implanted vascular access port in patients who require infrequent/intermittent

vascular access, as they have a lower rate of infection compared to tunneled and nontunneled CVADs.[13,71,98,114] (IV)

1. Contraindications to implanted vascular access ports include severe uncorrectable coagulopathy, uncontrolled sepsis or positive blood culture, and burns, trauma, or neoplasm of the chest that preclude chest wall placement; alternative sites where anterior chest wall is not feasible include the femoral vein or a trapezius approach.[71,115-119] (I)
2. Insertion of implanted vascular access ports in the upper arm may be an alternative site for patients in whom chest ports cannot be implanted.[72,120] (IV)
3. Advantages include low risk of complication during treatment, and patient benefits including minimal care and management and improved body image.[71,115-117] (II)

H. Consider a tunneled, cuffed CVAD for patients who are anticipated to require continuous long-term infusion therapy (eg, antineoplastic therapy, PN).[1,2,13,121] (I)

I. Consider the need for a power-injectable CVAD and know the pressure limits and other limitations (eg, maximum number of power injections) of the device including all attached or add-on devices (eg, implanted port access needle, extension set, needleless connector) to avoid catheter rupture.[122-124] (II)

VI. Arterial Catheters

A . Insert a peripheral arterial or pulmonary arterial catheter for short-term use for hemodynamic monitoring, obtaining blood samples, and analyzing blood gas in critically ill patients.[48,125,126] (V)

B. Consider use of a 20-gauge catheter for radial arterial access in adults; 1 large study demonstrated a low rate of complications using a 20-gauge vs an 18-gauge catheter.[127] (V)

C. Use ultrasound for arterial catheter insertion to reduce insertion-related complications (see Standard 22, *Vascular Visualization*).[128-130] (IV)

REFERENCES

Note: All references in this section were accessed between March 6, 2020, and September 1, 2020.

1. Chopra V, Flanders SA, Saint S, et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Ann Intern Med.* 2015;163(6 Suppl):S1-S40. doi:10.7326/M15-0744
2. Ullman AJ, Bernstein SJ, Brown E, et al. The Michigan Appropriateness Guide for Intravenous Catheters in pediatrics: miniMAGIC. *Pediatrics*. 2020;145(Suppl 3):S269-S284. doi:10.1542/peds.2019-3474I
3. Clark E, Giambra BK, Hingl J, Doellman D, Tofani B, Johnson N. Reducing risk of harm from extravasation: a 3-tiered evidence-based list of pediatric peripheral intravenous infusates. *J Infus Nurs.* 2013;36(1):37-45. doi:10.1097/NAN.0b013e3182798844
4. Dugan S, Le J, Jew RK. Maximum tolerated osmolarity for peripheral administration of parenteral nutrition in pediatric patients. *JPEN J Parenter Enteral Nutr.* 2014;38(7):847-851. doi:10.1177/0148607113495569
5. Perez CA, Figueroa SA. Complication rates of 3% hypertonic saline infusion through peripheral intravenous access. *J Neurosci Nurs.* 2017;49(3):191-195. doi:10.1097/JNN.0000000000000286
6. Roethlisberger D, Mahler HC, Altenburger U, Pappenberger A. If euhydric and isotonic do not work, what are acceptable pH and osmolality for parenteral drug dosage forms? *J Pharm Sci.* 2017;106(2):446-456. doi:10.1016/j.xphs.2016.09.034
7. Chopra V, Kaatz S, Swaminathan L, et al. Variation in use and outcomes related to midline catheters: results from a multicentre pilot study. *BMJ Qual Saf*. 2019;28(9):714-720. doi:10.1136/bmjqs-2018-008554
8. Ray-Barruel G, Cooke M, Mitchell M, Chopra V, Rickard CM. Implementing the I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: protocol for an interrupted time-series study. *BMJ Open.* 2018;8(6):e021290. doi:10.1136/bmjopen-2017-021290
9. Carr PJ, Rippey J, Moore T, et al. Reasons for removal of emergency department-inserted peripheral intravenous cannulae in admitted patients: a retrospective medical chart audit in Australia. *Infect Control Hosp Epidemiol*. 2016;37(7):874-876. doi:10.1017/ice.2016.70
10. Carr PJ, Rippey JCR, Cooke ML, et al. Derivation of a clinical decision-making aid to improve the insertion of clinically indicated peripheral intravenous catheters and promote vessel health preservation: an observational study. *PLoS One*. 2019;14(3):e0213923. doi:10.1371/journal.pone.0213923
11. Becerra MB, Shirley D, Safdar N. Prevalence, risk factors, and outcomes of idle intravenous catheters: an integrative review. *Am J Infect Control*. 2016;44(10):e167-e172. doi:10.1016/j.ajic.2016.03.073
12. Hawkins T, Greenslade JH, Suna J, et al. Peripheral intravenous cannula insertion and use in the emergency department: an intervention study. *Acad Emerg Med.* 2018;25(1):26-32. doi:10.1111/acem.13335
13. Paterson R, Chopra V, Brown E, et al. Selection and insertion of vascular access devices in pediatric populations: a systematic review of the literature. *Pediatrics.* 2020;145(Suppl 3):S243-S268. doi:10.1542/peds.2019-3474H
14. Fiorini J, Venturini G, Conti F, et al. Vessel health and preservation: an integrative review. *J Clin Nurs.* 2019;28(7-8):1039-1049. doi:10.1111/jocn.14707
15. van Loon FHJ, Buise MP, Claassen JJF, Dierick-van Daele ATM, Bouwman ARA. Comparison of ultrasound guidance with palpation and direct visualisation for peripheral vein cannulation in adult patients: a systematic review and meta-analysis. *Br J Anaesth*. 2018;121(2):358-366. doi:10.1016/j.bja.2018.04.047
16. Heinrichs J, Fritze Z, Klassen T, Curtis S. A systematic review and meta-analysis of new interventions for peripheral intravenous cannulation of children. *Pediatr Emerg Care.* 2013;29(7):858-866. doi:10.1097/PEC.0b013e3182999bcd
17. Heinrichs J, Fritze Z, Vandermeer B, Klassen T, Curtis S. Ultrasonographically guided peripheral intravenous cannulation of children and adults: a systematic review and meta-analysis. *Ann Emerg Med*. 2013;61(4):444-454.e441. doi:10.1016/j.annemergmed.2012.11.014
18. Pitts S, Ostroff M. The use of visualization technology for the insertion of peripheral intravenous catheters. *J Assoc Vasc Access.* 2019;24(3):10-14. https://doi.org/10.2309/j.java.2019.003.007
19. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health.* 2019;55(10):1214-1223. doi:10.1111/jpc.14384
20. Schults J, Rickard C, Kleidon T, Paterson R, Macfarlane F, Ullman A. Difficult peripheral venous access in children: an international survey and critical appraisal of assessment tools and escalation pathways. *J Nurs Scholarsh*. 2019;51(5):537-546. doi:10.1111/jnu.12505

21. Murayama R, Oya M, Abe-Doi M, Oe M, Komiyama C, Sanada H. Characteristics of subcutaneous tissues at the site of insertion of peripheral infusion in patients undergoing paclitaxel and carboplatin chemotherapy. *Drug Discov Ther*. 2019;13(5):288-293. doi:10.5582/ddt.2019.01064
22. Monasor-Ortolá D, Cortés-Castell E, Martínez-Pascual C, Esteve-Ríos A, Rizo-Baeza MM. Factors influencing the success of peripheral venous access in neonates. *J Pediatr Nurs.* 2019;47:e30-e35. doi:10.1016/j.pedn.2019.04.017
23. Gorski LA, Stranz M, Cook LS, et al. Development of an evidence-based list of noncytotoxic vesicant medications and solutions. *J Infus Nurs.* 2017;40(1):26-40. doi:10.1097/NAN.0000000000000202
24. Nguyen TT, Surrey A, Barmaan B, et al. Utilization and extravasation of peripheral norepinephrine in the emergency department. [published online ahead of print Jan 8, 2020]. *Am J Emerg Med.* 2020;S0735-6757(20)30014-0. doi:10.1016/j.ajem.2020.01.014
25. Medlej K, Kazzi AA, El Hajj Chehade A, et al. Complications from administration of vasopressors through peripheral venous catheters: an observational study. *J Emerg Med*. 2018;54(1):47-53. doi:10.1016/j.jemermed.2017.09.007
26. Loubani OM, Green RS. A systematic review of extravasation and local tissue injury from administration of vasopressors through peripheral intravenous catheters and central venous catheters. *J Crit Care.* 2015;30(3):653.e9-653.e6.53E17. doi:10.1016/j.jcrc.2015.01.014
27. Hallam C, Weston V, Denton A, et al. Development of the UK Vessel Health and Preservation (VHP) framework: a multi-organisational collaborative. *J Infect Prev*. 2016;17(2):65-72. doi:10.1177/1757177415624752
28. Pandurangadu AV, Tucker J, Brackney AR, Bahl A. Ultrasound-guided intravenous catheter survival impacted by amount of catheter residing in the vein. *Emerg Med J.* 2018;35(9):550-555. doi:10.1136/emermed-2017-206803
29. Kleidon T, Ullman AJ. Right device assessment and selection in pediatrics. In: Moureau NL, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access.* SpringerOpen; 2019:181-195. https://link.springer.com/content/pdf/10.1007%2F978-3-030-03149-7.pdf
30. Blanco P. Ultrasound-guided peripheral venous cannulation in critically ill patients: a practical guideline. *Ultrasound J.* 2019;11(1):27. doi:10.1186/s13089-019-0144-5
31. Paladini A, Chiaretti A, Sellasie KW, Pittiruti M, Vento G. Ultrasound-guided placement of long peripheral cannulas in children over the age of 10 years admitted to the emergency department: a pilot study. *BMJ Paediatr Open*. 2018;2(1):e000244. doi:10.1136/bmjpo-2017-000244
32. Badger J. Long peripheral catheters for deep arm vein venous access: a systematic review of complications. *Heart Lung.* 2019;48(3):222-225. doi:10.1016/j.hrtlng.2019.01.002
33. Halvorson EE, Case D, Skelton JA, McCrory MC. Vascular access in critically ill pediatric patients with obesity. *Pediatr Crit Care Med*. 2018;19(1):1-8. doi:10.1097/PCC.0000000000001368
34. Bahl A, Hijazi M, Chen NW, Lachapelle-Clavette L, Price J. Ultralong versus standard long peripheral intravenous catheters: a randomized controlled trial of ultrasonographically guided catheter survival. *Ann Emerg Med*. 2020;76(2):134-142. doi:10.1016/j.annemergmed.2019.11.013
35. Simonov M, Pittiruti M, Rickard CM, Chopra V. Navigating venous access: a guide for hospitalists. *J Hosp Med*. 2015;10(7):471-478. doi:10.1002/jhm.2335
36. Hagle ME, Mikell M. Peripheral venous access. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Wolters Kluwer/Lippincott Williams & Wilkins; 2014:303-334.
37. Marsh N, Webster J, Larson E, Cooke M, Mihala G, Rickard CM. Observational study of peripheral intravenous catheter outcomes in adult hospitalized patients: a multivariable analysis of peripheral intravenous catheter failure. *J Hosp Med.* 2018;13(2):83-89. doi:10.12788/jhm.2867
38. Wallis MC, McGrail MR, Webster J, et al. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from a randomized controlled trial. *Infect Control Hosp Epidemiol*. 2014;35(1):63-68. doi:10.1086/674398
39. Carr PJ, Higgins NS, Cooke ML, Rippey J, Rickard CM. Tools, clinical prediction rules, and algorithms for the insertion of peripheral intravenous catheters in adult hospitalized patients: a systematic scoping review of literature. *J Hosp Med*. 2017;12(10):851-858. doi:10.12788/jhm.2836
40. Kleidon TM, Rickard CM, Gibson V, et al. SMILE - Secure My Intravenous Line Effectively: a pilot randomised controlled trial of peripheral intravenous catheter securement in paediatrics. *J Tissue Viability*. 2020;29(2):82-90. doi:10.1016/j.jtv.2020.03.006
41. Ullman AJ, Takashima M, Kleidon T, Ray-Barruel G, Alexandrou E, Rickard CM. Global pediatric peripheral intravenous catheter practice and performance: a secondary analysis of 4206 catheters. *J Pediatr Nurs.* 2020;50:e18-e25. doi:10.1016/j.pedn.2019.09.023
42. Alexandrou E, Ray-Barruel G, Carr PJ, et al. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *J Hosp Med*. 2018;13(5):10.12788/jhm.3039. doi:10.12788/jhm.3039
43. Moureau NL, Alexadrou E. Device selection. In: Moureau NL, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access.* SpringerOpen; 2019:23-41. https://link.springer.com/content/pdf/10.1007%2F978-3-030-03149-7.pdf
44. Johnson PT, Christensen GM, Fishman EK. I.v. contrast administration with dual source 128-MDCT: a randomized controlled study comparing 18-gauge nonfenestrated and 20-gauge fenestrated catheters for catheter placement success, infusion rate, image quality, and complications. *AJR Am J Roentgenol.* 2014;202(6):1166-1170. doi:10.2214/AJR.13.11730
45. Verhoeff K, Saybel R, Mathura P, Tsang B, Fawcett V, Widder S. Ensuring adequate vascular access in patients with major trauma: a quality improvement initiative. *BMJ Open Qual.* 2018;7(1):e000090. doi:10.1136/bmjoq-2017-000090
46. Fischer AM, Riffel P, Henzler T, et al. More holes, more contrast? Comparing an 18-gauge non-fenestrated catheter with a 22-gauge fenestrated catheter for cardiac CT. *PLoS One*. 2020;15(6):e0234311. doi:10.1371/journal.pone.0234311
47. Alexander M, Gorski L, Corrigan A, Bullock M, Dickenson A, Earhart A. A technical and clinical application. In: Alexander M, Corrigan M, Gorski L, Phillips L, eds. *Core Curriculum for Infusion Nursing*. 4th ed. Wolters Kluwer/Lippincott Williams & Wilkins; 2014.
48. O'Grady N, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis*. 2011;52(9):1087-1099. doi:10.1093/cid/cir138
49. Centers for Disease Control and Prevention. Summary of recommendations, guidelines for the prevention of intravascular catheter-related infections (2011). Updated February 2017. https://www.cdc.gov/infectioncontrol/guidelines/bsi/recommendations.html
50. Sharp R, Esterman A, McCutcheon H, Hearse N, Cummings M. The safety and efficacy of midlines compared to peripherally inserted central catheters for adult cystic fibrosis patients: a retrospective, observational study. *Int J Nurs Stud*. 2014;51(5):694-702. doi:10.1016/j.ijnurstu.2013.09.002
51. Adams DZ, Little A, Vinsant C, Khandelwal S. The midline catheter: a clinical review. *J Emerg Med.* 2016;51(3):252-258. doi:10.1016/j.jemermed.2016.05.029
52. Cawcutt KA, Hankins RJ, Micheels TA, Rupp ME. Optimizing vascular-access device decision-making in the era of midline catheters. *Infect Control Hosp Epidemiol.* 2019;40(6):674-680. doi:10.1017/ice.2019.49

53. Dickson HG, Flynn O, West D, Alexandrou E, Mifflin N, Malone M. A cluster of failures of midline catheters in a hospital in the home program: a retrospective analysis. *J Infus Nurs.* 2019;42(4):203-208. doi:10.1097/NAN.0000000000000330
54. Seo H, Altshuler D, Dubrovskaya Y, et al. The safety of midline catheters for intravenous therapy at a large academic medical center. *Ann Pharmacother*. 2020;54(3):232-238. doi:10.1177/1060028019878794
55. Romesberg TL. Evaluating the evidence for midline catheter use in the newborn intensive care unit. *J Infus Nurs.* 2015;38(6):420-429. doi:10.1097/NAN.0000000000000134
56. Moureau N, Chopra V. Indications for peripheral, midline and central catheters: summary of the MAGIC recommendations. *Br J Nurs*. 2016;25(8):S15-S24. doi:10.12968/bjon.2016.25.8.S15
57. Anderson J, Greenwell A, Louderback J, Polivka BJ, Behr JH. Comparison of outcomes of extended dwell/midline peripheral intravenous catheters and peripherally inserted central catheters in children. *J Assoc Vasc Access.* 2016;21(3):158-164. https://doi.org/10.1016/j.java.2016.03.007
58. Norris AH, Shrestha NK, Allison GM, et al. 2018 Infectious Diseases Society of America clinical practice guideline for the management of outpatient parenteral antimicrobial therapy. *Clin Infect Dis.* 2019;68(1):e1-e35. doi:10.1093/cid/ciy745
59. Meyer BM. Making the most of midlines: a retrospective review of outcomes. *J Infus Nurs.* 2020;43(6):344-350. doi:10.1097/NAN.0000000000000393
60. Ryder M, Gunther RA, Nishikawa RA, et al. Investigation of the role of infusate properties related to midline catheter failure in an ovine model. *Am J Health Syst Pharm*. 2020;77(16):1336-1346. doi:10.1093/ajhp/zxaa175
61. DeVries M, Lee J, Hoffman L. Infection free midline catheter implementation at a community hospital (2 years). *Am J Infect Control*. 2019;47(9):1118-1121. doi:10.1016/j.ajic.2019.03.001
62. Pathak R, Gangina S, Jairam F, Hinton K. A vascular access and midlines program can decrease hospital-acquired central line-associated bloodstream infections and cost to a community-based hospital. *Ther Clin Risk Manag*. 2018;14:1453-1456. doi:10.2147/TCRM.S171748
63. Olsen MM, LeFebvre KB, Brassil KJ, eds. *Chemotherapy and Immunotherapy Guidelines and Recommendations for Practice*. Oncology Nursing Society; 2019.
64. Caparas JV, Hu JP. Safe administration of vancomycin through a novel midline catheter: a randomized, prospective clinical trial. *J Vasc Access*. 2014;15(4):251-256. doi:10.5301/jva.5000220
65. Caparas JV, Hung HS. Vancomycin administration through a novel midline catheter: summary of a 5-year, 1086-patient experience in an urban community hospital. *J Assoc Vasc Access*. 2017;22(1):38-41. https://doi.org/10.1016/j.java.2016.10.092
66. Abolfotouh MA, Salam M, Bani-Mustafa A, White D, Balkhy HH. Prospective study of incidence and predictors of peripheral intravenous catheter-induced complications. *Ther Clin Risk Manag.* 2014;10:993-1001. doi:10.2147/TCRM.S74685
67. Xu T, Kingsley L, DiNucci S, et al. Safety and utilization of peripherally inserted central catheters versus midline catheters at a large academic medical center. *Am J Infect Control.* 2016;44(12):1458-1461. doi:10.1016/j.ajic.2016.09.010
68. Hogle NJ, Balzer KM, Ross BG, et al. A comparison of the incidence of midline catheter-associated bloodstream infections to that of central line–associated bloodstream infections in 5 acute care hospitals. *Am J Infect Control.* 2020;48(9):1108-1110. doi:10.1016/j.ajic.2019.11.004
69. Bahl A, Karabon P, Chu D. Comparison of venous thrombosis complications in midlines versus peripherally inserted central catheters: are midlines the safer option? *Clin Appl Thromb Hemost*. 2019;25:1076029619839150. doi:10.1177/1076029619839150
70. Marschall J, Mermel LA, Fakih M, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol.* 2014;35(7):753-771. doi:10.1086/676533
71. Expert Panel on Interventional Radiology, Shaw CM, Shah S, et al. ACR Appropriateness Criteria® radiologic management of central venous access. *J Am Coll Radiol.* 2017;14(11S):S506-S529. doi:10.1016/j.jacr.2017.08.053
72. Duesing LA, Fawley JA, Wagner AJ. Central venous access in the pediatric population with emphasis on complications and prevention strategies. *Nutr Clin Pract*. 2016;31(4):490-501. doi:10.1177/0884533616640454
73. Ratz D, Hofer T, Flanders SA, Saint S, Chopra V. Limiting the number of lumens in peripherally inserted central catheters to improve outcomes and reduce cost: a simulation study. *Infect Control Hosp Epidemiol*. 2016;37(7):811-817. doi:10.1017/ice.2016.55
74. Austin RE, Shahrokhi S, Bolourani S, Jeschke MG. Peripherally inserted central venous catheter safety in burn care: a single-center retrospective cohort review. *J Burn Care Res*. 2015;36(1):111-117. doi:10.1097/BCR.0000000000000207
75. Costa P, Kimura AF, Brandon DH, Damiani LP. Predictors of nonelective removal of peripherally inserted central catheters in infants. *Biol Res Nurs*. 2016;18(2):173-180. doi:10.1177/1099800415590856
76. Clemence BJ, Maneval RE. Risk factors associated with catheter-related upper extremity deep vein thrombosis in patients with peripherally inserted central venous catheters: literature review: part 1. *J Infus Nurs*. 2014;37(3):187-196. doi:10.1097/NAN.0000000000000037
77. Govindan S, Snyder A, Flanders SA, Chopra V. Peripherally inserted central catheters in the ICU: a retrospective study of adult medical patients in 52 hospitals. *Crit Care Med.* 2018;46(12):e1136-e1144. doi:10.1097/CCM.0000000000003423
78. Crawford JD, Liem TK, Moneta GL. Management of catheter-associated upper extremity deep venous thrombosis. *J Vasc Surg Venous Lymphat Disord*. 2016;4(3):375-379. doi:10.1016/j.jvsv.2015.06.003
79. Chopra V, Fallouh N, McGuirk H, et al. Patterns, risk factors and treatment associated with PICC-DVT in hospitalized adults: a nested case–control study. *Thromb Res.* 2015;135(5):829-834. doi:10.1016/j.thromres.2015.02.012
80. Duwadi S, Zhao Q, Budal BS. Peripherally inserted central catheters in critically ill patients – complications and its prevention: a review. *Int J Nurs Sci.* 2018;6(1):99-105. doi:10.1016/j.ijnss.2018.12.007
81. Fallouh N, McGuirk HM, Flanders SA, Chopra V. Peripherally inserted central catheter-associated deep vein thrombosis: a narrative review. *Am J Med*. 2015;128(7):722-738. doi:10.1016/j.amjmed.2015.01.027
82. Swaminathan L, Flanders S, Rogers M, et al. Improving PICC use and outcomes in hospitalised patients: an interrupted time series study using MAGIC criteria. *BMJ Qual Saf*. 2018;27(4):271-278. doi:10.1136/bmjqs-2017-007342
83. Sheth H, Remtulla R, Moradi A, Smith R. Evaluation of upper extremity deep vein thrombosis risk factors and management. *J Cancer Sci and Clin Ther*. 2018;2:18-24.
84. Taxbro K, Hammarskjold F, Thelin B, et al. Clinical impact of peripherally inserted central catheters vs implanted port catheters in patients with cancer: an open-label, randomised, two-centre trial. *Br J Anaesth.* 2019;122(6):734-741. doi:10.1016/j.bja.2019.01.038
85. Chopra V, Anand S, Hickner A, et al. Risk of venous thromboembolism associated with peripherally inserted central catheters: a systematic review and meta-analysis. *Lancet*. 2013;382(9889):311-325. doi:10.1016/S0140-6736(13)60592-9
86. Chopra V, Ratz D, Kuhn L, Lopus T, Chenoweth C, Krein S. PICC-associated bloodstream infections: prevalence, patterns, and predictors. *Am J Med*. 2014;127(4):319-328. doi:10.1016/j.amjmed.2014.01.001

87. Noonan PJ, Hanson SJ, Simpson PM, Dasgupta M, Petersen TL. Comparison of complication rates of central venous catheters versus peripherally inserted central venous catheters in pediatric patients. *Pediatr Crit Care Med*. 2018;19(12):1097-1105. doi:10.1097/PCC.0000000000001707

88. Greene MT, Flanders SA, Woller SC, Bernstein SJ, Chopra V. The association between PICC use and venous thromboembolism in upper and lower extremities. *Am J Med.* 2015;128(9):986-93.e1. doi:10.1016/j.amjmed.2015.03.028

89. Al-Asadi O, Almusarhed M, Eldeeb H. Predictive risk factors of venous thromboembolism (VTE) associated with peripherally inserted central catheters (PICC) in ambulant solid cancer patients: retrospective single centre cohort study. *Thromb J*. 2019;17:2. doi:10.1186/s12959-019-0191-y

90. Takashima M, Schults J, Mihala G, Corley A, Ullman A. Complication and failures of central vascular access device in adult critical care settings. *Crit Care Med*. 2018;46(12):1998-2009. doi:10.1097/CCM.0000000000003370

91. Kleidon T, Ullman AJ, Zhang L, et al. How does your PICCOMPARE? a pilot randomized controlled trial comparing various PICC materials in pediatrics. *J Hosp Med*. 2018;13(8):517-525. doi:10.12788/jhm.2911

92. Ullman AJ, Bulmer AC, Dargaville TR, Rickard CM, Chopra V. Antithrombogenic peripherally inserted central catheters: overview of efficacy and safety. *Expert Rev Med Devices.* 2019;16(1):25-33. doi:10.1080/17434440.2019.1555466

93. McDiarmid S, Scrivens N, Carrier M, et al. Outcomes in a nurse-led peripherally inserted central catheter program: a retrospective cohort study. *CMAJ Open.* 2017;5(3):E535-E539. doi:10.9778/cmajo.20170010

94. Hill J. Clinical evaluation of the Navilyst PICC. Paper presented at Association for Vascular Access Annual Scientific Meeting; September 16-19, 2017; Phoenix, AZ.

95. Bozaan D, Skicki D, Brancaccio A, et al. Less lumens-less risk: a pilot intervention to increase the use of single-lumen peripherally inserted central catheters. *J Hosp Med*. 2019;14(1):42-46. doi:10.12788/jhm.3097

96. Kramer RD, Rogers MA, Conte M, Mann J, Saint S, Chopra V. Are antimicrobial peripherally inserted central catheters associated with reduction in central line-associated bloodstream infection? a systematic review and meta-analysis. *Am J Infect Control.* 2017;45(2):108-114. doi:10.1016/j.ajic.2016.07.021

97. Smith SN, Moureau N, Vaughn VM, et al. Patterns and predictors of peripherally inserted central catheter occlusion: the 3P-O study. *J Vasc Interv Radiol.* 2017;28(5):749-756.e2. doi:10.1016/j.jvir.2017.02.005

98. Kleidon TM, Rickard CM, Schults JA, et al. Development of a paediatric central venous access device database: a retrospective cohort study of practice evolution and risk factors for device failure. *J Paediatr Child Health.* 2020;56(2):289-297. doi:10.1111/jpc.14600

99. Kleidon TM, Horowitz J, Rickard CM, et al. Peripherally inserted central catheter thrombosis after placement via electrocardiography vs traditional methods [published online ahead of print Jul 14, 2020]. *Am J Med*. 2020;S0002-9343(20)30557-X. doi:10.1016/j.amjmed.2020.06.010

100. Schears GJ, Ferko N, Syed I, Arpino JM, Alsbrooks K. Peripherally inserted central catheters inserted with current best practices have low deep vein thrombosis and central line-associated bloodstream infection risk compared with centrally inserted central catheters: a contemporary meta-analysis [published online ahead of print, 2020 May 1, 2020]. *J Vasc Access*. 2020;1129729820916113. doi:10.1177/1129729820916113

101. Balsorano P, Virgili G, Villa G, et al. Peripherally inserted central catheter-related thrombosis rate in modern vascular access era-when insertion technique matters: a systematic review and meta-analysis. *J Vasc Access*. 2020;21(1):45-54. doi:10.1177/1129729819852203

102. Drew DA, Weiner DE. Peripherally Inserted Central Catheters (PICCs) in CKD: PICC'ing the best access for kidney disease patients. *Am J Kidney Dis*. 2016;67(5):724-727. doi:10.1053/j.ajkd.2016.01.013

103. Chick JF, Reddy SN, Yam BL, Kobrin S, Trerotola SO. Institution of a hospital-based central venous access policy for peripheral vein preservation in patients with chronic kidney disease: a 12-year experience. *J Vasc Interv Radiol*. 2017;28(3):392-397. doi:10.1016/j.jvir.2016.11.007

104. Paje D, Rogers MAM, Conlon A, Flanders SA, Bernstein SJ, Chopra V. Use of peripherally inserted central catheters in patients with advanced chronic kidney disease: a prospective cohort study. *Ann Intern Med.* 2019;171(1):10-18. doi:10.7326/M18-2937

105. Zhang S, Sun X, Lei Y. The microbiological characteristics and risk factors for PICC-related bloodstream infections in intensive care unit. *Sci Rep.* 2017;7(1):15074. doi:10.1038/s41598-017-10037-2

106. Lai NM, Chaiyakunapruk N, Lai NA, O'Riordan E, Pau WS, Saint S. Catheter impregnation, coating or bonding for reducing central venous catheter-related infections in adults. *Cochrane Database Syst Rev*. 2016;3(3):CD007878. doi:10.1002/14651858.CD007878.pub3

107. Ullman AJ, Marsh N, Mihala G, Cooke M, Rickard CM. Complications of central venous access devices: a systematic review. *Pediatrics*. 2015;136(5):e1331-1344. doi:10.1542/peds.2015-1507

108. American Nephrology Nurses Association. Vascular access for hemodialysis [position statement]. Updated December 2017. https://www.annanurse.org/download/reference/health/position/vascularAccess.pdf

109. Lutwick L, Al-Maani AS, Mehtar S, et al. Managing and preventing vascular catheter infections: a position paper of the international society for infectious diseases. *Int J Infect Dis.* 2019;84:22-29. doi:10.1016/j.ijid.2019.04.014

110. Lee T, Shah S, Leonard AC, Parikh P, Thakar CV. Acute kidney injury before dialysis initiation predicts adverse outcomes in hemodialysis patients. *Am J Nephrol*. 2018;47(6):427-434. doi:10.1159/000489949

111. Lok CE, Huber TS, Lee T, et al. KDOQI Clinical practice guideline for vascular access: 2019 update. *Am J Kidney Dis.* 2020;75(4S2):S1-S164. doi:10.1053/j.ajkd.2019.12.001

112. McGill RL, Ruthazer R, Meyer KB, Miskulin DC, Weiner DE. Peripherally inserted central catheters and hemodialysis outcomes. *Clin J Am Soc Nephrol.* 2016;11(8):1434-1440. doi:10.2215/CJN.01980216

113. Yessayan L, Heung M. Recognizing downstream consequences of acute kidney injury. *Am J Nephrol*. 2018;47(6):424-426. doi:10.1159/000489950

114. Santacruz E, Mateo-Lobo R, Riveiro J, et al. Infectious complications in home parenteral nutrition: a long-term study with peripherally inserted central catheters, tunneled catheters, and ports. *Nutrition.* 2019;58:89-93. doi:10.1016/j.nut.2018.06.016

115. Mateo-Lobo R, Riveiro J, Vega-Piñero B, Botella-Carretero JI. Infectious complications in home parenteral nutrition: a systematic review and meta-analysis comparing peripherally-inserted central catheters with other central catheters. *Nutrients.* 2019;11(9). doi:10.3390/nu11092083

116. Blanco-Guzman MO. Implanted vascular access device options: a focused review on safety and outcomes. *Transfusion.* 2018;58(Suppl 1):558-568. doi:10.1111/trf.14503

117. Voog E, Campion L, duRusquec P, et al. Totally implantable venous access ports: a prospective long-term study of early and late complications in adult patients with cancer. *Support Care Cancer.* 2018;26(1):81-89. doi:10.1007/s00520-017-3816-3

118. Çil BE, Öcal O, Eldem FG, Peynircioğlu B, Balkancı F. Trapezius port placement in patients with breast cancer: long-term follow-up and quality-of-life assessment. *J Vasc Interv Radiol.* 2019;30(1):69-73. doi:10.1016/j.jvir.2018.08.011

119. Hill S. Totally implanted ports: the trapezius approach in practice. *Br J Nurs.* 2015;24(19):S22-S26. doi:10.12968/bjon.2015.24.Sup19.S22
120. Seo TS, Song MG, Kang EY, Lee CH, Yong HS, Doo K. A single-incision technique for placement of implantable venous access ports via the axillary vein. *J Vasc Interv Radiol.* 2014;25(9):1439-1446. doi:10.1016/j.jvir.2013.12.571
121. Kovacevich DS, Corrigan M, Ross VM, McKeever L, Hall AM, Braunschweig C. American Society for Parenteral and Enteral Nutrition guidelines for the selection and care of central venous access devices for adult home parenteral nutrition administration. *JPEN J Parenter Enteral Nutr*. 2019;43(1):15-31. doi:10.1002/jpen.1455
122. Pohlod V. Standard short peripheral catheters (SPCs) versus power injectable SPCs during contrast computed tomography and magnetic resonance imaging angiography: a quality improvement study. *J Infus Nurs.* 2018;41(6):358-364. doi:10.1097/NAN.0000000000000301
123. Witting MD, Moayedi S, Dunning K, Babin LS, Cogan BM. Power injection through ultrasound-guided intravenous lines: safety and efficacy under an institutional protocol. *J Emerg Med.* 2017;52(1):16-22. doi:10.1016/j.jemermed.2016.09.017
124. Buijs SB, Barentsz MW, Smits MLJ, Gratama JWC, Spronk PE. Systematic review of the safety and efficacy of contrast injection via venous catheters for contrast-enhanced computed tomography. *Eur J Radiol Open*. 2017;4:118-122. doi:10.1016/j.ejro.2017.09.002
125. Gershengorn HB, Garland A, Kramer A, Scales DC, Rubenfeld G, Wunsch H. Variation of arterial and central venous catheter use in United States intensive care units. *Anesthesiology*. 2014;120(3):650-664. doi:10.1097/ALN.0000000000000008
126. Rizzi M, Goldenberg N, Bonduel M, Revel-Vilk S, Amankwah E, Albisetti M. Catheter-related arterial thrombosis in neonates and children: a systematic review. *Thromb Haemost*. 2018;118(6):1058-1066. doi:10.1055/s-0038-1642635
127. Nuttall G, Burckhardt J, Hadley A, et al. Surgical and patient risk factors for severe arterial line complications in adults. *Anesthesiology*. 2016;124(3):590-597. doi:10.1097/ALN.0000000000000967
128. Hebal F, Sparks HT, Rychlik KL, Bone M, Tran S, Barsness KA. Pediatric arterial catheters: complications and associated risk factors. *J Pediatr Surg*. 2018;53(4):794-797. doi:10.1016/j.jpedsurg.2017.08.057
129. Oliver LA, Oliver JA, Ohanyan S, Park W, Benelyahoo A, Vadivelu N. Ultrasound for peripheral and arterial access. *Best Pract Res Clin Anaesthesiol.* 2019;33(4):523-537. doi:10.1016/j.bpa.2019.10.002
130. Wang A, Hendin A, Millington SJ, Koenig S, Eisen LA, Shiloh AL. Better with ultrasound: arterial line placement. *Chest.* 2020;157(3):574-579. doi:10.1016/j.chest.2019.08.2209.

27. SITE SELECTION

Standard

27.1 The most appropriate vein and insertion site is selected to best accommodate the VAD required for the prescribed infusion therapy.

27.2 Vessel health and preservation are prioritized during site selection.

27.3 The type and duration of infusion therapy, patient preference, and the patient's physiologic condition (eg, age, diagnosis, comorbidities) and vascular condition (eg, history of vascular access attempts, vessel and skin health at site of insertion and proximal) are assessed when preparing for site selection and VAD insertion.

27.4 Selection of the most appropriate vein and insertion site occurs in collaboration with the patient/caregiver and the health care team based on the projected treatment plan.

Practice Recommendations

I. PIVCs: Short PIVCs, Long PIVCs, and Midline Catheters

A. All PIVCs, all populations:
   1. Use the venous site most likely to last the full length of the prescribed therapy.[1-5] (IV)
   2. Discuss the preference for VAD site selection with the patient and/or caregiver, including recommendations to use sites on the nondominant side.[2-7] (IV)
   3. Use vascular visualization technologies to identify and select the most appropriate vein for midline catheter insertion (refer to Standard 22, *Vascular Visualization*).
   4. Use caution with the following sites due to increased risk of nerve damage:
      a. Cephalic vein at the radial wrist with potential injury to the superficial radial nerve.
      b. Volar (inner) aspect of the wrist with potential injury to the median nerve.
      c. At/above the antecubital fossa with potential injury to the median and anterior interosseous nerve and the lateral and medial antebrachial nerves (refer to Standard 48, *Nerve Injury*).
   5. Avoid PIVC insertion in areas of:
      a. Flexion.
      b. Pain on palpation.
      c. Compromised skin and sites distal to these areas, such as areas with open wounds.
      d. Extremities with an infection.
      e. Planned procedures.
      f. Veins that are compromised (eg, previous cannulation, bruised, reddened/streaked, infiltrated, sclerosed, corded, or engorged).[5,8-19] (IV)
   6. Do not use visible veins of the chest, breast, abdomen, or other locations on the trunk of the body as there is no evidence supporting their safe outcomes. These veins are visible due to pathological reasons that might prevent safe infusion. (Committee Consensus)
   7. Do not use veins of the lower extremities (with the exception of neonates and infants), unless needed for an emergent insertion, due to risk of tissue damage, thrombophlebitis, and ulceration; remove as soon as possible.[9,10,20-24] (IV)

B. PIVC access site selection
   1. Adult patients
      a. Short PIVC**:** Insert PIVC via a forearm vessel to prolong the dwell time, increase the likelihood of the PIVC lasting the full length of the prescribed therapy, decrease pain during dwell time, promote self-care, and prevent accidental removal and occlusions. Choose veins found on the dorsal and ventral surfaces of the upper extremities, including the metacarpal, cephalic, basilic, and median veins.[1,2,8-13,21-23,25-33] (IV)
         i. Consider hand veins for short-term therapy (eg, less than 24 hours). PIVC insertion in

areas of flexion such as the hand is associated with higher rates of failure over time.[34] (V)

ii. Consider use of the external jugular vein in patients in acute care settings and in emergency situations when other veins cannot be accessed; collaborate with the provider for an alternative vascular access site as soon as possible.[35-37] (IV)

b. Long PIVC: Consider veins found on the dorsal and ventral surfaces of the upper extremities, including the cephalic, basilic, and median veins. Insertion should be in the forearm without crossing into the antecubital fossa.[28,29,38-40] (III)

c. Midline catheter: Select an upper arm site using the basilic, cephalic, and brachial veins.[16,28,41-43] (IV)

2. Neonates and pediatric patients

a. Avoid the antecubital fossa, which has a higher failure rate.

b. Short PIVC: Consider veins in the hand, forearm, and, if not walking, the foot.

i. For neonates and infants, when no alternative site is available, veins of the scalp may be used as a last resort. Avoid the hands, fingers, and thumbs.

c. Long PIVC: Consider veins in the forearm and the saphenous vein.

d. Midline catheter: For neonates and pediatric patients, select an upper arm site using the basilic, cephalic, and brachial veins. Additional site selections include veins in the leg (eg saphenous, popliteal, femoral) with the tip below the inguinal crease and in the scalp with the tip in the neck, above the thorax.[3,5,14,15,24,44-51] (IV)

3. Special considerations

a. Lymphedema: Consider restricting venipuncture to the contralateral upper extremities in patients with lymphedema and those at increased risk for lymphedema (eg, axillary surgical dissection or radiation therapy) based on the risk of decreased perfusion, impaired immune function, and increased risk of infection due to compromised axillary drainage.

i. Consider early referral to an infusion nurse/vascular access specialist.

ii. If emergent vascular access is needed, choose the most readily accessible vein for access in either upper extremity, then establish a plan for ongoing vascular access.[52-55] (V)

b. Renal dysfunction, presence of an AVF/AVG: Restrict venipuncture for PIVC insertion to the dorsum of the hand whenever possible and avoid the cephalic vein, regardless of arm dominance, in patients with an actual or planned dialysis fistula or graft. Avoid the use of forearm and upper arm veins for peripheral catheter insertion. A collaborative discussion with the patient and the provider is needed to discuss the benefits and risks of using a vein in an affected extremity (see Standard 29, *Vascular Access and Hemodialysis)*.[41,56-60] (IV)

i. Allow only nephrology clinicians to access the AVF/AVG unless there is a life-threatening condition or when there is validation of clinician training and competency.[57,61] (V)

c. Avoid venipuncture on an extremity with paralysis or hemiparesis (eg, traumatic injury, cerebrovascular accident) when feasible, due to alteration in normal blood flow and decreased sensation that would prevent reporting pain associated with nerve injury and other complications.[34] (V).

II. Central Venous Access via PICCs

A. Use ultrasound to identify and assess vasculature, including: size, depth, and trajectory of vessels; anatomy to avoid, such as arteries and nerves; optimal site for PICC insertion; and to increase first-time insertion success (refer to Standard 22, *Vascular Visualization*).

B. Select the basilic, brachial, or cephalic vein above the antecubital fossa that is most appropriate for PICC insertion, preferably the basilic vein; ensure a catheter-to-vessel ratio of less than 45%.[17,28,62-69] (III)

1. For neonates and pediatric patients, additional site selections include the axillary vein, temporal vein, and posterior auricular vein in the head and the saphenous and popliteal veins in the lower extremities. Use the best available vein in neonates and infants.

a. However, where possible, avoid:

i. Lower limb veins for PICC insertion related to abdominal pathology.

ii. Upper limb veins for neonates, infants, and children with single ventricle physiology.[51,70-77] (IV)

C. Avoid areas of pain on palpation or areas with wounds and veins that are compromised (eg, previous cannulation, bruised, reddened/streaked, infiltrated, sclerosed, corded, or engorged).[14,78] (IV)

D. Avoid PICCs in patients with CKD due to the risks of central vein stenosis and occlusion, as well as resultant venous depletion preventing future fistula construction. PICC insertion before or after hemodialysis initiation is associated with failure to transition to a working fistula (see Standard 29, *Vascular Access and Hemodialysis*).[29,35,41,58,59,79] (IV)

III. Central Venous Access via Nontunneled CVADs

A. Use ultrasound in adult and pediatric patients for vein identification, assessment, and insertion in all sites to decrease risks of cannulation failure, arterial puncture, hematoma, pneumothorax, and hemothorax (refer to Standard 22, *Vascular Visualization*).

B. Use a risk/benefit approach to site selection based on patient physiology, vascular history, infusion needs, and emergent nature of insertion.

1. Jugular approach: associated with less mechanical complications on insertion; risk of thrombosis and infection increase with longer dwell time.[80-82] (IV)

a. Use of the low internal jugular vein approach for insertion may be associated with improved securement.[34] (V)
b. Use the low internal jugular vein approach for insertion of a nontunneled CVAD in infants and children to minimize the risk of infection and venous thrombosis. May use the brachiocephalic (innominate) vein if needed.[83-90] (IV)

2. Femoral approach: associated with higher risk of infection but easily accessed with use of ultrasound in emergent/short-term situations.[24,91] (V)
3. Axillo-subclavian approach: associated with lower risks of infection and of symptomatic DVT but may be associated with increased mechanical complications on insertion (eg, pneumothorax if inserted medially). DVT and stenosis risk increases with long-term use of the subclavian site.[59,80,82,92] (IV)
   a. Use ultrasound-guided lateral axillo-subclavian or internal jugular approach to reduce risk of pinch-off syndrome and to avoid acute angle of catheters inserted into the internal jugular vein (see Standard 34, *Vascular Access Device Placement*).[93-95] (IV)
   b. Avoid placing a CVAD via the subclavian vein for patients with CKD.[59] (V).

IV. Central Venous Access via Tunneled, Cuffed CVADs and Implanted Vascular Access Ports

A. Collaborate with the health care team and patient in assessment and site selection for the insertion of tunneled, cuffed catheters and implanted vascular access ports.[29,85,96-98] (IV)
B. Use ultrasound in adult and pediatric patients for vein identification (eg, internal jugular in adult/children and brachiocephalic in children) and for assessment and insertion to decrease risks of cannulation failure, arterial puncture, hematoma, pneumothorax, and hemothorax (see Standard 22, *Vascular Visualization*).[99-103] (IV)
C. Consider the risks of catheter-associated deep vein thrombosis (CA-DVT) associated with implanted vascular access ports placed in the chest vs the arm.
   1. Complications associated with arm ports were not significantly different between arm- and chest-inserted implanted ports in patients with cancer based upon a meta-analysis; another study found that insertion of an implanted port in the arm vs insertion in the chest was associated with a significant increase in symptomatic, radiologically confirmed upper extremity DVT in patients with breast cancer (see Standard 53*, Catheter-Associated Deep Vein Thrombosis*).[104-106] (I)
D. Consider use of a tunneled, cuffed CVAD in CKD for short-term use when clinically indicated or long-term use (no maximum time limit identified). Internal jugular insertion is recommended; however, the following veins may be used if internal jugular insertion is not possible: external jugular, brachiocephalic, or femoral.[59,107] (V)

V. Peripheral Arterial Access for Hemodynamic Monitoring

A. Use ultrasound to identify, assess, and insert arterial catheters to increase first-attempt success and reduce insertion-related complications, such as hematoma (refer to Standard 22, *Vascular Visualization*).
B. Assess the circulation to the hand prior to puncturing the radial artery; perform a physical examination of hand circulation, such as assessing radial and ulnar pulses with the Allen test, pulse oximetry, or a Doppler flow study. Review the medical history (eg, trauma, previous radial artery cannulation, radial artery harvesting); assess for the use of anticoagulants (see Standard 44, *Blood Sampling*).[108,109] (V)
C. For adults, the radial artery is the most appropriate access for percutaneous cannulation.[24,108] (IV)
   1. For pediatric patients, use the radial, posterior tibial, and dorsalis pedis arteries. The brachial artery is not used in pediatric patients due to the absence of collateral blood flow.[110,111] (III)

REFERENCES

Note: All electronic references in this section were accessed between May 4, 2020, and August 29, 2020.

1. Steere L, Ficara C, Davis M, Moureau N. Reaching one peripheral intravenous catheter (PIVC) per patient visit with lean multimodal strategy: the PIV5Rights Bundle. *J Assoc Vasc Access.* 2019;24(3):31-43. https://doi.org/10.2309/j.java.2019.003.004
2. Schults J, Rickard C, Kleidon T, Paterson R, Macfarlane F, Ullman A. Difficult peripheral venous access in children: an international survey and critical appraisal of assessment tools and escalation pathways. *J Nurs Scholarsh*. 2019;51(5):537-546. doi:10.1111/jnu.12505
3. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health*. 2019;55(10):1214-1223. doi:10.1111/jpc.14384
4. Cooke M, Ullman AJ, Ray-Barruel G, Wallis M, Corley A, Rickard CM. Not "just" an intravenous line: consumer perspectives on peripheral intravenous cannulation (PIVC): an international cross-sectional survey of 25 countries. *PLoS One*. 2018;13(2):e0193436. doi:10.1371/journal.pone.0193436
5. Cawcutt KA, Hankins RJ, Micheels TA, Rupp ME. Optimizing vascular-access device decision-making in the era of midline catheters. *Infect Control Hosp Epidemiol*. 2019;40(6):674-680. doi:10.1017/ice.2019.49
6. Larsen E, Keogh S, Marsh N, Rickard C. Experiences of peripheral IV insertion in hospital: a qualitative study. *Br J Nurs*. 2017;26(19):S18-S25. doi:10.12968/bjon.2017.26.19.S18
7. Fiorini J, Venturini G, Conti F, et al. Vessel health and preservation: an integrative review. *J Clin Nurs*. 2019;28(7-8):1039-1049. doi:10.1111/jocn.14707
8. Helm RE, Klausner JD, Klemperer JD, Flint LM, Huang E. Accepted but unacceptable: peripheral IV catheter failure. *J Infus Nurs*. 2015;38(3):189-203. doi:10.1097/NAN.0000000000000100
9. Ray-Barruel G, Polit DF, Murfield JE, Rickard CM. Infusion phlebitis assessment measures: a systematic review. *J Eval Clin Pract*. 2014;20(2):191-202. doi:10.1111/jep.12107
10. Simin D, Milutinović D, Turkulov V, Brkić S. Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: an observational prospective study. *J Clin Nurs*. 2019;28(9-10):1585-1599. doi:10.1111/jocn.14760
11. Marsh N, Larsen E, Genzel J, et al. A novel integrated dressing to secure peripheral intravenous catheters in an adult acute hospital: a

pilot randomised controlled trial. *Trials*. 2018;19(1):596. doi:10.1186/s13063-018-2985-9

12. Carr PJ, Rippey JCR, Cooke ML, et al. From insertion to removal: a multicenter survival analysis of an admitted cohort with peripheral intravenous catheters inserted in the emergency department. *Infect Control Hosp Epidemiol*. 2018;39(10):1216-1221. doi:10.1017/ice.2018.190
13. Miliani K, Taravella R, Thillard D, et al. Peripheral venous catheter-related adverse events: evaluation from a multicentre epidemiological study in France (the CATHEVAL Project). *PLoS One*. 2017;12(1):e0168637. doi:10.1371/journal.pone.0168637
14. Farrelly JS, Stitelman DH. Complications in pediatric enteral and vascular access. *Semin Pediatr Surg*. 2016;25(6):371-379. doi:10.1053/j.sempedsurg.2016.10.006
15. Legemaat M, Carr PJ, van Rens RM, van Dijk M, Poslawsky IE, van den Hoogen A. Peripheral intravenous cannulation: complication rates in the neonatal population: a multicenter observational study. *J Vasc Access*. 2016;17(4):360-365. doi:10.5301/jva.5000558
16. DeVries M, Lee J, Hoffman L. Infection free midline catheter implementation at a community hospital (2 years). *Am J Infect Control*. 2019;47(9):1118-1121. doi:10.1016/j.ajic.2019.03.001
17. Campagna S, Gonella S, Zerla PA, et al. The risk of adverse events related to extended-dwell peripheral intravenous access. *Infect Control Hosp Epidemiol*. 2018;39(7):875-877. doi:10.1017/ice.2018.79
18. Dickson HG, Flynn O, West D, Alexandrou E, Mifflin N, Malone M. A cluster of failures of midline catheters in a hospital in the home program: a retrospective analysis. *J Infus Nurs*. 2019;42(4):203-208. doi:10.1097/NAN.0000000000000330
19. Sharp R, Esterman A, McCutcheon H, Hearse N, Cummings M. The safety and efficacy of midlines compared to peripherally inserted central catheters for adult cystic fibrosis patients: a retrospective, observational study. *Int J Nurs Stud*. 2014;51(5):694-702. doi:10.1016/j.ijnurstu.2013.09.002
20. Cicolini G, Manzoli L, Simonetti V, et al. Phlebitis risk varies by peripheral venous catheter site and increases after 96 hours: a large multi-centre prospective study. *J Adv Nurs*. 2014;70(11):2539-2549. doi:10.1111/jan.12403
21. Abolfotouh MA, Salam M, Bani-Mustafa A, White D, Balkhy HH. Prospective study of incidence and predictors of peripheral intravenous catheter-induced complications. *Ther Clin Risk Manag*. 2014;10:993-1001. doi:10.2147/TCRM.S74685
22. Benaya A, Schwartz Y, Kory R, Yinnon AM, Ben-Chetrit E. Relative incidence of phlebitis associated with peripheral intravenous catheters in the lower versus upper extremities. *Eur J Clin Microbiol Infect Dis*. 2015;34(5):913-916. doi:10.1007/s10096-014-2304-7
23. Urbanetto JS, Muniz FOM, Silva RMD, Freitas APC, Oliveira APR, Santos JCRD. Incidence of phlebitis and post-infusion phlebitis in hospitalised adults. *Rev Gaucha Enferm*. 2017;38(2):e58793. doi:10.1590/1983-1447.2017.02.58793
24. Centers for Disease Control and Prevention. Summary of recommendations, guidelines for the prevention of intravascular catheter-related infections (2011). Updated February 2017. https://www.cdc.gov/infectioncontrol/guidelines/bsi/recommendations.html
25. Wallis MC, McGrail M, Webster J, et al. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from a randomized controlled trial. *Infect Control Hosp Epidemiol*. 2014;35(1):63-68. doi:10.1086/674398
26. Webster J, Osborne S, Rickard CM, Marsh N. Clinically-indicated replacement versus routine replacement of peripheral venous catheters. *Cochrane Database Syst Rev*. 2019;1(1):CD007798. doi:10.1002/14651858.CD007798.pub5
27. Marsh N, Webster J, Larson E, Cooke M, Mihala G, Rickard CM. Observational study of peripheral intravenous catheter outcomes in adult hospitalized patients: a multivariable analysis of peripheral intravenous catheter failure. *J Hosp Med*. 2018;13(2):83-89. doi:10.12788/jhm.2867
28. Shaw SJ. Using the vessel health and preservation framework to enhance vein assessment and vascular access device selection. *Nurs Stand*. 2017;31(46):50-63. doi:10.7748/ns.2017.e10741
29. Simonov M, Pittiruti M, Rickard CM, Chopra V. Navigating venous access: a guide for hospitalists. *J Hosp Med*. 2015;10(7):471-478. doi:10.1002/jhm.2335
30. Kaur P, Rickard C, Domer GS, Glover KR. Dangers of peripheral intravenous catheterization: the forgotten tourniquet and other patient safety considerations. In: Stawicki SP, Firstenberg MS, eds. *Vignettes in Patient Safety: Volume 4*. IntechOpen Limited; 2019. doi:10.5772/intechopen.83854
31. Ansel B, Boyce M, Embree JL. Extending short peripheral catheter dwell time: a best practice discussion. *J Infus Nurs*. 2017;40(3):143-146. doi:10.1097/NAN.0000000000000137
32. DeVries M, Strimbu K. Short peripheral catheter performance following adoption of clinical indication removal. *J Infus Nurs*. 2019;42(2):81-90. doi:10.1097/NAN.0000000000000318
33. Alexandrou E, Ray-Barruel G, Carr PJ, et al. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *J Hosp Med*. 2018;13(5):10.12788/jhm.3039. doi:10.12788/jhm.3039
34. Hill S. Insertion. In: Moureau N, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access*. SpringerOpen; 2019:69-80. https://link.springer.com/content/pdf/10.1007%2F978-3-030-03149-7.pdf
35. Heffner A, Androes MP. Overview of central venous access in adults. UpToDate.com. Updated March 19, 2020. https://www.uptodate.com/contents/overview-of-central-venous-access-in-adults
36. Cavallaro G, Iorio O, Iossa A, et al. A prospective evaluation on external jugular vein cut-down approach for TIVAD implantation. *World J Surg Oncol*. 2015;13:243. doi:10.1186/s12957-015-0663-x
37. Costantino TG, Kirtz JF, Satz WA. Ultrasound-guided peripheral venous access vs. the external jugular vein as the initial approach to the patient with difficult vascular access. *J Emerg Med*. 2010;39(4):462-467. doi:10.1016/j.jemermed.2009.02.004
38. Badger J. Long peripheral catheters for deep arm vein venous access: a systematic review of complications. *Heart Lung*. 2019;48(3):222-225. doi:10.1016/j.hrtlng.2019.01.002
39. Qin KR, Nataraja RM, Pacilli M. Long peripheral catheters: is it time to address the confusion? *J Vasc Access*. 2019;20(5):457-460. doi:10.1177/1129729818819730
40. Fabiani A, Dreas L, Sanson G. Ultrasound-guided deep-arm veins insertion of long peripheral catheters in patients with difficult venous access after cardiac surgery. *Heart Lung*. 2017;46(1):46-53. doi:10.1016/j.hrtlng.2016.09.003
41. Chopra V, Flanders SA, Saint S, et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Ann Intern Med*. 2015;163(suppl 6):S1-S40. doi:10.7326/M15-0744
42. Chopra V, Kaatz S, Swaminathan L, et al. Variation in use and outcomes related to midline catheters: results from a multicentre pilot study. *BMJ Qual Saf*. 2019;28(9):714-720. doi:10.1136/bmjqs-2018-008554
43. Pathak R, Gangina S, Jairam F, Hinton K. A vascular access and midlines program can decrease hospital-acquired central line-associated bloodstream infections and cost to a community-based hospital. *Ther Clin Risk Manag*. 2018;14:1453-1456. doi:10.2147/TCRM.S171748
44. Ben Abdelaziz R, Hafsi H, Hajji H, et al. Peripheral venous catheter complications in children: predisposing factors in a multicenter prospective cohort study. *BMC Pediatr*. 2017;17(1):208. doi:10.1186/s12887-017-0965-y
45. Vinograd AM, Zorc JJ, Dean AJ, Abbadessa MKF, Chen AE. First-attempt success, longevity, and complication rates of ultrasound-guided peripheral intravenous catheters in children. *Pediatr Emerg Care*. 2018;34(6):376-380. doi:10.1097/PEC.0000000000001063
46. Monasor-Ortolá D, Cortés-Castell E, Martínez-Pascual C, Esteve-Ríos A, Rizo-Baeza MM. Factors influencing the success of peripheral venous access in neonates. *J Pediatr Nurs*. 2019;47:e30-e35. doi:10.1016/j.pedn.2019.04.017

47. Hugill K. Vascular access in neonatal care settings: selecting the appropriate device. *Br J Nurs*. 2016;25(3):171-176. doi:10.12968/bjon.2016.25.3.171
48. Pacilli M, Bradshaw CJ, Clarke SA. Use of 8-cm 22G-long peripheral cannulas in pediatric patients. *J Vasc Access*. 2018;19(5):496-500. doi:10.1177/1129729818761278
49. Romesberg TL. Evaluating the evidence for midline catheter use in the newborn intensive care unit. *J Infus Nurs*. 2015;38(6):420-429. doi:10.1097/NAN.0000000000000134
50. Chenoweth KB, Guo JW, Chan B. The extended dwell peripheral intravenous catheter is an alternative method of NICU intravenous Access. *Adv Neonatal Care*. 2018;18(4):295-301. doi:10.1097/ANC.0000000000000515
51. Wyckoff M, Sharpe EL. *Peripherally Inserted Central Catheters: Guideline for Practice.* 3rd ed. National Association of Neonatal Nurses; 2015.
52. Larocque G, McDiarmid S. The legacy of lymphedema: impact on nursing practice and vascular access. *Can Oncol Nurs J*. 2019;29(3):194-203.
53. McLaughlin SA, Staley AC, Vicini F, et al. Considerations for clinicians in the diagnosis, prevention, and treatment of breast cancer-related lymphedema: recommendations from a multidisciplinary expert ASBrS panel: part 1: definitions, assessments, education, and future directions. *Ann Surg Oncol*. 2017;24(10):2818-2826. doi:10.1245/s10434-017-5982-4
54. Wanchai A, Armer JM, Stewart BR, Lasinski BB. Breast cancer-related lymphedema: a literature review for clinical practice. *Int J Nurs Sci.* 2016;3(2):202-207.
55. Ferguson CM, Swaroop MN, Horick N, et al. Impact of ipsilateral blood draws, injections, blood pressure measurements, and air travel on the risk of lymphedema for patients treated for breast cancer. *J Clin Oncol.* 2016;34(7):691-698. doi:10.1200/JCO.2015.61.5948
56. Western Australian Department of Health, Renal Health Network. *Guideline for Vein Preservation in Chronic Kidney Disease*. Western Australian Department of Health; 2017. https://ww2.health.wa.gov.au/-/media/Files/Corporate/general-documents/Health-Networks/Renal/171010_PAP_VeinPreservationGuideline_V04_FINAL.pdf
57. American Nephrology Nurses Association. Vascular access for hemodialysis [position statement]. Published February 2003. Updated December 2017. https://www.annanurse.org/download/reference/health/position/vascularAccess.pdf
58. Norris AH, Shrestha NK, Allison GM, et al. 2018 Infectious Diseases Society of America clinical practice guideline for the management of outpatient parenteral antimicrobial therapy. *Clin Infect Dis*. 2019;68(1):1-4. doi:10.1093/cid/ciy867
59. Lok CE, Huber TS, Lee T, et al; KDOQI Vascular Access Guideline Work Group. KDOQI clinical practice guideline for vascular access: 2019 update. *Am J Kidney Dis*. 2020;75(4)(suppl 2):S1-S164. doi:10.1053/j.ajkd.2019.12.001
60. UK Renal Association. Preservation of sites for native vascular access (guidelines 2.1-2.2). In: Kumwenda M, Mitra S, Reid C, eds. *Clinical Practice Guideline: Vascular Access for Haemodialysis*. 6th ed. UK Renal Association; 2015. https://renal.org/wp-content/uploads/2017/06/vascular-access.pdf
61. American Nephrology Nurses Association. Vascular access fact sheet. Published 2018. https://www.annanurse.org/download/reference/practice/vascularAccessFactSheet.pdf
62. Li J, Fan YY, Xin MZ, et al. A randomised, controlled trial comparing the long-term effects of peripherally inserted central catheter placement in chemotherapy patients using B-mode ultrasound with modified Seldinger technique versus blind puncture. *Eur J Oncol Nurs*. 2014;18(1):94-103. doi:10.1016/j.ejon.2013.08.003
63. Sharp R, Cummings M, Fielder A, Mikocka-Walus A, Grech C, Esterman A. The catheter to vein ratio and rates of symptomatic venous thromboembolism in patients with a peripherally inserted central catheter (PICC): a prospective cohort study. *Int J Nurs Stud*. 2015;52(3):677-685. doi:10.1016/j.ijnurstu.2014.12.002
64. Paquet F, Boucher LM, Valenti D, Lindsay R. Impact of arm selection on the incidence of PICC complications: results of a randomized controlled trial. *J Vasc Access*. 2017;18(5):408-414. doi:10.5301/jva.5000738
65. Kleidon TM, Rickard CM, Schults JA, et al. Development of a paediatric central venous access device database: a retrospective cohort study of practice evolution and risk factors for device failure. *J Paediatr Child Health*. 2020;56(2):289-297. doi:10.1111/jpc.14600
66. Sharp R, Cummings M, Childs J, et al. Measurement of vein diameter for peripherally inserted central catheter (PICC) insertion: an observational study. *J Infus Nurs*. 2015;38(5):351-357. doi:10.1097/NAN.0000000000000125.
67. Moureau NL, Carr PJ. Vessel health and preservation: a model and clinical pathway for using vascular access devices. *Br J Nurs*. 2018;27(8):S28-S35. doi:10.12968/bjon.2018.27.8.S28.
68. Hawthorn A, Bulmer AC, Mosawy S, Keogh S. Implications for maintaining vascular access device patency and performance: application of science to practice. *J Vasc Access*. 2019;20(5):461-470. doi:10.1177/1129729818820200
69. Dawson RB. PICC Zone Insertion Method™ (ZIM™): a systematic approach to determine the ideal insertion site for PICCs in the upper arm. *J Assoc Vasc Access*. 2011;16(3):156-165. https://doi.org/10.2309/java.16-3-5
70. Chen H, Zhang X, Wang H, Hu X. Complications of upper extremity versus lower extremity placed peripherally inserted central catheters in neonatal intensive care units: a meta-analysis. *Intensive Crit Care Nurs*. 2020;56:102753. doi:10.1016/j.iccn.2019.08.003
71. Beard L, Levek C, Hwang S, Grover T. Prediction of nonelective central venous catheter removal in medically complex neonates. *Pediatr Qual Saf.* 2019;4(4):e179. doi:10.1097/pq9.0000000000000179
72. Bashir RA, Swarnam K, Vayalthrikkovil S, Yee W, Soraisham AS. Association between peripherally inserted central venous catheter insertion site and complication rates in preterm infants. *Am J Perinatol.* 2016;33(10):945-950. doi:10.1055/s-0036-1582127
73. Ma M, Garingo A, Jensen AR, Bliss D, Friedlich P. Complication risks associated with lower versus upper extremity peripherally inserted central venous catheters in neonates with gastroschisis. *J Pediatr Surg*. 2015;50(4):556-558. doi:10.1016/j.jpedsurg.2014.08.026
74. Kisa P, Ting J, Callejas A, Osiovich H, Butterworth SA. Major thrombotic complications with lower limb PICCs in surgical neonates. *J Pediatr Surg*. 2015;50(5):786-789. doi:10.1016/j.jpedsurg.2015.02.043
75. Paterson RS, Chopra V, Brown E, et al. Selection and insertion of vascular access devices in pediatrics: a systematic review. *Pediatrics*. 2020;145(Suppl 3):S243-S268. doi:10.1542/peds.2019-3474H
76. Ullman AJ, Bernstein SJ, Brown E, et al. The Michigan Appropriateness Guide for Intravenous Catheters in pediatrics: miniMAGIC. *Pediatrics*. 2020;145(Suppl 3):S269-S284. doi:10.1542/peds.2019-3474I
77. Richter RP, Law MA, Borasino S, Surd JA, Alten JA. Distal superficial femoral vein cannulation for peripherally inserted central catheter placement in infants with cardiac disease. *Congenit Heart Dis*. 2016;11(6):733-740. doi:10.1111/chd.12398
78. Ciofi Silva CL, Rossi LA, Canini SR, Gonçalves N, Furuya RK. Site of catheter insertion in burn patients and infection: a systematic review. *Burns*. 2014;40(3):365-373. doi:10.1016/j.burns.2013.10.026
79. McGill RL, Tsukahara T, Bhardwaj R, Kapetanos AT, Marcus RJ. Inpatient venous access practices: PICC culture and the kidney patient. *J Vasc Access*. 2015;16(3):206-210. doi:10.5301/jva.5000340
80. Frykholm P, Pikwer A, Hammarskjöld F, et al. Clinical guidelines on central venous catheterisation. Swedish Society of Anaesthesiology and Intensive Care Medicine. *Acta Anaesthesiol Scand*. 2014;58(5):508-524. doi:10.1111/aas.12295
81. Dix CH, Yeung DT, Rule ML, Ma DD. Essential, but at what risk? a prospective study on central venous access in patients with haematological malignancies. *Intern Med J*. 2012;42(8):901-906. doi:10.1111/j.1445-5994.2011.02596.x
82. Gupta S, Mallya SP, Bhat A, Baliga S. Microbiology of non-tunnelled catheter-related infections. *J Clin Diagn Res*. 2016;10(7):DC24-DC28. doi:10.7860/JCDR/2016/19058.8155

83. Goldstein SD, Pryor H, Salazar JH, et al. Ultrasound-guided percutaneous central venous access in low birth weight infants: feasibility in the smallest of patients. *J Laparoendosc Adv Surg Tech A*. 2015;25(9):767-769. doi:10.1089/lap.2014.0308
84. Malbezin S, Gauss T, Smith I, et al. A review of 5434 percutaneous pediatric central venous catheters inserted by anesthesiologists. *Paediatr Anaesth*. 2013;23(11):974-979. doi:10.1111/pan.12184
85. Duesing LA, Fawley JA, Wagner AJ. Central venous access in the pediatric population with emphasis on complications and prevention strategies. *Nutr Clin Pract*. 2016;31(4):490-501. doi:10.1177/0884533616640454
86. Östlund Å, Fläring U, Norberg Å, et al. Incidence of and risk factors for venous thrombosis in children with percutaneous non-tunnelled central venous catheters. *Br J Anaesth*. 2019;123(3):316-324. doi:10.1016/j.bja.2019.04.055
87. Jaffray J, Bauman M, Massicotte P. The impact of central venous catheters on pediatric venous thromboembolism. *Front Pediatr*. 2017;5:5. doi:10.3389/fped.2017.00005
88. Derderian SC, Good R, Vuille-Dit-Bille RN, Carpenter T, Bensard DD. Central venous lines in critically ill children: thrombosis but not infection is site dependent. *J Pediatr Surg*. 2019;54(9):1740-1743. doi:10.1016/j.jpedsurg.2018.10.109
89. Barone G, Pittiruti M, Ancora G, Vento G, Tota F, D'Andrea V. Centrally inserted central catheters in preterm neonates with weight below 1500 g by ultrasound-guided access to the brachio-cephalic vein [published online ahead of print Jul 10, 2020]. *J Vasc Access*. 2020;1129729820940174. doi:10.1177/1129729820940174
90. Habas F, Baleine J, Milési C, et al. Supraclavicular catheterization of the brachiocephalic vein: a way to prevent or reduce catheter maintenance-related complications in children. *Eur J Pediatr*. 2018;177(3):451-459. doi:10.1007/s00431-017-3082-x
91. Schmidt GA, Blaivas M, Conrad SA, et al. Ultrasound-guided vascular access in critical illness. *Intensive Care Med*. 2019;45(4):434-446. doi:10.1007/s00134-019-05564-7
92. Parienti JJ, Mongardon N, Mégarbane B, et al. Intravascular complications of central venous catheterization by insertion site. *N Engl J Med*. 2015;373(13):1220-1229. doi:10.1056/NEJMoa1500964
93. Ben Kridis W, Toumi N, Khanfir A. Causes of fracture of catheter of totally implantable venous access port: a systematic review. *Acta Med Iran*. 2020;57(12):686-689. https://doi.org/10.18502/acta.v57i12.3463
94. Yıldırım İ, Tütüncü AÇ, Bademler S, Özgür İ, Demiray M, Karanlık H. Does the real-time ultrasound guidance provide safer venipuncture in implantable venous port implantation? *J Vasc Access*. 2018;19(3):297-302. doi:10.1177/1129729817752606
95. Hong S, Seo TS, Song MG, Seol HY, Suh SI, Ryoo IS. Clinical outcomes of totally implantable venous access port placement via the axillary vein in patients with head and neck malignancy. *J Vasc Access*. 2019;20(2):134-139. doi:10.1177/1129729818781270
96. Davidson J, Paul A, Patel S, Davenport M, Ade-Ajayi N. Central vein preservation in critical venous access. *Eur J Pediatr Surg*. 2016;26(4):357-362. doi:10.1055/s-0035-1556567
97. Katsoulas T, Kapritsou M, Alexandrou E, et al. Peripherally inserted central catheter ports: a vascular access specialist's systematic approach. *J Vasc Nurs*. 2019;37(2):113-116. doi:10.1016/j.jvn.2019.03.001
98. Lee KA, Ramaswamy RS. Intravascular access devices from an interventional radiology perspective: indications, implantation techniques, and optimizing patency. *Transfusion*. 2018;58 (Suppl 1):549-557. doi:10.1111/trf.14501
99. Sun X, Xu J, Xia R, et al. Efficacy and safety of ultrasound-guided totally implantable venous access ports via the right innominate vein in adult patients with cancer: single-centre experience and protocol. *Eur J Surg Oncol*. 2019;45(2):275-278. doi:10.1016/j.ejso.2018.07.048
100. Sun X, Bai X, Shen J, Yu Z, Zhuang Z, Jin Y. Comparison between ultrasound-guided TIVAD via the right innominate vein and the right internal jugular vein approach. *BMC Surg*. 2019;19(1):189. doi:10.1186/s12893-019-0651-0
101. Xu L, Qin W, Zheng W, Sun X. Ultrasound-guided totally implantable venous access ports via the right innominate vein: a new approach for patients with breast cancer. *World J Surg Oncol*. 2019;17(1):196. doi:10.1186/s12957-019-1727-0
102. Avanzini S, Mameli L, Disma N, et al. Brachiocephalic vein for percutaneous ultrasound-guided central line positioning in children: a 20-month preliminary experience with 109 procedures. *Pediatr Blood Cancer*. 2017;64(2):330-335. doi:10.1002/pbc.26202
103. Mudan S, Giakoustidis A, Morrison D, et al. 1000 Port-A-Cath® placements by subclavian vein approach: single surgeon experience. *World J Surg*. 2015;39(2):328-334. doi:10.1007/s00268-014-2802-x
104. Li G, Zhang Y, Ma H, Zheng J. Arm port vs chest port: a systematic review and meta-analysis. *Cancer Manag Res*. 2019;11:6099-6112. doi:10.2147/CMAR.S205988
105. Tippit D, Siegel E, Ochoa D, et al. Upper-extremity deep vein thrombosis in patients with breast cancer with chest versus arm central venous port catheters. *Breast Cancer (Auckl).* 2018;12:1178223418771909. doi:10.1177/1178223418771909
106. Tabatabaie O, Kasumova GG, Kent TS, et al. Upper extremity deep venous thrombosis after port insertion: what are the risk factors? *Surgery*. 2017;162(2):437-444. doi:10.1016/j.surg.2017.02.020
107. Gouda ZE, Emara MM, Elbarbary HS, Koura MAA, Elarbagy AR. Studying alternative approaches for placement of cuffed hemodialysis catheters in hemodialysis patients with bilateral internal jugular vein occlusion. *J Vasc Access*. 2019;20(3):250-259. doi:10.1177/1129729818794414
108. Theodore AC, Clermont G, Dalton A. Intra-arterial catheterization for invasive monitoring: Indications, insertion techniques, and interpretation. UpToDate.com. Updated August 18, 2020. https://www.uptodate.com/contents/intra-arterial-catheterization-for-invasive-monitoring-indications-insertion-techniques-and-interpretation
109. Crumlet H, Johnson A. Arterial catheter insertion (perform). In: Weigand DL, ed. *AACN Procedure Manual for High Acuity, Progressive, and Critical Care.* Elsevier; 2017:501-507.
110. Tosetti S, Bertolizio G, Withington D, Collard V, Ingelmo P. Arterial line cannulation in children: is it time for guidelines? *Paediatr Anaesth*. 2018;28(6):564-565. doi:10.1111/pan.13394
111. O'Horo JC, Maki DG, Krupp AE, Safdar N. Arterial catheters as a source of bloodstream infection: a systematic review and meta-analysis. *Crit Care Med*. 2014;42(6):1334-1339. doi:10.1097/CCM.0000000000000166

28. IMPLANTED VASCULAR ACCESS PORTS

Standard

28.1 Only implanted vascular access ports (ports) and non-coring safety needles designed for power injection are used with power-injection equipment for radiologic imaging in accordance with manufacturers' directions for use.

28.2 Skin antisepsis is performed prior to each access of a port.

28.3 A sterile dressing is maintained over the access site if the port remains accessed.

Practice Recommendations

A. Assess patient needs and preferences related to pain management during port access (refer to Standard 32, *Pain Management for Venipuncture and Vascular Access Procedures*).

B. Use a patient's port, unless contraindicated (eg, existing complication with the device) as the preferred IV route in preference to insertion of an additional VAD (refer to

Standard 26, *Vascular Access Device Planning*). (Committee Consensus)

C. Adhere to Aseptic Non Touch Technique (ANTT) during port access (refer to Standard 18, *Aseptic Non Touch Technique*).
   1. Assess port site in preparation for port access: observe/palpate for swelling, pain, erythema, and drainage; presence of venous collaterals on the chest wall that may signal occlusion; erosion of the portal body through the skin; or signs of CA-DVT (see Standard 50, *Infection;* Standard 53, *Catheter-Associated Deep Vein Thrombosis*).[1-9] (IV)
   2. Perform skin antisepsis prior to port access and allow skin antiseptic agent to fully dry prior to port access (refer to Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*).
   3. Adhere to either Standard-ANTT or Surgical-ANTT during port access (based on ANTT risk assessment of ability to prevent touching Key-Sites and Key-Parts).
      a. Don sterile gloves when port site palpation is required after skin antisepsis and prior to insertion of the noncoring needle (see Standard 18, *Aseptic Non Touch Technique)*.[1,2,3,10] (V)

D. Access the port with the smallest-gauge noncoring needle to accommodate the prescribed therapy. Use of a safety-engineered noncoring needle is recommended and required in some jurisdictions (see Standard 21, *Medical Waste and Sharps Safety*).[3] (V)
   1. Reduce the risk of needle dislodgement after access; use a noncoring needle of length that allows the external components (eg, wings) to sit level with the skin and securely within the port (needle touches bottom of port upon insertion).[3] (V)
   2. Orient the bevel of the noncoring needle in the opposite direction from the outflow channel where the catheter is attached to the port body. In vitro testing demonstrates that a greater amount of protein is removed when flushing with this bevel orientation.[3,11-12] (IV)
   3. There is insufficient evidence to recommend the frequency of replacement of the noncoring needle when the port is used for a continuous infusion. Replace the noncoring needle according to manufacturers' directions for use or in accordance with organizational procedures.[1] (V)
   4. One study suggests needle insertion assistive devices may improve first-attempt success with insertion of the noncoring needle into the port.[13] (V)
   5. Implanted ports for apheresis with a funnel design are accessed with a short PIVC (16- or 18-gauge) in accordance with manufacturers' directions for use.[14,15] (V)

E. Flush and lock the port to assess function and maintain patency.
   1. Flush and aspirate for a blood return upon insertion of a noncoring needle and prior to each infusion to ensure patency (refer to Standard 41, *Flushing and Locking*).
   2. Recommendations vary regarding the frequency, solution, or solution volume to flush and lock ports not accessed for infusion; further research is needed.
      a. Use a volume of at least 10 mL of 0.9% sodium chloride when flushing a port.[12] (IV)
      b. Use of 0.9% sodium chloride alone may be as effective as heparin in locking to maintain port patency; if heparin is used, 5 mL of heparin 10 to 100 units/mL is commonly recommended every 4 to 12 weeks.[3,16,17] (IV)
      c. Extending maintenance flushing and locking to every 3 months with 10 mL of 0.9% sodium chloride and 3 or 5 mL of heparin (100 units/mL) was found to be safe and effective in prospective observational studies in adult oncology patients to maintain patency.[18-20] (IV)
      d. Flush ports accessed for intermittent infusions immediately before/after each infusion.[1-3] (IV)
      e. Consider use of antimicrobial lock therapy to treat a port-related infection or if the patient is at high risk for infection (refer to Standard 41, *Flushing and Locking*).

F. Use a transparent semipermeable membrane (TSM) dressing that covers the noncoring needle and access site when the port is accessed.
   1. Change the TSM dressing at least every 7 days; if gauze is needed over the noncoring needle and access site, change the dressing every 2 days (refer to Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes*).
   2. When gauze is used under the TSM dressing to solely support the wings of a noncoring needle, does not obscure the access site, and its integrity is not compromised (eg, not visibly soiled and remains free of moisture, drainage, or blood), change the TSM dressing at least every 7 days. (Committee Consensus)
   3. Guidelines for oncology patients suggest use of a chlorhexidine-impregnated dressing around the needle insertion site based on duration of infusions exceeding 4 to 6 hours.[3] (V)
   4. Secure the noncoring needle to reduce the risk for needle dislodgement and subsequent risk for infiltration/extravasation; the use of sterile tape strips was found to be successful in a quality improvement initiative.[3,10] (V)

G. Confirm that a port is indicated for power injection before using it for this purpose.[21-22] (IV)
   1. Ports are assigned a unique device identifier, an alphanumeric code, specific to that product. When used in the patient's health record in a retrievable manner, this code is used to obtain all information about that device (eg, product and manufacturer name, lot and serial number, date manufactured).[23-25] (V)

2. Other identification methods include review of operative procedure documentation, presence of identification (eg, cards) provided by the manufacturer, radiographic scout scan, and palpation of the port; however, do not use palpation of the port as the only identification method as not all power-injection–capable ports have unique characteristics identifiable by palpation. (Committee Consensus)
3. During and after power injection, be aware of the potential for catheter rupture, which can lead to extravasation, catheter fragment embolism, and the need for port removal and replacement. Suspect catheter rupture if the patient shows signs of localized swelling or erythema or reports pain (refer to Standard 51, *Catheter Damage [Embolism, Repair, Exchange]*).

H. Consider an annual chest radiograph assessment of port position and integrity (see Standard 51, *Catheter Damage [Embolism, Repair, Exchange]*).[26] (II)

I. Provide patient/caregiver education:
1. Prior to insertion: placement procedure, type of port, routine care expectations (frequency of flushing, expectations of ANTT during access, use for power injection, if indicated), and identification of potential complications and interventions.[27-28] (V)
2. Provision of written information about ports before placement was associated with decreased anxiety and improved level of knowledge.[27-28] (III)
3. When receiving infusions at home via an accessed port: daily dressing check, managing activities of daily living (bathing, clothing, seatbelts) to prevent needle dislodgement, reporting any signs or symptoms of complications (pain, burning, stinging, or soreness) and follow-up actions (see Standard 8, *Patient Education*).[29] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 26, 2020, and August 29, 2020.

1. Blanco-Guzman MO. Implanted vascular access device options: a focused review on safety and outcomes. *Transfusion.* 2018;58(Suppl 1): 558-568. doi:10.1111/trf.14503
2. Pinelli F, Cecero E, Degl'Innocenti D, et al. Infection of totally implantable venous access devices: a review of the literature. *J Vasc Access*. 2018;19(3):230-242. doi:10.1177/1129729818758999
3. Schulmeister L. Implanted venous ports. In: Camp-Sorrell D, Matey L, eds. *Access Device Standards of Practice for Oncology Nursing*. Oncology Nursing Society; 2017:65-73.
4. Burris J, Weiss M. Reduction of erosion risk in adult patients with implanted venous access ports. *Clin J Oncol Nurs.* 2014;18(4):403-405. doi:10.1188/14.CJON.403-405
5. Alverez-Rodriquez JA, Garcia-Suarez M, Fernandez-Garcia D, Mendez-Martinez C, Gomez-Salgado J. Analysis of peripheral central venous access ports at the forearm: an observational study. *Eur J Cancer Care (Engl).* 2018;27(6):e12929. doi:10.1111/ecc.12929
6. El-Balat A, Schmeil I, Karn T, et al. Catheter-related complications of subcutaneous implantable venous access devices in breast cancer patients. *In Vivo.* 2018;32(5):1275-1281. doi:10.21873/invivo.11377
7. Katsoulas T, Kapritsou M, Alexandrou E, et al. Peripherally inserted central catheter ports: a vascular access specialist's systematic approach. *J Vasc Nurs.* 2019;37(2):113-116. doi:10.1016/j.jvn.2019.03.001
8. Sotiriadis C, Hajdu SD, Doenz F, Qanadli SD. Brachial approach as an alternative technique of fibrin sheath removal for implanted port access devices. *Front Surg.* 2017;4:20. doi:10.3389/fsurg.2017.00020
9. Suleman A, Jarvis V, Hadziomerovic A, Carrier M, McDiarmid S. Implanted vascular access device related deep vein thrombosis in oncology patients: a prospective cohort study. *Thromb Res.* 2019;177:117-121. doi:10.1016/j.thromres.2019.02.033
10. Conley SB, Buckley P, Magarace L, Hsieh C, Vitale-Pedulla L. Standardizing best nursing practice for implanted ports: applying evidence-based professional guidelines to prevent central line associated bloodstream infections. *J Infus Nurs*. 2017;40(3):165-174. doi:10.1097/NAN.0000000000000217
11. Guiffant G, Durussel JJ, Flaud P, Vigier JP, Merckx J. Flushing ports of totally implantable venous access devices, and impact of the Huber point needle bevel orientation: experimental tests and numerical computation. *Med Devices (Auckl).* 2012;5:31-37. doi:10.2147/MDER.S30029
12. Chou PL, Fu JY, Cheng CH, et al. Current port maintenance strategies are insufficient: view based on actual presentations of implanted ports. *Medicine (Baltimore)*. 2019;98(44):e17757. doi:10.1097/MD.0000000000017757
13. Barton A, Pamment K, Fitzpatrick D. Evaluation of a device to improve non-coring needle insertion into implanted venous ports. *Br J Nurs*. 2018;27(19):S20-S24. doi:10.12968/bjon.2018.27.19.S20
14. Lin DM, Wu Y. Implantable vascular access devices–past, present, and future. *Transfusion.* 2018;58(Suppl 1):545-548. doi:10.1111/trf.14485
15. Gray KL, Steidley IG, Benson HL, Pearce CL, Bachman AM, Adamski J. Implementation and 2-year outcomes of the first FDA-approved implantable apheresis vascular access device. *Transfusion.* 2019;59(11):3461-3467. doi:10.1111/trf.15512
16. López-Briz E, Ruiz Garcia V, Cabello JB, Bort-Martí S, Carbonell Sanchis R, Burls A. Heparin versus 0.9% sodium chloride locking for prevention of occlusion in central venous catheters in adults. *Cochrane Database Syst Rev*. 2018;7(7):CD008462. doi:10.1002/14651858.CD008462.pub3
17. Rosenbluth G, Tsang L, Vittinghoff E, Wilson S, Wilson-Ganz J, Auerbach A. Impact of decreased dose for flush-lock of implanted venous access ports in pediatric oncology patients. *Pediatr Blood Cancer.* 2014;61(5):855-858. doi:10.1002/pbc.24949
18. Odabas H, Ozdemir NY, Ziraman I, et al. Effect of port-care frequency on venous port catheter related complications in cancer patients. *Int J Clin Oncol.* 2014;19(4):761-766. doi:10.1007/s10147-013-0609-7
19. Diaz JA, Rai SN, Wu X, Chao JH, Dias AL, Kloecker GH. Phase II trial on extending the maintenance flushing interval of implanted ports. *J Oncol Pract.* 2017;13(1):e22-e28. doi:10.1200/JOP.2016.010843
20. Solinas G, Platini F, Trivellato M, Rigo C, Alabiso O, Galetto AS. Port in oncology practice: 3-monthly locking with normal saline for catheter maintenance, a preliminary report. *J Vasc Access*. 2017;18(4):325-327. doi:10.5301/jva.5000740
21. Saijo F, Mutoh M, Tokumine J, et al. Late fracture of Groshong ports: a report of three cases. *J Vasc Access.* 2019;20(5):563-566. doi:10.1177/1129729819834512
22. ACR Committee on Drugs and Contrast Media. *ACR Manual on Contrast Media*. American College of Radiology; 2020. https://www.acr.org/Clinical-Resources/Contrast-Manual
23. US Food and Drug Administration. UDI basics. Updated May 14, 2019. https://www.fda.gov/medical-devices/unique-device-identification-system-udi-system/udi-basics
24. US Food and Drug Administration. Benefits of a UDI system. Updated September 27, 2018. https://www.fda.gov/medical-devices/unique-device-identification-system-udi-system/benefits-udi-system

25. US National Library of Medicine. Access GUDID – identify your medical device. https://accessgudid.nlm.nih.gov/
26. Ben Kridis W, Toumi N, Khanfir A. Causes of fracture of catheter of totally implantable venous access port: a systematic review. *Acta Med Iran.* 2020;57(12):686-689. https://doi.org/10.18502/acta.v57i12.3463
27. Piredda M, Migliozzi A, Biagioli V, Carassiti M, De Marinis MG. Written Information improves patient knowledge about implanted ports. *Clin J Oncol Nurs*. 2016;20(2):E28-E33. doi:10.1188/16.CJON.E28-E33
28. Piredda M, Biagioli V, Giannarelli D, et al. Improving cancer patients' knowledge about totally implantable access port: a randomized controlled trial. *Support Care Cancer*. 2016;24(2):833-841. doi:10.1007/s00520-015-2851-1
29. Gorski LA. *Fast Facts for Nurses About Home Infusion Therapy: The Expert's Best Practice Guide in a Nutshell.* Springer Publishing Company; 2017.

29. VASCULAR ACCESS AND HEMODIALYSIS

Standard

29.1 Selection of the most appropriate VAD for hemodialysis occurs in collaboration with the patient/caregiver and the heath care and nephrology teams based on the projected treatment plan.

29.2 Hemodynamic monitoring, venipuncture, and blood pressure measurement are not performed on the extremity with an arteriovenous fistula (AVF) or arteriovenous graft (AVG).

Practice Recommendations

A. Use principles of vessel health and preservation for both peripheral and central vasculature for patients on hemodialysis or likely to require future hemodialysis.[1] (IV)
   1. Begin planning for hemodialysis vascular access with the patient and family beginning at CKD stage 4 (glomerular filtration rate [GFR] <30 mL/min/1.73 m^2)
      a. Preserve vessels in patients with acute kidney injury; in the 2-year period prior to hemodialysis, acute kidney injury was associated with significantly lower odds of transitioning to hemodialysis with an AVF/AVG.[1-4] (IV)
   2. Determine the access method in preparation for hemodialysis; the order for access preference is AVF, AVG, and long-term CVAD (tunneled, cuffed hemodialysis catheter); nontunneled hemodialysis CVADs may be placed for short-term immediate hemodialysis needs in the hospitalized patient.[1,5] (IV)
   3. Limit use of temporary, noncuffed, nontunneled hemodialysis CVADs to a maximum of 2 weeks due to increased risk for infection and consider their use only in patients with need for emergent access.[1] (IV)
   4. Evaluate life expectancy, surgical risk, and quality of life for older patients requiring hemodialysis when considering an AVF or AVG vs a hemodialysis catheter.[1,6] (IV)
   5. Restrict venipuncture for both phlebotomy and PIVC placement to the dorsum of the hand whenever possible, regardless of arm dominance, in patients with an actual or planned dialysis fistula or graft. Avoid use of forearm and upper arm veins for phlebotomy or peripheral catheter placement in patients with an actual or planned dialysis fistula or graft.[7,8] (IV)
   6. Avoid placement of a CVAD via the subclavian vein and avoid PICCs whenever possible due to an increased risk for thrombosis, central vein stenosis, and occlusion; the order of preference for CVAD placement is internal jugular, external jugular, femoral, subclavian, and lumbar vein.
      a. PICC placement before or after hemodialysis initiation is associated with failure to transition to a working fistula; consult with the nephrology team when available before PICC placement.[1,4] (IV)

B. Allow only nephrology/dialysis clinicians to access the hemodialysis VAD unless there is a life-threatening condition or when there is validation of clinician training and competency.[6,7] (V)

C. Provide dressing changes and site care for hemodialysis access devices, including AVFs and AVGs (when dressings are present), in accordance with ANTT (refer to Standard 18, *Aseptic Non Touch Technique*).
   1. Use an alcohol-based chlorhexidine solution as a first-line antiseptic solution for VAD exit site care; if sensitive to chlorhexidine, use povidone iodine preferably with alcohol.[1] (IV)
   2. Consider the use of a chlorhexidine dressing as a strategy in reducing the risk for infection.[9,10] (IV)
   3. Apply povidone-iodine ointment or bacitracin/gramicidin/polymyxin B ointment at the CVAD exit site during the site care and catheter dressing change if not using a chlorhexidine dressing; alternatives include triple antibiotic ointment (bacitracin/neomycin/polymyxin B).
      a. Recognize that ingredients in antibiotic and povidone-iodine ointments may interact with the chemical composition of certain catheters; check with the catheter manufacturer to ensure that the selected ointment will not interact with the catheter material.
      b. Avoid use of mupirocin ointment at the catheter insertion site due to the risks of facilitating mupirocin resistance and the potential damage it can cause to polyurethane catheters.[1,11-13] (I)

D. Provide hub care in accordance with ANTT (refer to Standard 18, *Aseptic Non Touch Technique*).
   1. Wear a mask (both clinician and patient) to reduce the risk of droplet transmission of oropharyngeal flora.[7] (V)
   2. Disinfect CVAD and vascular graft hubs (threads of the female end) after cap is removed and before accessing. Perform every time the catheter is accessed or disconnected. If a closed system, high-flow

needleless-style cap is used, follow the manufacturer's directions for cleaning and changing of caps (see Standard 36, *Needleless Connectors*).[1,7,12-14] (II)

E. Lock hemodialysis CVADs with heparin solution or low concentration citrate (<5%); consider locking CVAD with tissue plasminogen activator (tPA) prophylactically once per week to reduce the risk of CVAD occlusion; other antimicrobial solutions may be used in accordance with organizational policies, procedures, or practice guidelines (see Standard 41, *Flushing and Locking*).[1,15,16] (IV)
   1. The choice of locking solution is based upon clinician discretion due to inadequate evidence to demonstrate a difference between solutions.[1] (V)

F. Conduct monthly surveillance for BSIs and other dialysis events and share results with the health care team (see Standard 6, *Quality Improvement*).[11] (IV)

G . Promote patient engagement through activities including shared decision-making and empowerment such as monitoring clinician infection prevention practices (eg, hand hygiene before each hemodialysis access procedure); provide patient education as an integral part of patient engagement. Address the following patient education topics:
   1. Hemodialysis vascular access when the patient is at CKD stage 4.
   2. Vein preservation.
   3. Infection prevention.
   4. Protection of AVF, AVG, or CVAD.
   5. Access management when away from the dialysis unit.
   6. Signs/symptoms of VAD dysfunction, infection, or other complications and how to report.[1,7,8,11,13,17,18] (IV)

REFERENCES

Note: All electronic references in this section were accessed between May 6, 2020, and August 29, 2020.

1. Lok CE, Huber TS, Lee T, et al; KDOQI Vascular Access Guideline Work Group. KDOQI clinical practice guideline for vascular access: 2019 update. *Am J Kidney Dis*. 2020;75(4)(Suppl 2):S1-S164. doi:10.1053/j.ajkd.2019.12.001
2. Lee T, Shah S, Leonard AC, Parikh P, Thakar CV. Acute kidney injury before dialysis initiation predicts adverse outcomes in hemodialysis patients. *Am J Nephrol*. 2018;47(6):427-434. doi:10.1159/000489949
3. Yessayan L, Heung M. Recognizing downstream consequences of acute kidney injury. *Am J Nephrol*. 2018;47(6):424-426. doi:10.1159/000489950
4. McGill RL, Ruthazer R, Meyer KB, Miskulin DC, Weiner DE. Peripherally inserted central catheters and hemodialysis outcomes. *Clin J Am Soc Nephrol*. 2016;11(8):1434-1440. doi:10.2215/CJN.01980216
5. ESRD National Coordinating Center. Fistula First Catheter Last (FFCL) for professionals. Esrdncc.org. https://esrdncc.org/en/fistula-first-catheter-last/ffcl-for-professionals/
6. Arhuidese IJ, Cooper MA, Rizwan M, Nejim B, Malas MB. Vascular access for hemodialysis in the elderly. *J Vasc Surg.* 2019;69(2):517-525.e1. doi:10.1016/j.jvs.2018.05.219
7. American Nephrology Nurses Association. Vascular access fact sheet. Published 2018. https://www.annanurse.org/download/reference/practice/vascularAccessFactSheet.pdf
8. American Nephrology Nurses Association. Vascular access for hemodialysis [position statement]. Published February 2003. Updated December 2017. https://www.annanurse.org/download/reference/health/position/vascularAccess.pdf
9. Righetti M, Palmieri N, Bracchi O, et al. Tegaderm™ CHG dressing significantly improves catheter-related infection rate in hemodialysis patients. *J Vasc Access*. 2016;17(5):417-422. doi:10.5301/jva.5000596
10. Apata IW, Hanfelt J, Bailey JL, Niyyar VD. Chlorhexidine-impregnated transparent dressings decrease catheter-related infections in hemodialysis patients: a quality improvement project. *J Vasc Access*. 2017;18(2):103-108. doi:10.5301/jva.5000658
11. Centers for Disease Control and Prevention. Dialysis safety: core interventions. Published 2016. https://www.cdc.gov/dialysis/prevention-tools/core-interventions.html
12. Marschall J, Mermel LA, Fakihm M, et al. Strategies to prevent central line–associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol.* 2014;35(7):753-771. doi:10.1086/676533
13. Soi V, Moore CL, Kumbar L, Yee J. Prevention of catheter-related bloodstream infections in patients on hemodialysis: challenges and management strategies. *Int J Nephrol Renovasc Dis.* 2016;9:95-103. doi:10.2147/IJNRD.S76826
14. Cooney MR, Manickam N, Becherer P, et al. The use of 3.15% chlorhexidine gluconate/70% alcohol hub disinfection to prevent central line-associated bloodstream infections in dialysis patients. *Br J Nurs.* 2020;29(2):S24-S26. doi:10.12968/bjon.2020.29.2.S24
15. Mai H, Zhao Y, Salerno S, et al. Citrate versus heparin lock for prevention of hemodialysis catheter-related complications: updated systematic review and meta-analysis of randomized controlled trials. *Int Urol Nephrol*. 2019;51(6):1019-1033. doi:10.1007/s11255-019-02150-0
16. Hemmelgarn BR, Manns BJ, Soroka SD, et al. Effectiveness and cost of weekly recombinant tissue plasminogen activator hemodialysis catheter locking solution. *Clin J Am Soc Nephrol*. 2018;13(3):429-435. doi:10.2215/CJN.08510817
17. Mariano VD, Castro-Sanchez E. Partnering with patients undergoing hemodialysis to prevent catheter-associated bloodstream infections. *J Assoc Vasc Access.* 2017;22(4):210-213. https://doi.org/10.1016/j.java.2017.06.003
18. Amini M. Evaluation the effectiveness of an educational intervention to decrease central line-associated bloodstream infections among hemodialysis patients. *Am J Infect Control.* 2016;44(12):1703-1704. doi:10.1016/j.ajic.2016.07.001

30. UMBILICAL CATHETERS

Standard

30.1 The clinical need for an umbilical catheter is assessed on a daily basis, and the catheter should be promptly removed when no longer indicated.

Practice Recommendations

A. Establish organizational guidelines for appropriate use of umbilical arterial catheters (UACs) and umbilical venous catheters (UVCs) based on severity of illness, therapy needs considering gestational age and birth weight, and to minimize their unneeded utilization and associated complications.[1,2] (IV)
   1. Use UACs for obtaining frequent blood samples and continuous blood pressure monitoring.[3,4] (V)
   2. Use UVCs for the infusion of medications and solutions, PN, and blood products.[3] (V)

3. Maintain patency and reduce risk of thrombosis by continuous infusion of heparin 0.25 to 1.00 unit/mL (total dose of heparin: 25–200 units/kg/d).[5] (II)

B. Perform skin antisepsis prior to insertion.
   1. Use povidone-iodine, alcohol-based chlorhexidine solution, or aqueous chlorhexidine solution.[6,7] (IV)
   2. Use both aqueous and alcohol-based chlorhexidine with caution in preterm neonates, low-birth-weight neonates, and within the first 14 days of life due to risks of chemical burns to the skin. Systemic absorption has been reported due to skin immaturity; however, systemic effects are not documented. Use chlorhexidine antiseptic agents with caution in infants under 2 months of age. Studies have not established one antiseptic solution as superior for safety or efficacy in neonates.[8] (V)
   3. Avoid the use of tincture of iodine in premature neonates (<32 weeks) due to the potential deleterious effect on the neonatal thyroid gland.[9-12] (II)
   4. Remove antiseptics after the procedure is complete using sterile water or saline (see Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*).[10] (V)

C. Determine the length of catheter to be inserted by anatomical measurement of shoulder to umbilicus length, by equations based on body weight, or with other research-based protocols to achieve successful tip placement.[12-16] (III)

D. Place the catheter tip for:
   1. UACs in the thoracic portion of the descending aorta below the aortic arch (ie, between the thoracic vertebrae 6 and 9 for high position) or below the renal arteries and above the aortic bifurcation into the common iliac arteries (ie, between lumbar vertebrae 3 and 4 for low position).[3,4] (V, A/P)
      a. The high position is associated with decreased risk of complications.[5,17,18] (I)
   2. UVCs in the inferior vena cava (IVC) at, or superior to, the diaphragm below the junction with the right atrium.[13,19-21] (IV)
   3. When a low-lying UVC is placed in emergency situations with the tip in a noncentral position, due to higher risk of infection and complications, consider temporary until more permanent access can be obtained.[4,21-23] (V)

E. Confirm the catheter tip location by radiography, echocardiography, ultrasonography, or other methods of confirmation before catheter use.[19,24-27] (IV)
   1. For UVC, obtain anteroposterior (AP) radiographic view of the chest and abdomen for tip location at or slightly cephalad to the diaphragm. Use of the cardiac silhouette is reported to be more accurate than positioning based on vertebral bodies. When an AP view is insufficient to identify the catheter pathway and tip location, a lateral or cross-table view may be needed.[28,29] (V)
   2. For UAC, obtain AP radiographic view of the chest and abdomen to verify tip location.[3,4] (V)
   3. Consider real-time imaging guidance for patients with congenital cardiac conditions.[30] (V)
   4. Ultrasound imaging using parasternal long- and short-axis views for UVC tip location compares favorably to radiography. Injection of normal saline through the catheter may assist in visualizing the exact tip location.[19,24,31,32] (IV)
   5. Neonatal echocardiography may be superior to chest and abdominal radiography in extremely low-birth-weight neonates or for identifying malpositioned catheters.[20,24,25] (IV)

F. Choose a method for securing the UVC and UAC based on promotion of security, skin integrity, decreasing complications, and ease of utilization and management. There is currently a lack of evidence demonstrating the superiority of one method over others. These catheters are at risk for significant complications resulting from migration and dislodgement, such as extravasation, thrombosis, and necrotizing enterocolitis. Powered RCTs are needed to establish the superiority of one securement method over another.[18,23,26,33,34] (IV)
   1. Organizational protocols should be developed also recognizing that neonates are at high risk for catheter-associated skin injuries (see Standard 55, *Catheter-Associated Skin Injury*).[10] (IV)

G. Do not use topical antibiotic ointment or creams on umbilical sites due to the risk of fungal infections and antimicrobial resistance.[2] (IV)

H. Monitor for signs and symptoms of potential complications including, but not limited to, bleeding from the umbilical stump, extravasation, hemorrhage, air embolism, infection, thrombosis, pleural effusion, pericardial effusion, cardiac tamponade, cardiac arrhythmias, liver damage, and peripheral vascular constriction. Anticipate the use of point-of-care ultrasound as available or echocardiogram for diagnostic purposes.[18,26,33,35] (IV)

I. Remove umbilical catheters promptly when no longer needed or if a complication occurs.
   1. Consider limiting UVC dwell time to 7 to 10 days; risks of infectious and thrombotic complications are increased with longer dwell times.[18,36-41] (IV)
   2. Consider UVC removal at 4 days followed by insertion of a PICC for continued infusion as one infection prevention strategy.[42] (V)
   3. Consider limiting UAC dwell time to no more than 5 days.[2,18,43] (IV)
   4. Remove umbilical catheters slowly over several minutes after placing an umbilical tie around the stump. For removal of UACs, the final 5 cm of catheter length should be slowly withdrawn at 1 cm/min to allow vasospasm.[3] (V, A/P)

REFERENCES

1. Shahid S, Dutta S, Symington A, Shivananda S, McMaster University N. Standardizing umbilical catheter usage in preterm infants. *Pediatrics*. 2014;133(6):e1742-e1752. doi:10.1542/peds.2013-1373

2. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. *Am J Infect Control*. 2011;39(4 Suppl 1):S1-S34. doi:10.1016/j.ajic.2011.01.003
3. Ramasethu J, Seo S. *MacDonald's Atlas of Procedures in Neonatology*. 6th ed. Wolter Kluwer; 2020.
4. Gomella TL, Eyal FG, Bany-Mohammed F, eds. *Gomella's Neonatology Management, Procedures, On-Call Problems, Diseases and Drugs.* 8th ed. Mc Graw Hill Education; 2020.
5. Monagle P, Chan AKC, Goldenberg NA, et al. Antithrombotic therapy in neonates and children: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141 (2 Suppl):e737S-e801S. doi:10.1378/chest.11-2308
6. Johnson J, Bracken R, Tamma PD, Aucott SW, Bearer C, Milstone AM. Trends in chlorhexidine use in us neonatal intensive care units: results from a follow-up national survey. *Infect Control Hosp Epidemio*l. 2016;37(9):1116-1118. doi:10.1017/ice.2016.125
7. Sathiyamurthy S, Banerjee J, Godambe SV. Antiseptic use in the neonatal intensive care unit - a dilemma in clinical practice: an evidence based review. *World J Clin Pediatr.* 2016;5(2):159-171. doi:10.5409/wjcp.v5.i2.159
8. Professional Disposables International. Chlorascrub supplement approval letter. US Food and Drug Administration; May 17, 2012. Accessed August 29, 2020. https://www.accessdata.fda.gov/drugsatfda_docs/appletter/2012/021524Orig1s011ltr.pdf
9. Aitken J, Williams FL. A systematic review of thyroid dysfunction in preterm neonates exposed to topical iodine. *Arch Dis Child Fetal Neonatal Ed*. 2014;99(1):F21-F28. doi:10.1136/archdischild-2013-303799
10. Brandon D, Hill C, Heimall L, et al. *Neonatal Skin-Care Evidence-Based Clinical Practice Guidelines*. 4th ed. Association of Women's Health, Obstetric and Neonatal Nurses; 2018.
11. Pinsker JE, McBayne K, Edwards M, Jensen K, Crudo DF, Bauer AJ. Transient hypothyroidism in premature infants after short-term topical iodine exposure: an avoidable risk? *Pediatr Neonatol.* 2013;54(2):128-131. doi:10.1016/j.pedneo.2012.10.005
12. Gupta AO, Peesay MR, Ramasethu J. Simple measurements to place umbilical catheters using surface anatomy. *J Perinatol.* 2015;35(7):476-480. doi:10.1038/jp.2014.239
13. Kieran EA, Laffan EE, O'Donnell CP. Estimating umbilical catheter insertion depth in newborns using weight or body measurement: a randomised trial. *Arch Dis Child Fetal Neonatal Ed.* 2016;101(1):F10-F15. doi:10.1136/archdischild-2014-307668
14. Lean WL, Dawson JA, Davis PG, Theda C, Thio M. Accuracy of five formulae to determine the insertion length of umbilical venous catheters. *Arch Dis Child Fetal Neonatal Ed*. 2019;104(2):F165-F169. doi:10.1136/archdischild-2017-314280
15. Lean WL, Dawson JA, Davis PG, Theda C, Thio M. Accuracy of 11 formulae to guide umbilical arterial catheter tip placement in newborn infants. *Arch Dis Child Fetal Neonatal Ed*. 2018;103(4):F364-F369. doi:10.1136/archdischild-2017-313039
16. Sheta A, Kamaluddeen M, Soraisham AS. Umbilical venous catheter insertion depth estimation using birth weight versus surface measurement formula: a randomized controlled trial. *J Perinatol.* 2020;40(4):567-572. doi:10.1038/s41372-019-0456-0
17. Barrington KJ. Umbilical artery catheters in the newborn: effects of position of the catheter tip. *Cochrane Database Syst Rev.* 2000;1999(2):CD000505. doi:10.1002/14651858.CD000505
18. Levit OL, Shabanova V, Bizzarro MJ. Umbilical catheter-associated complications in a level IV neonatal intensive care unit. *J Perinatol*. 2020;40(4):573-580. doi:10.1038/s41372-019-0579-3
19. Hoellering AB, Koorts PJ, Cartwright DW, Davies MW. Determination of umbilical venous catheter tip position with radiograph. *Pediatr Crit Care Med.* 2014;15(1):56-61. doi:10.1097/PCC.0b013e31829f5efa
20. Karber BC, Nielsen JC, Balsam D, Messina C, Davidson D. Optimal radiologic position of an umbilical venous catheter tip as determined by echocardiography in very low birth weight newborns. *J Neonatal Perinatal Med*. 2017;10(1):55-61. doi:10.3233/NPM-1642
21. El Ters N, Claassen C, Lancaster T, et al. Central versus low-lying umbilical venous catheters: a multicenter study of practices and complications. *Am J Perinatol.* 2019;36(11):1198-1204. doi:10.1055/s-0038-1676482
22. Grizelj R, Vukovic J, Bojanic K, et al. Severe liver injury while using umbilical venous catheter: case series and literature review. *Am J Perinatol.* 2014;31(11):965-974. doi:10.1055/s-0034-1370346
23. Shahroor M, Maarouf AM, Yang J, Yankanah R, Shah PS, Mohamed A. Complications associated with low position versus good position umbilical venous catheters in neonates of ≤32 weeks' gestation [published online ahead of print 2020 Aug 9, 2020]. *Am J Perinatol.* 2020;10.1055/s-0040-1715117. doi:10.1055/s-0040-1715117
24. Sharma D, Farahbakhsh N, Tabatabaii SA. Role of ultrasound for central catheter tip localization in neonates: a review of the current evidence. *J Matern Fetal Neonatal Med*. 2019;32(14):2429-2437. doi:10.1080/14767058.2018.1437135
25. Franta J, Harabor A, Soraisham AS. Ultrasound assessment of umbilical venous catheter migration in preterm infants: a prospective study. *Arch Dis Child Fetal Neonatal Ed*. 2017;102(3):F251-F255. doi:10.1136/archdischild-2016-311202
26. Hoellering A, Tshamala D, Davies MW. Study of movement of umbilical venous catheters over time. *J Paediatr Child Health*. 2018;54(12):1329-1335. doi:10.1111/jpc.14073
27. Plooij-Lusthusz AM, van Vreeswijk N, van Stuijvenberg M, Bos AF, Kooi EMW. Migration of umbilical venous catheters. *Am J Perinatol*. 2019;36(13):1377-1381. doi:10.1055/s-0038-1677016
28. Doreswamy SM, Thomas S, Dutta S. Intra- and inter-rater agreement between x-ray views for umbilical catheter position [published online ahead of print, Nov 18, 2019]. *Am J Perinatol*. 2019;10.1055/s-0039-1700863. doi:10.1055/s-0039-1700863
29. Butler GC, Al-Assaf N, Tarrant A, Ryan S, El-Khuffash A. Using lateral radiographs to determine umbilical venous catheter tip position in neonates. *Ir Med J*. 2014;107(8):256-258.
30. DeWitt AG, Zampi JD, Donohue JE, Yu S, Lloyd TR. Fluoroscopy-guided umbilical venous catheter placement in infants with congenital heart disease. *Congenit Heart Dis*. 2015;10(4):317-325. doi:10.1111/chd.12233
31. Upadhyay J, Basu S, Srivastava Y, et al. Agitated saline contrast to delineate central venous catheter position in neonates [published online ahead of print Jul 29, 2020]. *J Perinatol.* 2020;10.1038/s41372-020-0761-7. doi:10.1038/s41372-020-0761-7
32. Simanovsky N, Ofek-Shlomai N, Rozovsky K, Ergaz-Shaltiel Z, Hiller N, Bar-Oz B. Umbilical venous catheter position: evaluation by ultrasound. *Eur Radiol*. 2011;21(9):1882-1886. doi:10.1007/s00330-011-2129-z
33. Dubbink-Verheij GH, Visser R, Tan RNGB, Roest AAW, Lopriore E, Te Pas AB. Inadvertent migration of umbilical venous catheters often leads to malposition. *Neonatology.* 2019;115(3):205-210. doi:10.1159/000494369
34. Sulemanji M, Vakili K, Zurakowski D, Tworetzky W, Fishman SJ, Kim HB. Umbilical venous catheter malposition is associated with necrotizing enterocolitis in premature infants. *Neonatology*. 2017;111(4):337-343. doi:10.1159/000451022
35. Derinkuyu BE, Boyunaga OL, Damar C, et al. Hepatic Complications of umbilical venous catheters in the neonatal period: the ultrasound spectrum. *J Ultrasound Med.* 2018;37(6):1335-1344. doi:10.1002/jum.14443
36. Sobczak A, Klepacka J, Amrom D, Zak I, Kruczek P, Kwinta P. Umbilical catheters as vectors for generalized bacterial infection in premature infants regardless of antibiotic use. *J Med Microbiol.* 2019;68(9):1306-1313. doi:10.1099/jmm.0.001034

37. Dubbink-Verheij GH, Bekker V, Pelsma ICM, et al. Bloodstream infection incidence of different central venous catheters in neonates: a descriptive cohort study. *Front Pediatr.* 2017;5:142. doi:10.3389/fped.2017.00142
38. Yumani DF, van den Dungen FA, van Weissenbruch MM. Incidence and risk factors for catheter-associated bloodstream infections in neonatal intensive care. *Acta Paediatr.* 2013;102(7):e293-e298. doi:10.1111/apa.12256
39. Dubbink-Verheij GH, Visser R, Roest AA, van Ommen CH, Te Pas AB, Lopriore E. Thrombosis after umbilical venous catheterisation: prospective study with serial ultrasound. *Arch Dis Child Fetal Neonatal Ed*. 2020;105(3):299-303. doi:10.1136/archdischild-2018-316762
40. Shalabi M, Adel M, Yoon E, et al. Risk of infection using peripherally inserted central and umbilical catheters in preterm neonates. *Pediatrics*. 2015;136(6):1073-1079. doi:10.1542/peds.2015-2710
41. Vachharajani AJ, Vachharajani NA, Morris H, et al. Reducing peripherally inserted central catheters in the neonatal intensive care unit. *J Perinatol.* 2017;37(4):409-413. doi:10.1038/jp.2016.243
42. Sanderson E, Yeo KT, Wang AY, et al. Dwell time and risk of central-line-associated bloodstream infection in neonates. *J Hosp Infect*. 2017;97(3):267-274. doi:10.1016/j.jhin.2017.06.023
43. Ergaz Z, Simanovsky N, Rozovsky K, et al. Clinical outcome of umbilical artery catheter-related thrombosis - a cohort study. *J Perinatol*. 2012;32(12):933-940. doi:10.1038/jp.2012.4

31. VASCULAR ACCESS AND THERAPEUTIC APHERESIS

Standard

31.1 The most appropriate VAD for therapeutic apheresis is selected in collaboration with the patient/caregiver and the health care team based on the projected treatment plan.

Practice Recommendations

A. Consider the following when choosing the most appropriate VAD for therapeutic apheresis: the type of apheresis procedure (centrifugation-based or filter-based systems); adequacy of superficial and deep peripheral veins; acuity; duration and frequency; inpatient vs outpatient, or critically ill; patient preference; underlying disease state; and availability of staff and resources to obtain vascular access.[1,2] (V)
B. Consider either peripheral or central VADs for therapeutic apheresis; peripheral venous access is the primary access method in European countries, while CVADs are used primarily in North America, South America, Central America, and increasingly in Asia.[1,3-5] (V)
    1. Insert 2 PIVCs for the apheresis procedure, 1 for access or withdrawal of blood for apheresis and 1 for return of the patient's cells and replacement fluid.
        a. Use a large-gauge PIVC (eg, 16- to 18-gauge) in the antecubital vein or other large veins, such as the basilic or cephalic veins, in the forearm for access, and in smaller veins for the return.[1,5] (IV)
        b. Peripheral vein access is not recommended in young children due to small veins but may be possible with older children and adolescents.[1] (IV)
    2. Consider the benefits of dialysis-capable CVADs that include reliable blood flow and reduced resistance to withstand high negative pressures required to draw blood into the apheresis device; use a CVAD with a catheter size of at least 11.5 French (Fr) for adults.[1,2] (IV)
        a. Appropriate catheter sizes for use of a nontunneled or tunneled, cuffed CVAD in pediatric patients range from 6.0 to 7.0 Fr for patients weighing less than 10 kg, 6.0 to 8.0 Fr for patients weighing between 10 and 30 kg, 8.0 to 10.0 Fr for patients weighing between 30 and 50 kg, and 11.5 Fr or larger for children weighing more than 50 kg.[2] (IV)
        b. PICCs are not appropriate for apheresis procedures due to small catheter gauge and higher failure rates.[1] (IV)
        c. General recommendations for locking CVADs used for apheresis include high-concentration heparin and sodium citrate (see Standard 41, *Flushing and Locking*).[1,6,7] (IV)
            i. Heparin-induced thrombocytopenia (HIT) was identified as a risk in patients with multiple myeloma who required stem cell harvesting for autologous hematopoietic stem cell transplantation. An unusually high frequency of HIT was identified (4%).[8] (V)
    3. Consider an implanted vascular access port for patients requiring long-term treatment; improvement in port design allowing for high flow rates has led to increasing port use in both adults and children.[1,2,9] (V)
    4. Avoid AVFs and AVGs for long-term apheresis; the failure rate associated with AVFs is high.[1,10] (V)

REFERENCES

1. Ipe TS, Marques MB. Vascular access for therapeutic plasma exchange. *Transfusion.* 2018;58 (Suppl 1):580-589. doi:10.1111/trf.14479
2. Lin DM, Wu Y. Implantable vascular access devices - past, present, and future. *Transfusion.* 2018;58 (Suppl 1):545-548. doi:10.1111/trf.14485
3. Putensen D, Leverett D, Patel B, Rivera J. Is peripheral access for apheresis procedures underutilized in clinical practice? A single centre experience. *J Clin Apher.* 2017;32(6):553-559. doi:10.1002/jca.21508
4. Doherty DJ, Pottle A, Malietzis G, Hakim N, Barbir M, Crane JS. Vascular access in lipoprotein apheresis: a retrospective analysis from the UK's largest lipoprotein apheresis centre. *J Vasc Access.* 2018;19(1):52-57. doi:10.5301/jva.5000755
5. Ritzenthaler T, Beraud M, Gobert F, Dailler F. Influence of vascular access devices upon efficiency of therapeutic plasma exchange. *J Clin Apher.* 2019;34(1):33-38. doi:10.1002/jca.21669
6. Passero BA, Zappone P, Lee HE, Novak C, Maceira EL, Naber M. Citrate versus heparin for apheresis catheter locks: an efficacy analysis. *J Clin Apher.* 2015;30(1):22-27. doi:10.1002/jca.21346
7. Osby M, Barton P, Lam CN, Tran MH. Acid-citrate-dextrose formula A versus heparin as primary catheter lock solutions for therapeutic apheresis. *Transfusion.* 2014;54(3):735-743. doi:10.1111/trf.12310
8. Mian H, Warkentin TE, Sheppard JI, et al. Autoimmune HIT due to apheresis catheter heparin flushes for stem cell harvesting before

autotransplantation for myeloma. *Blood*. 2017;130(14):1679-1682. doi:10.1182/blood-2017-06-788679

9. Gray KL, Steidley IG, Benson HL, Pearce CL, Bachman AM, Adamski J. Implementation and 2-year outcomes of the first FDA-approved implantable apheresis vascular access device. *Transfusion.* 2019;59(11):3461-3467. doi:10.1111/trf.15512
10. Wooster M, Wilson R, Shames M, Moudgill N. Arteriovenous access does not perform as well for plasmapheresis. *J Vasc Access.* 2017;18(2):144-147. doi:10.5301/jva.500064432.

32. PAIN MANAGEMENT FOR VENIPUNCTURE AND VASCULAR ACCESS PROCEDURES

Standard

32.1 Appropriate strategies are implemented to reduce pain associated with phlebotomy and VAD-related procedures (eg, insertion, implanted vascular access port access) based upon assessment of patient's condition, developmental level, and engagement of patients and families to determine preferences.

Practice Recommendations

A. Recognize factors influencing clinicians to underuse pain management strategies with VAD-related procedures such as underestimation of procedural pain, time, lack of orders, and cost.[1,2] (II)
B. Improve the patient experience of PIVC insertion.
   1. Incorporate pain management strategies as a standard practice.
   2. Engage patient (adults and children) in decision-making for vascular access.
   3. Employ interventions to increase first-time success (see Standard 22, *Vascular Visualization*; Standard 26, *Vascular Access Device Planning*; Standard 27, *Site Selection*; Standard 34, *Vascular Access Device Placement*).[1-7] (IV)
C. Use local anesthetic agents to reduce pain in all adult and pediatric populations.
   1. Vapocoolant spray used prior to skin antisepsis and before IV cannulation is associated with decreased pain during the procedure; some studies are inconsistent in clinical findings.[8-14] (I)
   2. Topical transdermal agents.[1,4,5,7,12,15] (II)
   3. Jet injection of pressure-accelerated lidocaine (needle-free method) is found to be effective.[16-19] (I)
   4. Intradermal lidocaine (to be avoided in pregnancy) or bacteriostatic 0.9% sodium chloride.[1,4,6,20] (II)
      a. Rare allergic reactions can occur with lidocaine and bacteriostatic saline (benzyl alcohol); assess for past use/reactions and monitor for an allergic response.[6] (V)
D. Use behavioral interventions such as distraction, relaxation, breathing exercises.[1,6,7] (V)
E. Assess and identify pain with consideration to development level in children.
   1. Infancy: crying, facial expression, and body posture are indicative of pain.
   2. Toddlers: behaviors such as facial expression, bodily movement, and crying may be indicative of pain.
   3. Preschoolers and school-aged children are able to self-report pain.[7,20] (II)
F. Provide nonanalgesic pain management strategies to children with attention to growth and development level (see Standard 2, *Special Patient Populations: Neonatal, Pediatric, Pregnant, and Older Adults*).[7,21-22] (II)
   1. Use pain management strategies for infants that include a combination of techniques, including swaddling, breastfeeding, pacifiers, and rocking; 1 to 2 mL of 24% sucrose (eg, provided on a pacifier) provided before venipuncture has been shown to be beneficial in reducing pain without serious side effects or harm.[21,23,24] (I)
   2. Use distraction techniques.
      a. Distraction is effective with toddlers (eg, "peek-a-boo," blowing bubbles, books).[21] (II)
      b. The use of "virtual reality" by use of a computer-simulated environment accessed through a head-mounted device was found to be effective in children in decreasing pain associated with venipuncture.[25-27] (II)
      c. The use of any type of distraction technique is associated with reduced anxiety and perception of pain in school-aged children.[7,25-32] (I)
      d. Use of a vibrating cold device can provide distraction and potential blocking of pain impulses consistent with gate control theory of pain management.[32-35] (II)
         i. Recognize that cold and vibration at the venipuncture site may impact accuracy of laboratory results (refer to Standard 44, *Blood Sampling*).
G. Recognize that some patients may have a significant fear of needles and that pain management strategies may reduce fear.
   1. Employ techniques that reduce fear whenever possible, which may include distraction (eg, watching television, conversation during procedure), keeping the needle/catheter out of site, and use of analgesic/anesthetic agents.[6] (V)
H. Educate clinicians about pain management strategies that are underused due to lack of knowledge, clinician underestimation of pain related to vascular access, time, and cost restraints.[1,2,5,7,15,22] (V)

REFERENCES

1. Alobayli FY. Factors influencing nurses' use of local anesthetics for venous and arterial access. *J Infus Nurs*. 2019;42(2):91-107. doi:10.1097/NAN.0000000000000316
2. Katende G, Mugabi B. Comforting strategies and perceived barriers to pediatric pain management during IV line insertion procedure in Uganda's national referral hospital: a descriptive study. *BMC Pediatr*. 2015;15:122. doi:10.1186/s12887-015-0438-0

3. Robinson-Reilly M, Paliadelis P, Cruickshank M. Venous access: the patient experience. *Support Care Cancer*. 2016;24(3):1181-1187. doi:10.1007/s00520-015-2900-9
4. Bond M, Crathorne L, Peters J, et al. First do no harm: pain relief for the peripheral venous cannulation of adults, a systematic review and network meta-analysis. *BMC Anesthesiol*. 2016;16(1):81. doi:10.1186/s12871-016-0252-8
5. Cooke M, Ullman AJ, Ray-Barruel G, Wallis M, Corley A, Rickard CM. Not "just" an intravenous line: consumer perspectives on peripheral intravenous cannulation (PIVC). an international cross-sectional survey of 25 countries. *PLoS One*. 2018;13(2):e0193436. doi:10.1371/journal.pone.0193436
6. Cook LS. Needle phobia. *J Infus Nurs*. 2016;39(5):273-279. doi:10.1097/NAN.0000000000000184
7. Kleye I, Hedén L, Karlsson K, Sundler AJ, Darcy L. Children's individual voices are required for adequate management of fear and pain during hospital care and treatment [published online ahead of print May 4, 2020]. *Scand J Caring Sci*. 2020;10.1111/scs.12865. doi:10.1111/scs.12865
8. Mace SE. Prospective, double blind, randomized, controlled trial comparing vapocoolant spray versus placebo spray in adults undergoing intravenous cannulation. *Scand J Pain*. 2017;17:8-15. doi:10.1016/j.sjpain.2017.06.002
9. Griffith RJ, Jordan V, Herd D, Reed PW, Dalziel SR. Vapocoolants (cold spray) for pain treatment during intravenous cannulation. *Cochrane Database Syst Rev*. 2016;4:CD009484. doi:10.1002/14651858.CD009484.pub2
10. Zhu Y, Peng X, Wang S, et al. Vapocoolant spray versus placebo spray/no treatment for reducing pain from intravenous cannulation: a meta-analysis of randomized controlled trials. *Am J Emerg Med*. 2018;36(11):2085-2092. doi:10.1016/j.ajem.2018.03.068
11. Barbour T, O'Keefe S, Mace SE. Patient and healthcare provider responses from a prospective double-blind, randomized controlled trial comparing vapocoolant spray versus placebo spray in adults undergoing venipuncture in the emergency department. *Pain Manag Nurs.* 2017;19(4):391-399. doi:10.1016/j.pmn.2017.09.006
12. Dalvandi A, Ranjbar H, Hatamizadeh M, Rahgoi A, Bernstein C. Comparing the effectiveness of vapocoolant spray and lidocaine/procaine cream in reducing pain of intravenous cannulation: a randomized clinical trial. *Am J Emerg Med.* 2017;35(8):1064-1068.
13. Falotico PG, Linda Ryan L. Will patients perceive a numbing spray to be an effective method of anesthetizing an intravenous site? *J Perianesth Nurs.* 2017;32(1):22-27. doi:10.1016/j.jopan.2015.02.004
14. Edwards C, Noah C. A randomized, double-blind trial to determine if vapocoolant in the adult population improves patient perception of pain with peripheral intravascular access. *Adv Emerg Nurs J*. 2017;39(4):288-294. doi:10.1097/TME.0000000000000165
15. Martin HA. The power of topical anesthetics and distraction for peripheral intravenous catheter placement in the pediatric perianesthesia area. *J Perianesth Nurs.* 2018;33(6):880-886. doi:10.1016/j.jopan.2017.08.005
16. Lunoe MM, Drendel AL, Levas MN, et al. A randomized clinical trial of jet-injected lidocaine to reduce venipuncture pain for young children. *Ann Emerg Med*. 2015;66(5):466-474. doi:10.1016/j.annemergmed.2015.04.003
17. Jain S, Hegenbarth MA, Humiston SG, Gunter E, Anson L, Giovanni JE. Increasing ED use of jet lidocaine for IV-related pain management. *Pediatrics.* 2017;139(4):e20161697. doi:10.1542/peds.2016-1697
18. Stoltz P, Manworren RCB. Comparison of children's venipuncture fear and pain: randomized controlled trial of EMLA® and J-Tip Needleless Injection System.® *J Pediatr Nurs.* 2017;37:91-96. doi:10.1016/j.pedn.2017.08.025
19. Kelly S, Russell J, Devgon P, Rosen P. Transformation of the peripheral intravenous catheter placement experience in pediatrics. *J Vasc Access*. 2017;18(3):259-263. doi:10.5301/jva.5000652
20. Oman KS, Fink R, Kleiner C, et al. Intradermal lidocaine or bacteriostatic normal saline to decrease pain before intravenous catheter insertion: a meta-analysis. *J Perianesth Nurs*. 2014;29(5):367-376. doi:10.1016/j.jopan.2013.12.008
21. Thrane SE, Wanless S, Cohen SM, Danford CA. The assessment and non-pharmacologic treatment of procedural pain from infancy to school age through a developmental lens: a synthesis of evidence with recommendations. *J Pediatr Nurs*. 2016;31(1):e23-e32. doi:10.1016/j.pedn.2015.09.002
22. Ali S, McGrath T, Drendel AL. An evidence-based approach to minimizing acute procedural pain in the emergency department and beyond. *Pediatr Emerg Care.* 2016;32(1):36-42. doi:10.1097/PEC.0000000000000669
23. Stevens B, Yamada J, Ohlsson A, Haliburton S, Shorkey A. Sucrose for analgesia in newborn infants undergoing painful procedures. *Cochrane Database Syst Rev*. 2016;7(7):CD001069. doi:10.1002/14651858.CD001069.pub5
24. De Bernardo G, Riccitelli M, Sordino D, et al. Oral 24% sucrose associated with nonnutritive sucking for pain control in healthy term newborns receiving venipuncture beyond the first week of life. *J Pain Res*. 2019;12:299-305. doi:10.2147/JPR.S184504
25. Chan E, Hovenden M, Ramage E, et al. Virtual reality for pediatric needle procedural pain: two randomized clinical trials. *J Pediatr*. 2019;209:160-167.e4. doi:10.1016/j.jpeds.2019.02.034
26. Chan E, Foster S, Sambell R, Leong P. Clinical efficacy of virtual reality for acute procedural pain management: a systematic review and meta-analysis. *PLoS One*. 2018;13(7):e0200987. doi:10.1371/journal.pone.0200987
27. Dunn A, Patterson J, Biega CF, et al. A novel clinician-orchestrated virtual reality platform for distraction during pediatric intravenous procedures in children with hemophilia: randomized controlled trial. *JMIR Serious Games*. 2019;7(1):e10902. doi:10.2196/10902
28. Olsen K, Weinberg E. Pain-less practices: techniques to reduce procedural pain and anxiety in pediatric acute care. *Clin Pediatr Emerg Med.* 2017;18(1):32-41. https://doi.org/10.1016/j.cpem.2017.01.007
29. Aydin D, Sahiner NC. Effects of music therapy and distraction cards on pain relief during phlebotomy in children. *Appl Nurs Res*. 2017;33:164-168. doi:10.1016/j.apnr.2016.11.011
30. Sahiner NC, Bal MD. The effects of three different distraction methods on pain and anxiety in children. *J Child Health Care*. 2016;20(3):277-285. doi:10.1177/1367493515587062
31. Birnie KA, Noel M, Chambers CT, Uman LS, Parker JA. Psychological interventions for needle-related procedural pain and distress in children and adolescents. *Cochrane Database Syst Rev*. 2018;10(10):CD005179. doi:10.1002/14651858.CD005179.pub4
32. Bergomi P, Scudeller L, Pintaldi S, Dal Molin A. Efficacy of non-pharmacological methods of pain management in children undergoing venipuncture in a pediatric outpatient clinic: a randomized controlled trial of audiovisual distraction and external cold and vibration. *J Pediatr Nurs*. 2018;42:e66-e72. doi:10.1016/j.pedn.2018.04.011
33. Moadad N, Kozman K, Shahine R, Ohanian S, Kurdahi Badr L. Distraction using the BUZZY for children during an IV insertion. *J Pediatr Nurs.* 2016;31(1):64-72. doi:10.1016/j.pedn.2015.07.010
34. Potts DA, Davis KF, Elci OU, Fein JA. A vibrating cold device to reduce pain in the pediatric emergency department: a randomized clinical trial. *Pediatr Emerg Care*. 2019;35(6):419-425. doi:10.1097/PEC.0000000000001041
35. Ballard A, Khadra C, Adler S, Trottier ED, Le May S. Efficacy of the Buzzy device for pain management during needle-related procedures: a systematic review and meta-analysis. *Clin J Pain*. 2019;35(6):532-543. doi:10.1097/AJP.0000000000000069033.

33. VASCULAR ACCESS SITE PREPARATION AND SKIN ANTISEPSIS

Standard

33.1 Skin antisepsis is performed prior to VAD placement.
33.2 The intended VAD insertion site is visibly clean prior to application of an antiseptic solution; if visibly soiled, cleanse the intended site with soap and water prior to application of antiseptic solution(s).

Practice Recommendations

A. Remove excess hair at the insertion site if needed to facilitate application of VAD dressings; use single-patient-use scissors or disposable-head surgical clippers; do not shave as this may increase the risk for infection.[1,2] (I)
B. Evaluate patient history of any allergy or sensitivity to skin antiseptics (see Standard 55, *Catheter-Associated Skin Injury*).[3,4] (V)
C. Perform skin antisepsis using the preferred skin antiseptic agent of alcohol-based chlorhexidine solution.[5-10] (I)
    1. If there is a contraindication to chlorhexidine solution, an iodophor (eg, povidone-iodine) or 70% alcohol may also be used.[5,6,10] (IV)
    2. Aqueous chlorhexidine may be considered if there is a contraindication to alcohol-based chlorhexidine.[3] (IV)
    3. For preterm neonates, low-birth-weight infants, and within the first 14 days of life:
        a. Use povidone-iodine, alcohol-based or aqueous chlorhexidine solution.[4,11-17] (I)
        b. Use both aqueous and alcohol-based chlorhexidine with caution due to risks of chemical burns to the skin. Systemic absorption has been reported due to skin immaturity; however, systemic effects are not documented. Studies have not established one antiseptic solution as superior for safety or efficacy in neonates.[11-17] (IV)
        c. Avoid the use of tincture of iodine due to the potential deleterious effect on the neonatal thyroid gland.[18-20] (II)
        d. Remove antiseptics after the procedure is complete using sterile water or saline.[11,16] (IV)
D. Use a single-use sterile applicator containing sterile solution, not a multiple use product (eg, bottle of antiseptic solution).[3,5] (IV)
    1. Follow manufacturers' directions for use to determine appropriate product application and dry times; always allow product to naturally dry without wiping, fanning, or blowing on skin.[3] (V)

REFERENCES

1. Shi D, Yao Y, Yu W. Comparison of preoperative hair removal methods for the reduction of surgical site infections: a meta-analysis. *J Clin Nurs*. 2017;26(19-20):2907-2914. doi:10.1111/jocn.13661
2. Lefebvre A, Saliou P, Lucet JC, et al. Preoperative hair removal and surgical site infections: network meta-analysis of randomized controlled trials. *J Hosp Infect*. 2015;91(2):100-108. doi:10.1016/j.jhin.2015.06.020
3. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines*. Pappin Communications; 2019.
4. Doellman D, Buckner J, Garrett JH Jr. *Best Practice Guidelines in the Care and Maintenance of Pediatric Central Venous Catheters*. 2nd ed. Association for Vascular Access; 2015.
5. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect*. 2014;86(suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2
6. Marschall J, Mermel LA, Fakih M, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(7):753-771. doi:10.1086/676533
7. Mimoz O, Lucet JC, Kerforne T, et al. Skin antisepsis with chlorhexidine-alcohol versus povidone iodine-alcohol, with and without skin scrubbing, for prevention of intravascular-catheter-related infection (CLEAN): an open-label, multicentre, randomised, controlled, two-by-two factorial trial. *Lancet*. 2015;386(10008):2069-2077. doi:10.1016/S0140-6736(15)00244-5
8. Lai NM, Lai NA, O'Riordan E, Chaiyakunapruk N, Taylor JE, Tan K. Skin antisepsis for reducing central venous catheter-related infections. *Cochrane Database Syst Rev*. 2016;7(7):CD010140. doi:10.1002/14651858.CD010140.pub2
9. Maiwald M, Chan ES. The forgotten role of alcohol: a systematic review and meta-analysis of the clinical efficacy and perceived role of chlorhexidine in skin antisepsis. *PLoS One*. 2012;7(9):e44277. doi:10.1371/journal.pone.0044277
10. Boyce JM. Best products for skin antisepsis. *Am J Infect Control*. 2019;47S:A17-A22. doi:10.1016/j.ajic.2019.03.012
11. Wyckoff MM, Sharpe E. *Peripherally Inserted Central Catheters: Guidelines for Practice.* 3rd ed. National Association of Neonatal Nurses; 2015.
12. Johnson J, Bracken R, Tamma PD, Aucott SW, Bearer C, Milstone AM. Trends in chlorhexidine use in US neonatal intensive care units: results from a follow-up national survey. *Infect Control Hosp Epidemiol*. 2016;37(9):1116-1118. doi:10.1017/ice.2016.125
13. Sathiyamurthy S, Banerjee J, Godambe SV. Antiseptic use in the neonatal intensive care unit - a dilemma in clinical practice: an evidence based review. *World J Clin Pediatr*. 2016;5(2):159-171. doi:10.5409/wjcp.v5.i2.159
14. Brandon D, Hill C, Heimall L, et al. *Neonatal Skin-Care Evidence-Based Clinical Practice Guidelines.* 4th ed. Association of Women's Health, Obstetric and Neonatal Nurses; 2018.
15. Professional Disposables International. Chlorascrub supplement approval letter. US Food and Drug Administration; May 17, 2012. Accessed August 29, 2020. https://www.accessdata.fda.gov/drugsatfda_docs/appletter/2012/021524Orig1s011ltr.pdf
16. Vanzi V, Pitaro R. Skin injuries and chlorhexidine gluconate-based antisepsis in early premature infants: a case report and review of the literature. *J Perinat Neonat Nurs*. 2018;32(4):341-350. doi:10.1097/JPN.0000000000000334
17. Kieran EA, O'Sullivan A, Miletin J, Twomey AR, Knowles SJ, O'Donnell CPF. 2% Chlorhexidine-70% isopropyl alcohol versus 10% povidone-iodine for insertion site cleaning before central line insertion in preterm infants: a randomised trial. *Arch Dis Child Fetal Neonatal Ed.* 2018;103(2):F101-F106. doi:10.1136/archdischild-2016-312193
18. Aitken J, Williams FL. A systematic review of thyroid dysfunction in preterm neonates exposed to topical iodine. *Arch Dis Child Fetal Neonatal Ed*. 2014;99(1):F21-F28. doi:10.1136/archdischild-2013-303799
19. Pinsker JE, McBayne K, Edwards M, Jensen K, Crudo DF, Bauer AJ. Transient hypothyroidism in premature infants after short-term topical iodine exposure: an avoidable risk? *Pediatr Neonatol.* 2013;54(2):128-131. doi:10.1016/j.pedneo.2012.10.005
20. Williams FL, Watson J, Day C, et al. Thyroid dysfunction in preterm neonates exposed to iodine. *J Perinat Med.* 2017;45(1):135-143. doi:10.1515/jpm-2016-014134.

34. VASCULAR ACCESS DEVICE PLACEMENT

Standard

34.1 A new, sterile VAD is used for each catheterization attempt, including use of introducers.

34.2 The VAD is not altered outside the manufacturers' directions for use.

34.3 Proper tip location for CVADs is verified prior to use.

34.4 The patient and caregiver are educated about the rationale for VAD insertion and expectations during the procedure.

Practice Recommendations

I. PIVCs: Short PIVCs, Long PIVCs, and Midline Catheters

A. Consider implementation of a PIVC insertion bundle to improve insertion success or reduce complications. High-level synthesis studies investigated bundled PIVC insertion and management interventions; no clear evidence emerged to support a specific intervention bundle.[1-5] (I)

B. Consider early referral to an infusion/vascular access specialist if patient assessment yields no visible or palpable veins.[6-11] (IV)
   1. Consider use of a population-specific DIVA assessment tool to guide early referral to an infusion/vascular access specialist if indicated. In several published reviews, some tools are better at identifying children and adults with DIVA; each tool has limitations, and further study is needed.[4,5,12-19] (I)

C. Assess the need for measures to reduce pain of insertion (refer to Standard 32, *Pain Management for Venipuncture and Vascular Access Procedures*).

D. Use visualization technology to aid in peripheral vein identification and selection for patients with DIVA (refer to Standard 22, *Vascular Visualization*).
   1. Choose a long PIVC as follows:
      a. When all aspects of a short PIVC are met, but the vessel is difficult to palpate or visualize with the naked eye; ultrasound guidance/near infrared technology is recommended.
      b. Evaluate depth of vessel when choosing a long PIVC to ensure two-thirds of catheter lies within vein.[20-24] (III)

E. Use an appropriate method to promote vascular distention when inserting a short PIVC, including:
   1. Use of gravity or impeding venous flow with the use of a blood pressure cuff or tourniquet (while maintaining arterial circulation).
   2. Use of controlled warming.[25] (V)

F. Adhere to principles of Standard-ANTT or Surgical-ANTT with PIVC insertion based upon the assessment of the complexity of insertion.
   1. Use Standard-ANTT for simple PIVC insertion.
      a. Don a new pair of disposable, nonsterile gloves in preparation for PIVC insertion; do not touch/palpate the insertion site after skin antisepsis.[26-31] (IV)
      b. If repalpation of the vein is required after skin antisepsis, use sterile gloves for palpation and insertion and adhere to the principles of Surgical-ANTT to prevent recontamination of the insertion site. Contamination of nonsterile gloves is well documented.[3,32-35] (I)
   2. Use Surgical-ANTT for more complex insertion techniques (eg, accelerated/Seldinger) and/or need to touch Key-Sites and/or Key-Parts directly (refer to Standard 18*, Aseptic Non Touch Technique*).

G. Restrict PIVC insertion attempts to no more than 2 attempts per clinician at PIVC insertion. Multiple unsuccessful attempts cause pain to the patient, delay treatment, limit future vascular access, increase cost, and increase the risk for complications.[2,5,11,18,36-38] (IV)
   1. After 2 unsuccessful attempts, escalate to a clinician with a higher skill level and/or consider alternative routes of medication administration. (Committee Consensus)

H. Use single-patient-use tourniquets.[39-41] (I)

I. Long PIVCs and midline catheters: use the safest available insertion technique, including the Seldinger, modified Seldinger technique (MST), or accelerated Seldinger technique (AST), to reduce the risk for insertion-related complications such as air embolism, guidewire loss, embolism, inadvertent arterial cannulation, and bleeding.[42-48] (IV)
   1. Use a maximal sterile barrier with VAD insertion using MST.[43,44,48] (V)
   2. Consider a partial barrier with VAD insertion using AST.[49] (IV)

J. Ensure appropriate midline catheter length for selected vessel and for proper tip location.
   1. Adult: tip location should be at level of axilla.[44,46,50-52] (IV)
   2. Neonates and pediatric patients: select an upper arm site using the basilic, cephalic, and brachial veins. Additional site selections include veins in the leg (eg, saphenous, popliteal, femoral) with the tip below the inguinal crease and in the scalp with the tip in the neck above the thorax (refer to Standard 27*, Site Selection*).

K. Immediately remove the PIVC in the following situations:
   1. If nerve damage is suspected, such as when the patient reports severe pain on insertion (ie, electrical shock-like pain) or paresthesias (eg, numbness or tingling) related to the insertion; promptly notify the provider (refer to Standard 48, *Nerve Injury*).
   2. If an artery is inadvertently accessed, remove the catheter and apply pressure to the peripheral site until hemostasis is achieved. Assess circulatory status and, if impaired, notify the provider promptly.[16] (V)

L. Midline catheters: consider measuring arm circumference at insertion to establish a baseline and monitor arm circumference on a regular basis due to risk of CA-DVT (see Standard 53, *Catheter-Associated Deep Vein Thrombosis*).[53,54] (IV).

II. CVADs

A. Implement the central line bundle when placing CVADs, which includes the following interventions: hand hygiene, skin antisepsis using alcohol-based chlorhexidine, maximal sterile barrier precautions, preference for upper body insertion site to reduce risk of infection (see Standard 18, *Aseptic Non Touch Technique*; Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*).[27,36,55-62] (IV)

B. Use ultrasound when inserting CVADs to increase success rates and decrease insertion-related complications (refer to Standard 22, *Vascular Visualization*).
   1. For tunneled, cuffed CVADs and implanted vascular access port insertion: use an ultrasound-guided MST rather than venous cutdown or landmark percutaneous technique to improve insertion success and reduce postinsertion complication rates in both adult and pediatric patients.[63-65] (I)

C. Ensure adherence to proper technique through use of and completion of a standardized checklist performed by an educated health care clinician and empower the clinician to stop the procedure for any breaches in aseptic technique. Completion of a checklist should be done by someone other than the inserter of the CVAD.[58,61,66-71] (III)

D. Use a standardized supply cart or kit that contains all necessary components for the insertion of a CVAD.[61] (IV)

E. Measure midarm circumference between insertion site and axilla to obtain baseline measurement upon insertion of a PICC; the rationale for baseline measurement is for comparison in assessment for CA-DVT (see Standard 53, *Catheter-Associated Deep Vein Thrombosis*).[53] (IV)

F. Use the safest available insertion technique for neck and chest placement, including the Seldinger or MST and Trendelenburg position, to reduce the risk for insertion-related complications such as air embolism, guidewire loss, embolism, inadvertent arterial cannulation, and bleeding.[60,71-78] (IV)

G. Implement appropriate actions upon complications associated with CVAD insertion as follows:
   1. Inadvertent arterial puncture can typically be managed by catheter removal and digital pressure when promptly recognized.
      a. If location of the catheter is unclear, measuring intraluminal pressure with a transducer may indicate catheter position.
      b. Inadvertent arterial puncture during insertion of a large-bore CVAD or dilator may be a life-threatening complication with recommendations to leave the device in place and immediately consult with a surgeon or interventional radiologist. Treatment options include open operative approach and repair and, more commonly, endovascular management (see Standard 54, *Central Vascular Access Device Malposition*).[57,71,78-84] (V)
   2. Cardiac arrhythmias, often due to manipulation of the guidewire, typically resolve with reposition of guidewire or catheter. If arrhythmias persist, notify the provider.[57,79,82] (V)
   3. Medial subclavian insertion is associated with the highest risk of pneumothorax.
      a. The jugular site is preferred in the patient with pre-existing respiratory compromise.
      b. If significant unilateral lung disease is present, ipsilateral insertion is recommended for jugular or subclavian cannulation to prevent further respiratory compromise with pneumothorax in lungs without injury or disease.[59,78,79,85] (V)
   4. Potential related symptoms of nerve damage include diaphragmatic paralysis, hoarseness, impaired muscle strength, dysfunction of sympathetic nervous system (refer to Standard 48, *Nerve Injury*).
   5. Air embolism (refer to Standard 52, *Air Embolism*).
   6. Catheter malposition (refer to Standard 54, *Central Vascular Access Device Malposition*).

H. Ensure proper placement of the CVAD tip, within the lower one-third of the superior vena cava (SVC) or CAJ (refer to Standard 23, *Central Vascular Access Device Tip Location*).
   1. For lower body insertion sites, the CVAD tip should be positioned in the IVC above the level of the diaphragm.
   2. Before use of the CVAD for infusion, if required, the inserter should properly reposition the CVAD and obtain a confirmation of correct location (refer to Standard 23, *Central Vascular Access Device Tip Location*; Standard 54, *Central Vascular Access Device Malposition*).

I. Evaluate and assess patients who have a cardiovascular implantable electronic device (eg, subcutaneous implantable device, epicardial leads, or a leadless pacemaker) in place or planned insertion for the most appropriate catheter and insertion site.
   1. Consider the contralateral side as preferred for CVAD insertion, but if the ipsilateral side must be used (eg, the patient has bilateral implanted leads in place), a PICC may be the safest option.[59,86,87] (V)
   2. Consider options that preserve vessel health in the patient with CKD who requires insertion of a CVAD and a cardiovascular implantable electronic device. Nontunneled catheters should be avoided, with rapid progression to fistula/graft creation recommended.[59,86-92] (IV)
   3. Determine the integrity of a pre-existing pacemaker unit and leads before and after CVAD insertion. There are currently no practice guidelines developed related to pacemakers and CVADs.[90,91] (V)

III. Arterial Catheters

A. Use ultrasound to aid in artery identification and selection (refer to Standard 22, *Vascular Visualization*).
B. Wear a cap, mask, sterile gloves, and eyewear and use a small fenestrated sterile drape when placing a peripheral arterial catheter.[27,31,93-95] (III)
C. Employ maximal sterile barrier precautions when placing pulmonary artery and arterial catheters via the axillary or femoral artery.[31,94,95] (III)

REFERENCES

Note: All electronic references in this section were accessed between May 11, 2020, and August 30, 2020.

1. DeVries M, Strimbu K. Short peripheral catheter performance following adoption of clinical indication removal. *J Infus Nurs*. 2019;42(2):81-90. doi:10.1097/NAN.0000000000000318
2. Steere L, Ficara C, Davis M, Moureau N. Reaching one peripheral intravenous catheter (PIVC) per patient visit with lean multimodal strategy: the PIV5Rights™ Bundle. *J Assoc Vasc Access.* 2019;24(3):31-43. https://doi.org/10.2309/j.java.2019.003.004
3. Ray-Barruel G, Xu H, Marsh N, Cooke M, Rickard CM. Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: a systematic review. *Infect Dis Health*. 2019;24(3):152-168. doi:10.1016/j.idh.2019.03.001
4. Parker SI, Benzies KM, Hayden KA, Lang ES. Effectiveness of interventions for adult peripheral intravenous catheterization: a systematic review and meta-analysis of randomized controlled trials. *Int Emerg Nurs*. 2017;31:15-21. doi:10.1016/j.ienj.2016.05.004
5. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health*. 2019;55(10):1214-1223. doi:10.1111/jpc.14384
6. Carr PJ, Rippey JCR, Cooke ML, et al. Factors associated with peripheral intravenous cannulation first-time insertion success in the emergency department: a multicentre prospective cohort analysis of patient, clinician and product characteristics. *BMJ Open*. 2019;9(4):e022278. doi:10.1136/bmjopen-2018-022278
7. Armenteros-Yeguas V, Gárate-Echenique L, Tomás-López MA, et al. Prevalence of difficult venous access and associated risk factors in highly complex hospitalised patients. *J Clin Nurs*. 2017;26 (23-24):4267-4275. doi:10.1111/jocn.13750
8. McCarthy ML, Shokoohi H, Boniface KS, et al. Ultrasonography versus landmark for peripheral intravenous cannulation: a randomized controlled trial. *Ann Emerg Med*. 2016;68(1):10-18. doi:10.1016/j.annemergmed.2015.09.009
9. van Loon FH, Puijn LA, Houterman S, Bouwman AR. Development of the A-DIVA scale: a clinical predictive scale to identify difficult intravenous access in adult patients based on clinical observations. *Medicine (Baltimore)*. 2016;95(16):e3428. doi:10.1097/MD.0000000000003428
10. Sou V, McManus C, Mifflin N, Frost SA, Ale J, Alexandrou E. A clinical pathway for the management of difficult venous access. *BMC Nurs*. 2017;16:64. doi:10.1186/s12912-017-0261-z
11. Hallam C, Weston V, Denton A, et al. Development of the UK Vessel Health and Preservation (VHP) framework: a multi-organisational collaborative. *J Infect Prev*. 2016;17(2):65-72. doi:10.1177/1757177415624752
12. Whalen M, Maliszewski B, Baptiste DL. Establishing a dedicated difficult vascular access team in the emergency department: a needs assessment. *J Infus Nurs*. 2017;40(3):149-154. doi:10.1097/NAN.0000000000000218
13. Fiorini J, Venturini G, Conti F, et al. Vessel health and preservation: an integrative review. *J Clin Nurs*. 2019;28(7-8):1039-1049. doi:10.1111/jocn.14707
14. Rippey JC, Carr PJ, Cooke M, Higgins N, Rickard CM. Predicting and preventing peripheral intravenous cannula insertion failure in the emergency department: clinician 'gestalt' wins again. *Emerg Med Australas*. 2016;28(6):658-665. doi:10.1111/1742-6723.12695
15. Schults J, Rickard C, Kleidon T, Paterson R, Macfarlane F, Ullman A. Difficult peripheral venous access in children: an international survey and critical appraisal of assessment tools and escalation pathways. *J Nurs Scholarsh*. 2019;51(5):537-546. doi:10.1111/jnu.12505
16. Kaur P, Rickard C, Domer GS, Glover KR. Dangers of peripheral intravenous catheterization: the forgotten tourniquet and other patient safety considerations. In: Stawicki SP, Firstenberg MS, eds. *Vignettes in Patient Safety: Volume 4*. IntechOpen Limited; 2019. doi:10.5772/intechopen.83854
17. Carr PJ, Higgins NS, Cooke ML, Rippey J, Rickard CM. Tools, clinical prediction rules, and algorithms for the insertion of peripheral intravenous catheters in adult hospitalized patients: a systematic scoping review of literature. *J Hosp Med*. 2017;12(10):851-858. doi:10.12788/jhm.2836
18. Hartman JH, Baker J, Bena JF, Morrison SL, Albert NM. Pediatric vascular access peripheral iv algorithm success rate. *J Pediatr Nurs*. 2018;39:1-6. doi:10.1016/j.pedn.2017.12.002
19. Ehrhardt BS, Givens KEA, Lee RC. Making it stick: developing and testing the difficult intravenous access (DIVA) tool. *Am J Nurs*. 2018;118(7):56-62. doi:10.1097/01.NAJ.0000541440.91369.00
20. Scoppettuolo G, Pittiruti M, Pitoni S, et al. Ultrasound-guided "short" midline catheters for difficult venous access in the emergency department: a retrospective analysis. *Int J Emerg Med*. 2016;9(1):3. doi:10.1186/s12245-016-0100-0
21. Blanco P. Ultrasound-guided peripheral venous cannulation in critically ill patients: a practical guideline. *Ultrasound J*. 2019;11(1):27. doi:10.1186/s13089-019-0144-5
22. Paladini A, Chiaretti A, Sellasie KW, Pittiruti M, Vento G. Ultrasound-guided placement of long peripheral cannulas in children over the age of 10 years admitted to the emergency department: a pilot study. *BMJ Paediatr Open*. 2018;2(1):e000244. doi:10.1136/bmjpo-2017-000244
23. Badger J. Long peripheral catheters for deep arm vein venous access: a systematic review of complications. *Heart Lung*. 2019;48(3):222-225. doi:10.1016/j.hrtlng.2019.01.002
24. Bahl A, Hijazi M, Chen NW, Lachapelle-Clavette L, Price J. Ultralong versus standard long peripheral intravenous catheters: a randomized controlled trial of ultrasonographically guided catheter survival. *Ann Emerg Med*. 2020;S0196-0644(19)31383-6. doi:10.1016/j.annemergmed.2019.11.013
25. Horigan A, VanHoy M, Kaiser H, et al. *2018 ENA Clinical Practice Guideline: Difficult Venous Access* [position statement]. Emergency Nurses Association; 2018.
26. Clare S, Rowley S. Implementing the Aseptic Non Touch Technique (ANTT®) clinical practice framework for aseptic technique: a pragmatic evaluation using a mixed methods approach in two London hospitals. *J Infect Prev*. 2018;19(1):6-15. doi:10.1177/1757177417720996
27. Centers for Disease Control and Prevention. Summary of recommendations, guidelines for the prevention of intravascular catheter-related infections (2011). Updated February 2017. https://www.cdc.gov/infectioncontrol/guidelines/bsi/recommendations.html
28. Rowley S, Clare S. *Guidance Document: Standardizing the Critical Clinical Competency of Aseptic, Sterile, and Clean Techniques With A Single International Standard: Aseptic Non Touch Technique (ANTT®).* Association for Vascular Access; 2019. https://www.avainfo.org/resource/resmgr/files/position_statements/ANTT.pdf
29. National Institute for Health and Care Excellence (NICE). Healthcare-associated infections: prevention and control in primary and community care. NICE; 2012. Revised February 2017. https://www.nice.org.uk/guidance/cg139

30. Carr PJ, Rippey JCR, Cooke ML, et al. From insertion to removal: a multicenter survival analysis of an admitted cohort with peripheral intravenous catheters inserted in the emergency department. *Infect Control Hosp Epidemiol*. 2018;39(10):1216-1221. doi:10.1017/ice.2018.190
31. Bell T, O'Grady NP. Prevention of central line-associated bloodstream infections. *Infect Dis Clin North Am*. 2017;31(3):551-559. doi:10.1016/j.idc.2017.05.007
32. DeVries M, Valentine M, Mancos P. Protected clinical indication of peripheral intravenous lines: successful implementation. *J Assoc Vasc Access.* 2016;21(2):89-92. http://dx.doi.org/10.1016/j.java.2016.03.001
33. Hall M, Trivedi U, Rumbaugh K, Dissanaike S. Contamination of unused, nonsterile gloves in the critical care setting: a comparison of bacterial glove contamination in medical, surgical and burn intensive care units. *The Southwest Respiratory and Critical Care Chronicles.* 2014;2(5):3-10. https://pulmonarychronicles.com/index.php/pulmonarychronicles/article/view/106
34. Assadian O, Leaper DJ, Kramer A, Ousey KJ. Can the design of glove dispensing boxes influence glove contamination? *J Hosp Infect*. 2016;94(3):259-262. doi:10.1016/j.jhin.2016.09.005
35. Moran V, Heuertz R. Cross contamination: are hospital gloves reservoirs for nosocomial infections? *Hosp Top*. 2017;95(3):57-62. doi:10.1080/00185868.2017.1300484
36. Moureau NL, Carr PJ. Vessel health and preservation: a model and clinical pathway for using vascular access devices. *Br J Nurs*. 2018;27(8):S28-S35. doi:10.12968/bjon.2018.27.8.S28
37. Simin D, Milutinović D, Turkulov V, Brkić S. Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: an observational prospective study. *J Clin Nurs*. 2019;28(9-10):1585-1599. doi:10.1111/jocn.14760
38. Fields JM, Piela NE, Au AK, Ku BS. Risk factors associated with difficult venous access in adult ED patients. *Am J Emerg Med.* 2014;32(10):1179-1182. doi:10.1016/j.ajem.2014.07.008
39. Salgueiro-Oliveira AS, Costa PJDS, Braga LM, Graveto JMGN, Oliveira VS, Parreira PMSD. Health professionals' practices related with tourniquet use during peripheral venipuncture: a scoping review. *Rev Lat Am Enfermagem*. 2019;27:e3125. doi:10.1590/1518-8345.2743-3125
40. Culjak M, Gveric Grginic A, Simundic AM. Bacterial contamination of reusable venipuncture tourniquets in tertiary-care hospital. *Clin Chem Lab Med*. 2018;56(8):e201-e203. doi:10.1515/cclm-2017-0994
41. Mehmood Z, Mubeen SM, Afzal MS, Hussain Z. Potential risk of cross-infection by tourniquets: a need for effective control practices in Pakistan. *Int J Prev Med*. 2014;5(9):1119-1124.
42. Caparas JV, Hu JP. Safe administration of vancomycin through a novel midline catheter: a randomized, prospective clinical trial. *J Vasc Access*. 2014;15(4):251-256. doi:10.5301/jva.5000220
43. Yokota T, Tokumine J, Lefor AK, Hasegawa A, Yorozu T, Asao T. Ultrasound-guided placement of a midline catheter in a patient with extensive postburn contractures: a case report. *Medicine (Baltimore)*. 2019;98(3):e14208. doi:10.1097/MD.0000000000014208
44. Dickson HG, Flynn O, West D, Alexandrou E, Mifflin N, Malone M. A cluster of failures of midline catheters in a hospital in the home program: a retrospective analysis. *J Infus Nurs*. 2019;42(4):203-208. doi:10.1097/NAN.0000000000000330
45. Thaut L, Weymouth W, Hunsaker B, Reschke D. Evaluation of central venous access with accelerated Seldinger technique versus modified Seldinger technique. *J Emerg Med*. 2019;56(1):23-28. doi:10.1016/j.jemermed.2018.10.021
46. Adams DZ, Little A, Vinsant C, Khandelwal S. The midline catheter: a clinical review. *J Emerg Med*. 2016;51(3):252-258. doi:10.1016/j.jemermed.2016.05.029
47. DeVries M, Lee J, Hoffman L. Infection free midline catheter implementation at a community hospital (2 years). *Am J Infect Control*. 2019;47(9):1118-1121. doi:10.1016/j.ajic.2019.03.001
48. Caparas J, Hung H. Vancomycin administration through a novel midline catheter: summary of a 5-year 1086-patient experience in an urban community hospital. *J Assoc Vasc Access.* 2017;22(1):38-41. https://doi.org/10.1016/j.java.2016.10.092
49 Caparas J. Maximal sterile barrier vs. partial-body drape for midline Insertion. *J Assoc Vasc Access*. 2016;21(4):253-254. https://doi.org/10.1016/j.java.2016.10.040
50. Simonov M, Pittiruti M, Rickard CM, Chopra V. Navigating venous access: a guide for hospitalists. *J Hosp Med*. 2015;10(7):471-478. doi:10.1002/jhm.2335
51. Seo H, Altshuler D, Dubrovskaya Y, et al. The safety of midline catheters for intravenous therapy at a large academic medical center. *Ann Pharmacother*. 2020;54(3):232-238. doi:10.1177/1060028019878794
52. Chopra V, Kaatz S, Swaminathan L, et al. Variation in use and outcomes related to midline catheters: results from a multicentre pilot study. *BMJ Qual Saf*. 2019;28(9):714-720. doi:10.1136/bmjqs-2018-008554
53. Bahl A, Karabon P, Chu D. Comparison of venous thrombosis complications in midlines versus peripherally inserted central catheters: are midlines the safer option? *Clin Appl Thromb Hemost*. 2019;25:1076029619839150. doi:10.1177/1076029619839150
54. Lisova K, Hromadkova J, Pavelková K, Zauška V, Havlin J, Charvat J. The incidence of symptomatic upper limb venous thrombosis associated with midline catheter: prospective observation. *J Vasc Access*. 2018;19(5):492-495. doi:10.1177/1129729818761276
55. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect*. 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2
56. Duesing LA, Fawley JA, Wagner AJ. Central venous access in the pediatric population with emphasis on complications and prevention strategies. *Nutr Clin Pract*. 2016;31(4):490-501. doi:10.1177/0884533616640454
57. Ares G, Hunter CJ. Central venous access in children: indications, devices, and risks. *Curr Opin Pediatr*. 2017;29(3):340-346. doi:10.1097/MOP.0000000000000485
58. Lorente L. What is new for the prevention of catheter-related bloodstream infections? *Ann Transl Med*. 2016;4(6):119. doi:10.21037/atm.2016.03.10
59. Heffner A, Androes MP. Overview of central venous access in adults. Up-to Date.com. Updated March 19, 2020. https://www.uptodate.com/contents/overview-of-central-venous-access-in-adults
60. Campagna S, Gonella S, Berchialla P, et al. A retrospective study of the safety of over 100,000 peripherally-inserted central catheters days for parenteral supportive treatments. *Res Nurs Health*. 2019;42(3):198-204. doi:10.1002/nur.21939
61. Marschall J, Mermel LA, Fakih M, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(7):753-771. doi:10.1086/676533
62. Ling ML, Apisarnthanarak A, Jaggi N, et al. APSIC guide for prevention of central line associated bloodstream infections (CLABSI). *Antimicrob Resist Infect Control*. 2016;5:16. doi:10.1186/s13756-016-0116-5
63. Hsu CC, Kwan GN, Evans-Barns H, Rophael JA, van Driel ML. Venous cutdown versus the Seldinger technique for placement of totally implantable venous access ports. *Cochrane Database Syst Rev*. 2016;2016(8):CD008942. doi:10.1002/14651858.CD008942.pub2
64. Vierboom L, Darani A, Langusch C, Soundappan S, Karpelowsky J. Tunnelled central venous access devices in small children: a comparison of open vs. ultrasound-guided percutaneous insertion in children weighing ten kilograms or less. *J Pediatr Surg*. 2018;53(9):1832-1838. doi:10.1016/j.jpedsurg.2018.03.025
65. Tagliari AP, Staub FL, Guimarães JR, Migliavacca A, Mossmann Dda F. Evaluation of three different techniques for insertion of totally implantable venous access device: a randomized clinical trial. *J Surg Oncol*. 2015;112(1):56-59. doi:10.1002/jso.23962

66. Franco-Sadud R, Schnobrich D, Mathews BK, et al. Recommendations on the use of ultrasound guidance for central and peripheral vascular access in adults: a position statement of the society of hospital medicine. *J Hosp Med*. 2019;14:E1-E22. doi:10.12788/jhm.3287
67. Hugill K. Vascular access in neonatal care settings: selecting the appropriate device. *Br J Nurs*. 2016;25(3):171-176. doi:10.12968/bjon.2016.25.3.171
68. Chopra V, O'Horo JC, Rogers MA, Maki DG, Safdar N. The risk of bloodstream infection associated with peripherally inserted central catheters compared with central venous catheters in adults: a systematic review and meta-analysis. *Infect Control Hosp Epidemiol*. 2013;34(9):908-918. doi:10.1086/671737
69. Wichmann D, Belmar Campos CE, Ehrhardt S, et al. Efficacy of introducing a checklist to reduce central venous line associated bloodstream infections in the ICU caring for adult patients. *BMC Infect Dis*. 2018;18(1):267. doi:10.1186/s12879-018-3178-6
70. Centers for Disease Control and Prevention. Central Line Insertion Practices (CLIP) adherence monitoring. National Healthcare Safety Network, Centers for Disease Control and Prevention. Published January 2020. https://www.cdc.gov/nhsn/pdfs/pscmanual/5psc_clipcurrent.pdf
71. Practice guidelines for central venous access 2020: an updated report by the American Society of Anesthesiologists Task Force on central venous access. *Anesthesiology*. 2020;132(1):8-43. doi:10.1097/ALN.0000000000002864
72. Schmidt GA, Blaivas M, Conrad SA, et al. Ultrasound-guided vascular access in critical illness. *Intensive Care Med*. 2019;45(4):434-446. doi:10.1007/s00134-019-05564-7
73. Calvache JA, Rodríguez MV, Trochez A, Klimek M, Stolker RJ, Lesaffre E. Incidence of mechanical complications of central venous catheterization using landmark technique: do not try more than 3 times. *J Intensive Care Med*. 2016;31(6):397-402. doi:10.1177/0885066614541407
74. Noonan PJ, Hanson SJ, Simpson PM, Dasgupta M, Petersen TL. Comparison of complication rates of central venous catheters versus peripherally inserted central venous catheters in pediatric patients. *Pediatr Crit Care Med*. 2018;19(12):1097-1105. doi:10.1097/PCC.0000000000001707
75. Wang YC, Lin PL, Chou WH, Lin CP, Huang CH. Long-term outcomes of totally implantable venous access devices. *Support Care Cancer*. 2017;25(7):2049-2054. doi:10.1007/s00520-017-3592-0
76. Blanco-Guzman MO. Implanted vascular access device options: a focused review on safety and outcomes. *Transfusion*. 2018;58 (Suppl 1): 558-568. doi:10.1111/trf.14503
77. Williams TL, Bowdle TA, Winters BD, Pavkovic SD, Szekendi MK. Guidewires unintentionally retained during central venous catheterization. *J Assoc Vasc Access*. 2014;19(1):29-34. https://doi.org/10.1016/j.java.2013.12.001
78. Hoffman T, Du Plessis M, Prekupec MP, et al. Ultrasound-guided central venous catheterization: a review of the relevant anatomy, technique, complications, and anatomical variations. *Clin Anat*. 2017;30(2):237-250. doi:10.1002/ca.22768
79. Kornbau C, Lee KC, Hughes GD, Firstenberg MS. Central line complications. *Int J Crit Illn Inj Sci*. 2015;5(3):170-178. doi:10.4103/2229-5151.164940
80. Tasopoulou KM, Argyriou C, Mantatzis M, Kantartzi K, Passadakis P, Georgiadis GS. Endovascular repair of an inadvertent right vertebral artery rupture during dialysis catheter insertion. *Ann Vasc Surg*. 2018;51:324.e11-324.e16. doi:10.1016/j.avsg.2018.02.022
81. Akkan K, Cindil E, Kilic K, Ilgit E, Onal B, Erbas G. Misplaced central venous catheter in the vertebral artery: endovascular treatment of foreseen hemorrhage during catheter withdrawal. *J Vasc Access*. 2014;15(5):418-423. doi:10.5301/jva.5000267
82. Lee KA, Ramaswamy RS. Intravascular access devices from an interventional radiology perspective: indications, implantation techniques, and optimizing patency. *Transfusion*. 2018;58(Suppl 1):549-557. doi:10.1111/trf.14501
83. Young M, You T. Overview of complications of central venous catheters and their prevention. UpToDate.com. Updated May 20, 2020. https://www.uptodate.com/contents/overview-of-complications-of-central-venous-catheters-and-their-prevention
84. Stefaniak JJ, Wujtewicz MA, Wujtewicz M. Inadvertent cannulation of vertebral artery with a dialysis catheter. *J Vasc Access*. 2017;18(5):e71-e72. doi:10.5301/jva.5000701
85. Parienti JJ, Mongardon N, Mégarbane B, et al. Intravascular complications of central venous catheterization by insertion site. *N Engl J Med*. 2015;373(13):1220-1229. doi:10.1056/NEJMoa1500964
86. Sun W, Ma Y, Liu B, Ge R, Wang K, Song Q. Two successful insertions of peripherally inserted central catheter in a super elderly patient with bilateral pacemaker placement. *J Vasc Access*. 2017;18(1):e1-e2. doi:10.5301/jva.5000582
87. Liu B, Sun W, Wang K. A successful insertion of PICC in patient with cardiac angiosarcoma and neoplasty of right atrium and pacemaker: a case report. *Medicine (Baltimore)*. 2017;96(51):e9225. doi:10.1097/MD.0000000000009225
88. Sainathan S, Hempstead M, Andaz S. A single institution experience of seven hundred consecutively placed peripherally inserted central venous catheters. *J Vasc Access*. 2014;15(6):498-502. doi:10.5301/jva.5000248
89. Aurshina A, Hingorani A, Alsheekh A, Kibrik P, Marks N, Ascher E. Placement issues of hemodialysis catheters with pre-existing central lines and catheters. *J Vasc Access*. 2018;19(4):366-369. doi:10.1177/1129729818757964
90. Bhadauria D, Chellappan A, Gurjar M, Kaul A, Sharma RK, Prasad N. The "dilemma of double lifelines": central venous catheter co-existence with transvenous cardiac pacemaker. *J Vasc Access*. 2017;18(1):e3-e5. doi:10.5301/jva.5000622
91. Kusztal M, Nowak K. Cardiac implantable electronic device and vascular access: strategies to overcome problems. *J Vasc Access*. 2018;19(6):521-527. doi:10.1177/1129729818762981
92. Maradey JA, Jao GT, Vachharajani TJ. Leadless pacemaker placement in a patient with chronic kidney disease: a strategy to preserve central veins. *Hemodial Int*. 2018;22(4):E57-E59. doi:10.1111/hdi.12665
93. Miller AG, Bardin AJ. Review of ultrasound-guided radial artery catheter placement. *Respir Care*. 2016;61(3):383-388. doi:10.4187/respcare.04190
94. O'Horo JC, Maki DG, Krupp AE, Safdar N. Arterial catheters as a source of bloodstream infection: a systematic review and meta-analysis. *Crit Care Med*. 2014;42(6):1334-1339. doi:10.1097/CCM.0000000000000166
95. Schults JA, Long D, Pearson K, et al. Insertion, management, and complications associated with arterial catheters in paediatric intensive care: a clinical audit. *Aust Crit Care*. 2019;S1036-7314(18)30349-7. doi:10.1016/j.aucc.2019.05.003

Section Six: Vascular Access Device Management

Section Standards

I. To ensure patient safety, the clinician is competent in vascular access device (VAD) management, including knowledge of relevant anatomy, physiology, and VAD management techniques aimed at maintaining vascular access and reducing the risk of complications.

II. Indications and protocols for VAD management are established in organizational policies, procedures, and/or practice guidelines and according to manufacturers' directions for use.

35. FILTRATION

Standard

35.1 Parenteral nutrition (PN) solutions are filtered using a filter appropriate to the type of solution.

35.2 Blood and blood components are filtered using a filter appropriate to the prescribed component.

35.3 Intraspinal infusion solutions are filtered using a surfactant-free, particulate-retentive, and air-eliminating filter.

35.4 Medications withdrawn from glass ampoules are filtered using a filter needle or filter straw.

Practice Recommendations

A. Prime and position filters adhering to manufacturers' directions for use.
   1. Locate the in-line filter on the administration set as close to the VAD hub as possible. Add-on components (eg, extension sets, stopcocks) below or after the filter will result in additional particulate matter infusing to the patient.[1,2] (IV)
   2. Prevent changes in flow rate, especially with very slow flow rates or infusion of medications that alter hemodynamic status, by positioning the in-line filter near the level of the VAD insertion site. Inadvertent back-siphoning (when filter is positioned below the level of the infusion site) and bolusing (when filter is positioned above the level of the infusion site) are prevented by closing a downstream clamp if the filter position needs to be temporarily changed.[3] (V)

B. Consider filtration of solutions and medications to:
   1. Reduce microbubbles (<1 mm in diameter) of air entrained in infusion solutions and medications.
      a. Changes in solution temperature and pressure can increase the number of microbubbles in solution. Microbubbles are also common in hemodialysis and cardiopulmonary bypass. Once inside the bloodstream, platelets, white blood cells, and other proteins attach to microbubbles, thickening the wall of the gas bubble and allowing adherence to the endothelial surface of vein walls. Endothelial damage produces edema and inflammation. Obstruction of small pulmonary microcirculation occurs. Autopsy results have located microbubbles surrounded by fibrin and the presence of pulmonary fibrosis.[4-7] (IV)
   2. Reduce particulate matter in critically ill patients that can cause thrombogenesis, impaired microcirculation, and alter immune response.
      a. Patients in intensive care are estimated to receive more than a million particles with a size greater than 2 microns on a daily basis.[2,8-10] (IV)
      b. Multiple studies in neonatal and adult populations show no improvement of clinical outcomes with use of in-line filters; however, 3 studies in pediatric populations showed significant reduction in systemic inflammatory response syndrome (SIRS) and reduction in respiratory and renal dysfunction but no difference in cardiovascular, hepatic, or neurological dysfunction. The smaller number and diameter of vessels in infants could be one explanation for these differences. Limited fluid volume for drug dilution in infants may also increase the frequency of drug precipitate in the presence of contact between incompatible drugs.[2,8-12] (III)
   3. Reduce the incidence of phlebitis associated with peripheral venous catheters.
      a. A systematic review found that in-line filter use reduced the occurrence of phlebitis in hospitalized patients. However, variation in types of catheters, filter pore sizes, infusion solutions, phlebitis definitions, and study design added to the uncertain benefits of filtration.[11] (I)
      b. In-line filtration with a 0.2-micron filter in surgical patients resulted in a significant reduction in phlebitis rates at 48 hours, lower visual infusion phlebitis (VIP) scores, and longer dwell times than the nonfilter group in a randomized controlled trial (RCT). Six months after the original

study, the researchers reported high rates of patient satisfaction from a qualitative patient survey. The cost of filters was offset by reducing the need for unplanned removal and insertion of a new peripheral catheter.[12,13] (III)

C. Use the appropriate pore size in-line filter as required by the specific solution or medication to be infused. Consult with pharmacy for specific medication information.
   1. Some medications may require a specific pore size due to the molecular size of the medication (eg, amphotericin B) and/or the concentration for infusion (eg, mannitol).[14] (V)
   2. Recommendations for filtration of protein-based medications (eg, immunoglobulin, monoclonal antibodies, enzymes) vary greatly, including many drugs with no filtration instructions and many variations in filter pore size recommended. Many protein-based medications indicate the need for "low protein binding filters," which includes filters made of polyethersulfone, polyvinylidene fluoride, and cellulose acetate.[15,16] (IV)
   3. Drug adsorption to the filter material may occur initially but does not cause significant drug loss once all binding sites are saturated, although filter material, small volume doses, and slow flow rates may increase problems with drug loss.[16,17] (IV)

D. Use air-eliminating filters for infusion in all patients with a medical diagnosis involving right-to-left cardiac or pulmonary shunting to prevent air and particulate matter from reaching the arterial circulation, also known as paradoxical embolization. Hypercoagulable states and increased right heart pressure are associated with increased risk of paradoxical embolization.[4,18] (IV)

E. Change add-on filters to coincide with administration set changes; use a primary administration set with an integrated in-line filter whenever possible to reduce tubing manipulation and risks of contamination, misuse, and accidental disconnection/misconnection (refer to Standard 43, *Administration Set Management*).

F. Recognize that in-line filter use in combination with syringe pumps for low-flow rates produces no significant statistical difference in in-line pressure monitoring, pump start-up delay, flow variability, or time to reach a steady-state flow.[19,20] (IV)

G. Filter PN solutions with the correct filter pore size.
   1. Use a 0.2-micron filter for PN solutions without lipid injectable emulsions (ILEs) and change every 24 hours.
   2. Use a 1.2-micron filter for PN solutions containing ILE (also known as total nutrient admixture [TNA]) and change every 24 hours.
   3. Use a separate 1.2-micron filter for separately infused ILE; attach to an injection site below or after the 0.2-micron filter used for dextrose/amino acid solution. Change the lipid emulsions filter every 12 hours (refer to Standard 63, *Parenteral Nutrition*).

H. Filter blood and blood components using a filter designed to remove blood clots and harmful particles; standard blood administration sets include a 170- to 260-micron filter. Sets for other components (eg, platelets) may have similar filter pore size but also have a smaller total priming volume (refer to Standard 64, *Blood Administration*).

I. Filter intraspinal infusion medications using a surfactant-free 0.2-micron filter (refer to Standard 56, *Intraspinal Access Devices*).

J. Use a filter needle or filter straw to withdraw any medication from glass ampoules and replace the filter needle or filter straw with a new sterile needle after the medication is withdrawn from the ampoule; recognize that glass fragments may enter the ampoule when opened (refer to Standard 20, *Compounding and Preparation of Parenteral Solutions and Medications*).

REFERENCES

Note: All electronic references in this section were accessed between April 14, 2020, and September 2, 2020.

1. Perez M, Décaudin B, Chahla WA, et al. Effectiveness of in-line filters to completely remove particulate contamination during a pediatric multidrug infusion protocol. *Sci Rep.* 2018;8(1):7714. doi:10.1038/s41598-018-25602-6
2. Perez M, Maiguy-Foinard A, Barthélémy C, Décaudin B, Odou P. Particulate matter in injectable drugs: evaluation of risks to patients. *Pharm Technol Hosp Pharm.* 2016;1(2):91-103. https://doi.org/10.1515/pthp-2016-0004
3. Chau D, Gish B, Tzanetos D, Zhang C. A dangerous side of in-line IV filters when used for vasoactive infusions in infants [Letter to the Editor]. *Anesthesia Patient Safety Foundation (APSF) Newsletter.* 2013;28(2)43-46. https://www.apsf.org/wp-content/uploads/newsletters/2013/fall/pdf/APSF201310.pdf
4. Myers GJ. Air in intravenous lines: a need to review old opinions [Editorial]. *Perfusion.* 2017;32(6):432–435. doi:10.1177/0267659117706834
5. Fok H, Jiang B, Chowienczyk P, Clapp B. Microbubbles shunting via a patent foramen ovale impair endothelial function. *JRSM Cardiovasc Dis.* 2015;4:2048004015601564. doi:10.1177/2048004015601564
6. Brull SJ, Prielipp RC. Vascular air embolism: a silent hazard to patient safety. *J Crit Care.* 2017;42:255-263. doi:10.1016/j.jcrc.2017.08.010
7. Forsberg U, Jonsson P, Stegmayr B. Air contamination during medical treatment results in deposits of microemboli in the lungs: an autopsy study. *Int J Artif Organs.* 2019;42(9):477–481. doi:10.1177/0391398819840363
8. Langille SE. Particulate matter in injectable drug products. *PDA J Pharm Sci Technol.* 2013;67(3):186-200. doi:10.5731/pdajpst.2013.00922
9. Perez M, Décaudin B, Abou Chahla W, et al. In vitro analysis of overall particulate contamination exposure during multidrug IV therapy: impact of infusion sets. *Pediatr Blood Cancer.* 2015;62(6):1042-1047. doi:10.1002/pbc.25442
10. Benlabed M, Perez M, Gaudy R, et al. Clinical implications of intravenous drug incompatibilities in critically ill patients. *Anaesth Crit Care Pain Med.* 2019;38(2):173-180. doi:10.1016/j.accpm.2018.04.003
11. Niël-Weise BS, Stijnen T, van den Broek PJ. Should in-line filters be used in peripheral intravenous catheters to prevent infusion-related phlebitis? a systematic review of randomized controlled trials. *Anesth Analg.* 2010;110(6):1624-1629. doi:10.1213/ANE.0b013e3181da8342
12. Villa G, Chelazzi C, Giua R, et al. In-line filtration reduces postoperative venous peripheral phlebitis associated with cannulation:

a randomized clinical trial. *Anesth Analg.* 2018;127(6):1367-1374. doi:10.1213/ANE.0000000000003393

13. Villa G, Giua R, Amass T, et al. In-line filtration reduced phlebitis associated with peripheral venous cannulation: focus on cost-effectiveness and patients' perspectives. *J Vasc Access.* 2020;21(2):154-160. doi:10.1177/1129729819861187
14. Gahart BL, Nazareno AR, Ortega MQ. *Gahart's 2021 Intravenous Medications: A Handbook for Nurses and Health Professionals.* 37th ed. Elsevier; 2021.
15. Besheer A. Protein adsorption to in-line filters of intravenous administration sets. *J Pharm Sci.* 2017;106(10):2959-2965. doi:10.1016/j.xphs.2017.05.028
16. Werner BP, Winter G. Particle contamination of parenteralia and in-line filtration of proteinaceous drugs. *Int J Pharm.* 2015;496(2):250-267. doi:10.1016/j.ijpharm.2015.10.082
17. Bononi I, Forgetta C, Baldisserotto A, Tognon M. Simulated infusion of paclitaxel with in-line filters. *Chemotherapy.* 2011;57(3):204-208. doi:10.1159/000327368
18. Dowling MM, Quinn CT, Ramaciotti C, et al. Increased prevalence of potential right-to-left shunting in children with sickle cell anaemia and stroke. *Br J Haematol.* 2017;176(2):300-308. doi:10.1111/bjh.14391
19. Jonckers T, Berger I, Kuijten T, Meijer E, Andriessen P. The effect of in-line infusion filtering on in-line pressure monitoring in an experimental infusion system for newborns. *Neonatal Netw.* 2014;33(3):133-137. doi:10.1891/0730-0832.33.3.133
20. Chau DF, Vasilopoulos T, Schoepf M, Zhang C, Fahy BG. Syringe pump performance maintained with IV filter use during low flow rate delivery for pediatric patients. *Anesth Analg.* 2016;123(3):705-714. doi:10.1213/ANE.0000000000001273

36. NEEDLELESS CONNECTORS

Standard

36.1 A luer-locking needleless connector is used to connect syringes and/or administration sets to a VAD hub or other injection site to eliminate use of needles and reduce needlestick injuries.

Practice Recommendations

A. Use a needleless connector attached directly to the VAD hub, the female hub of an attached extension set, or an injection site on an administration set to facilitate intermittent infusion of solutions and medications. The primary purpose of needleless connectors is to eliminate the use of needles when connecting administration sets and/or syringes to the VAD or injection sites and reduce subsequent needlestick injuries and exposure to bloodborne pathogens.
   1. For continuous infusion, the clinical outcomes for use of needleless connectors as an additional add-on device between the VAD and the administration set are unknown.
   2. Ensure that all luer-locking connections are secure to prevent inadvertent disconnections and leaks in the infusion system.
   3. Avoid using a needleless connector for red blood cell (RBC) transfusion and when continuous infusion of rapid flow rates of crystalloid solutions is required. In vitro testing with negative, neutral, and positive needleless connectors demonstrates the greatest reduction in flow rates through large-bore catheters. Negative clinical outcomes might result when therapies with rapid flow rates are impeded.[1-6] (V)

B. Know the internal mechanism for fluid displacement of the needleless connector in use (eg, negative or positive displacement, neutral, or antireflux). Follow manufacturers' directions for use for flushing, clamping, and disconnection. The category names of needleless connectors are derived from clinical application of their functionality; however, there are no established criteria from device regulatory agencies that determine which device is assigned to each category.
   1. In the absence of manufacturer directions, consider the reported reflux volume for each type and use the following sequence:
      a. Negative displacement–flush, clamp, disconnect
      b. Positive displacement–flush, disconnect, clamp
      c. Neutral and antireflux–no specific sequence required.
   2. Standardize the type of needleless connector within the organization to reduce the risk for confusion about these steps and improve clinical outcomes.
   3. Fluid reflux is documented by in vitro studies in all types of needleless connectors, with quantities ranging from 0.02 to 50.37 μL. Negative displacement devices produce the greatest volume of reflux, and antireflux devices containing a bidirectional, pressure-sensitive valve have the least amount of reflux. Due to the internal mechanism, positive displacement devices have the greatest volume of reflux at connection, while the greatest amount of reflux occurs at disconnection for all other types of needleless connectors.[2,7-10] (V)

C. Many additional factors, such as body movement, respirations, syringe plunger rebound, and coughing, cause changes within a catheter lumen that can allow blood to move into the lumen. The time required for undisturbed blood to coagulate inside a catheter lumen and the minimum volume of blood that would cause lumen occlusion are unknown. Smaller catheter lumens will allow for blood to reflux for a greater distance into the lumen.[8] (V)

D. The type of needleless connector that produces the least amount of thrombotic VAD lumen occlusion remains controversial and requires further study. The quantity and frequency of thrombolytic drugs used for catheter clearance have been used as surrogates for monitoring VAD lumen occlusion and correlated to the type of needleless connector in use.[8,11,12] (IV)

E. Evaluate published outcomes of infection risks associated with each type of needleless connector when making product purchase decisions, focusing on risks, benefits, and educational requirements. Studies comparing different types of needleless connectors demonstrate that all types allow microbial ingress, and one

type is not superior to another regarding internal contamination. Contamination occurs in VADs with coagulase negative staphylococci as the most common organism.[13-23] (II)

F. Use stopcocks (ie, 3-way taps) or manifolds with a bonded needleless connector or close by adding a needleless connector rather than a solid cap. The method of closure has greater influence on contamination rather than the type of fluid displacement inside the needleless connector. Replace the stopcock with a needleless connector as soon as clinically indicated.[24-26] (I)

G. Disinfect the connection surface and sides of the needleless connector attached to any VAD to reduce introduction of intraluminal microbes. Use active or passive disinfection. Follow manufacturers' directions for use of both the needleless connector and disinfectant agent. Primary factors influencing this practice include the disinfection agent, the time required (ie, application and drying), and the method of application.
   1. Perform active disinfection by a vigorous mechanical scrub using a flat swab pad containing 70% isopropyl alcohol or alcohol-based chlorhexidine suitable for use with medical devices.
      a. Recent studies show no difference in effectiveness of scrub time between 5 to 15 seconds with 70% isopropyl alcohol and alcohol-based chlorhexidine gluconate, and researchers have suggested that removal of all organisms may not be possible when there is extensive contamination.
      b. An additional type of active disinfection device contains an alcohol-impregnated sponge used to apply the mechanical scrub prior to use of a needleless connector and the internal lumen of a stopcock and is immediately discarded after the scrub time. In vitro testing has shown this device to be ineffective for decontamination of the internal lumen of a stopcock. For disinfecting needleless connectors, one in vitro study reported this device to be equal to an alcohol pad and another study reported moderate effectiveness, meaning that 5% to 15% of surface contamination was left on 2 types of needleless connectors when compared to use of an alcohol pad. Clinical performance and outcomes with this device have not been reported.
      c. Drying time with 70% isopropyl alcohol is 5 seconds; alcohol-based chlorhexidine requires 20 seconds. Povidone iodine requires longer than 6 minutes to be thoroughly dry, making it less favorable to clinical practice. Drying times in clinical practice depend on the humidity and climate in the care setting.[4,27-33] (II)
   2. Perform passive disinfection by applying a cap or covering containing a disinfectant agent (eg, 70% isopropyl alcohol, iodinated alcohol) to create a physical barrier to contamination between uses. Follow manufacturers' directions for use regarding time for effectiveness after attachment and the maximum length of effectiveness. Once removed, discard used disinfection caps and do not reattach to the needleless connector. Use multidisciplinary implementation strategies including staff education and leadership support and provide consistent feedback to staff regarding outcomes, as this has been shown to decrease catheter-associated bloodstream infection (CABSI) rates.[28,34-36] (I)
   3. Studies comparing active and passive methods of disinfection show both processes to be effective.
      a. Active disinfection with alcohol-based chlorhexidine gluconate swab pads or passive disinfection with caps containing 70% isopropyl alcohol were associated with lower rates of CABSI, while swab pads containing 70% isopropyl alcohol were the least effective according to a meta-analysis of quasi-experimental studies. A quasi-experimental study did not show a significant CABSI reduction in a pediatric critical care setting, probably associated with a short duration of catheter dwell in this population.
      b. A recent RCT on disinfection of needleless connectors on central vascular access devices (CVADs) compared 70% isopropyl alcohol wipes, alcohol-based chlorhexidine gluconate wipes, and caps with 70% isopropyl alcohol. CABSI rates were low in both groups using isopropyl alcohol and zero in the group using alcohol-based chlorhexidine gluconate.[30,37,38] (I)
   4. Disinfect the connection surface before each entry.
      a. Studies focus on disinfection practices before the initial entry into the needleless connector; however, studies do not address the need for disinfection before subsequent entries required to administer an intermittent medication (eg, saline flushing before and after the medication, locking the VAD). Although the need for a full disinfection process before subsequent entries is unknown, removal of organic and inorganic debris (eg, blood-tinged fluid, dried medication, clothing lint, inadvertent touch contamination) with a disinfection pad between each entry may provide additional protection for the intraluminal fluid pathway. (Committee Consensus)
   5. Adhere to Standard-Aseptic Non Touch Technique (Standard-ANTT) when accessing and changing a needleless connector.
      a. Attach only a sterile syringe tip or sterile male luer end of the intravenous (IV) administration set to the needleless connector.
      b. Ensure that disinfecting supplies are readily available at the bedside to facilitate staff compliance with needleless connector disinfection (see Standard 18, *Aseptic Non Touch Technique*).[3,4,7,39] (IV)
   6. Use of needleless connectors with an antimicrobial coating (eg, silver, chlorhexidine/silver) requires adequate disinfection techniques, as technology alone does not replace disinfection practices. Silver-coated

needleless connectors have been shown to decrease rates of CABSI, although significant amounts of biofilm and microorganisms were recovered from coated and noncoated connectors.[40,41] (IV)

7. Monitor clinician compliance to ensure that the chosen method for disinfection is applied consistently for needleless connectors on all VADs as this is a critical element for reduction of intraluminal contamination and subsequent bloodstream infection (BSI).[27,28,42,43] (II)

H. Change the needleless connector no more frequently than 96-hour intervals or according to the manufacturers' directions for use. Changing on a more frequent time interval adds no benefit and has been shown to increase the risk of CABSI.
   1. When used within a continuous infusion system, the needleless connector is changed when the primary administration set is changed (eg, 96 hours). One study reported that changing the needleless connector every 24 hours with blood or lipid infusion increased CABSI rates in pediatric stem cell transplant patients.
   2. Additionally, the needleless connector should be changed in the following circumstances: if the needleless connector is removed for any reason; if there is residual blood or debris within the needleless connector; prior to drawing a sample for blood culture from the VAD; upon contamination; per organizational policies, procedures, and/or practice guidelines; or per the manufacturers' directions for use (see Standard 50, *Infection*).[3,44,45] (IV)

REFERENCES

Note: All electronic references in this section were accessed between April 14, 2020, and September 2, 2020.

1. US Department of Labor. Occupational Safety and Health Administration. Bloodborne pathogens. Standard 29 CFR 1910.1030. https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030
2. Hadaway L. Needleless connectors for IV catheters. *Am J Nurs.* 2012;112(11):32-44. doi:10.1097/01.NAJ.0000422253.72836.c1
3. Ling ML, Apisarnthanarak A, Jaggi N, et al. APSIC guide for prevention of central line associated bloodstream infections (CLABSI). *Antimicrob Resist Infect Control*. 2016;5:16. doi:10.1186/s13756-016-0116-5
4. Loveday H, Wilson J, Pratt R, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect.* 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2
5. Liu D, Keijzers G. Do SmartSite antireflux valves limit the flow rate of 0.9% normal saline through intravenous cannulas? *Eur J Emerg Med.* 2013;20(2):123-125. doi:10.1097/MEJ.0b013e32835730fc
6. Lehn RA, Gross JB, McIsaac JH, Gipson KE. Needleless connectors substantially reduce flow of crystalloid and red blood cells during rapid infusion. *Anesth Analg*. 2015;120(4):801-804. doi:10.1213/ANE.0000000000000630
7. Harrold K. Guide to the safe use of needlefree connectors. *Br J Nurs*. 2019;28(Sup14b):1-6. doi:10.12968/bjon.2019.28.Sup14b.1
8. Hull GJ, Moureau NL, Sengupta S. Quantitative assessment of reflux in commercially available needle-free IV connectors. *J Vasc Access.* 2018;19(1):12-22. doi:10.5301/jva.5000781
9. Elli S, Abbruzzese C, Cannizzo L, Lucchini A. In vitro evaluation of fluid reflux after flushing different types of needleless connectors. *J Vasc Access.* 2016;17(5):429-434. doi:10.5301/jva.5000583
10. Curran E. Needleless connectors: the vascular access catheter's microbial gatekeeper. *J Infect Prev*. 2016;17(5):234-240. doi:10.1177/1757177416657164
11. Steere L, Rousseau M, Durland L. Lean Six Sigma for intravenous therapy optimization: a hospital use of lean thinking to improve occlusion management. *J Assoc Vasc Access.* 2018;23(1):42-50. https://doi.org/10.1016/j.java.2018.01.002
12. Williams A. Catheter occlusion in home infusion: the influence of needleless connector design on central catheter occlusion. *J Infus Nurs.* 2018;41(1):52-57. doi:10.1097/NAN.0000000000000259
13. Casey A, Karpanen T, Nightingale P, Elliott T. An in vitro comparison of microbial ingress into 8 different needleless IV access devices. *J Infus Nurs*. 2015;38(1):18-25. doi:10.1097/NAN.0000000000000082
14. Casey AL, Karpanen TJ, Nightingale P, Elliott TS. The risk of microbial contamination associated with six different needle-free connectors. *Br J Nurs.* 2018;27(2):S18-S26. doi:10.12968/bjon.2018.27.2.S18
15. Casey A, Karpanen T, Nightingale P, Chaganti S, Elliott TSJ. Microbiologic contamination of a positive-and a neutral-displacement needleless intravenous access device in clinical use. *Am J Infect Control.* 2016;44(12):1678-1680. doi:10.1016/j.ajic.2016.06.027
16. Curran E. Outbreak column 19: needleless connectors (NCs) tales from nine outbreaks. *J Infect Prev.* 2016;17(5):241-247. doi:10.1177/1757177416650202doi:10.1016/j.ajic.2016.06.027
17. Guembe M, Pérez Granda MJ, Cruces R, Alcalá L, Bouza E. The NeutraClear® needleless connector is equally effective against catheter colonization compared to MicroClave.® *J Vasc Access*. 2017;18(5):415-418. doi:10.5301/jva.5000775
18. Hankins R, Majorant OD, Rupp ME, et al. Microbial colonization of intravascular catheter connectors in hospitalized patients. *Am J Infect Control.* 2019;47(12):1489-1492. doi:10.1016/j.ajic.2019.05.024
19. Delgado M, Capdevila JA, Sauca G, et al. Positive-pressure needleless connectors did not increase rates of catheter hub colonization respecting the use of neutral-pressure needleless connectors in a prospective randomized trial. *Enferm Infecc Microbiol Clin.* 2020;38(3):119-122. doi:10.1016/j.eimc.2019.07.012
20. Slater K, Cooke M, Whitby M, et al. Microorganisms present on peripheral intravenous needleless connectors in the clinical environment. *Am J Infect Control.* 2017;45(8):932-934. doi:10.1016/j.ajic.2017.02.008
21. Clavier T, Ferguen M, Gouin P, et al. Impact of MaxZero™ needle-free connector on the incidence of central venous catheter-related infections in surgical intensive care unit. *Aust Crit Care.* 2019;32(2):107-111. doi:10.1016/j.aucc.2018.03.003
22. Koeppen M, Weinert F, Oehlschlaeger S, Koerner A, Rosenberger P, Haeberle HA. Needle-free connectors catheter-related bloodstream infections: a prospective randomized controlled trial. *Intensive Care Med Exp*. 2019;7(1):63. doi:10.1186/s40635-019-0277-7
23. Rosenthal VD. Clinical impact of needle-free connector design: a systematic review of literature [published online ahead of print Feb 14, 2020]. *J Vasc Access*. 2020;1129729820904904. doi:10.1177/1129729820904904
24. Hadaway L. Stopcocks for inusion therapy: evidence and experience. *J Infus Nurs.* 2018;41(1):24-34. doi:10.1097/NAN.0000000000000258
25. Rosenthal VD. Impact of needle-free connectors compared with 3-way stopcocks on catheter-related bloodstream infection rates: a meta-analysis. *Am J Infect Control*. 2020;48(3):281-284. doi:10.1016/j.ajic.2019.08.015
26. Sengul T, Guven B, Ocakci AF, Kaya N. Connectors as a risk factor for blood-associated infections (3-way stopcock and needleless connector): a randomized-experimental study. *Am J Infect Control.* 2020;48(3):275-280. doi:10.1016/j.ajic.2019.08.020
27. Marschall J, Mermel LA, Fakih M, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol.* 2014;35(Suppl 2):S89-S107.

28. Moureau NL, Flynn J. Disinfection of needleless connector hubs: clinical evidence systematic review. *Nurs Res Pract*. 2015;2015:796762. doi:10.1155/2015/796762
29. Slater K, Cooke M, Fullerton F, et al. Peripheral intravenous catheter needleless connector decontamination study—randomized controlled trial. *Am J Infect Control*. 2020;48(9):1013-1018. doi:10.1016/j.ajic.2019.11.030
30. Rickard CM, Flynn J, Larsen E, et al. Needleless connector decontamination for prevention of central venous access device infection: a pilot randomized controlled trial [published online ahead of print Jul 29, 2020]. *Am J Infect Control.* 2020;S0196-6553(20)30731-8. doi:10.1016/j.ajic.2020.07.026
31. ECRI Institute. Evaluation: BD Bard access site-scrub IPA disinfection device for needle-free IV connectors. *Health Devices.* Published March 12, 2020. https://www.ecri.org/search-results/member-preview/hdjournal/pages/eval-bard-site-scrub-ipa-device
32. Holroyd JL, Paulus DA, Rand KH, Enneking FK, Morey TE, Rice MJ. Universal intravenous access cleaning device fails to sterilize stopcocks. *Anesth Analg*. 2014;118(2):333-343. doi:10.1213/ANE.0000000000000059
33. Slater K, Fullerton F, Cooke M, Snell S, Rickard CM. Needleless connector drying time—how long does it take? *Am J Infect Control.* 2018;46(9):1080-1081. doi:10.1016/j.ajic.2018.05.007
34. Beeler C, Kerley D, Davis C, et al. Strategies for the successful implementation of disinfecting port protectors to reduce CLABSI in a large tertiary care teaching hospital. *Am J Infect Control*. 2019;47(12):1505-1507. doi:10.1016/j.ajic.2019.05.016
35. Voor In 't Holt AF, Helder OK, Vos MC, et al. Antiseptic barrier cap effective in reducing central line-associated bloodstream infections: a systematic review and meta-analysis. *Int J Nurs Stud.* 2017;69:34-40. doi:10.1016/j.ijnurstu.2017.01.007
36. Inchingolo R, Pasciuto G, Magnini D, et al. Educational interventions alone and combined with port protector reduce the rate of central venous catheter infection and colonization in respiratory semi-intensive care unit. *BMC Infect Dis*. 2019;19(1):215. doi:10.1186/s12879-019-3848-z
37. Flynn JM, Larsen EN, Keogh S, Ullman AJ, Rickard CM. Methods for microbial needleless connector decontamination: a systematic review and meta-analysis. *Am J Infect Control*. 2019;47(8):956-962. doi:10.1016/j.ajic.2019.01.002
38. Helder OK, van Rosmalen J, van Dalen A, et al. Effect of the use of an antiseptic barrier cap on the rates of central line–associated bloodstream infections in neonatal and pediatric intensive care. *Am J Infect Control.* 2020;48(10)1171-1178. doi:10.1016/j.ajic.2019.11.026
39. Flynn JM, Keogh SJ, Gavin NC. Sterile v aseptic non-touch technique for needle-less connector care on central venous access devices in a bone marrow transplant population: a comparative study. *Eur J Oncol Nurs.* 2015;19(6):694-700. doi:10.1016/j.ejon.2015.05.003
40. Jacob JT, Chernetsky Tejedor S, Dent Reyes M, et al. Comparison of a silver-coated needleless connector and a standard needleless connector for the prevention of central line-associated bloodstream infections. *Infect Control Hosp Epidemiol*. 2015;36(3):294-301. doi:10.1017/ice.2014.58
41. Perez E, Williams M, Jacob JT, et al. Microbial biofilms on needleless connectors for central venous catheters: a comparison of standard and silver-coated devices collected from patients in an acute care hospital. *J Clin Microbiol*. 2014;52(3):823-831. doi:10.1128/JCM.02220-13
42. Cameron-Watson C. Port protectors in clinical practice: an audit. *Br J Nurs.* 2016;25(8):S25-S31. doi:10.12968/bjon.2016.25.8.S25
43. McBeth CL. Scrub the hub: CLABSI prevention through nurse leader, staff engagement. *Nurse Leader.* 2020;18(2):116-119. https://doi.org/10.1016/j.mnl.2020.01.007
44. Sherertz RJ, Karchmer TB, Palavecino E, Bischoff W. Blood drawn through valved catheter hub connectors carries a significant risk of contamination. *Eur J Clin Microbiol Infect Dis.* 2011;30(12):1571-1577. doi:10.1007/s10096-011-1262-6
45. Sandora TJ, Graham DA, Conway M, Dodson B, Potter-Bynoe G, Margossian SP. Impact of needleless connector change frequency on central line-associated bloodstream infection rate. *Am J Infect Control.* 2014;42(5):485-489. doi:10.1016/j.ajic.2014.01.022

37. OTHER ADD-ON DEVICES

Standard

37.1 Add-on devices are used only when clinically indicated for a specific purpose and in accordance with manufacturers' directions for use.

37.2 Add-on devices are of luer-lock or integrated design and are compatible with the administration system to ensure a secure connection, reduce manipulation, and minimize the risk of leaks, disconnections, or misconnections. A catheter with an integrated extension set is not considered an add-on device.

Practice Recommendations

A. Use add-on devices of luer-lock or integrated design (eg, single lumen and multilumen extension sets, manifold sets, extension loops, cannula caps, needleless connectors, in-line filters, and stopcocks [3-way tap]) to add length, enable filtration capabilities, for safe handling, or to enhance function of the infusion system (eg, adding an extension to decrease movement/manipulation at the peripheral intravenous catheter [PIVC] hub). See Standard 35, *Filtration*; Standard 36, *Needleless Connectors*.[1-3] (III)

B. Limit the use of add-on devices whenever possible to decrease excessive manipulations, accidental disconnections or misconnections, and risk of contamination and subsequent infection. Add-on devices may cause challenges with drug delivery and increase costs.[4-18] (III)
   1. Propofol anesthesia may increase the risk for postoperative infection because of microorganism growth in stopcock dead spaces. Bacterial contamination of the patient's skin, the clinician's hands, and the environment contribute to infection risk associated with stopcocks.[1] (IV)
   2. Use a stopcock or manifold with an integrated needleless connector rather than a solid cap or replace the stopcock with a needleless connector to reduce stopcock contamination.[1,19] (IV)
   3. Before accessing the add-on device, disinfect the hub with active or passive disinfection (refer to Standard 36, *Needleless Connectors*).

C. Change add-on device with new VAD insertion, with each administration set replacement if integrated tubing design (eg, filter part of administration set), or as defined by the organization, and whenever the integrity of the product is compromised or suspected to be compromised.[20,21] (V)

REFERENCES

Note: All electronic references in this section were accessed May 20, 2020.

1. Hadaway L. Stopcocks for infusion therapy: evidence and experience. *J Infus Nurs.* 2018;41(1):24-34. doi:10.1097/NAN.0000000000000258
2. Perez M, Décaudin B, Abou Chahla W, et al. Effectiveness of in-line filters to completely remove particulate contamination during a pediatric multidrug infusion protocol. *Sci Rep.* 2018;8(1):7714. doi:10.1038/s41598-018-25602-6
3. Villa G, Chelazzi C, Giua R, et al. In-line filtration reduces postoperative venous peripheral phlebitis associated with cannulation: a randomized clinical trial. *Anesth Analg*. 2018;127(6):1367-1374. doi:10.1213/ANE.0000000000003393
4. Benedict A, Mayer A, Craven H. Closed arterial lab sampling devices: a study of compliance and best practice. *Br J Nurs.* 2017;26(14):S24-S29. doi:10.12968/bjon.2017.26.14.S24
5. Genay S, Décaudin B, Scoccia S, et al. An in vitro evaluation of infusion methods using a syringe pump to improve noradrenaline administration. *Acta Anaesthesiol Scand.* 2015;59(2):197-204. doi:10.1111/aas.12439
6. Hankins R, Majorant OD, Rupp ME, et al. Microbial colonization of intravascular catheter connectors in hospitalized patients. *Am J Infect Control*. 2019;47(12):1489–1492. doi:10.1016/j.ajic.2019.05.024
7. Koeppen M, Weinert F, Oehlschlaeger S, Koerner A, Rosenberger P, Haeberle HA. Needle-free connectors catheter-related bloodstream infections: a prospective randomized controlled trial. *Intensive Care Med Exp.* 2019;7(1):63. doi:10.1186/s40635-019-0277-7
8. Kuntz MT, Dudaryk R, McNeer RR. Can variable practice habits and injection port dead-volume put patients at risk? *J Clin Monit Comput.* 2019;33(4):549-556. doi:10.1007/s10877-018-0179-3
9. Marschall J, Mermel LA, Fakih M, et al; Society for Healthcare Epidemiology of America. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(7):753-771.
10. Nandy P, Young M, Haugen SP, et al. Evaluation of one-way valves used in medical devices for prevention of cross-contamination. *Am J Infect Control.* 2017;45(7):793-798. doi:10.1016/j.ajic.2017.02.015
11. Rosenthal VD. Clinical impact of needle-free connector design: a systematic review of literature [published online ahead of print Feb 14, 2020]. *J Vasc Access.* 2020;1129729820904904. doi:10.1177/1129729820904904
12. Rosenthal VD. Impact of needle-free connectors compared with 3-way stopcocks on catheter-related bloodstream infection rates: a meta-analysis. *Am J Infect Control.* 2020;48(3):281-284. doi:10.1016/j.ajic.2019.08.015
13. Sengul T, Guven B, Ocakci AF, Kaya N. Connectors as a risk factor for blood-associated infections (3-way stopcock and needleless connector): a randomized-experimental study. *Am J Infect Control*. 2020;48(3):275-280. doi:10.1016/j.ajic.2019.08.020
14. Devrim İ. Letter to the Editor regarding "Connectors as a risk factor for blood-associated infections (3-way stopcock and needleless connector): a randomized-experimental study." *Am J Infect Control*. 2020;48(3):351–352. doi:10.1016/j.ajic.2019.10.026
15. Sengul T, Guven B, Ocakci AF, Kaya N. Response to a Letter to the Editor regarding "Connectors as a risk factor for blood-associated infections (3-way stopcock and needleless connector): a randomized-experimental study." *Am J Infect Control.* 2020;48(3):350–351. doi:10.1016/j.ajic.2019.11.001
16. US Food and Drug Administration. Tips for health care providers to reduce medical device misconnections. Published December 13, 2017. https://www.fda.gov/medical-devices/medical-device-connectors/tips-health-care-providers-reduce-medical-device-misconnections
17. US Food and Drug Administration. Medical device connectors. Published September 7, 2018. https://www.fda.gov/medical-devices/general-hospital-devices-and-supplies/medical-device-connectors
18. Weberding NT, Saladino RA, Minnigh MB, et al. Adenosine administration with a stopcock technique delivers lower-than-intended drug doses. *Ann Emerg Med.* 2018;71(2):220-224. doi:10.1016/j.annemergmed.2017.09.002
19. Sandora TJ, Graham DA, Conway M, Dodson B, Potter-Bynoe G, Margossian SP. Impact of needleless connector change frequency on central line-associated bloodstream infection rate. *Am J Infect Control*. 2014;42(5):485-489.
20. Alexander M, Gorski L, Corrigan A, Bullock M, Dickenson A, Earhart A. Technical and clinical application. In: Alexander M, Corrigan A, Gorski L, Phillips L, eds. *Core Curriculum for Infusion Nursing*. 4th ed. Wolters Kluwer/Lippincott Williams & Wilkins; 2014:1-85.
21. O'Grady NP, Alexander M, Burns LA, et al. *Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011.* Centers for Disease Control and Prevention; 2011:51-57. Updated October 2017. https://www.cdc.gov/infectioncontrol/pdf/guidelines/bsi-guidelines-H.pdf

38. VASCULAR ACCESS DEVICE SECUREMENT

KEY DEFINITIONS

Adhesive securement device (ASD): an adhesive-backed device that adheres to the skin with a mechanism to hold the VAD in place; a separate dressing is placed over the ASD. Both the dressing and ASD must be removed and replaced at specific intervals during the VAD dwell time.

Integrated securement device (ISD): a device that combines a dressing with securement functions; includes transparent, semipermeable window and a bordered fabric collar with built-in securement technology.

Subcutaneous anchor securement system (SASS): a securement device that anchors the VAD in place via flexible feet/posts that are placed just beneath the skin; these act to stabilize the catheter right at the point of insertion. A separate dressing is placed over the SASS. The SASS does not need to be changed at regular intervals when the dressing is changed; it can remain in place if there are no associated complications.

Tissue adhesive (TA): a medical-grade cyanoacrylate glue that can seal the insertion site and temporarily bond the catheter to the skin at the point of insertion and under the catheter hub. TA should be reapplied at each dressing change.

Standard

38.1 VADs are secured to prevent complications associated with VAD motion at the insertion site and unintentional loss of access.

38.2 Methods used to secure the VAD do not interfere with the ability to routinely assess and monitor the access site or impede vascular circulation or delivery of the prescribed therapy.

Practice Recommendations

A. Use a securement method (integrated securement device [ISD]; subcutaneous anchor securement system [SASS], tissue adhesive (TA) or adhesive securement device [ASD]), in addition to the primary dressing, to stabilize and secure VADs. Inadequate securement can cause unintentional dislodgement and complications requiring premature removal.
   1. Additional securement as an adjunct to the primary dressing reduces motion at the insertion site and subsequent complications that interrupt necessary infusion therapy; decreases pain, fear, and anxiety related to VAD replacement; and reduces the overall cost of health care.[1-12] (I)

B. Choose the most appropriate method for VAD securement based upon factors including VAD type, patient age, skin turgor and integrity, anticipated duration of therapy, previous adhesive skin injury, and any type of drainage from the insertion site.[1-7] (II)

C. Avoid use of sutures as they are not effective alternatives to a securement method; sutures are associated with needlestick injury, support the growth of biofilm, and increase the risk of CABSI.[6-12] (II)

D. Evaluate the effectiveness of a combination of securement measures to reduce complication and failure. More RCTs with appropriate sample sizes are needed to confirm this bundled approach.[6,9,11,13,14] (III)
   1. Avoid use of nonsterile tape; rolls of nonsterile tape can become contaminated with pathogenic bacteria.[15,16] (V)

E. Evaluate the use of securement options such as TA in addition to a primary dressing or an ISD for enhanced catheter stabilization for short PIVCs. Although sample sizes are small, both have demonstrated reduced rates of failure in adults and pediatric patients and in some studies prolonged the PIVC dwell time.[12,17-19] (II)
   1. There is some evidence that additional securement, either an ISD or TA, for short PIVCs reduces complication rates. These small studies are inconclusive, and more large efficacy trials are needed.[2,9,11,13,17-21] (II)
   2. Two small studies (1 in adults and 1 in pediatric patients) did not show a reduction in complications and failure of short PIVCs when an ASD was used as an adjunct to the primary dressing.[8,19] (IV)
   3. Cyanoacrylate TA for securement has been studied in vitro, in animals, in pilot PIVC and arterial RCTs, and in 1 large superiority PIVC RCT. Conflicting results have been reported. Reduced failure and increased dwell time have been reported when TA is applied in addition to a transparent dressing with or without a border in PIVC pilot RCTs and observational studies in various patient populations; however, 1 superiority PIVC securement RCT in adult inpatients demonstrated no reduction in PIVC failure, concluding that more large RCTs are needed to confirm the safety and cost effectiveness of innovative dressing and securement methods.[2,12,17,18,20,22,23] (II)
   4. Use a securement method for long PIVCs and midline catheters.[24] (V, Committee Consensus)

F. Use a SASS, ISD, TA, or ASD for peripherally inserted central catheters (PICCs) as an alternative to sutures; they are considered to be safer than sutures and reduce risk of complications, including infection and dislodgement.[21,25-29] (I)
   1. Small pilot and observational studies report improved outcomes when securement methods including SASS, ISD, and TA are used compared to ASDs. More powered clinical trials are needed to confirm the safety and efficacy of various securement methods in all patient populations.[10,21,27,29-32] (II)

G. Evaluate the potential for clinical and fiscal efficacy of SASS for PICCs and CVADs, including both tunneled, cuffed and tunneled, noncuffed catheters in adult and pediatric patients.[25,27,28,32-34] (III)
   1. Studies comparing the use of ASD and SASS as effective and acceptable securement for PICCs; tunneled, cuffed; and tunneled, noncuffed CVADs are limited to 1 pilot RCT and several small descriptive studies. Single-center observational studies demonstrate SASS to be more effective than traditional sutures and ASD in preventing catheter failure, especially dislodgement in patients with altered skin integrity. Patient and clinician satisfaction with SASSs has been favorable; however, more powered clinical trials are needed to confirm clinical safety and efficacy.[25,27,28,35] (III)
   2. The National Institute for Clinical Excellence (NICE) in the United Kingdom advocates the potential patient safety and cost benefit of SASSs, particularly for use greater than 15 days, and also concludes that more robust trial design is required to confirm these outcomes.[27] (IV)

H. Assess the benefits of TA as an adjunct to the primary method of dressing and securement as it provides immediate hemostasis at the insertion site and prolongs the interval between VAD insertion and the first dressing change. The application of TA at the catheter insertion site has been demonstrated in in vivo trials, animal studies, and some small clinical trials to provide a barrier to microorganism growth on the catheter tip. Confirmatory clinical trials are inconclusive; a pediatric pilot RCT reported a reduction in catheter tip colonization; however, 1 large, adult RCT reported no reduction in microorganisms cultured on catheter tips, suggesting

more larger clinical RCTs are required to confirm these results.[2,12,17,20,21,31,36,37] (II)

1. For nontunneled CVADs inserted into veins of the neck and groin, the most effective method of dressing and securement remains challenging and unclear. Pilot trials undertaken in adult and pediatric patients in critical care units demonstrate that alternatives such as ISDs and TA used in conjunction with sutures might reduce failure compared to ASDs and traditional sutures alone; however, further trials are necessary.[6,7,36,38] (III)

I. Do not use rolled bandages, with or without elastic properties, as a primary method of VAD securement, as they do not adequately secure the VAD.
   1. A single tubular sleeve that can be easily removed to inspect the insertion site is preferred to a rolled bandage if additional security is required.[11] (IV)
   2. The presence of skin disorders that contradict the use of medical adhesives (ie, pediatric epidermolysis bullosa, toxic epidermal necrolysis, and burns) may necessitate the use of tubular gauze mesh rather than ASDs. Single-center observational studies demonstrate that the use of SASS might be effective and safe in this patient population; however, these studies are small, and close observation of this vulnerable patient group is recommended.[25,27,28] (III)

J. Assess the integrity of VAD securement with each dressing change and change the securement device according to the manufacturers' directions for use. Remove ASDs with each dressing change to allow for appropriate skin antisepsis and apply a new ASD. TA should be reapplied at each dressing change. A securement device designed to remain in place for the life of the VAD (eg, SASS) does not need to be removed and replaced regularly with each dressing change; however, it should be assessed during catheter care and management to ensure its integrity.[5-7,21,27,36,38] (I)

K. Be aware of the risk of catheter-associated skin injury.
   1. Assess skin when the securement device is changed; anticipate potential risk for skin injury due to age, joint movement, and presence of edema.[6,39,40] (III)
   2. Apply barrier solutions to skin prior to dressing and securement to reduce the risk of catheter-associated skin injury (see Standard 55, *Catheter-Associated Skin Injury*).[2,5,6,40,41] (II)

L. Never readvance a dislodged VAD into the vein. After assessment of the tip location, the infusion therapy, and other influencing factors, the VAD can be secured at the current location; however, removal, reinsertion at a new site, or exchange might be the most appropriate intervention if the catheter is no longer in an appropriate position for infusion of the required therapy (refer to Standard 54, *Central Vascular Access Device Malposition*).

REFERENCES

1. Barton A. Keeping up to date with catheter securement: an overview. *Br J Nurs.* 2016;25(14):S5-S6. doi:10.12968/bjon.2016.25.14.S5
2. Corley A, Marsh N, Ullman AJ, Rickard CM. Tissue adhesive for vascular access devices: who, what, where and when? *Br J Nurs.* 2017;26(19):S4-S17. doi:10.12968/bjon.2017.26.19.S4
3. Hitchcock J, Savine L. Medical adhesive-related skin injuries associated with vascular access. *Br J Nurs.* 2017;26(8):S4-S12. doi:10.12968/bjon.2017.26.8.S4
4. Inwood S. An exploration of the past, present and future of catheter securement. *Br J Nurs.* 2014;23(8):S26-S27. doi:10.12968/bjon.2014.23.Sup8.S26
5. Rickard C, Ullman A, Kleidon T, Marsh N. Ten tips for dressing and securement of IV device wounds. *Aust Nurs Midwifery J*. 2017;24(10):32-34.
6. Ullman AJ, Cooke ML, Mitchell M, et al. Dressing and securement for central venous access devices (CVADs): a Cochrane systematic review. *Int J Nurs Stud.* 2016;59:177-196. doi:10.1016/j.ijnurstu.2016.04.003
7. Mitchell ML, Ullman AJ, Takashima M, et al. Central venous access device securement and dressing effectiveness: the CASCADE pilot randomised controlled trial in the adult intensive care. *Aust Crit Care.* 2020;33(5)441-451. doi:10.1016/j.aucc.2019.10.002
8. Laudenbach N, Braun CA, Klaverkamp L, Hedman-Dennis S. Peripheral i.v. stabilization and the rate of complications in children: an exploratory study. *J Pediatr Nurs*. 2014;29(4):348-353. doi:10.1016/j.pedn.2014.02.002
9. Marsh N, Webster J, Mihala G, Rickard CM. Devices and dressings to secure peripheral venous catheters: a Cochrane systematic review and meta-analysis. *Int J Nurs Stud*. 2017;67:12-19. doi:10.1016/j.ijnurstu.2016.11.007
10. Waterhouse J, Bandisode V, Brandon D, Olson M, Docherty SL. Evaluation of the use of a stabilization device to improve the quality of care in patients with peripherally inserted central catheters. *AACN Adv Crit Care.* 2014;25(3):213-220. doi:10.1097/NCI.0000000000000026
11. Corley A, Ullman AJ, Mihala G, Ray-Barruel G, Alexandrou E, Rickard CM. Peripheral intravenous catheter dressing and securement practice is associated with site complications and suboptimal dressing integrity: a secondary analysis of 40,637 catheters. *Int J Nurs Stud.* 2019;100:103409. doi:10.1016/j.ijnurstu.2019.103409
12. Kleidon TM, Rickard CM, Gibson V, et al. SMILE - Secure My Intravenous Line Effectively: a pilot randomised controlled trial of peripheral intravenous catheter securement in paediatrics. *J Tissue Viability*. 2020;29(2):82-90. doi:10.1016/j.jtv.2020.03.006
13. Indarwati F, Mathew S, Munday J, Keogh S. Incidence of peripheral intravenous catheter failure and complications in paediatric patients: systematic review and meta analysis. *Int J Nurs Stud.* 2020;102:103488. doi:10.1016/j.ijnurstu.2019.103488
14. Biasucci DG, Pittiruti M, Taddei A, et al. Targeting zero catheter-related bloodstream infections in pediatric intensive care unit: a retrospective matched case-control study. *J Vasc Access.* 2018;19(2):119-124. doi:10.5301/jva.5000797
15. Lalayanni C, Baliakas P, Xochelli A, et al. Outbreak of cutaneous zygomycosis associated with the use of adhesive tape in haematology patients. *J Hosp Infect.* 2012;81(3):213-215. doi:10.1016/j.jhin.2012.04.007
16. McClusky J, Davis M, Dahl K. A gap in patient tape storage and use practices puts patients at risk for cutaneous fungal infections. *Am J Infect Control*. 2015;43(2):182-184. doi:10.1016/j.ajic.2014.10.028
17. Bugden S, Shean K, Scott M, et al. Skin glue reduces the failure rate of emergency department-inserted peripheral intravenous catheters: a randomized controlled trial. *Ann Emerg Med.* 2016;68(2):196-201. doi:10.1016/j.annemergmed.2015.11.026
18. Marsh N, Larsen E, Genzel J, et al. A novel integrated dressing to secure peripheral intravenous catheters in an adult acute hospital: a

pilot randomised controlled trial. *Trials.* 2018;19(1):596. doi:10.1186/s13063-018-2985-9

19. Marsh N, Webster J, Flynn J, et al. Securement methods for peripheral venous catheters to prevent failure: a randomised controlled pilot trial. *J Vasc Access*. 2015;16(3):237-244. doi:10.5301/jva.5000348
20. Rickard CM, Marsh N, Webster J, et al. Dressings and Securements for the Prevention of Peripheral Intravenous Catheter Failure in Adults (SAVE): a pragmatic, randomised controlled, superiority trial. *Lancet.* 2018;392(10145):419-430. doi:10.1016/S0140-6736(18)31380-1
21. Kleidon TM, Ullman AJ, Gibson V, et al. A pilot randomized controlled trial of novel dressing and securement techniques in 101 pediatric patients. *J Vasc Interv Radiol.* 2017;28(11):1548-1556.e1. doi:10.1016/j.jvir.2017.07.012
22. Guido A, Zhang S, Yang C, Pook L. An innovative cyanoacrylate device developed to improve the current standard of care for intravascular catheter securement. *J Vasc Access*. 2020;21(3):293-299. doi:10.1177/1129729819872881
23. Schults JA, Long D, Pearson K, et al. Insertion, management, and complications associated with arterial catheters in paediatric intensive care: a clinical audit. *Aust Crit Care*. 2020;33(4):326-332. doi:10.1016/j.aucc.2019.05.003
24. Ventura R, O'Loughlin C, Vavrik B. Clinical evaluation of a securement device used on midline catheters. *Br J Nurs.* 2016;25(14):S16-S22. doi:10.12968/bjon.2016.25.14.S16
25. Dolcino A, Salsano A, Dato A, et al. Potential role of a subcutaneously anchored securement device in preventing dislodgment of tunneled-cuffed central venous devices in pediatric patients. *J Vasc Access.* 2017;18(6):540-545. doi:10.5301/jva.5000780
26. Luo X, Guo Y, Yu H, Li S, Yin X. Effectiveness, safety and comfort of StatLock securement for peripherally-inserted central catheters: a systematic review and meta-analysis. *Nurs Health Sci*. 2017;19(4):403-413. doi:10.1111/nhs.12361
27. Macmillan T, Pennington M, Summers JA, et al. SecurAcath for securing peripherally inserted central catheters: a nice medical technology guide. *Appl Health Econ Health Policy.* 2018;16(6):779-791. doi:10.1007/s40258-018-0427-1
28. Pittiruti M, Scoppettuolo G, Dolcetti L, et al. Clinical experience of a subcutaneously anchored sutureless system for securing central venous catheters. *Br J Nurs*. 2019;28(2):S4-S14. doi:10.12968/bjon.2019.28.2.S4
29. Ralph Webber JL, Maningo-Salinas MJ. "Sticking it to them"—reducing migration of peripherally inserted central catheters. *J Assoc Vasc Access.* 2020;25(1):10-15. https://doi.org/10.2309/j.java.2020.001.004
30. Rickard CM, Marsh NM, Webster J, et al. Peripherally InSerted CEntral catheter dressing and securement in patients with cancer: the PISCES trial. protocol for a 2x2 factorial, superiority randomised controlled trial. *BMJ Open.* 2017;7(6):e015291. doi:10.1136/bmjopen-2016-015291
31. Chan RJ, Northfield S, Larsen E, et al. Central venous Access device SeCurement And Dressing Effectiveness for peripherally inserted central catheters in adult acute hospital patients (CASCADE): a pilot randomised controlled trial. *Trials.* 2017;18(1):458. doi:10.1186/s13063-017-2207-x
32. Goossens GA, Grumiaux N, Janssens C, et al. SecurAstaP trial: securement with SecurAcath versus StatLock for peripherally inserted central catheters, a randomised open trial. *BMJ Open.* 2018;8(2):e016058. doi:10.1136/bmjopen-2017-016058
33. Zerla PA, Canelli A, Cerne L, et al. Evaluating safety, efficacy, and cost-effectiveness of PICC securement by subcutaneously anchored stabilization device. *J Vasc Access.* 2017;18(3):238-242. doi:10.5301/jva.5000655
34. McParlan D, Edgar L, Gault M, Gillespie S, Menelly R, Reid M. Intravascular catheter migration: a cross-sectional and health-economic comparison of adhesive and subcutaneous engineered stabilisation devices for intravascular device securement. *J Vasc Access.* 2020;21(1):33-38. doi:10.1177/1129729819851059
35. Pinelli F, Pittiruti M, Van Boxtel T, et al. GAVeCeLT-WoCoVA consensus on subcutaneously anchored securement devices for the securement of venous catheters: current evidence and recommendations for future research [published online ahead of print Jul 2, 2020]. *J Vasc Access.* 2020;1129729820924568. doi:10.1177/1129729820924568
36. Ullman AJ, Long D, Williams T, et al. Innovation in central venous access device security: a pilot randomized controlled trial in pediatric critical care. *Pediatr Crit Care Med.* 2019;20(10):e480-e488. doi:10.1097/PCC.0000000000002059
37. Prince D, Solanki Z, Varughese R, Mastej J, Prince D. Antibacterial effect and proposed mechanism of action of a topical surgical adhesive. *Am J Infect Control*. 2018;46(1):26-29. doi:10.1016/j.ajic.2017.07.008
38. Rickard CM, Edwards M, Spooner AJ, et al. A 4-arm randomized controlled pilot trial of innovative solutions for jugular central venous access device securement in 221 cardiac surgical patients. *J Crit Care*. 2016;36:35-42. doi:10.1016/j.jcrc.2016.06.006
39. Broadhurst D, Moureau N, Ullman AJ; World Congress of Vascular Access (WoCoVA) Skin Impairment Management Advisory Panel. Management of central venous access device-associated skin impairment: an evidence-based algorithm. *J Wound Ostomy Continence Nurs.* 2017;44(3):211-220. doi:10.1097/WON.0000000000000322
40. Ullman AJ, Kleidon TM, Turner K, et al. Skin complications associated with pediatric central venous access devices: prevalence, incidence, and risk. *J Pediatr Oncol Nurs*. 2019;36(5):343-351. doi:10.1177/1043454219849572
41. Ullman AJ, Mihala G, O'Leary K, et al. Skin complications associated with vascular access devices: a secondary analysis of 13 studies involving 10,859 devices. *Int J Nurs Stud*. 2019;91:6-13. doi:10.1016/j.ijnurstu.2018.10.006

39. JOINT STABILIZATION

Standard

39.1 Joint stabilization devices, such as an arm board or splint, are used to facilitate infusion delivery, maintain device functionality, and minimize infusion therapy complications and are not considered restraints.

Practice Recommendations

A. The joint stabilization device is:
   1. Used to facilitate infusion delivery, maintain device functionality, and minimize complications; however, avoid use if possible due to restricted movement of the stabilized body part.[1-4] (III)
   2. Padded as needed and supports the area of flexion (eg, hand, arm, elbow, foot) in order to maintain a functional position.[5-7] (A/P)
   3. Applied in a manner that permits visual inspection and assessment of the vascular access site and vascular pathway and does not exert pressure that will cause circulatory constriction, pressure injury, or nerve damage in the area of flexion or under the device.[3, 5-10] (A/P, IV)
   4. Used when a PIVC is placed in the antecubital fossa. This site is not recommended, but if a PIVC is present, the joint is stabilized.[11] (V)

5. Considered for indwelling radial arterial catheters at areas of flexion.[12,13] (IV)
6. Removed periodically for assessment of circulatory status, range of motion and function, and skin integrity.[3, 5-7] (A/P, IV)

B. Do not use wooden tongue depressors as joint stabilization devices in preterm infants or immunocompromised individuals due to the risk of a fungal infection.[14] (IV)

REFERENCES

Note: All electronic references in this section were accessed between April 14, 2020, and September 2, 2020.

1. Ayat-Isfahani F, Pashang M, Davoudi B, Sadeghian S, Jalali A. Effects of injection-site splinting on the incidence of phlebitis in patients taking peripherally infused amiodarone: a randomized clinical trial. *J Vasc Nurs*. 2017;35(1):31-35. doi:10.1016/j.jvn.2016.11.001
2. Bilal S. Question 1: does use of a splint increase the functional duration of cannulae in neonates? *Arch Dis Child.* 2014;99(7):694-695. doi:10.1136/archdischild-2013-305928
3. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health*. 2019;55(10):1214-1223. doi:10.1111/jpc.14384
4. Ullman AJ, Takashima M, Kleidon T, Ray-Barruel G, Alexandrou E, Rickard CM. Global pediatric peripheral intravenous catheter practice and performance: a secondary analysis of 4206 catheters. *J Pediatr Nurs.* 2020;50:e18-e25. doi:10.1016/j.pedn.2019.09.023
5. Haesler E, ed. *Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline 2019.* 3rd ed. European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel, Pan Pacific Pressure Injury Alliance; 2019:181-189, 191-193. http://www.internationalguideline.com/guideline
6. Kyle T, Carman S. Key pediatric nursing interventions. In: Kyle T, Carman S, eds. *Essentials of Pediatric Nursing.* 4th ed. Wolters Kluwer; 2021:chap 13.
7. Morgan S. Structure and function of the musculoskeletal system. In: Norris TL, ed. *Porth's Essentials of Pathophysiology.* 5th ed. Wolters Kluwer; 2020:chap 47.
8. Haldar R, Kaushal A, Srivastava S, Singh PK. Paediatric intravenous splint: a cause of pressure injury during neurosurgery in prone position. *Pediatr Neurosurg*. 2016;51(1):55–56. doi:10.1159/000441062
9. Schlüer AB, Schols JM, Halfens RJ. Risk and associated factors of pressure ulcers in hospitalized children over 1 year of age. *J Spec Pediatr Nurs.* 2014;19(1):80-89. doi:10.1111/jspn.12055
10. Visscher M, Taylor T. Pressure ulcers in the hospitalized neonate: rates and risk factors. *Sci Rep.* 2014;4:7429. doi:10.1038/srep07429
11. Gorski LA. Peripheral I.V. catheters: initiation and maintenance of peripheral infusion therapy. In: Gorski LA, ed. *Phillips's Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 7th ed. F.A. Davis; 2018:262-328.
12. Schults JA, Long D, Pearson K, et al. Insertion, management, and complications associated with arterial catheters in paediatric intensive care: a clinical audit. *Aust Crit Care.* 2020;33(4):326-332. doi:10.1016/j.aucc.2019.05.003
13. Theodore AC, Clermont G, Dalton A. Indications, interpretation, and techniques for arterial catheterization for invasive monitoring. UpToDate.com. Updated August 18, 2020. Accessed August 25, 2020. https://www.uptodate.com/contents/indications-interpretation-and-techniques-for-arterial-catheterization-for-invasive-monitoring#H3881874139
14. Akl KF. Misuse of the wooden tongue depressor. *Indian J Pediatr.* 2010;77(5):579. doi:10.1007/s12098-010-0026-0

40. SITE PROTECTION

Standard

40.1 Site protection and/or physical immobilization devices (eg, clear VAD covers and mitts) are used to protect VADs or VAD sites, thus maintaining infusion therapy and device functionality.
40.2 The use of physical immobilization devices (eg, restraints) to protect VADs or VAD sites is not routinely implemented except for nonviolent behavior that hinders medical treatment, such as infusion therapy.

Practice Recommendations

A. Use site protection and/or physical immobilization devices for specific patient populations, including pediatric, elderly, or those with cognitive dysfunction at risk for the VAD being accidentally dislodged or removed.[1-7] (IV)
B. The site protection and/or physical immobilization devices are:
   1. Selected based on an assessment of the patient's physical, behavioral, cognitive, and psychological status and/or need for temporary VAD site protection from water, other contaminants, or movement due to activities of daily living. Consider VAD site or line protection methods for the duration of the VAD and, if all other measures have been tried or have failed, physical immobilization devices (eg, soft devices restraining a hand or hands).[1-5,7] (III)
   2. Used in a manner that permits visual inspection and assessment of the vascular access site and vascular pathway and does not exert pressure that will cause circulatory constriction, pressure injuries, or nerve damage under the device, and in accordance with manufacturers' directions for use. Physical immobilization devices should be distal to the VAD site so circulation is not impeded. The site protection method or selected immobilization device should not interfere with the prescribed infusion rate, delivery method, or catheter securement.[2,5,8-10] (A/P, IV)
   3. Removed at established intervals to allow assessment of the extremity's circulatory status and provide an opportunity for supervised range-of-motion activities.[8,11] (A/P)
C. Assess regularly the need for the physical immobilization device and discontinue it as soon as the patient's condition allows.[5,7,11] (V)
D. Educate the patient/caregiver on the need for and appropriate use of physical immobilization devices (refer to Standard 8, *Patient Education*).
E. Document, at a minimum, the rationale for the physical immobilization device; type and location of the immobilization device; release and reapplication of the device; frequency of and findings from site and circulatory assessment; any complications caused by the immobilization device; patient's response to the immobilization device; reassessment of need for the immobilization

device; patient education; and removal of the device.[7,11,12] (V)

REFERENCES

Note: All electronic references in this section were accessed between April 14, 2020, and September 2, 2020.

1. Balmforth JE, Thomas AN. Unplanned removal of medical devices in critical care units in North West England between 2011 and 2016. *Am J Crit Care*. 2019;28(3):213-221. doi:10.4037/ajcc2019961
2. Büyükyılmaz F, Şahiner NC, Cağlar S, Eren H. Effectiveness of an intravenous protection device in pediatric patients on catheter dwell time and phlebitis score. *Asian Nurs Res (Korean Soc Nurs Sci)*. 2019;13(4):236-241.
3. Fariña-López E, Estévez-Guerra GJ, Polo-Luque ML, Hanzeliková Pogrányivá A, Penelo E. Physical restraint use with elderly patients: perceptions of nurses and nursing assistants in Spanish acute care hospitals. *Nurs Res*. 2018;67(1):55-59. doi:10.1097/NNR.0000000000000252
4. Galazzi A, Adamini I, Consonni D, et al. Accidental removal of devices in intensive care unit: an eight-year observational study. *Intensive Crit Care Nurs.* 2019;54:34-38. doi:10.1016/j.iccn.2019.06.002
5. Hevener S, Rickabaugh B, Marsh T. Using a decision wheel to reduce use of restraints in a medical-surgical intensive care unit. *Am J Crit Care*. 2016;25(6):479-486. doi:10.4037/ajcc2016929
6. Indarwati F, Mathew S, Munday J, Keogh S. Incidence of peripheral intravenous catheter failure and complications in paediatric patients: systematic review and meta analysis. *Int J Nurs Stud*. 2020;102:103488. doi:10.1016/j.ijnurstu.2019.103488
7. Luk E, Burry L, Rezaie S, Mehta S, Rose L. Critical care nurses' decisions regarding physical restraints in two Canadian ICUs: a prospective observational study. *Can J Crit Care Nurs*. 2015;26(4):16-22.
8. Haesler E, ed. *Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline 2019*. 3rd ed. European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel, Pan Pacific Pressure Injury Alliance; 2019:181-193. http://www.internationalguideline.com/guideline
9. Kirk AP, McGlinsey A, Beckett A, Rudd P, Arbour R. Restraint reduction, restraint elimination, and best practice: role of the clinical nurse specialist in patient safety. *Clin Nurse Spec*. 2015;29(6):321-328. doi:10.1097/NUR.0000000000000163
10. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. *Am J Infect Control*. 2011;39(4 Suppl 1):S12-S13. doi:10.1016/j.ajic.2011.01.003
11. Lippincott. Restraint application. In: Lippincott, eds. *Lippincott® Nursing Procedures*. 8th ed. Kindle e-Book. Wolters Kluwer; 2019.
12. Clark JS. Documentation review tool for patients in restraints or seclusion. HCPro.com. *HIM Briefings*. 2019;34(10):10-11.

41. FLUSHING AND LOCKING

Standard

41.1 VADs are flushed and aspirated for a blood return prior to each infusion to assess catheter function and prevent complications.

41.2 VADs are flushed after each infusion to clear the infused medication from the catheter lumen, thereby reducing the risk of contact between incompatible medications.

41.3 Each VAD lumen is locked after completion of the final flush to decrease the risk of intraluminal occlusion, depending on the solution used, to reduce CABSI.

41.4 Standardized protocols for flushing and locking solutions are established within each organization.

Practice Recommendations

A. Use single-dose systems (eg, single-dose vials or prefilled labeled syringes) for all VAD flushing and locking.[1,2] (IV)
   1. A syringe or needle/cannula should be considered contaminated once it has been used to enter or connect to a patient's IV solution container or administration set.[1] (V)
   2. Use commercially available prefilled syringes to reduce the risk of CABSI, save time for syringe preparation, and aid optimal flushing technique and objectives.[3-10] (II)
   3. If multidose vials must be used, dedicate a vial to a single patient. Do not store multidose vials in patient treatment areas and store according to manufacturers' directions for use; discard if sterility is compromised or questionable.[1,11] (V)
   4. Do not use IV solution containers (eg, bags or bottles) as a source for obtaining flush solutions.[2,12] (V)
   5. Inform patients that prefilled flush syringes are associated with disturbances in taste and odor, which has been found to be more prominent with flushing CVADs than with PIVCs. The cause is thought to be substances leaching from the plastic syringe due to sterilization methods. These sensations may be significant enough to impact appetite and may increase nausea, especially if administered rapidly.[13-16] (II)

B. Disinfect connection surfaces (ie, needleless connectors, injection ports) before flushing and locking procedures (refer to Standard 36, *Needleless Connectors*).

C. Flush all VADs with preservative-free 0.9% sodium chloride.[17] (V)
   1. Use a minimum volume equal to twice the internal volume of the catheter system (eg, catheter plus add-on devices). Larger volumes (eg, 5 mL for PIVC, 10 mL for CVADs) may remove more fibrin deposits, drug precipitate, and other debris from the lumen. Factors to consider when choosing the flush volume include the type and size of catheter, age of the patient, and type of infusion therapy being given. Infusion of blood components, blood sampling, PN, contrast media, and other viscous solutions may require larger flush volumes.[7,18-22] (IV)
   2. If bacteriostatic 0.9% sodium chloride is used, limit flush volume to no more than 30 mL in a 24-hour period to reduce the possible toxic effects of the preservative, benzyl alcohol.[23] (V)
   3. Use only preservative-free solutions for flushing all VADs in neonates and infants to prevent toxicity.[24,25] (V)
   4. Use 5% dextrose in water followed by preservative-free 0.9% sodium chloride when the medication is incompatible with sodium chloride. Do not allow dextrose to reside in the catheter lumen as it provides nutrients for biofilm growth.[26,27] (IV)

5. Never use sterile water for flushing VADs.[28] (V)

D. Assess VAD function using a 10-mL syringe or a syringe specifically designed to generate lower injection pressure (ie, 10-mL diameter syringe barrel), taking note of any resistance.[9,22] (III)
   1. During the initial flush, slowly aspirate the VAD for free-flowing blood return that is the color and consistency of whole blood, an important component of assessing catheter function prior to administration of medications and solutions (refer to Standard 49, *Central Vascular Access Device Occlusion*; Standard 54*, Central Vascular Access Device Malposition*).
   2. Do not forcibly flush any VAD with any syringe size. If resistance is met and/or no blood return noted, take further steps (eg, checking for closed clamps or kinked sets, removing dressing) to locate an external cause of the obstruction. Internal causes may require diagnostic tests, including, but not limited to, a chest radiograph to confirm tip location and mechanical causes (eg, pinch-off syndrome), color duplex ultrasound or fluoroscopy to identify thrombotic causes (see Standard 53, *Catheter-Associated Deep Vein Thrombosis*; Standard 54, *Central Vascular Access Device Malposition*).[18,19] (V)
   3. After confirming catheter patency, use an appropriately sized syringe for medication dose. Do not transfer the medication to a larger syringe.[4] (V)
   4. Do not use prefilled flush syringes for dilution of medications. Differences in gradation markings, an unchangeable label on prefilled syringes, partial loss of the drug dose, and possible contamination increase the risk of serious medication errors with syringe-to-syringe drug transfer (see Standard 20, *Compounding and Preparation of Parenteral Solutions and Medications*).[4,29] (V)

E. Flush the VAD lumen with preservative-free 0.9% sodium chloride following the administration of an IV push medication at the same rate of injection as the medication. Use an amount of flush solution to adequately clear the medication from the lumen of the administration set and VAD.[4,18,22] (V)

F. Use positive-pressure techniques to minimize blood reflux into the VAD lumen.[18,20,22,30,31] (I)
   1. Prevent syringe-induced blood reflux by leaving a small amount (eg, 0.5–1.0 mL) of flush solution in a traditional syringe (ie, not a prefilled syringe) to avoid compression of the plunger rod gasket or by using a prefilled syringe designed to prevent this type of reflux.[7,18] (IV)
   2. Prevent connection/disconnection reflux by using the appropriate sequence for flushing, clamping, and disconnecting determined by the type of needleless connector being used (refer to Standard 36, *Needleless Connectors*).
   3. Use a pulsatile flushing technique. In vitro studies have shown that 10 short boluses of 1-mL solution interrupted by brief pauses may be more effective at removing solid deposits (eg, fibrin, drug precipitate, intraluminal bacteria) compared to continuous low-flow techniques. Clinical studies are needed to provide more clarity on the true effect of this technique.[7,18,22,31,32] (III)
   4. Consider flushing all lumens of a multilumen catheter after obtaining blood samples to reduce the possibility of changing intraluminal pressure causing blood reflux into the other lumens. (Committee Consensus)
   5. Follow manufacturers' directions for use regarding clamping the VAD when not in use. Clamping can prevent contamination and exsanguination in the event of inadvertent disconnection of any set or add-on device. (Committee Consensus)

G. Lock short and long PIVCs and midline catheters immediately following each use.
   1. In adults, use preservative-free 0.9% sodium chloride for locking.[18,22,33-37] (I)
   2. In neonates and pediatric patients, use preservative-free 0.9% sodium chloride or heparin 0.5 to 10 units/mL. Outcome data in these patient populations are inconclusive.[17,25,34,38-43] (I)
   3. In 2 prospective cohort studies, intermittent flushing (locking) with 0.9% sodium chloride was associated with a lower rate of complication and similar duration of patency when compared to continuous infusion in PIVCs placed in newborns.[39,44] (IV)
   4. For PIVCs and midline catheters not being used for intermittent infusion, consider removal as soon as no longer required, but if they must be maintained, lock at least once every 24 hours.[38,39] (III)

H. Lock CVADs with either preservative-free 0.9% sodium chloride or heparin 10 units/mL according to the manufacturers' directions for use for the VAD and needleless connector.[7,18,19,22,32,41,45-49] (I)
   1. RCTs have shown equivalent outcomes with heparin and sodium chloride lock solutions for multilumen, nontunneled CVADs, PICCs, and implanted vascular access ports while accessed and when the access needle is removed. There is insufficient evidence to recommend one lock solution over another.[7,19,20,32,47,50] (II)
   2. Use heparin or preservative-free 0.9% sodium chloride for locking CVADs in children.[50] (II)
   3. Volume of the lock solution should equal the internal volume of the VAD and add-on devices plus 20%. Flow characteristics during injection will cause overspill into the bloodstream. Lock solution density is less than whole blood, allowing leakage of lock solution and ingress of blood into the catheter lumen when the CVAD tip location is higher than the insertion site.[18,19,22] (V)
   4. In one in vivo study using a pulsatile flow-loop model, an estimated 40% of the initial catheter locking solution was lost due to leakage during

instillation. Slower instillation may improve retention of the locking solution within the catheter.[51] (IV)

5. There is insufficient evidence to recommend the optimal frequency, solution, or volume to maintain the patency of implanted vascular access ports not accessed for infusion.
   a. Use at least 10 mL of 0.9% sodium chloride.
   b. Use of 0.9% sodium chloride alone may be as effective as heparin in maintaining patency.
   c. Extending maintenance flushing to every 3 months with 10 mL of 0.9% sodium chloride and 3 or 5 mL of heparin (100 units/mL) was found to be safe and effective in maintaining patency.
   d. Flush accessed but noninfusing implanted vascular access ports daily (see Standard 28, *Implanted Vascular Access Ports*).[52,53] (IV)
6. Inform patients of potential conflicts with religious beliefs when using heparin derived from animal products (eg, porcine, bovine) and obtain assent. Use preservative-free 0.9% sodium chloride instead of heparin when possible in this patient population.[54] (IV)

I. Lock hemodialysis CVADs with citrate or heparin lock solution; low-concentration citrate (<5%) is recommended to reduce the risk of CABSI and CVAD dysfunction; tissue plasminogen activator (tPA) may be used prophylactically once per week to reduce CVAD occlusion; the choice of locking solution is based upon clinician discretion due to inadequate evidence to demonstrate a difference between solutions (refer to Standard 29, *Vascular Access and Hemodialysis*).

J. General recommendations for maintaining patency in CVADs used for apheresis include high-concentration heparin and sodium citrate.
   1. Heparin-induced thrombocytopenia (HIT) was identified as a risk in patients with multiple myeloma who required stem cell harvesting for autotransplantation. An unusually high frequency of HIT was identified (4%). Refer to Standard 31, *Vascular Access and Therapeutic Apheresis*.

K. Use solution containing heparin (eg, 1 unit/mL of heparin) or preservative-free 0.9% sodium chloride as a continuous infusion to maintain patency of arterial catheters used for hemodynamic monitoring. The decision to use preservative-free 0.9% sodium chloride instead of heparin infusion should be based on the clinical risk of catheter occlusion, the anticipated length of time the arterial catheter will be required, and patient factors such as heparin sensitivities.[55-59] (I)

L. Apply the following recommendations for neonates and pediatric patients:
   1. Use a continuous infusion of heparin 0.5 units/kg for all CVADs in neonates. There is insufficient evidence to support use of intermittent heparin vs 0.9% sodium chloride in long-term CVADs in infants and children.[30,60] (I)
   2. Maintain patency and reduce risk of thrombosis by continuous infusion of heparin 0.25 to 1.00 unit/mL (total dose of heparin: 25–200 units/kg/d) for umbilical arterial catheters in neonates (refer to Standard 30, *Umbilical Catheters*).

M. Change to an alternative locking solution when the heparin lock solution is thought to be the cause of adverse drug reactions from heparin; when heparin-induced thrombocytopenia and thrombosis (HITT) develops; and when there are spurious laboratory studies drawn from the CVAD that has been locked with heparin. High concentrations of heparin used in hemodialysis catheters could lead to systemic anticoagulation. HIT has been reported with the use of heparin lock solutions, although the prevalence is unknown (see Standard 44, *Blood Sampling*).[18,25,61] (IV)

N. Use antimicrobial locking solutions for therapeutic and prophylactic purposes in patients with long-term CVADs in the following circumstances: patients with a history of multiple CABSIs, high-risk patient populations, and in facilities with unacceptably high rates of CVAD-associated BSI, despite implementation of other methods of infection prevention.[27,62-79] (II)
   1. There is insufficient evidence to indicate the optimal locking solution for long-term CVADs. Factors associated with increased risk of complication (eg, occlusion, infection, altered catheter integrity) in outpatients with CVADs include devices with more than 1 lumen, female gender, and administration of PN.[80-82] (II)
      a. Antibiotic lock solutions contain supratherapeutic concentrations of antibiotics and may be combined with heparin; however, heparin may stimulate *Staphylococcus aureus* biofilm formation. Anticipate the chosen antibiotic to be based on the specific infecting organism or on prevalent organisms within the organization when prophylaxis is the goal. For therapeutic use, start the antibiotic lock solutions within 48 to 72 hours of diagnosis; however, the optimal duration of use is not established.[18,62,64,83] (V)
      b. Antiseptic locking solutions include solutions used alone or in numerous combinations, including, but not limited to, ethanol, taurolidine, citrate, concentrated sodium chloride, and ethylenediaminetetraacetic acid (EDTA).[18,80,82,84-89] (II)
   2. Consult with pharmacy to assure that combination lock solutions are physically compatible, chemically stable, and produce the desired antimicrobial effect.[64,78] (IV)
   3. Consider and evaluate compatibility of the catheter material with the lock solution.
      a. While ethanol lock solution has been proven to be effective in eliminating bacterial growth within biofilm, it has also been associated with negative outcomes: altered catheter integrity, systemic symptoms, and plasma precipitation with potential for catheter occlusion. The impact on catheter integrity is related to the concentration of ethanol

lock solution used and the duration of exposure to the catheter inner lumen.[27,70,73,81,82,89] (II)

4. Monitor sodium citrate, an anticoagulant with antimicrobial effects, for systemic anticoagulation, hypocalcemia that could produce cardiac arrest, and protein precipitate formation with concentrations greater than 12%.[19,90] (III)
   a. Monitor trisodium citrate for protein precipitation, which could cause lumen occlusion.[91] (V)
5. The length of time that antimicrobial lock solutions should reside inside the CVAD lumen is inconclusive; up to 12 hours per day may be required, thus limiting use in patients receiving continuous or frequent intermittent infusions.[18,64] (V)
6. Aspirate all antimicrobial locking solutions from the CVAD lumen at the end of the locking period. Do not flush the lock solution into the patient's bloodstream, as this could increase development of antibiotic resistance and other adverse effects. Gentamicin-resistant bacteria from gentamicin lock solution have been reported to increase CABSI rates.[19,64] (V)

REFERENCES

Note: All electronic references in this section were accessed between July 14, 2019, and September 2, 2020.

1. Centers for Disease Control and Prevention. One & only campaign. https://www.cdc.gov/injectionsafety/one-and-only.html
2. Institute for Safe Medications Practices. Two unsafe practices: administration of a product with a precipitate and reuse of a saline flush syringe. Published April 6, 2017. https://www.ismp.org/resources/two-unsafe-practices-administration-product-precipitate-and-reuse-saline-flush-syringe
3. Keogh S, Marsh N, Higgins N, Davies K, Rickard C. A time and motion study of peripheral venous catheter flushing practice using manually prepared and prefilled flush syringes. *J Infus Nurs*. 2014;37(2):96-101. doi:10.1097/NAN.0000000000000024
4. Institute for Safe Medication Practices. ISMP safe practice guidelines for adult IV push medications: a compilation of safe practices from the ISMP Adult IV Push Medication Safety Summit. Institute for Safe Medication Practices; 2015. https://www.ismp.org/sites/default/files/attachments/2017-11/ISMP97-Guidelines-071415-3.%20FINAL.pdf
5. Devrim İ, Yaşar N, İşgüder R, et al. Clinical impact and cost-effectiveness of a central line bundle including split-septum and single-use prefilled flushing devices on central line-associated bloodstream infection rates in a pediatric intensive care unit. *Am J Infect Control*. 2016;44(8):e125–e128. doi:10.1016/j.ajic.2016.01.038
6. Gerçeker GÖ, Sevgili SA, Yardımcı F. Impact of flushing with aseptic non-touch technique using pre-filled flush or manually prepared syringes on central venous catheter occlusion and bloodstream infections in pediatric hemato-oncology patients: a randomized controlled study. *Eur J Oncol Nurs*. 2018;33:78–84. doi:10.1016/j.ejon.2018.02.002
7. Pittiruti M, Bertoglio S, Scoppettuolo G, et al. Evidence-based criteria for the choice and the clinical use of the most appropriate lock solutions for central venous catheters (excluding dialysis catheters): a GAVeCeLT consensus. *J Vasc Access*. 2016;17(6):453–464. doi:10.5301/jva.5000576.
8. Rosenthal VD, Udwadia FE, Kumar S, et al. Clinical impact and cost-effectiveness of split-septum and single-use prefilled flushing device vs 3-way stopcock on central line-associated bloodstream infection rates in India: a randomized clinical trial conducted by the International Nosocomial Infection Control Consortium (INICC). *Am J Infect Control*. 2015;43(10):1040–1045. doi:10.1016/j.ajic.2015.05.042
9. Keogh S, Flynn J, Marsh N, Mihala G, Davies K, Rickard C. Varied flushing frequency and volume to prevent peripheral intravenous catheter failure: a pilot, factorial randomised controlled trial in adult medical-surgical hospital patients. *Trials*. 2016;17(1):348. doi:10.1186/s13063-016-1470-6
10. Saliba P, Cuervo G, Hornero A, et al. The impact of flushing with prefilled saline syringes on the incidence of peripheral venous catheter failure: a quasi-experimental study. *J Vasc Access*. 2020;21(4):490-496. doi:10.1177/1129729819888423
11. Institute for Safe Medications Practices. Alarming survey results from CDC: unsafe injection practices continue. Published October 5, 2017. https://www.ismp.org/resources/alarming-survey-results-cdc-unsafe-injection-practices-continue
12. Dolan SA, Arias KM, Felizardo G, et al. APIC position paper: safe injection, infusion, and medication vial practices in health care. *Am J Infect Control*. 2016;44(7):750-757. doi:10.1016/j.ajic.2016.02.033
13. Hamze B, Vaillancourt R, Sharp D, Villarreal G. A comparison of taste and odor perception in pediatric patients receiving a 0.9% sodium chloride flush from 2 different brands of prefilled 0.9% sodium chloride syringes. *J Infus Nurs*. 2016;39(1):18-24. doi:10.1097/NAN.0000000000000150
14. Chaveli-López B. Oral toxicity produced by chemotherapy: a systematic review. *J Clin Exp Dent*. 2014;6(1):e81-e90. doi:10.4317/jced.51337
15. Maheswaran T, Abikshyeet P, Sitra G, Gokulanathan S, Vaithiyanadane V, Jeelani S. Gustatory dysfunction. *J Pharm Bioallied Sci*. 2014;6(Suppl 1):S30-S33. doi:10.4103/0975-7406.137257
16. Mancini D, Vaillancourt R, Pouliot A, Lin A, Sharp D. Taste and odour disturbances in pediatric patients undergoing IV flush with normal saline administered by prefilled or freshly prepared syringes: randomized single-blind study. *Can J Hosp Pharm*. 2014;67(5):353-357. doi:10.4212/cjhp.v67i5.1389
17. Benner K, Lucas AJ. ASHP therapeutic position statement on the institutional use of 0.9% sodium chloride injection to maintain patency of peripheral indwelling intermittent infusion devices. *Am J Health Syst Pharm*. 2012;69(14):1252-1254. doi:10.2146/ajhp120076
18. Goossens GA. Flushing and locking of venous catheters: available evidence and evidence deficit. *Nurs Res Pract*. 2015;2015:985686. doi:10.1155/2015/985686
19. Lee KA, Ramaswamy RS. Intravascular access devices from an interventional radiology perspective: indications, implantation techniques, and optimizing patency. *Transfusion*. 2018;58(Suppl 1):549-557. doi:10.1111/trf.14501
20. Hawthorn A, Bulmer AC, Mosawy S, Keogh S. Implications for maintaining vascular access device patency and performance: application of science to practice. *J Vasc Access*. 2019;20(5):461-470. doi:10.1177/1129729818820200
21. Milani A, Mazzocco K, Gandini S, et al. Incidence and determinants of port occlusions in cancer outpatients: a prospective cohort study. *Cancer Nurs*. 2017;40(2):102-107. doi:10.1097/NCC.0000000000000357
22. Manuel B. Intravascular therapy: maintaining catheter lumen patency. *JBI Evidence Summary*. The Joanna Briggs Institute EBP Database; 2018.
23. Drugs.com website. Heparin lock flush solution. Updated February 20, 2020. https://www.drugs.com/pro/heparin-lock-flush-solution.html
24. US Food and Drug Administration. Hep Lock U/P Preservative Free (Heparin Lock Flush Solution, USP). Published March 1, 2019. https://www.accessdata.fda.gov/drugsatfda_docs/label/2005/017037s154,055,156lbl.pdf
25. Gahart B, Nazareno A, Ortega M. *Gahart's 2020 Intravenous Medications: A Handbook for Nurses and Health Professionals.* 36th ed. Elsevier; 2020.

26. Seneviratne CJ, Yip JW, Chang JW, Zhang CF, Samaranayake LP. Effect of culture media and nutrients on biofilm growth kinetics of laboratory and clinical strains of *Enterococcus faecalis*. *Arch Oral Biol*. 2013;58(10):1327-1334. doi:10.1016/j.archoralbio.2013.06.017
27. Duesing LA, Fawley JA, Wagner AJ. Central venous access in the pediatric population with emphasis on complications and prevention strategies. *Nutr Clin Pract*. 2016;31(4):490-501. doi:10.1177/0884533616640454
28. US Food and Drug Administration. Sterile water for injection, USP. Published September 2014. https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/018632s051lbl.pdf
29. Shastay A. Unsafe practice continues: reuse of a saline flush syringe. *Home Healthc Now*. 2019;37(3):176-177. doi:10.1097/NHH.0000000000000784
30. Bradford NK, Edwards RM, Chan RJ. Heparin versus 0.9% sodium chloride intermittent flushing for the prevention of occlusion in long term central venous catheters in infants and children: a systematic review. *Int J Nurs Stud*. 2016;59:51-59. doi:10.1016/j.ijnurstu.2016.02.014
31. Dal Molin A, Allara E, Montani D, et al. Flushing the central venous catheter: is heparin necessary? *J Vasc Access*. 2014;15(4):241-248. doi:10.5301/jva.5000225
32. Ferroni A, Gaudin F, Guiffant G, et al. Pulsative flushing as a strategy to prevent bacterial colonization of vascular access devices. *Med Devices (Auckl)*. 2014;7:379-383. doi:10.2147/MDER.S71217
33. Patidar AB, Choudhary M, Bindu K, Midha V. Comparative efficacy of heparin saline and normal saline flush for maintaining patency of peripheral intravenous lines: a randomized control trial. *Int J Health Sci Res*. 2014;4(3):159-166.
34. You T, Jiang J, Chen J, Xu W, Xiang L, Jiao Y. Necessity of heparin for maintaining peripheral venous catheters: a systematic review and meta-analysis. *Exp Ther Med*. 2017;14(2):1675-1684. doi:10.3892/etm.2017.4706
35. Wang R, Zhang MG, Luo O, et al. Heparin saline versus normal saline for flushing and locking peripheral venous catheters in decompensated liver cirrhosis patients: a randomized controlled trial. *Medicine (Baltimore)*. 2015;94(31):e1292. doi:10.1097/MD.0000000000001292
36. Xu L, Hu Y, Huang X, Fu J, Zhang J. Heparinized saline versus normal saline for maintaining peripheral venous catheter patency in China: an open-label, randomized controlled study. *J Int Med Res*. 2017;45(2):471-480. doi:10.1177/0300060516685203
37. Kumar M, Vandermeer B, Bassler D, Mansoor N. Low-dose heparin for prolonging the patency of peripheral intravenous catheters in adults–a systematic review and meta-analysis. *Int J Med*. 2014;2(1):13-21. http://dx.doi.org/10.14419/ijm.v2i1.2179
38. Schreiber S, Zanchi C, Ronfani L, et al. Normal saline flushes performed once daily maintain peripheral intravenous catheter patency: a randomised controlled trial. *Arch Dis Child*. 2015;100(7):700-703. doi:10.1136/archdischild-2014-307478
39. Stok D, Wieringa JW. Continuous infusion versus intermittent flushing: maintaining peripheral intravenous access in newborn infants. *J Perinatol*. 2016;36(10):870-873. doi:10.1038/jp.2016.94
40. Upadhyay A, Verma KK, Lal P, Chawla D, Sreenivas V. Heparin for prolonging peripheral intravenous catheter use in neonates: a randomized controlled trial. *J Perinatol*. 2015;35(4):274-277. doi:10.1038/jp.2014.203
41. Gunes A, Bramhagen AC. Heparin or sodium chloride for prolonging peripheral intravenous catheter use in children - a systematic review. *J Pediatr Nurs*. 2018;43:e92-e99. doi:10.1016/j.pedn.2018.08.001
42. Kumar M, Vandermeer B, Bassler D, Mansoor N. Low-dose heparin use and the patency of peripheral IV catheters in children: a systematic review. *Pediatrics*. 2013;131(3):e864-e872. doi:10.1542/peds.2012-2403
43. Bisogni S, Giusti F, Ciofi D, Festini F. Heparin solution for maintaining peripheral venous catheter patency in children: a survey of current practice in Italian pediatric units. *Issues Compr Pediatr Nurs*. 2014;37(2):122-135. doi:10.3109/01460862.2014.895562
44. Hoff R, Vervisch K, De Coen K, Smets K. Continuous infusion vs. intermittent flushing of peripheral cannulas in neonates using a needleless connector: a prospective cohort study. *J Perinat Med*. 2019;47(4):464-469. doi:10.1515/jpm-2018-0285
45. Heidari Gorji MA, Rezaei F, Jafari H, Yazdani Cherati J. Comparison of the effects of heparin and 0.9% sodium chloride solutions in maintenance of patency of central venous catheters. *Anesth Pain Med*. 2015;5(2):e22595. doi:10.5812/aapm.22595
46. Klein J, Jepsen A, Patterson A, Reich RR, Mason TM. Heparin versus normal saline: flushing effectiveness in managing central venous catheters in patients undergoing blood and marrow transplantation. *Clin J Oncol Nurs*. 2018;22(2):199-202. doi:10.1188/18.CJON.199-202
47. López-Briz E, Ruiz Garcia V, Cabello JB, Bort-Martí S, Carbonell Sanchis R, Burls A. Heparin versus 0.9% sodium chloride locking for prevention of occlusion in central venous catheters in adults. *Cochrane Database Syst Rev*. 2018;7(7):CD008462. doi:10.1002/14651858.CD008462.pub3
48. Zhong L, Wang HL, Xu B, et al. Normal saline versus heparin for patency of central venous catheters in adult patients - a systematic review and meta-analysis. *Crit Care*. 2017;21(1):5. doi:10.1186/s13054-016-1585-x
49. Smith SN, Moureau N, Vaughn VM, et al. Patterns and predictors of peripherally inserted central catheter occlusion: the 3P-O study. *J Vasc Interv Radiol*. 2017;28(5):749-756.e2. doi:10.1016/j.jvir.2017.02.005
50. Conway MA, McCollom C, Bannon C. Central venous catheter flushing recommendations: a systematic evidence-based practice review. *J Pediatr Oncol Nurs*. 2014;31(4):185-190. doi:10.1177/1043454214532028
51. Barbour MC, McGah PM, Ng CH, Clark AM, Gow KW, Aliseda A. Convective leakage makes heparin locking of central venous catheters ineffective within seconds: experimental measurements in a model superior vena cava. *ASAIO J*. 2015;61(6):701-709. doi:10.1097/MAT.0000000000000280
52. Diaz JA, Rai SN, Wu X, Chao JH, Dias AL, Kloecker GH. Phase II trial on extending the maintenance flushing interval of implanted ports. *J Oncol Pract*. 2017;13(1):e22-e28. doi:10.1200/JOP.2016.010843
53. Solinas G, Platini F, Trivellato M, Rigo C, Alabiso O, Galetto AS. Port in oncology practice: 3-monthly locking with normal saline for catheter maintenance, a preliminary report. *J Vasc Access*. 2017;18(4):325-327. doi:10.5301/jva.5000740
54. Eriksson A, Burcharth J, Rosenberg J. Animal derived products may conflict with religious patients' beliefs. *BMC Med Ethics*. 2013;14:48. doi:10.1186/1472-6939-14-48
55. Ziyaeifard M, Alizadehasl A, Aghdaii N, et al. Heparinized and saline solutions in the maintenance of arterial and central venous catheters after cardiac surgery. *Anesth Pain Med*. 2015;5(4):e28056. doi:10.5812/aapm28056
56. Nethathe G, Mbeki M. Heparin flush vs saline flush for use in the maintenance of adult ventral venous and intra-arterial catheters: potential harm, too little gain? *Southern African J Anesth Analg*. 2016;22(2):70-71. doi:10.1080/22201181.2016.1151172
57. Robertson-Malt S, Malt GN, Farquhar V, Greer W. Heparin versus normal saline for patency of arterial lines. *Cochrane Database Syst Rev*. 2014;2014(5):CD007364. doi:10.1002/14651858.CD007364.pub2
58. Tully R, McGrath B, Moore JA, Rigg J, Alexander P. Observational study of the effect of heparin-containing flush solutions on the incidence of arterial catheter occlusion. *J Intensive Care Soc*. 2014;15(3):213-215. https://doi.org/10.1177/175114371401500307
59. Monagle P, Chan AKC, Goldenberg NA, et al. Antithrombotic therapy in neonates and children: antithrombotic therapy and prevention of thrombosis. 9th ed. American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest*. 2012;141(2 Suppl):e737S-e801S. doi:10.1378/chest.11-2308

60. Onyeama SJ, Hanson SJ, Dasgupta M, Hoffmann RG, Faustino EV; Prophylaxis against thrombosis practice study investigators. Factors associated with continuous low-dose heparin infusion for central venous catheter patency in critically ill children worldwide. *Pediatr Crit Care Med*. 2016;17(8):e352-e361. doi:10.1097/PCC.0000000000000854

61. Mian H, Warkentin TE, Sheppard JI, et al. Autoimmune HIT due to apheresis catheter heparin flushes for stem cell harvesting before autotransplantation for myeloma. *Blood*. 2017;130(14):1679-1682. doi:10.1182/blood-2017-06-788679

62. Gudiol C, Nicolae S, Royo-Cebrecos C, et al. Administration of taurolidine-citrate lock solution for prevention of central venous catheter infection in adult neutropenic haematological patients: a randomised, double-blinded, placebo-controlled trial (TAURCAT). *Trials*. 2018;19(1):264. doi:10.1186/s13063-018-2647-y

63. Ares G, Hunter CJ. Central venous access in children: indications, devices, and risks. *Curr Opin Pediatr*. 2017;29(3):340-346. doi:10.1097/MOP.0000000000000485

64. Justo JA, Bookstaver PB. Antibiotic lock therapy: review of technique and logistical challenges. *Infect Drug Resist*. 2014;7:343-363. doi:10.2147/IDR.S51388

65. Freire MP, Pierrotti LC, Zerati AE, et al. Role of lock therapy for long-term catheter-related infections by multidrug-resistant bacteria. *Antimicrob Agents Chemother*. 2018;62(9):e00569-18. doi:10.1128/AAC.00569-18

66. Liu F, Hansra S, Crockford G, et al. Tetrasodium EDTA is effective at eradicating biofilms formed by clinically relevant microorganisms from patients' central venous catheters. *mSphere*. 2018;3(6):e00525-18. doi:10.1128/mSphere.00525-18

67. Boersma RS, Jie KS, Voogd AC, Hamulyak K, Verbon A, Schouten HC. Concentrated citrate locking in order to reduce the long-term complications of central venous catheters: a randomized controlled trial in patients with hematological malignancies. *Support Care Cancer*. 2015;23(1):37-45. doi:10.1007/s00520-014-2320-2

68. Taylor JE, Tan K, Lai NM, McDonald SJ. Antibiotic lock for the prevention of catheter-related infection in neonates. *Cochrane Database Syst Rev*. 2015;(6):CD010336. doi:10.1002/14651858.CD010336.pub2

69. Tsai HC, Huang LM, Chang LY, et al. Central venous catheter-associated bloodstream infections in pediatric hematology-oncology patients and effectiveness of antimicrobial lock therapy. *J Microbiol Immunol Infect*. 2015;48(6):639-646. doi:10.1016/j.jmii.2014.07.008

70. Rahhal R, Abu-El-Haija MA, Fei L, et al. Systematic review and meta-analysis of the utilization of ethanol locks in pediatric patients with intestinal failure. *JPEN J Parenter Enteral Nutr*. 2018;42(4):690-701. doi:10.1177/0148607117722753

71. Soman R, Gupta N, Suthar M, et al. Antibiotic lock therapy in the era of gram-negative resistance. *J Assoc Physicians India*. 2016;64(2):32-37.

72. van de Wetering MD, van Woensel JB, Lawrie TA. Prophylactic antibiotics for preventing gram positive infections associated with long-term central venous catheters in oncology patients. *Cochrane Database Syst Rev*. 2013;2013(11):CD003295. doi:10.1002/14651858.CD003295.pub3

73. McGrath E, Du W, Rajpurkar M. Preemptive ethanol lock therapy in pediatric hematology/oncology patients with catheter-associated bloodstream infection: impact on length of stay, cost, and catheter salvage. *Clin Pediatr (Phila)*. 2018;57(3):285-293. doi:10.1177/0009922817717327

74. Hogan S, Zapotoczna M, Stevens NT, Humphreys H, O'Gara JP, O'Neill E. In vitro approach for identification of the most effective agents for antimicrobial lock therapy in the treatment of intravascular catheter-related infections caused by staphylococcus aureus. *Antimicrob Agents Chemother*. 2016;60(5):2923-2931. doi:10.1128/AAC.02885-15

75. Norris LB, Kablaoui F, Brilhart MK, Bookstaver PB. Systematic review of antimicrobial lock therapy for prevention of central-line-associated bloodstream infections in adult and pediatric cancer patients. *Int J Antimicrob Agents*. 2017;50(3):308-317. doi:10.1016/j.ijantimicag.2017.06.013

76. Pliakos EE, Andreatos N, Ziakas PD, Mylonakis E. The cost-effectiveness of antimicrobial lock solutions for the prevention of central line-associated bloodstream infections. *Clin Infect Dis*. 2019;68(3):419-425. doi:10.1093/cid/ciy511

77. Vassallo M, Dunais B, Roger PM. Antimicrobial lock therapy in central-line associated bloodstream infections: a systematic review. *Infection*. 2015;43(4):389-398. doi:10.1007/s15010-015-0738-1

78. Wei Y, Yang JW, Boddu SH, Jung R, Churchwell MD. Compatibility, stability, and efficacy of vancomycin combined with gentamicin or ethanol in sodium citrate as a catheter lock solution. *Hosp Pharm*. 2017;52(10):685-690. doi:10.1177/0018578717726992

79. Sun Y, Wan G, Liang L. Taurolidine lock solution for catheter-related bloodstream infections in pediatric patients: a meta-analysis. *PLoS One*. 2020;15(4):e0231110. doi:10.1371/journal.pone.0231110

80. Spires SS, Rebeiro PF, Miller M, Koss K, Wright PW, Talbot TR. Medically attended catheter complications are common in patients with outpatient central venous catheters. *Infect Control Hosp Epidemiol*. 2018;39(4):439-444. doi:10.1017/ice.2018.8

81. Tan M, Lau J, Guglielmo BJ. Ethanol locks in the prevention and treatment of catheter-related bloodstream infections. *Ann Pharmacother*. 2014;48(5):607-615. doi:10.1177/1060028014524049

82. Noelting J, Jurewitsch B, Allard JP. Non-antibiotic antimicrobial catheter lock solutions in patients on home parenteral nutrition. *Nutrients*. 2018;10(9):1165. doi:10.3390/nu10091165

83. Gominet M, Compain F, Beloin C, Lebeaux D. Central venous catheters and biofilms: where do we stand in 2017? *APMIS*. 2017;125(4):365-375. doi:10.1111/apm.12665

84. Quirt J, Belza C, Pai N, et al. Reduction of Central line–associated bloodstream infections and line occlusions in pediatric intestinal failure patients receiving long-term parenteral nutrition using an alternative locking solution, 4% tetrasodium ethylenediaminetetraacetic acid [published online ahead of print Aug 7, 2020]. *JPEN J Parenter Enteral Nutr*. 2020;10.1002/jpen.1989. doi:10.1002/jpen.1989

85. Tribler S, Brandt CF, Petersen AH, et al. Taurolidine-citrate-heparin lock reduces catheter-related bloodstream infections in intestinal failure patients dependent on home parenteral support: a randomized, placebo-controlled trial. *Am J Clin Nutr*. 2017;106(3):839-848. doi:10.3945/ajcn.117.158964

86. Klek S, Szczepanek K, Hermanowicz A, Galas A. Taurolidine lock in home parenteral nutrition in adults: results from an open-label randomized controlled clinical trial. *JPEN J Parenter Enteral Nutr*. 2015;39(3):331-335. doi:10.1177/0148607114525804

87. Olthof ED, Versleijen MW, Huisman-de Waal G, Feuth T, Kievit W, Wanten GJ. Taurolidine lock is superior to heparin lock in the prevention of catheter related bloodstream infections and occlusions. *PLoS One*. 2014;9(11):e111216. doi:10.1371/journal.pone.0111216

88. Saunders J, Naghibi M, Leach Z, et al. Taurolidine locks significantly reduce the incidence of catheter-related blood stream infections in high-risk patients on home parenteral nutrition. *Eur J Clin Nutr*. 2015;69(2):282-284. doi:10.1038/ejcn.2014.32

89. Mermel LA, Alang N. Adverse effects associated with ethanol catheter lock solutions: a systematic review. *J Antimicrob Chemother*. 2014;69(10):2611-2619. doi:10.1093/jac/dku182

90. Winnicki W, Herkner H, Lorenz M, et al. Taurolidine-based catheter lock regimen significantly reduces overall costs, infection, and dysfunction rates of tunneled hemodialysis catheters. *Kidney Int*. 2018;93(3):753-760. doi:10.1016/j.kint.2017.06.026

91. Golestaneh L, Mokrzycki MH. Prevention of hemodialysis catheter infections: ointments, dressings, locks, and catheter hub devices. *Hemodial Int*. 2018;22(S2):S75-S82. doi:10.1111/hdi.12703

42. VASCULAR ACCESS DEVICE ASSESSMENT, CARE, AND DRESSING CHANGES

Standard

42.1 The entire infusion system, from the VAD insertion site to the solution container, is routinely assessed for system integrity, infusion accuracy, identification of complications, and expiration dates of the infusate, dressing, and administration set.

42.2 The necessity of the VAD is routinely assessed and is removed upon unresolved complication and when no longer necessary for treatment.

42.3 Site care, including skin antisepsis and dressing changes, is performed at established intervals and immediately if the dressing integrity becomes compromised (eg, lifted/detached on any border edge or within transparent portion of dressing; visibly soiled; presence of moisture, drainage, or blood) or compromised skin integrity is present under the dressing.

42.4 A sterile dressing, combined or integrated with a securement device appropriate for patient's condition and patient preference, is maintained on all peripheral and central VADs to protect the site, provide a microbial barrier, and promote skin health and VAD securement.

42.5 Aseptic Non Touch Technique (ANTT) is adhered to when providing site care and dressing changes on VADs.

Practice Recommendations

A. Implement a postinsertion care bundle in conjunction with a culture of safety and quality to reduce the risk of catheter-related infection during daily care and management (refer to Standard 50, *Infection*).

B. Assess and discuss with the patient's health care team the continuing need for the VAD on a daily basis (refer to Standard 45, *Vascular Access Device Removal*).

C. Assess the entire infusion system through visual inspection, from the solution container, progressing down the administration set to the patient and VAD insertion site with each infusion intervention.[1,2] (V)
   1. Assess VAD patency (refer to Standard 41, *Flushing and Locking*).
   2. Assess the VAD site and surrounding area, by palpation and inspection, including catheter pathway, for integrity of skin, dressing, and securement device.[1] (V)
      a. Identify signs of complications (eg, evidence of dislodgement, redness, tenderness, swelling, infiltration, induration, body temperature elevation, and drainage) by visual inspection and palpation through the dressing and through patient reports about any discomfort (eg, pain, paresthesias, numbness, or tingling). Refer to Section Seven: *Vascular Access Device Complications*.
      b. Remove nontransparent dressing to visually inspect site if patient has local tenderness or other signs of possible local infection; otherwise, use palpation for assessment.[1,2] (V)
      c. Measure the external CVAD length at each dressing change or when catheter dislodgement is suspected and compare to the external CVAD length documented at insertion (see Standard 10, *Documentation in the Health Record*; Standard 54, *Central Vascular Access Device Malposition*).[1,3] (V)
      d. Measure circumference of the extremity and compare to baseline measurement when clinically indicated to assess the presence of edema and possible catheter-associated deep vein thrombosis (CA-DVT) for midline catheters and PICCs (refer to Standard 10, *Documentation in the Health Record;* Standard 53, *Catheter-Associated Deep Vein Thrombosis*).

D. Assess VAD site, entire infusion system, and patient for signs of complications at a frequency dependent on patient factors, such as age, condition, and cognition; type/frequency of infusate; and health care setting:
   1. In inpatient and nursing facilities, assess CVADs with each infusion and at least daily.
   2. In inpatient and nursing facilities, assess PIVCs at least every 4 hours; every 1 to 2 hours for patients who are critically ill/sedated or have cognitive deficits; hourly for neonatal/pediatric patients; and more often for patients receiving infusions of vesicant medications.
   3. In outpatient or home care settings, assess VAD at every visit and teach the patient or caregiver to check the VAD site with each infusion or at least once per day or, for continuous PIVC infusions, every 4 hours during waking hours for signs of complications and to report signs/symptoms or altered dressing integrity immediately to their home care or other health care provider.[1-7] (V)

E. Assess the integrity of securement devices designed to remain in place for the life of the VAD (eg, SASS) with each dressing change (refer to Standard 38, *Vascular Access Device Securement*).

F. Change transparent semipermeable membrane (TSM) dressings at least every 7 days (except neonatal patients) or immediately if dressing integrity is disrupted (eg, lifted/detached on any border edge or within transparent portion of dressing; visibly soiled; presence of moisture, drainage, or blood) or compromised skin integrity is present under the dressing.[2,4,5,8-10] (III)
   1. In neonatal patients, perform dressing change as needed per patient or clinical indications due to risk of catheter dislodgement, patient discomfort, or skin injury.[10-14] (V)

G. Change sterile gauze at least every 2 days when inspection of the insertion site is necessary or if dressing integrity disrupted (eg, if damp, loosened, or visibly soiled); note that a gauze dressing underneath a TSM dressing is considered a gauze dressing, unless the site is not obscured (eg, to support wings of an implanted VAD noncoring needle).[5,14] (V)

H. Perform dressing changes on VADs, using either Standard-ANTT or Surgical-ANTT (based on ANTT risk assessment of ability to prevent touching Key-Sites and Key-Parts). See Standard 18, *Aseptic Non Touch Technique*.[5,15] (V)

I. Use a dressing change kit to standardize the procedure and improve time efficiency.[1,16] (V)

J. Prepare skin for optimal skin health and dressing adherence.
   1. Remove dressing and adhesive-based securement device, maintaining skin integrity and preventing VAD dislodgement (eg, avoiding rapid and/or vertical pulling or insufficient support of skin when removing the dressing). Use sterile gloves if there is a need to touch the insertion site, as this is a Key-Site in accordance with ANTT.[3,17,18] (V)
   2. Remove excess hair at the insertion site if needed to facilitate application of VAD dressings; use single-patient-use scissors or disposable-head surgical clippers; do not shave, as this may increase the risk for infection (refer to Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*).
   3. Perform skin antisepsis at VAD site (refer to Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*).
   4. Assess and protect skin integrity at VAD site with each dressing change (see Standard 55, *Catheter-Associated Skin Injury*).[3] (V)
      a. Anticipate potential risk for skin injury (eg, due to age, malnutrition, dehydration, dermatologic conditions, diabetes mellitus, radiation therapy, immunosuppression, joint movement, and presence of edema).[17,19-22] (V)
      b. Use a sterile alcohol-free skin barrier product, compatible with skin antiseptic agent, to protect at-risk skin (eg, elderly/neonates; race [African Americans]; patients with malnutrition, dehydration, dermatologic conditions, edema, diabetes mellitus, renal insufficiency, immunosuppression, hematologic malignancies; low/high humidity; radiation therapy; medications, such as antineoplastic agents, anti-inflammatories, long-term corticosteroid use, anticoagulants) and when using an adhesive-based securement method to prevent skin irritation and breakdown; allow to dry prior to dressing application. Silicone-based skin barrier films have been reported in use with neonates and premature infants, although this practice is off-label, and further research is required.[17,19,23-25] (II)
      c. Do not apply antimicrobial ointment to VAD insertion sites as part of routine catheter site care (exception: hemodialysis catheters). See Standard 29, *Vascular Access and Hemodialysis*.[5] (V)
      d. Evaluate the beneficial use of gum mastic liquid adhesive on adult patients when enhanced adhesive adherence is needed (eg, diaphoresis, drainage, bleeding); consider use of skin barrier film prior to application of liquid adhesive and ensure correct technique in dressing removal to prevent catheter-associated skin injury due to increased bonding of adhesives to skin.[17,26-28] (IV)
      e. Consider use of a hemostatic agent to control bleeding and reduce need for additional dressing changes; TA has shown promising effects in promoting hemostasis post-VAD insertion.[29-32] (III)

K. Select the type of sterile dressing (TSM or gauze) considering factors such as the type of VAD, risk of bleeding or infection, skin condition, known allergies or sensitivities, patient size, patient preference, cost, sterility, wear time, and ease of use of dressing, with the goal of selecting and applying a dressing that will have minimal dressing disruptions (as multiple dressing changes increase the risk of infection).[10,19,31-50] (I)
   1. Limited evidence suggests a TSM dressing, which permits site visualization and reduces the number of dressing changes, is associated with less catheter failures due to dislodgement or accidental removal.[34] (I)
   2. Use sterile gauze dressings for drainage from the catheter exit site (unless hemostatic agent used to absorb serosanguinous drainage) or if patient is diaphoretic.[5,14,39,51] (V)
   3. Use chlorhexidine-impregnated dressings for all patients 18 years and older with short-term nontunneled CVADs. Use for arterial catheters and other CVADs when all other CABSI prevention strategies have proven ineffective. Use with caution among patients with fragile skin and/or complicated skin pathologies; monitor for erythema and dermatitis at the dressing site.
      a. For premature neonates, chlorhexidine-impregnated dressings are not recommended to protect the site of short-term, nontunneled CVADs due to the risk of serious adverse skin reactions.
      b. For pediatric patients less than 18 years and nonpremature neonates, no recommendation can be made about the use of chlorhexidine-impregnated dressings to protect the site of short-term, nontunneled CVADs due to the lack of enough evidence. More large clinical trials are needed to confirm the clinical efficacy and safety in this patient population (refer to Standard 50, *Infection*).
   4. Consider an alternative dressing if catheter-associated skin injury is present and not resolved with use of a transparent or gauze dressing (refer to Standard 55, *Catheter-Associated Skin Injury*).
   5. For tunneled, cuffed CVADs, a dressing may no longer be required when the subcutaneous tunnel is healed. Time to heal is patient-specific, although 1 study cited 3 weeks.[5,50] (V)

L. Use a securement method to stabilize and secure VADs (refer to Standard 38, *Vascular Access Device Securement*).

M. Label the dressing with the date performed or date to be changed, avoiding placement of the label over the insertion/exit site.[1,52] (V)

N. Use chlorhexidine bathing to minimize the risk of CABSI (refer to Standard 50, *Infection*).
   1. Consider application of a chlorhexidine-impregnated cloth over the TSM and along the first 6 inches of the administration set daily in the intensive care unit (ICU) setting.[53,54] (IV)
   2. Consider the use of daily chlorhexidine bathing in patients in the ICU with a CVAD in situ, including infants over 2 months of age, as a strategy to reduce CABSI if other CABSI prevention strategies have not been effective (refer to Standard 50, *Infection*).

O. Do not use rolled bandages, with or without elastic properties, as a primary method of VAD securement, as they do not adequately secure the VAD (refer to Standard 38, *Vascular Access Device Securement*).
   1. Use a single tubular sleeve that can be easily removed to inspect the insertion site rather than a rolled bandage (refer to Standard 38, *Vascular Access Device Securement*).
   2. The presence of skin disorders that contradict the use of medical adhesives (ie, pediatric epidermolysis bullosa, toxic epidermal necrolysis, and burns) may necessitate the use of tubular gauze mesh rather than ASDs. Single-center observational studies demonstrate that the use of SASSs might be effective and safe in this patient population; however, these studies are small, and close observation of this vulnerable patient group is recommended (refer to Standard 38, *Vascular Access Device Securement*).
   3. If using medical tape for protection of add-on devices or portions of catheter beyond the dressing, select the type of tape based on the intended use and patient's skin condition; use a roll dedicated to a single-patient use.[52,55-57] (IV)

P. Keep sharp objects away from the VAD; never use scissors or pins on or near the catheter.[1] (V)

Q. Protect VAD when patient is showering or bathing by covering the catheter site with a clear plastic wrap or device designed for this purpose. Cover the connections and protect hub connections from water contamination.[1] (V)

R. Avoid taking blood pressure measurements or placement of a tourniquet over the site/upper extremity with a PICC or on an extremity with a peripheral VAD during periods of infusion.[1,58] (V)

REFERENCES

Note: All electronic references in this section were accessed between June 3, 2020, and September 4, 2020.

1. Gorski LA. *Phillips's Manual of I.V. Therapeutics: Evidence Based Practice for Infusion Therapy*. 7th ed. F.A. Davis Company; 2018.
2. Mobley RE, Bizzarro MJ. Central line-associated bloodstream infections in the NICU: successes and controversies in the quest for zero. *Semin Perinatol*. 2017;41(3):166-174. doi:10.1053/j.semperi.2017.03.006
3. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines*. Pappin Communications; 2019.
4. Moureau NL, Carr PJ. Vessel health and preservation: a model and clinical pathway for using vascular access devices. *Br J Nurs*. 2018;27(8):S28-S35. doi:10.12968/bjon.2018.27.8.S28
5. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect*. 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2
6. Gorski LA, Hallock D, Kuehn SC, Morris P, Russell JM, Skala LC. Recommendations for frequency of assessment of the short peripheral catheter [position statement]. *J Infus Nurs*. 2012;35(5):290-292. doi:10.1097/NAN.0b013e318267f636
7. Ray-Barruel G, Cooke M, Chopra V, Mitchell M, Rickard CM. The I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: a clinimetric evaluation. *BMJ Open*. 2020;10(1):e035239. doi:10.1136/bmjopen-2019-035239
8. Günther SC, Schwebel C, Hamidfar-Roy R, et al. Complications of intravascular catheters in ICU: definitions, incidence and severity. a randomized controlled trial comparing usual transparent dressings versus new-generation dressings (the ADVANCED study). *Intensive Care Med*. 2016;42(11):1753-1765. doi:10.1007/s00134-016-4582-2
9. Timsit JF, Bouadma L, Ruckly S, et al. Dressing disruption is a major risk factor for catheter-related infections. *Crit Care Med*. 2012;40(6):1707-1714. doi:10.1097/CCM.0b013e31824e0d46
10. Ullman AJ, Cooke ML, Mitchell M, et al. Dressings and securement devices for central venous catheters (CVC). *Cochrane Database Syst Rev*. 2015;2015(9):CD010367.doi:10.1002/14651858.CD010367.pub2
11. Cho HJ, Cho HK. Central line-associated bloodstream infections in neonates. *Korean J Pediatr*. 2019;62(3):79-84. doi:10.3345/kjp.2018.07003
12. Savage T, Hodge DE, Pickard K, Myers P, Powell K, Cayce JM. Sustained reduction and prevention of neonatal and pediatric central line-associated bloodstream infection following a nurse-driven quality improvement initiative in a pediatric facility. *J Assoc Vasc Access*. 2018;23(1):30-41. https://doi.org/10.1016/j.java.2017.11.002
13. Wyckoff MM, Sharpe EL. *Peripherally Inserted Central Catheters: Guideline for Practice*. 3rd ed. National Association of Neonatal Nurses; 2015.
14. Jamous S, Kouatly I, Zaatari R, Kurdahi Badr L. Achieving a zero central line-asssociated bloodstream infection rate in 4 critical care units in Lebanon. *J Infus Nurs*. 2019;42(5):249-253. doi:10.1097/NAN.0000000000000335
15. Conley SB, Buckley P, Magarace L, Hsieh, C, Pedulla LV. Standardizing best nursing practice for implanted ports: applying evidence-based professional guidelines to prevent central line-associated bloodstream infections. *J Infus Nurs*. 2017;40(3):165-174. doi:10.1097/NAN.0000000000000217
16. Yaglowski J. All-inclusive central line dressing kits: a lean approach. *Crit Care Nurs Q*. 2020;43(1):99-106. doi:10.1097/CNQ.0000000000000296
17. McNichol L, Lund C, Rosen T, Gray M. Medical adhesives and patient safety: state of the science. consensus statements for the assessment, prevention, and treatment of adhesive-related skin injuries. *J Wound Ostomy Continence Nurs*. 2013;40(4):365-380. doi:10.1097/WON.0b013e3182995516
18. dos Santos BN, de Oliveira MC, Braga FTMM, Margatho AS, Esparrachiari LCC, de Campos Pereira Silveira R. Local cutaneous effects associated with chlorhexidine-impregnated gel dressing in hematopoietic stem cell transplantation patients. *Open J Nurs*. 2018;8(2):115-129. doi:10.4236/ojn.2018.82010
19. Broadhurst D, Moureau N, Ullman AJ; World Congress of Vascular Access (WoCoVA) Skin Impairment Management Advisory panel. Management of central venous access device-associated skin impairment: an evidence-based algorithm. *J Wound*

Ostomy Continence Nurs. 2017;44(3):211-220. doi:10.1097/WON.0000000000000322

20. Cheng CE, Kroshinsky D. Iatrogenic skin injury in hospitalized patients. *Clin Dermatol*. 2011;29(6):622-632. doi:10.1016/j.clindermatol.2011.08.006
21. Zhao H, He Y, Huang H, et al. Prevalence of medical adhesive-related skin injury at peripherally inserted central catheter insertion site in oncology patients. *J Vasc Access*. 2018;19(1):23-27. doi:10.5301/jva.5000805
22. Kutzscher L. Management of irritant contact dermatitis and peripherally inserted central catheters. *Clin J Oncol Nurs*. 2012;16(2):E48-E58. doi:10.1188/12.CJON.E48-E55
23. George M, Pal U, Guduri V, Smith G. Use of a barrier film (3M Cavilon No Sting Barrier Film) to reduce local skin complications around peripherally inserted central catheter lines: a randomised prospective controlled study. *World Counc Enteros Ther J*. 2016;36(4):8-13.
24. Thayer D. Skin damage associated with intravenous therapy. *J Infus Nurs*. 2012;35(6):390-401. doi:10.1097/NAN.0b013e318270a91e
25. Pivkina AI, Gusarov VG, Blot SI, Zhivotneva IV, Pasko NV, Zamyatin MN. Effect of an acrylic terpolymer barrier film beneath transparent catheter dressings on skin integrity, risk of dressing disruption, catheter colonisation and infection. *Intensive Crit Care Nurs*. 2018;46:17-23. doi:10.1016/j.iccn.2017.11.002
26. Yates S, McNichol L, Heinecke SB, Gray M. Embracing the concept, defining the practice, and changing the outcome. setting the standard for medical adhesive-related skin injury interventions in WOC nursing practice. *J Wound Ostomy Continence Nurs*. 2017;44(1):13-17. doi:10.1097/WON.0000000000000290
27. Ryder M, Duley C. Evaluation of compatibility of a gum mastic liquid adhesive and liquid adhesive remover with an alcoholic chlorhexidine gluconate skin preparation. *J Infus Nurs*. 2017;40(4):245-252. doi:10.1097/NAN.0000000000000230
28. DeVries M, Sarbenoff J, Scott N, Wickert M, Hayes LM. Improving vascular access dressing integrity without increased skin complications. *J Wound Ostomy Continence Nurs*. In press.
29. Blough L, Hinson K, Hen J. The science of a "Seal" for PICC line management: BioSeal CVC Powder; an alternative hemostatic agent that keeps sites dry and intact. *J Assoc Vasc Access*. 2010;15(2):66-73. https://doi.org/10.2309/java.15-2-4
30. Wilder KD, Wall G, Haggard D, Epperson T. CLABSI reduction strategy: a systematic central line quality improvement initiative integrating line-rounding principles and a team approach. *Adv Neonatal Care*. 2016;16(3):170-177. doi:10.1097/ANC.0000000000000259
31. Ullman AJ, Long D, Williams T, et al. Innovation in central venous access device security: a pilot randomized controlled trial in pediatric critical care. *Pediatr Crit Care Med*. 2019;20(10):e480-e488. doi:10.1097/PCC.0000000000002059
32. Kleidon TM, Ullman AJ, Gibson V, et al. A pilot randomized controlled trial of novel dressing and securement techniques in 101 pediatric patients. *J Vasc Interv Radiol*. 2017;28(11):1548-1556.e1. doi:10.1016/j.jvir.2017.07.012
33. Chico-Padrón RM, Carrión-García L, Delle-Vedove-Rosales L, et al. Comparative safety and costs of transparent versus gauze wound dressings in intravenous catheterization. *J Nurs Care Qual*. 2011;26(4):371-376. doi:10.1097/NCQ.0b013e318210741b
34. Dang F, Li HJ, Tian JH. Comparative efficacy of 13 antimicrobial dressings and different securement devices in reducing catheter-related bloodstream infections: a Bayesian network meta-analysis. *Medicine (Baltimore)*. 2019;98(14):e14940. doi:10.1097/MD.0000000000014940
35. Doellman D, Buckner J, Garrett JH Jr. *Best Practice Guidelines in the Care and Maintenance of Pediatric Central Venous Catheters*. 2nd ed. Association for Vascular Access; 2015.
36. Duzkaya DS, Sahiner NC, Uysal G, Yakut T, Citak A. Chlorhexidine-impregnated dressings and prevention of catheter-associated bloodstream infections in a pediatric intensive care unit. *Crit Care Nurse*. 2016;36(6):e1-e7. doi:10.4037/ccn2016561
37. Edwards M, Rickard CM, Rapchuk I, et al. A pilot trial of bordered polyurethane dressings, tissue adhesive and sutureless devices compared with standard polyurethane dressings for securing short-term arterial catheters. *Crit Care Resusc*. 2014;16(3):175-183.
38. Gerceker GO, Yardimci F, Aydinok Y. Randomized controlled trial of care bundles with chlorhexidine dressing and advanced dressings to prevent catheter-related bloodstream infections in pediatric hematology-oncology patients. *Eur J Oncol Nurs*. 2017;28:14-20. doi:10.1016/j.ejon.2017.02.008
39. Loveday HP, Wilson JA, Prieto J, Wilcox MH. epic3: revised recommendation for intravenous catheter and catheter site care. *J Hosp Infect*. 2016;92(4):346-348. doi:10.1016/j.jhin.2015.11.011
40. Reynolds H, Taraporewalla K, Tower M, Rickard CM. Assessment of dressing and securement techniques for peripheral arterial catheters: a narrative review. *Vasc Access*. 2015;1(1):21-32.
41. Rickard CM, Marsh N, Webster J, et al. Dressings and securements for the prevention of peripheral intravenous catheter failure in adults (SAVE): a pragmatic, randomised controlled, superiority trial. *Lancet*. 2018;392(10145):419-430. doi:10.1016/S0140-6736(18)31380-1
42. Centers for Disease Control and Prevention. 2017 updated recommendations on the use of chlorhexidine-impregnated dressings for prevention of intravascular catheter-related infections. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of Healthcare Quality and Promotion. Updated July 17, 2017. https://www.cdc.gov/infectioncontrol/pdf/guidelines/c-i-dressings-H.pdf
43. Margatho AS, Ciol MA, Hoffman JM, et al. Chlorhexidine-impregnated gel dressing compared with transparent polyurethane dressing in the prevention of catheter-related infections in critically ill adult patients: a pilot randomised controlled trial. *Aust Crit Care*. 2019;32(6):471-478. doi:10.1016/j.aucc.2018.11.001
44. Marsh N, Larsen E, Genzel J, et al. A novel integrated dressing to secure peripheral intravenous catheters in an adult acute hospital: a pilot randomised controlled trial. *Trials*. 2018;19(1):596. doi:10.1186/s13063-018-2985-9
45. Marsh N, Webster J, Mihala G, Rickard CM. Devices and dressings to secure peripheral venous catheters: a Cochrane systematic review and meta-analysis. *Int J Nurs Stud*. 2017;67:12-19. doi:10.1016/j.ijnurstu.2016.11.007
46. Chan RJ, Northfield S, Larsen E, et al. Central venous Access device SeCurement And Dressing Effectiveness for peripherally inserted central catheters in adult acute hospital patients (CASCADE): a pilot randomised controlled trial. *Trials*. 2017;18(1):458. doi:10.1186/s13063-017-2207-x
47. Biehl LM, Huth A, Panse J, et al. A randomized trial on chlorhexidine dressings for the prevention of catheter-related bloodstream infections in neutropenic patients. *Ann Oncol*. 2016;27(10):1916-1922. doi:10.1093/annonc/mdw275
48. Jenks M, Craig J, Green W, Hewitt N, Arber M, Sims A. Tegaderm CHG IV securement dressing for central venous and arterial catheter insertion sites: a NICE medical technology guidance. *Appl Heal Econ Heal Policy*. 2016;14(2):135-149. doi:10.1007/s40258-015-0202-5
49. Reynolds H, Taraporewalla K, Tower M, et al. Novel technologies can provide effective dressing and securement for peripheral arterial catheters: a pilot randomised controlled trial in the operating theatre and the intensive care unit. *Aust Crit Care*. 2015;28(3):140-148. doi:10.1016/j.aucc.2014.12.001
50. de Campos Pereira Silveira RC, dos Reis PED, Ferreira EB, Braga FTMM, Galvão CM, Clark AM. Dressings for the central venous catheter to prevent infection in patients undergoing hematopoietic stem cell transplantation: a systematic review and meta-analysis. *Support Care Cancer*. 2020;28(2):425-438. doi:10.1007/s00520-019-05065-9

51. Lutwick L, Al-Maani AS, Mehtar S, et al. Managing and preventing vascular catheter infections: a position paper of the International Society for Infectious Diseases. *Int J Infect Dis*. 2019;84:22-29. doi:10.1016/j.ijid.2019.04.014
52. Harris PN, Ashhurst-Smith C, Berenger SJ, Shoobert A, Ferguson JK. Adhesive tape in the health care setting: another high-risk fomite? *Med J Aust*. 2012;196(1):34. doi:10.5694/mja11.11211
53. Huang SS, Septimus E, Kleinman K, et al. Chlorhexidine versus routine bathing to prevent multidrug-resistant organisms and all-cause bloodstream infections in general medical and surgical units (ABATE Infection trial): a cluster-randomised trial. *Lancet*. 2019;393(10177):1205-1215. doi:10.1016/S0140-6736(18)32593-5
54. The REDUCE MRSA Trial Working Group. *Universal ICU Decolonization Toolkit: An Enhanced Protocol*. AHRQ Publication No. 13-0052-EF. Agency for Healthcare Research and Quality; 2013. https://www.ahrq.gov/sites/default/files/publications/files/universalicu.pdf
55. Krug L, Machan M, Villalba J. Securing the endotracheal tube with adhesive tape: an integrative literature review. *AANA J*. 2014;82(6):457-464.
56. McClusky J, Davis M, Dahl K. A gap in patient tape storage and use practices puts patients at risk for cutaneous fungal infections. *Am J Infect Control*. 2015;43(2):182-184. doi:10.1016/j.ajic.2014.10.028
57. Lalayanni C, Baliakas P, Xochelli A, et al. Outbreak of cutaneous zygomycosis associated with the use of adhesive tape in haematology patients. *J Hosp Infect*. 2012;81(3):213-215. doi:10.1016/j.jhin.2012.04.007
58. Ranum A, Hagle M. Diagnostic testing and values. In: Weinstein S, Hagle ME, eds. *Plumer's Principles and Practices of Infusion Therapy*. 9th ed. Lippincott, Williams & Wilkins; 2014:108-141.

43. ADMINISTRATION SET MANAGEMENT

Standard

43.1 Administration set changes are performed with adherence to Standard-ANTT at a frequency based upon factors such as patient condition, type, rate, and frequency of solution administered, immediately upon suspected contamination, when the integrity of the product or system has been compromised, and when a new VAD is placed.

43.2 Administration sets are of a luer-lock design to ensure a secure connection, reduce manipulation, and minimize the risk of leaks, disconnections, or misconnections.

Practice Recommendations

I. General

A. Use administration sets with integrated add-on devices (eg, filters) to minimize the number of connections, thus reducing the risk of contamination, misuse, and accidental disconnection (refer to Standard 37, *Other Add-On Devices*).
B. Use administration sets with luer-lock design; use administration sets with anti—free-flow mechanisms with electronic infusion pumps.[1] (V)
C. Do not use administration sets that have injection ports for high-risk medications delivered via an epidural, intrathecal, or arterial route (see Standard 56, *Intraspinal Access Devices*).[2] (V)
D. Use administration sets with composite material recommended for drugs at risk of tubing adsorption, which may affect accuracy of drug delivery (eg, nitroglycerin, diazepam, insulin). Monitor clinical response to medication.[1,3–9] (IV)
E. Consider use of a new administration set when initiating a new concentration of a continuous IV medication to prevent infusing any of the previous concentration remaining in the tubing at the rate intended for the new concentration.[10] (V)
F. Never use an administration set for more than 1 patient.[11] (V)
G. Adhere to Standard-ANTT when connecting, changing, and accessing administration set injection ports (see Standard 18, *Aseptic Non Touch Technique*).[12] (V)
H. Use an extension set with parallel lumens when multiple administration sets must be connected to the same VAD lumen. Delays in flow rates, leakage from the infusion system, and other unintended therapy interruptions are reduced with these extension sets as compared to a manifold of multiple stopcocks.[1,10,13] (V)
I. Label administration sets.
    1. Indicate the date of initiation or date of change based on organizational policies, procedures, and/or practice guidelines.
    2. When there are different access sites (ie, intraspinal, intraosseous [IO], subcutaneous) or multiple fluid containers connected to a VAD, label the tubing with the route and/or medication/solution near the connection to the solution container and near the patient's access site.[2] (V)
J. Teach nonclinical staff, patients, and caregivers not to connect/disconnect administration sets to prevent misconnections. In some home care setting situations, caregivers may connect and disconnect devices if they are trained and competency is demonstrated.[2,14] (V)
K. Trace all catheters/administration sets/add-on devices between the patient and solution container to the VAD before connecting or reconnecting any infusion/device, at each care transition to a new setting or service, and as part of the handoff process.[15] (IV)
L. Minimize risk of strangulation or entanglement related to the use of administration sets. Research is needed to test preventative strategies such as individual risk assessment, ongoing assessment of need for continuous vs intermittent infusions, increased supervision or video surveillance, avoiding use of extension sets, coiling excess tubing, and use of accessories to stabilize flexible lines (eg, clear plastic sleeve over administration set).[2,16,17] (V)

II. Primary and Secondary Continuous Infusions

A. Replace primary and secondary continuous administration sets used to administer solutions other than lipid, blood, or blood products no more frequently than every 96 hours but at least every 7 days (unless otherwise stated in manufacturers' directions for use), when the

VAD is changed, or if the integrity of the product or system has been compromised.[12,15,18–25] (II)

B. Plan to change the primary administration set to coincide with the VAD change and/or initiation of a new solution container.[12] (V)

C. When using a secondary administration set:
   1. Use a primary continuous administration set that contains a back-check valve or use a dedicated pump set with integrated mechanisms to prevent retrograde flow of the secondary medication into the primary solution container.[1,15] (V)
   2. When high-risk medications are given through the primary infusion system concurrently with the primary infusion, attach the administration set below the electronic infusion pump controlling the primary fluid flow and use a separate electronic infusion pump to control the rate of the high-risk medication.[26] (V)
   3. Avoid disconnecting primary and secondary continuous administration sets whenever possible.[14] (IV)
      a. When administering a secondary intermittent medication, check compatibility with the primary solution; this avoids the need to disconnect or replace the secondary administration set. If compatible, use the secondary administration set and back prime from the primary infusion container.[10] (V)
         i. If disconnection of a continuous or an intermittent infusion administration set is unavoidable, aseptically attach a new, sterile, compatible covering device to protect male luer ends on administration sets, ensuring correct connection of catheters/administration sets/add-on devices.[14] (IV)
         ii. If the secondary administration set is disconnected from the primary set, the secondary administration set is now considered a primary intermittent administration set and is changed every 24 hours.[1] (V)
      b. Follow the manufacturers' directions for correctly positioning primary and secondary fluid containers and the needed height differences between these containers (ie, head height differential). Incorrect head height differential can lead to unintended flow rates. Alterations in flow rate may occur due to differences in the level of solution in each container (eg, bag, glass bottle), the height of the IV pole, and the position of the pump.[26] (V)

III. Primary Intermittent Infusions

A. Change intermittent administration sets every 24 hours.
   1. There is an absence of studies addressing administration set changes for intermittent infusions. When an intermittent infusion is repeatedly disconnected and reconnected for infusion delivery/administration, there is increased risk of contamination at the spike end, catheter hub, needleless connector, and the male luer end of the administration set, potentially increasing risk for CABSI. (Committee Consensus)

B. Attach a new, sterile, compatible covering device to the male luer end of the administration set after each intermittent use. Do not attach the exposed male luer end of the administration set to a port on the same administration set (ie, "looping").[15,27] (IV)

IV. Parenteral Nutrition

A. Replace administration sets with inline and add-on filters for PN solutions (with or without lipids) every 24 hours or with each new PN container (see Standard 35, *Filtration*; Standard 63, *Parenteral Nutrition*).[12-14,21,28] (I)

B. Replace administration sets used for ILE infused separately every 12 hours and with each new container/as per product monograph. The characteristics of ILE (iso-osmotic, near neutral-alkaline pH, and containing glycerol) are conducive to the growth of microorganisms.[12,28] (V)

C. Use administration sets free of di(2-ethylhexyl)phthalate (DEHP) to administer lipid-based infusates, such as ILE or PN solution containing a lipid fat emulsion. DEHP is lipophilic and is extracted into the lipid solution with commonly used polyvinyl chloride administration sets and containers. DEHP is considered a toxin, and studies have demonstrated increased DEHP levels in lipid solutions, which is especially a risk with neonatal, pediatric, and long-term home care patients.[1,28] (V)

V. Propofol Infusions

A. Replace administration sets used to administer propofol infusions at least every 6 to 12 hours, per the manufacturers' directions for use, or when the container is changed.[19,29] (I)

VI. Blood and Blood Components

A. Change the transfusion administration set in conjunction with manufacturers' directions for use.
   1. Clinical studies establishing the maximum time for set use are lacking; in accordance with the AABB, if the first unit requires 4 hours for transfusion, the administration set and filter are not reused. Transfusion guidelines from other countries recommend changing the administration set every 12 hours.
   2. Note that most standard filters have a 4-unit maximum capacity; follow manufacturers' directions for use (refer to Standard 64, *Blood Administration*).

VII. Hemodynamic and Arterial Pressure Monitoring

A. Replace the disposable or reusable transducer and other components of the system, including the administration set, continuous flush device, and flush solution

used for invasive hemodynamic pressure monitoring every 96 hours, immediately upon suspected contamination, or when the integrity of the product or system has been compromised.[24] (II)

B. Minimize the number of manipulations and entries into the system.[19] (II)

REFERENCES

Note: All electronic references in this section were accessed between June 3, 2020, and September 4, 2020.

1. Gorski LA. *Phillips's Manual of I.V. Therapeutics: Evidence-Based Practice for Infusion Therapy*. 7th ed. F.A. Davis Company; 2018.
2. The Joint Commission. Managing risk during transition to new ISO tubing connector standards. *Sentinel Event Alert*. Issue 53. August 20, 2014. https://www.jointcommission.org/-/media/tjc/documents/resources/patient-safety-topics/sentinel-event/sea_53_connectors_8_19_14_final.pdf
3. Jin SE, You S, Jeon S, Hwang SJ. Diazepam adsorption to PVC- and non-PVC-based tubes in administration sets with quantitative determination using a high-performance liquid chromatographic method. *Int J Pharm*. 2016;506(1-2):414-419. doi:10.1016/j.ijpharm.2016.04.040
4. Jin SE, You S, Jeon S, Byon HJ, Hwang SJ. Evaluation of drug adsorption to PVC- and non-PVC-based tubes in administration sets using a pump. *J Vis Exp*. 2017;(121):55086. doi:10.3791/55086
5. Jin SE, Jeon S, Byon HJ, Hwang SJ. Evaluation of tacrolimus sorption to PVC- and non-PVC-based tubes in administration sets: pump method vs. drip method. *Int J Pharm*. 2017;528(1-2):172-179. doi:10.1016/j.ijpharm.2017.05.040
6. Kim CO, Song J, Min JY, Park SJ, Lee HM, Byon HJ. A comparison of the pharmacokinetic and pharmacodynamic properties of nitroglycerin according to the composition of the administration set: a preliminary study. *Medicine (Baltimore)*. 2018;97(9):e9829. doi:10.1097/md.0000000000009829
7. Woodward Z, Brooks P, Morris-Smith B, Wallis M, Ogbourne SM. Adsorption and leachable contamination of flucloxacillin, cyclosporin and amiodarone following delivery through an intravenous administration set. *Pharm Res*. 2018;35(6):121. doi:10.1007/s11095-018-2409-2
8. Maurer F, Lorenz DJ, Pielsticker G. Adherence of volatile propofol to various types of plastic tubing. *J Breath Res*. 2017;11(1):016009. doi:10.1088/1752-7163/aa567e
9. Ley SC, Ammann J, Herder C, Dickhaus T, Hartmann M, Kindgen-Milles D. Insulin adsorption to catheter materials used for intensive insulin therapy in critically ill patients: polyethylene versus polyurethane–possible cause of variation in glucose control? *Open Crit Care Med J*. 2014;7:1-6. doi:10.2174/1874828701407010001
10. AAMI Foundation. Quick guide: improving the safe use of multiple IV infusions. AAMI Foundation; 2016. https://www.aami.org/docs/default-source/foundation/infusion/infusion_therapy_quick_guide2.pdf
11. Dolan SA, Arias KM, Felizardo G, et al. APIC position paper: safe injection, infusion, and medication vial practices in health care. *Am J Infect Control*. 2016;44(7):750-757. doi:10.1016/j.ajic.2016.02.033
12. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect*. 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2
13. Hadaway L. Stopcocks for infusion therapy: evidence and experience. *J Infus Nurs*. 2018;41(1):24-34. doi:10.1097/NAN.0000000000000258
14. Duncan M, Warden P, Bernatchez SF, Morse D. A bundled approach to decrease the rate of primary bloodstream infections related to peripheral intravenous catheters. *J Assoc Vasc Access*. 2018;23(1):15-22. doi:10.1016/j.java.2017.07.004
15. Pinkney S, Fan M, Chan K, et al. Multiple intravenous infusions phase 2b: laboratory study. *Ont Health Technol Assess Ser*. 2014;14(5):1-163.
16. Garros D, King WJ, Brady-Fryer B, Klassen TP. Strangulation with intravenous tubing: a previously undescribed adverse advent in children. *Pediatrics*. 2003;111(6 Pt 1):e732-e734. doi:10.1542/peds.111.6.e732
17. Lunetta P, Laari M. Strangulation by intravenous tubes. *Lancet*. 2005;365(9470):1542. doi:10.1016/S0140-6736(05)66454-9
18. Ullman AJ, Cooke ML, Gillies D, et al. Optimal timing for intravascular administration set replacement. *Cochrane Database Syst Rev*. 2013;2013(9):CD003588. doi:10.1002/14651858.CD003588.pub3
19. Canadian Agency for Drugs and Technologies in Health. *Changing Total Parenteral Nutrition Tubes in Pediatric In-Hospital Patients: A Review of Clinical Effectiveness and Guidelines*. Canadian Agency for Drugs and Technologies in Health; 2015.
20. Rickard CM, Wallis SC, Courtney M, Lipman J, Daley PJ. Intravascular administration sets are accurate and in appropriate condition after 7 days of continuous use: an in vitro study. *J Adv Nurs*. 2002;37(4):330-337. doi:10.1046/j.1365-2648.2002.02099.x
21. Mobley RE, Bizzarro MJ. Central line-associated bloodstream infections in the NICU: successes and controversies in the quest for zero. *Semin Perinatol*. 2017;41(3):166-174. doi:10.1053/j.semperi.2017.03.006
22. Rickard C, Marsh N, Larsen E, et al. Administration sets/infusion tubing: how often should they be changed. *Infect Dis Health*. 2017;22(suppl 1):S2. https://doi.org/10.1016/j.idh.2017.09.008
23. Simon A, Fleischhack G, Wiszniewsky G, Hasan C, Bode U, Kramer MH. Influence of prolonged use of intravenous administration sets in paediatric cancer patients on CVAD-related bloodstream infection rates and hospital resources. *Infection*. 2006;34(5):258-263. doi:10.1007/s15010-006-5646-y
24. Daud A, Rickard C, Cooke M, Reynolds H. Replacement of administration sets (including transducers) for peripheral arterial catheters: a systematic review. *J Clin Nurs*. 2013;22(3-4):303-317. doi:10.1111/j.1365-2702.2012.04346.x
25. Comisso I, Lucchini A. Hospital-acquired catheter-related bloodstream infection prevention. In: Comisso I, Lucchini A, Bambi S, Giusti GD, Manici M, eds. *Nursing in Critical Care Setting: An Overview From Basic to Sensitive Outcomes*. Springer International Publishing; 2018:279-304. https://link.springer.com/book/10.1007/978-3-319-50559-6#toc
26. Cassano-Piché A, Fan M, Sabovitch S, et al. Multiple intravenous infusions phase 1b: practice and training scan. *Ont Health Technol Assess Ser*. 2012;12(16):1-132.
27. Institute for Safe Medication Practices. Failure to cap IV tubing and disconnect IV ports place patients at risk for infections. *ISMP Medication Safety Alert!* Published July 26, 2007. https://www.ismp.org/resources/failure-cap-iv-tubing-and-disinfect-iv-ports-place-patients-risk-infections
28. Ayers P, Bobo ES, Hurt RT, Mays AA, Worthington PH, eds. *ASPEN Parenteral Nutrition Handbook*. 3rd ed. American Society for Parenteral and Enteral Nutrition (ASPEN); 2020.
29. Diprivan® (Propofol) Injectable Emulsion, USP. Package insert. Fresenius Kabi; 2014. https://diprivan-us.com/

44. BLOOD SAMPLING

Standard

44.1 Patient identification and proper labeling of all blood sample containers are performed at the time of sample collection and in the presence of the patient.

44.2 Blood conservation techniques are employed for blood sampling to reduce the risk of hospital-acquired anemia.
44.3 Collaboration among managers, clinicians, and providers from all departments is necessary to decrease overuse of blood sampling and reduce preanalytical errors.

Practice Recommendations

I. General

A. Educate the patient about the purpose and process for blood sampling. The patient should be in a seated or recumbent position. When chairs with safety features (eg, arm rest, protection from falling if syncope occurs) are not available, the recumbent position should be chosen. Advise the patient to avoid any exercise for 24 hours before blood sampling. Exercise and changes from supine to upright positions can alter plasma volume because of the force of gravity on venous hydrostatic changes and distribution of body fluids, which can change the values of hemoglobin, hematocrit, and other cell counts.[1-6] (IV)
B. Assess the patient for fasting prior to collection of blood samples, if appropriate for the requested laboratory values.[1,5,7] (IV)
C. Work with laboratory management, managers from other patient care areas, and providers to identify and decrease blood testing that is not clinically indicated or is unnecessary for the medical diagnosis. Unnecessary testing leads to additional diagnostic procedures and overdiagnosis; anemia in neonates, pediatrics, and adult critical care patients; and increased costs.[8-11] (IV)
D. Ensure that all clinicians involved with collecting blood samples have documented competency with equipment and techniques. Blood samples obtained by nonlaboratory staff are more likely to be rejected due to gaps in clinician knowledge about obtaining blood samples. Educational programs decrease frequency of daily blood tests prescribed, the number of rejected samples, contamination of blood cultures, and hemolysis rates. RCTs are necessary to identify the specific educational processes that produce improvement in outcomes of blood sampling (see Standard 5, *Competency and Competency Assessment*).[12-18] (II)
E. Employ a standardized procedure to prevent errors, hemolysis, and clotted samples in the preanalytical phase (before the sample reaches the laboratory) where the majority of these events occur. These errors delay treatment decisions due to spurious laboratory values, enhance the potential for patient harm, and increase costs of care.[19-21] (IV)
    1. Use 2 different unique identifiers to confirm patient identification before obtaining the sample. Electronic patient identification systems (eg, barcoding) for patient identification and sample container labeling have been shown to reduce these errors when compared to manual methods.[22-26] (IV)
    2. Label all evacuated collection tubes, one at a time, in the presence of the patient and ensure all information is visible.[5,6,23] (IV)
    3. Use the correct evacuated collection tube for the specific test required. Evacuated collection tubes contain different additives as indicated by the colored closure top and labeling and are based on international standards. Do not remove the closure from the tube.[6,27] (V)
    4. Obtain blood samples using the correct sequence according to the evacuated tube manufacturers' directions for use (eg, color of the closure) to prevent carryover of additives between collection tubes.[5,6,28] (IV)
    5. Prevent erythrocyte damage and hemolysis by gentle inversion of the collection tube according to the manufacturers' directions for use. Avoid vigorous shaking to mix the tube contents.[5,6,29] (II)
    6. Fill evacuated collection tubes with at least 90% of the total volume or the manufacturer's stated volume as underfilling can cause inaccurate values due to the incorrect ratio between blood and additives.[2,6,30] (IV)
    7. Prevent venous stasis and other causes of spurious laboratory data by avoiding repetitive fist clenching or hand pumping, limiting tourniquet time to less than 1 minute, and removing tourniquet as soon as blood begins to flow into evacuated tube. Use of cold and vibration at the venipuncture site may impact accuracy of test results. Use of infrared light vascular visualization devices will identify the vein and may eliminate the need for a tourniquet (see Standard 22, *Vascular Visualization*).[2,5,6] (IV)
    8. A centralized phlebotomy service for hospitalized patients has been shown to reduce preanalytical errors. A phlebotomy checklist is recommended to reduce blood sampling errors, regardless of the clinician performing the tasks.[23,31] (IV)
    9. Place all blood samples in a closed, leakproof container and dispatch to the laboratory immediately using an appropriate delivery method. Maintain ambient temperature between 15° and 25° C. Maintain the closure-up position for samples containers. Use of pneumatic tube systems for blood sample delivery requires assessment of differences in the factors of the pneumatic system in use. If delivery must be delayed (eg, home-drawn samples), properly store and control the temperature to reduce the risk for inaccurate laboratory values and the potential for hemolysis.[1,5,29,32] (IV)
F. Perform all infection prevention practices including:
    1. Hand hygiene before the procedure and appropriate use of gloves.
    2. Adherence to ANTT.
    3. Use of single-patient tourniquets.

4. Use of venipuncture and sampling devices according to manufacturers' directions for use including activation of safety-engineered devices.
5. Use of a needleless transfer device to transfer blood from syringe to the evaluated tube.
6. Appropriate skin antisepsis agents and application technique without repalpation of site (see Standard 16, *Hand Hygiene*; Standard 21, *Medical Waste and Sharps Safety*).[1,6,7,33] (II)

G. Discard the needle and tube holder as 1 unit; do not attempt to recap the needle or separate the double-end needle from the holder as needlestick injuries have been reported.[34] (V)

H. Reduce the risk of in vitro hemolysis by strict adherence to the standardized procedure for obtaining blood samples. Hemolysis is the most common cause of blood sample rejection by the laboratory and causes erroneous values for many tests (eg, electrolytes, glucose, cardiac biomarkers, coagulation times).
1. Provide patient information to the laboratory staff as needed to aid in distinguishing between in vivo and in vitro hemolysis. In vivo hemolysis (in the intravascular space) may occur from medical diagnoses and comorbidities. In vitro hemolysis during blood sampling is related to increased fragility of RBCs.[35] (IV)
2. Multiple factors have been shown to produce higher rates of hemolysis including samples:
   a. Drawn in the emergency department (ED) when compared to inpatient units and other non-ED areas.
   b. Drawn by nurses and medical staff when compared to phlebotomists.
   c. Drawn from PIVCs when compared to a direct venipuncture by straight needles and steel-winged needles.
   d. Drawn from veins of the hand and forearm when compared to sites in the antecubital fossa.
   e. Transported through pneumatic tube systems when compared to hand transport.
   f. Filling less than half of evacuated tubes compared to those filled more than halfway.
   g. Use of smaller-gauge IV catheters (eg, 22-gauge vs 16-gauge); however, studies of an ultrathin-walled, 25-gauge, steel-winged needle reported no alteration in sample quality when compared with 21-gauge needles.
   h. From venipunctures with greater than 1 minute of tourniquet time.[6,36-38] (IV)
3. Although the following factors have been studied regarding rates of hemolysis, conflicting outcomes or quality of the studies do not provide answers about:
   a. Use of evacuated tubes vs syringes.
   b. The size and type of the evacuated tube.
   c. The level of venipuncture difficulty and the rate of blood flow.[36] (IV)
4. Hemolysis cannot be correctly identified by visual inspection of the blood sample alone. Automated detection of cell-free hemoglobin is recommended to determine the presence and degree of hemolysis. Contact the clinical laboratory about parameters for the free hemoglobin level that would cause a sample to be rejected.[35] (IV)

I. Reduce blood loss associated with blood sampling, a significant cause of hospital-acquired anemia in patients of all ages, which may increase the need for blood transfusion and its inherent risks. Collaborate with the laboratory about the minimum volume of blood required for each test. Monitor the total volume of blood collected over a given period (eg, 1% to 5% total blood volume over a 24-hour period). Blood volume in adults is calculated to be 65 to 70 mL/kg; in children it is calculated to be 75 to 80 mL/kg; neonatal volume is greater per kilogram than children. The following strategies, alone and in combination, are reported to decrease blood loss associated with obtaining blood samples:
1. Eliminating unnecessary laboratory tests.
2. Reducing the frequency of obtaining blood samples.
3. Drawing blood samples based on clinical need rather than a regular schedule.
4. Delaying umbilical cord clamping in term and preterm infants without urgent need of resuscitation.
5. Using small-volume collection tubes (eg, requiring only 2.0–3.5 mL of blood); however, some tubes with volumes of less than 1 mL produce differences in values. Each laboratory should perform validation studies on introduction of new collection tubes.
6. Using point-of-care testing methods.
7. Using closed-loop systems for venous and arterial VADs, as these systems return the blood to the patient.
8. Using the push-pull or mixing method.[6,39-50] (IV)

J. Use precautions for obtaining blood cultures to avoid false-negative and false-positive results and to reduce incorrect classification as a CABSI.
1. Use a dedicated phlebotomy team to reduce blood culture contamination.
2. Avoid drawing blood cultures from a peripheral catheter, either on insertion or during the dwell of the catheter.
3. Use a CVAD for drawing blood cultures only when the catheter is suspected of being the source of infection. Draw a set of blood cultures from a peripheral vein simultaneously with the CVAD sample to confirm the BSI diagnosis.
4. For multilumen CVADs, draw a separate sample from each lumen and label appropriately.
5. Remove the needleless connector before obtaining a sample for blood from a CVAD.
6. Obtain blood for culturing prior to administering antibiotics.

7. Consider use of a standardized sterile blood culture collection kit to reduce sample contamination.
8. Disinfect the rubber septum of the blood culture bottles using 70% alcohol and allow to dry. Iodine products are not recommended as they can degrade the stopper material.
9. Obtain 2 sets of blood cultures to increase the sensitivity for detecting organism growth.
10. Draw blood for culture before drawing the sample for other tests.
11. Draw a quantity of blood that is sufficient for isolating organisms: 10 mL per bottle for adults (2 or 3 sets of aerobic and anaerobic bottles from different peripheral sites) is the optimal quantity, with more than 5 mL recommended. For neonates and pediatrics, a weight-based volume may be used or no more than 1% of the total blood volume.
12. Divert and discard the initial blood sample when drawing from a direct venipuncture. The volume of blood that should be discarded or diverted to a different container is controversial, with 1.5 to 2.0 mL and 7.0 mL showing a reduction in false-positive results. When drawing blood culture samples from a CVAD, send the first sample drawn for culture without discarding.
13. Transport the filled blood culture bottles to the laboratory within 2 hours; do not refrigerate as this may kill some organisms.
14. Recognize that differential time to positivity (DTP) is used to diagnose CABSI. When the same quantity from peripheral and CVAD-drawn samples are compared, the catheter sample becomes positive within 2 hours of the sample from the peripheral venipuncture.[6,11,51-59] (IV)

II. Blood Sampling via Direct Venipuncture

A. Perform venipuncture for phlebotomy on the opposite extremity of an infusion. If phlebotomy must be performed on the extremity with infusing solutions, a vein below or distal to the site of infusion should be used.[6,60] (V)
B. Restrict venipuncture for blood sampling to the dorsum of the hand whenever possible, regardless of hand dominance, in patients with an actual or planned dialysis fistula or graft (refer to Standard 29, *Vascular Access and Hemodialysis*).
C. Consider restricting venipuncture for blood sampling to the contralateral upper extremities in patients with lymphedema and those at risk for lymphedema (axillary surgical lymph node dissection, radiation therapy). Traditionally, avoidance of the ipsilateral arm has been based on the risk of infection from punctures that could lead to lymphedema due to compromised axillary drainage. Evidence for avoiding all venipuncture on the at-risk upper extremity comes from conflicting studies; however, there remains recommendations to avoid all venipuncture procedures on at-risk extremities.[61-63] (IV)
D. When feasible, avoid venipunctures on an extremity with alteration in normal venous blood flow (eg, paralysis or hemiparesis from a cerebrovascular accident) and/or decreased sensation that could prevent perception of pain, such as needle-to-nerve contact (refer to Standard 48, *Nerve Injury*).
E. Perform venipuncture in the median cubital, cephalic, or basilic veins of the antecubital fossa using a straight needle or steel-winged needle. When using a winged metal needle to obtain coagulation tests, draw the first sample into a discard tube to remove the air in the tubing attached to the winged needle and ensure the correct ratio of blood to additives in the collection tube. Release the tourniquet as soon as blood flow begins to reduce hemoconcentration.[5,6,28] (IV)
F. Perform skin antisepsis prior to all venipunctures and adhere to ANTT for the entire procedure. If repeated palpation is necessary, the antiseptic solution must be reapplied before venipuncture. Allow time for all antiseptic solution to thoroughly dry before venipuncture to avoid the possibility of the solution causing hemolysis (see Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*).[6,47,55,64] (IV)
G. Perform venipuncture in neonates by a skilled phlebotomist instead of heel lance methods due to the increased pain from the heel lance. Additional studies are needed to determine the most appropriate method for pain control for heel lance. Automatic lancing devices are preferred over manual devices to control the depth of puncture and to reduce the risk of bone or cartilage infection.[65-67] (II)
H. Draw samples for blood culture from a direct venipuncture using appropriate diversion techniques to reduce the risk of false-positive results.[56,57] (IV)

III. Blood Sampling via Direct Arterial Puncture

A. Assess the circulation to the hand prior to puncturing the radial artery; perform a physical examination of hand circulation, such as assessing radial and ulnar pulses with an Allen test, pulse oximetry, or Doppler flow study. Review medical history (eg, trauma, previous radial artery cannulation, radial artery harvesting); assess presence of anticoagulants.[68,69] (IV)
B. Use a 20-gauge or smaller needle (eg, 23-gauge) to reduce pain associated with radial artery puncture and reduce arterial damage; however, smaller needles could cause hemolysis. Choose a needle with sufficient length to access the artery.[70,71] (IV)
C. Use ultrasound guidance to improve success (refer to Standard 22, *Vascular Visualization*).
D. Adhere to ANTT with direct arterial puncture; use sterile gloves when repalpation of the artery is required

after skin antisepsis (refer to Standard 18, *Aseptic Non Touch Technique*).

E. Collect arterial blood using a heparinized syringe. Expel air from the syringe immediately after obtaining the sample, and gently rotate the syringe to mix the blood with heparin. Immediately transport the sample to the laboratory.[71] (V)

IV. Blood Sampling via a VAD

A. Carefully analyze risks vs benefits before deciding to use a VAD for obtaining blood samples.
   1. Risks of venipuncture include pain, damage to skin and nearby nerves, and hematoma in patients receiving anticoagulants or with bleeding disorders, as well as psychological stress, anxiety, and dissatisfaction with care.[72] (IV)
   2. Risks associated with sampling from a PIVC include hemolysis of the sample, contamination of the sample from infusing solutions and medications, local complications from excessive catheter movement (eg, phlebitis, infiltration), and dislodgement from the insertion site.[72] (IV)
   3. Risks associated with sampling from a CVAD include increased hub manipulation and the potential for intraluminal contamination, alterations in VAD patency, and erroneous laboratory values associated with adsorption of medications infused through the VAD.[73-76] (IV)

B. Short PIVCs
   1. Obtain blood samples from indwelling short PIVCs for adult and pediatric patients. Obtaining the sample at the time of insertion may result in hemolysis and spurious laboratory values due to length of tourniquet time. Study protocols have reported stopping infusing solutions for 1 to 2 minutes and wasting 1 to 2 mL of blood. Sampling of blood from indwelling short PIVCs produced results for complete blood counts, blood chemistry, and coagulation studies that are not different from a direct venipuncture. Although most studies show some level of statistical difference when compared to direct venipuncture, these differences were not relevant to clinical decisions. Obtaining blood cultures from short PIVCs at insertion or during the dwell is not recommended.[6,72,77-79] (II)
   2. Higher hemolysis rates are associated with blood sampling from short PIVCs. One systematic review highlighted many confounding variables without adequate control, including visual or automated hemolysis measurement, use of evacuated tubes vs syringes, and catheter gauge and site. Hemolysis rates of less than 5% may be acceptable in patients requiring frequent blood sampling and/or who have difficult peripheral veins. High rates of hemolysis (eg, 15%) may be offset by the significantly high rates of parent/patient satisfaction with using the catheter for this purpose.[72,79] (II)
   3. A small tube device advanced through an existing short PIVC is associated with decreased hemolysis rates in studies of volunteers and patients. An RCT in surgical gastrointestinal patients reported no hemolyzed samples and no statistical difference in catheter complication rates. The wait time between infusion and obtaining the sample is reported to be 30 seconds as opposed to 2 minutes, and no waste or discard volume is needed.[80-82] (III)
   4. Veins of the antecubital fossa produce the lowest rates of hemolysis. However, short PIVCs inserted for infusion into veins of the antecubital fossa are not recommended due to higher catheter complication rates in areas of joint flexion (see Standard 27, *Site Selection*).[36] (IV)

C. Although long PIVCs and midline catheters may be labeled for obtaining blood samples, no evidence is available regarding the techniques or outcomes of this procedure.

D. Use blood samples obtained from IO devices with caution. Studies comparing arterial and venous samples with samples from the IO space are from small heterogeneous samples with a weak level of agreement (see Standard 57, *Intraosseous Access Devices*).[83] (II)

E. CVADs
   1. Draw the blood sample from a dedicated lumen not used for administration of the drug being monitored, if possible. Evaluate elevated test results when a dedicated CVAD lumen cannot be used. Prior to dose adjustment, retesting via direct venipuncture may be necessary. Provide drug name, dose, time of last infusion, and specimen collection time to the laboratory. Therapeutic drug monitoring is most common for anticoagulants, antibiotics, and immunosuppressants with dosage adjustment based on tests results.[6] (V)
      a. Cyclosporine adheres to the intraluminal CVAD wall regardless of flushing and/or lapse of time between infusion and obtaining the sample from the catheter. High drug levels of cyclosporine and tacrolimus have been reported when given through CVADs constructed of silicone, polyurethane, and polyurethane with silver.[74,84,85] (III)
      b. Studies of vancomycin and tobramycin levels have shown statistical differences when compared to direct venipuncture and capillary finger sticks; however, these differences have not been clinically significant to alter dosing.[59,86] (IV)
      c. Accuracy of coagulation values from a blood sample obtained from a heparinized CVAD are inconclusive due to many confounding variables. These include specific procedures used (eg, waste/discard, push-pull), adherence of heparin to the catheter material and/or intraluminal biofilm, and discard volumes that could be detrimental to the patient. Elimination of heparin locking solution could make use of a CVAD

possible; however, therapeutic heparin infusions will present these same issues. Retesting via a direct venipuncture is required when questionable results are obtained (see Standard 41, *Flushing and Locking*).[87,88] (II)

2. Avoid using a CVAD for obtaining blood samples for culturing as these samples are more likely to produce false-positive results. Use of a CVAD for this purpose should be limited to the need for diagnosis of a CABSI and the presence of difficult venous access when use of vascular visualization technology has failed.
   a. Remove and discard the used needleless connector prior to drawing a blood sample to reduce risk of a false-positive blood culture result.
   b. If using a blood culture bottle designed for direct filling from the CVAD, maintain the bottle upright and follow manufacturers' directions for use to avoid reflux of the broth medium into the CVAD and vein.
   c. Send the initial blood volume aspirated from the CVAD for blood culture without a discard volume. Assess for the use of antimicrobial CVAD locking solution, which may interfere with culture results.
   d. A fever/sepsis screening checklist and a blood culture decision algorithm resulted in fewer blood cultures being drawn from a CVAD in critically ill pediatric patients without increase in mortality, readmission, or episodes of infection.[6,58,89,90] (IV)
3. Evaluate the use of the push-pull (ie, mixing) method vs the discard method for obtaining a sample from CVADs.
   a. The push-pull method produces clinically useful laboratory values in adults and pediatric patients while reducing the amount of wasted blood and reducing hub manipulation. Studies include complete blood counts, electrolytes, renal and liver function tests, glucose, coagulation studies, blood gases, C-reactive protein, and therapeutic drug monitoring for gentamicin. These studies report 4 to 6 mL of blood withdrawn into the syringe and flushed back into the catheter lumen without disconnecting the syringe. These aspiration/return or push-pull cycles are repeated for a total of 4 cycles.[41,43,46,91] (IV)
   b. For the discard method, studies of the volume for discard are limited, ranging from 2 to 25 mL. This wide variation depends upon the internal volume of the CVAD, saline flushing prior to drawing the discard volume, and the specific laboratory tests needed. Coagulation studies require the largest discard volume to produce accurate results; however, this volume could produce hospital-acquired anemia.[87,88,92] (IV)
4. Use a closed-loop blood collection system for arterial and venous catheters in adults and pediatric patients to allow return of any blood withdrawn for the purpose of clearing the catheter lumen, often known as the discard or waste. Do not reinfuse the discard sample in a disconnected syringe due to risk of contamination and blood clot formation.[17,43-45] (IV)
5. Ensure a standardized protocol for consistent use by all staff including:
   a. Thorough flushing of the VAD lumen (eg, 10-20 mL of preservative-free 0.9% sodium chloride) before and after obtaining the blood sample.
   b. The need to stop solutions and medications infusing through other lumens. Length of time is unknown but would be associated with the internal volume of the specific CVAD.
   c. Choosing the appropriate CVAD lumen for obtaining samples based on the largest lumen or the configuration of the lumen exit sites. For catheters with a staggered lumen exit at the tip, the sample should be drawn from the lumen exiting at the point farthest away from the heart and above other lumen exits used for infusion. Follow CVAD manufacturers' directions for use for these decisions.[59,87] (IV)
6. Do not routinely use CVADs infusing PN for blood sampling as manipulation may increase the risk for CABSI.[75,76] (V)

F. Arterial catheters
   1. Use a closed-loop system when drawing from an existing arterial catheter to reduce hospital-acquired anemia and subsequent need for transfusion. A closed-loop system reduces intraluminal contamination and CABSI when compared to a stopcock method.[48] (II)

REFERENCES

Note: All electronic references in this section were accessed between March 8, 2020, and August 28, 2020.

1. World Health Organization. WHO guidelines on drawing blood: best practices in phlebotomy. World Health Organization; 2010. http://www.euro.who.int/__data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf?ua-1
2. De la Salle B. Pre- and postanalytical errors in haematology. *Int J Lab Hematol.* 2019;41(Suppl 1):170-176. doi:10.1111/ijlh.13007
3. Zemlin AE. Errors in the extra-analytical phases of clinical chemistry laboratory testing. *Indian J Clin Biochem.* 2018;33(2):154-162. doi:10.1007/s12291-017-0657-2
4. Lippi G, Cervellin G. Acutely developing, spurious anaemia without actual blood loss: a paradigmatic case report. *Biochem Med (Zagreb).* 2017;27(2):421-425. doi:10.11613/BM.2017.045
5. Lima-Oliveira G, Volanski W, Lippi G, Picheth G, Guidi GC. Pre-analytical phase management: a review of the procedures from patient preparation to laboratory analysis. *Scand J Clin Lab Invest.* 2017;77(3):153-163. doi:10.1080/00365513.2017.1295317
6. Clinical and Laboratory Standards Institute (CLSI). *Collection of Diagnostic Venous Blood Specimens*. 7th ed. Clinical and Laboratory Standards Institute; 2017.

7. Lippi G, Baird GS, Banfi G, et al. Improving quality in the preanalytical phase through innovation, on behalf of the European Federation for Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for Preanalytical Phase (WG-PRE). *Clin Chem Lab Med.* 2017;55(4):489-500. doi:10.1515/cclm-2017-0107
8. Wheeler D, Marcus P, Nguyen J, et al. Evaluation of a resident-led project to decrease phlebotomy rates in the hospital: think twice, stick once. *JAMA Intern Med.* 2016;176(5):708-710. doi:10.1001/jamainternmed.2016.0549
9. Erard Y, Del Giorno R, Zasa A, et al. A multi-level strategy for a long lasting reduction in unnecessary laboratory testing: a multicenter before and after study in a teaching hospital network [published online ahead of print Oct 19, 2018]. *Int J Clin Pract.* 2019;73(3):e13286. doi:10.1111/ijcp.13286
10. Woods-Hill CZ, Lee L, Xie A, et al. Dissemination of a novel framework to improve blood culture use in pediatric critical care. *Pediatr Qual Saf.* 2018;3(5):e112. doi:10.1097/pq9.0000000000000112
11. El Feghaly RE, Chatterjee J, Dowdy K, et al. A quality improvement initiative: reducing blood culture contamination in a children's hospital. *Pediatrics.* 2018;142(4):e20180244. doi:10.1542/peds.2018-0244
12. Thakkar RN, Kim D, Knight AM, Riedel S, Vaidya D, Wright SM. Impact of an educational intervention on the frequency of daily blood test orders for hospitalized patients. *Am J Clin Pathol.* 2015;143(3):393-397. doi:10.1309/AJCPJS4EEM7UAUBV
13. Aykal G, Keşapli M, Aydin Ö, et al. Pre-test and post-test applications to shape the education of phlebotomists in a quality management program: an experience in a training hospital. *J Med Biochem*. 2016;35(3):347-353.
14. Al-Hamad A, Al-Ibrahim M, Alhajhouj E, Al-Alshaikh Jaffer W, Altowaileb J, Alfaraj H. Nurses' competency in drawing blood cultures and educational intervention to reduce the contamination rate. *J Infect Public Health.* 2016;9(1):66-74. https://doi.org/10.1016/j.jiph.2015.06.007
15. Nair A, Elliott SP, Al Mohajer M. Knowledge, attitude, and practice of blood culture contamination: a multicenter study. *Am J Infect Control.* 2017;45(5):547-548. doi:10.1016/j.ajic.2017.01.008
16. Cai Q, Zhou Y, Yang D. Nurses' knowledge on phlebotomy in tertiary hospitals in China: a cross-sectional multicentric survey. *Biochem Med (Zagreb).* 2018;28(1):010703. doi:10.11613/BM.2018.010703
17. Jones S, Spangler P, Keiser M, Turkelson C. Impact of nursing education on phlebotomy blood loss and hospital-acquired anemia: a quality improvement project. *Dimens Crit Care Nurs*. 2019;38(1):13-19. doi:10.1097/DCC.0000000000000333
18. Makhumula-Nkhoma N, Weston KL, McSherry R, Atkinson G. The impact of venepuncture training on the reduction of pre-analytical blood sample haemolysis rates: a systematic review. *J Clin Nurs.* 2019;28(23-24):4166-4176. doi:10.1111/jocn.14997
19. Simundic AM, Church S, Cornes MP, et al. Compliance of blood sampling procedures with the CLSI H3-A6 guidelines: an observational study by the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) working group for the preanalytical phase (WG-PRE). *Clin Chem Lab Med.* 2015;53(9):1321-1331. doi:10.1515/cclm-2014-1053
20. Hjelmgren H, Nilsson A, Andersson-Papadogiannakis N, Ritzmo C, Ygge BM, Nordlund B. Retrospective study showed that blood sampling errors risked children's well-being and safety in a Swedish paediatric tertiary care. *Acta Paediatr.* 2019;108(3):522-528. doi:10.1111/apa.14528
21. Lippi G, Simundic AM; European Federation for Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for Preanalytical Phase (WG-PRE). The EFLM strategy for harmonization of the preanalytical phase. *Clin Chem Lab Med.* 2018;56(10):1660-1666. doi:10.1515/cclm-2017-0277
22. Seferian EG, Jamal S, Clark K, et al. A multidisciplinary, multifaceted improvement initiative to eliminate mislabelled laboratory specimens at a large tertiary care hospital. *BMJ Qual Saf.* 2014;23(8):690-697. doi:10.1136/bmjqs-2014-003005
23. Giavarina D, Lippi G. Blood venous sample collection: recommendations overview and a checklist to improve quality. *Clin Biochem.* 2017;50(10-11):568-573. doi:10.1016/j.clinbiochem.2017.02.021
24. Kaufman RM, Dinh A, Cohn CS, et al. Electronic patient identification for sample labeling reduces wrong blood in tube errors. *Transfusion.* 2019;59(3):972-980. doi:10.1111/trf.15102
25. Spain D, Crilly J, Pierce J, Steele M, Scuffham P, Keijzers G. Can a barcode scanner for blood collection improve patient identification integrity in the emergency department? A prospective before-and-after study. *Emerg Med Australas.* 2015;27(1):47-54. doi:10.1111/1742-6723.12334
26. Le RD, Melanson SE, Petrides AK, et al. Significant reduction in preanalytical errors for nonphlebotomy blood draws after implementation of a novel integrated specimen collection module. *Am J Clin Pathol.* 2016;146(4):456-461. doi:10.1093/ajcp/aqw139
27. Lippi G, von Meyer A, Cadamuro J, Simundic AM. Blood sample quality. *Diagnosis (Berl).* 2019;6(1):25-31. doi:10.1515/dx-2018-0018
28. Jacobsen KK, Brandt I, Christensen AV, et al. Order of draw practices in venous blood sampling at clinical biochemistry departments in the Danish health care system. *Clin Biochem.* 2018;56:113-116. doi:10.1016/j.clinbiochem.2018.04.020
29. Magnette A, Chatelain M, Chatelain B, Ten Cate H, Mullier F. Preanalytical issues in the haemostasis laboratory: guidance for the clinical laboratories. *Thromb J.* 2016;14:49. doi:10.1186/s12959-016-0123-z
30. Lippi G, Salvagno GL, Radišić Biljak V, et al. Filling accuracy and imprecision of commercial evacuated sodium citrate coagulation tubes. *Scand J Clin Lab Invest.* 2019;79(4):276-279. doi:10.1080/00365513.2019.1609696
31. Lippi G, Becan-McBride K, Behúlová D, et al. Preanalytical quality improvement: in quality we trust. *Clin Chem Lab Med.* 2013;51(1):229-241. doi:10.1515/cclm-2012-0597
32. Nybo M, Lund ME, Titlestad K, Maegaard CU. Blood sample transportation by pneumatic transportation systems: a systematic literature review. *Clin Chem.* 2018;64(5):782-790. doi:10.1373/clinchem.2017.280479
33. Ballout RA, Diab B, Harb AC, Tarabay R, Khamassi S, Akl EA. Use of safety-engineered devices by healthcare workers for intravenous and/or phlebotomy procedures in healthcare settings: a systematic review and meta-analysis. *BMC Health Serv Res.* 2016;16:458. doi:10.1186/s12913-016-1705-y
34. US Department of Labor. Disposal of contaminated needles and blood tube holders used for phlebotomy. *Safety and Health Information Bulletin.* Occupational Safety and Health Administration. Published March 10, 2015. http://www.osha.gov/dts/shib/shib101503.html
35. Simundic AM, Baird G, Cadamuro J, Costelloe SJ, Lippi G. Managing hemolyzed samples in clinical laboratories. *Crit Rev Clin Lab Sci.* 2020;57(1):1-21. doi:10.1080/10408363.2019.1664391
36. McCaughey EJ, Vecellio E, Lake R, et al. Key factors influencing the incidence of hemolysis: a critical appraisal of current evidence. *Crit Rev Clin Lab Sci.* 2017;54(1):59-72. doi:10.1080/10408363.2016.1250247
37. Padoan A, Sirini S, Mazzone R, et al. Evaluation of an improved small gauge needle for venipuncture in children with difficult venous access: impact on sample quality, phlebotomist satisfaction and patient pain perception. *Clin Chim Acta.* 2020;500:213-219. doi:10.1016/j.cca.2019.10.019
38. Mouser A, Uettwiller-Geiger D, Plokhoy E, Berube J, Ahuja AJ, Stankovic AK. Evaluation of pain and specimen quality by use of a novel 25-gauge blood collection set with ultra-thin wall cannula and 5-bevel tip design. *J Appl Lab Med.* 2017;2(2):201-210. doi:10.1373/jalm.2017.023564
39. Lemyre B, Sample M, Lacaze-Masmonteil T; Canadian Paediatric Society, Fetus and Newborn Committee. Minimizing blood loss and

the need for transfusions in very premature infants. *Paediatr Child Health.* 2015;20(8):451-462. doi:10.1093/pch/20.8.451

40. Briggs EN, Hawkins DJ, Hodges AM, Monk AM. Small volume vacuum phlebotomy tubes: a controlled before-and-after study of a patient blood management initiative in an Australian adult intensive care unit. *Crit Care Resusc*. 2019;21(4):251-257.
41. Byrne D. Comparing the push-pull versus discard blood sample method from adult central vascular access devices. *J Infus Nurs*. 2016;39(3):130-135. doi:10.1097/NAN.0000000000000167
42. Jensen PR, Markewitz BA. Safe reduction of blood volume in the blood gas laboratory. *Lab Med.* 2016;47(4):326-329. doi:10.1093/labmed/lmw039
43. Hess S, Decker M. Comparison of the single-syringe push-pull technique with the discard technique for obtaining blood samples from pediatric central venous access devices. *J Pediatr Oncol Nurs.* 2017;34(6):381-386. doi:10.1177/1043454217713453
44. Steffen K, Doctor A, Hoerr J, et al. Controlling phlebotomy volume diminishes PICU transfusion: Implementation processes and impact. *Pediatrics.* 2017;140(2):e20162480. doi:10.1542/peds.2016-2480
45. Whitehead NS, Williams LO, Meleth S, et al. Interventions to prevent iatrogenic anemia: a laboratory medicine best practices systematic review. *Crit Care*. 2019;23(1):278. doi:10.1186/s13054-019-2511-9
46. McBride C, Miller-Hoover S, Proudfoot JA. A standard push-pull protocol for waste-free sampling in the pediatric intensive care unit. *J Infus Nurs.* 2018;41(3):189-197. doi:10.1097/NAN.0000000000000279
47. Salvagno GL, Demonte D, Poli G, Favaloro EJ, Lippi G. Impact of low volume citrate tubes on results of first-line hemostasis testing. *Int J Lab Hematol.* 2019;41(4):472-477. doi:10.1111/ijlh.13028
48. Benedict A, Mayer A, Craven H. Closed arterial lab sampling devices: a study of compliance and best practice. *Br J Nurs.* 2017;26(14):S24-S29. doi:10.12968/bjon.2017.26.14.S24
49. World Health Organization (WHO). *Guideline: Delayed Umbilical Cord Clamping for Improved Maternal and Infant Health and Nutrition Outcomes.* World Health Organization; 2014.
50. Committee on Obstetric Practice. Committee opinion no. 684: delayed umbilical cord clamping after birth. *Obstet Gynecol.* 2017;129(1):e5-e10. doi:10.1097/AOG.0000000000001860
51. Bae M, In Kim H, Park JH, et al. Improvement of blood culture contamination rate, blood volume, and true positive rate after introducing a dedicated phlebotomy team. *Eur J Clin Microbiol Infect Dis.* 2019;38(2):325-330. doi:10.1007/s10096-018-3430-4
52. Handrup MM, Møller JK, Rutkjær C, Schrøder H. Importance of blood cultures from peripheral veins in pediatric patients with cancer and a central venous line. *Pediatr Blood Cancer.* 2015;62(1):99-102. doi:10.1002/pbc.25171
53. Choi J, Ensafi S, Chartier LB, Van Praet O. A quality improvement initiative to decrease the rate of solitary blood cultures in the emergency department. *Acad Emerg Med.* 2017;24(9):1080-1087. doi:10.1111/acem.13161
54. Long B, Koyfman A. Best clinical practice: blood culture utility in the emergency department. *J Emerg Med.* 2016;51(5):529-539. doi:10.1016/j.jemermed.2016.07.003
55. Garcia RA, Spitzer ED, Beaudry J, et al. Multidisciplinary team review of best practices for collection and handling of blood cultures to determine effective interventions for increasing the yield of true-positive bacteremias, reducing contamination, and eliminating false-positive central line-associated bloodstream infections. *Am J Infect Control.* 2015;43(11):1222-1237. doi:10.1016/j.ajic.2015.06.030
56. Syed S, Liss DT, Costas CO, Atkinson JM. Diversion principle reduces skin flora contamination rates in a community hospital. *Arch Pathol Lab Med.* 2020;144(2):215-220. doi:10.5858/arpa.2018-0524-OA
57. Rupp ME, Cavalieri RJ, Marolf C, Lyden E. Reduction in blood culture contamination through use of initial specimen diversion device. *Clin Infect Dis.* 2017;65(2):201-205. doi:10.1093/cid/cix304
58. Timsit J, Rupp M, Bouza E, et al. A state of the art review on optimal practices to prevent, recognize, and manage complications associated with intravascular devices in the critically ill. *Intensive Care Med.* 2018;44(6):742-759. doi:10.1007/s00134-018-5212-y
59. Wilson K, Jamerson PA. Comparison of central venous catheter and peripheral vein samples of antibiotics in children with cystic fibrosis. *J Spec Pediatr Nurs.* 2013;18(1):33-41. doi:10.1111/jspn.12006
60. Ranum A, Hagle M. Diagnostic testing and values. In: Weinstein S, Hagle ME, eds. *Plumer's Principles and Practices of Infusion Therapy.* 9th ed. Wolters Kluwer Health; 2014:108-141.
61. Jakes AD, Twelves C. Breast cancer-related lymphoedema and venepuncture: a review and evidence-based recommendations. *Breast Cancer Res Treat.* 2015;154(3):455-461. doi:10.1007/s10549-015-3639-1
62. Ferguson CM, Swaroop MN, Horick N, et al. Impact of ipsilateral blood draws, injections, blood pressure measurements, and air travel on the risk of lymphedema for patients treated for breast cancer. *J Clin Oncol.* 2016;34(7):691-698. doi:10.1200/JCO.2015.61.5948
63. Olsen MM, LeFebvre KB, Brassil KJ. *Chemotherapy and Immunotherapy Guidelines and Recommendations for Practice.* Oncology Nursing Society; 2019.
64. Heireman L, Van Geel P, Musger L, Heylen E, Uyttenbroeck W, Mahieu B. Causes, consequences and management of sample hemolysis in the clinical laboratory. *Clin Biochem.* 2017;50(18):1317-1322. doi:10.1016/j.clinbiochem.2017.09.013
65. Shah VS, Ohlsson A. Venepuncture versus heel lance for blood sampling in term neonates. *Cochrane Database Syst Rev.* 2011;2011(10):CD001452. doi:10.1002/14651858.CD001452
66. Noureldein M, Gowda H. Question 2: is it safe to use the centre of the heel for obtaining capillary blood samples in neonates? *Arch Dis Child.* 2018;103(4):401-404. doi:10.1136/archdischild-2017-314214
67. Bellieni C, Stazzoni G, Tei M, et al. How painful is a heelprick or a venipuncture in a newborn? *J Matern Fetal Neonatal Med.* 2016;29(2):202-206. doi:10.3109/14767058.2014.992334
68. Miller AG, Bardin AJ. Review of ultrasound-guided radial artery catheter placement. *Respir Care.* 2016;61(3):383-388. doi:10.4187/respcare.04190
69. Kiang SC, Nasiri AJ, Strilaeff RR, et al. Analysis of subjective and objective screening techniques as predictors of safety for radial artery intervention. *Ann Vasc Surg.* 2020;65:33-39. doi:10.1016/j.avsg.2019.11.011
70. Patout M, Lamia B, Lhuillier E, et al. A randomized controlled trial on the effect of needle gauge on the pain and anxiety experienced during radial arterial puncture. *PLoS ONE.* 2015;10(9):e0139432. doi:10.1371/journal.pone.0139432
71. Hill S, Moore S. Arterial blood gas sampling: using a safety and preheparinised syringe. *Br J Nurs.* 2018;27(14):S20-S26. doi:10.12968/bjon.2018.27.14.S20
72. Twibell KR, Hofstetter P, Siela D, Brown D, Jones HM. A comparative study of blood sampling from venipuncture and short peripheral catheters in pediatric inpatients. *J Infus Nurs.* 2019;42(5):237-247. doi:10.1097/NAN.0000000000000338
73. Martinez JM, Santo AE, Godinho A, et al. Acute leukemia patients: a CLABSI risk special population. *Ann Hematol Oncol.* 2018;5(2):1192.
74. Hacker C, Verbeek M, Schneider H, Steimer W. Falsely elevated cyclosporin and tacrolimus concentrations over prolonged periods of time due to reversible adsorption to central venous catheters. *Clin Chim Acta.* 2014;433:62-68. doi:10.1016/j.cca.2014.02.031
75. Ayers P, Adams S, Boullata J, et al. A.S.P.E.N. parenteral nutrition safety consensus recommendations translation into practice. *Nutr Clin Pract.* 2014;29(3):277-282. doi:10.1177/0884533614531294

76. Buchman AL, Opilla M, Kwasny M, Diamantidis TG, Okamoto R. Risk factors for the development of catheter-related bloodstream infections in patients receiving home parenteral nutrition. *JPEN J Parenter Enteral Nutr.* 2014;38(6):744-749. doi:10.1177/0148607113491783
77. Hambleton VL, Gómez IA, Andreu FAB. Venipuncture versus peripheral catheter: do infusions alter laboratory results? *J Emerg Nurs.* 2014;40(1):20-26. doi:10.1016/j.jen.2012.03.014
78. Jeong Y, Park H, Jung MJ, Kim MS, Byun S, Choi Y. Comparisons of laboratory results between two blood samplings: venipuncture versus peripheral venous catheter-a systematic review with meta-analysis. *J Clin Nurs.* 2019;28(19-20):3416-3429. doi:10.1111/jocn.14918
79. Coventry LL, Jacob AM, Davies HT, Stoneman L, Keogh S, Jacob ER. Drawing blood from peripheral intravenous cannula compared with venepuncture: a systematic review and meta-analysis. *J Adv Nurs.* 2019;75(11):2313-2339. doi:10.1111/jan.14078
80. Natali R, Wand C, Doyle K, Noguez JH. Evaluation of a new venous catheter blood draw device and its impact on specimen hemolysis rates. *Pract Lab Med.* 2018;10:38-43. doi:10.1016/j.plabm.2018.01.002
81. Mulloy DF, Lee SM, Gregas M, Hoffman KE, Ashley SW. Effect of peripheral IV based blood collection on catheter dwell time, blood collection, and patient response. *Appl Nurs Res.* 2018;40:76-79. doi:10.1016/j.apnr.2017.12.006
82. Adams S, Toroni B, Lele M. Effect of the PIVO device on the procedure of phlebotomy from peripheral IV catheters. *Nurs Res Pract.* 2018;2018:7380527. doi:10.1155/2018/7380527
83. Jousi M, Laukkanen-Nevala P, Nurmi J. Analysing blood from intraosseous access: a systematic review. *Eur J Emerg Med.* 2019;26(2):77-85. doi:10.1097/MEJ.0000000000000569
84. Garbin LM, Tonani M, Salvador M, et al. Cyclosporine level: difference between blood samples collected through peripheral and central venous access. *J Clin Nurs.* 2013;22(3-4):395-404. doi:10.1111/j.1365-2702.2012.04187.x
85. Garbin LM, Simões BP, Curcioli ACJV, de Carvalho EC. Serum cyclosporine levels: the influence of the time interval between interrupting the infusion and obtaining the samples: a randomized clinical trial. *Cancer Nurs*. 2018;41(4):E55-E61. doi:10.1097/NCC.0000000000000544
86. Lichliter RL, Tremewan LE, Shonka NM, et al. Therapeutic antibiotic serum concentrations by two blood collection methods within the pediatric patient: a comparative effectiveness trial. *J Spec Pediatr Nurs.* 2018;23(2):e12212. doi:10.1111/jspn.12212
87. Dalton KA, Aucoin J, Meyer B. Obtaining coagulation blood samples from central venous access devices: a review of the literature. *Clin J Oncol Nurs.* 2015;19(4):418-423. doi:10.1188/15.CJON.19-04AP
88. Jeon M, Han A, Kang H, Lee KH, Lee JH, Lee JH. A comparison of coagulation test results from heparinized central venous catheter and venipuncture. *Blood Coagul Fibrinolysis.* 2020;31(2):145-151. doi:10.1097/MBC.0000000000000890
89. Sherertz RJ, Karchmer TB, Palavecino E, Bischoff W. Blood drawn through valved catheter hub connectors carries a significant risk of contamination. *Eur J Clin Microbiol Infect Dis.* 2011;30(12):1571-1577. doi:10.1007/s10096-011-1262-6
90. Woods-Hill CZ, Fackler J, Nelson McMillan K, et al. Association of a clinical practice guideline with blood culture use in critically ill children. *JAMA Pediatr*. 2017;171(2):157-164. doi:10.1001/jamapediatrics.2016.3153
91. Chen J, Boodhan S, Nanji M, et al. A reliable and safe method of collecting blood samples from implantable central venous catheters for determination of plasma gentamicin concentrations. *Pharmacotherapy.* 2011;31(8):776-784. doi:10.1592/phco.31.8.776
92. Villalta-García P, López-Herránz M, Mazo-Pascual S, Honrubia-Fernández T, Jáñez-Escalada L, Fernández-Pérez C. Reliability of blood test results in samples obtained using a 2-mL discard volume from the proximal lumen of a triple-lumen central venous catheter in the critically ill patient: blood sampling from a central venous catheter in critical care. *Nurs Crit Care.* 2017;22(5):298-304. doi:10.1111/nicc.12220

45. VASCULAR ACCESS DEVICE REMOVAL

Standard

45.1 The clinical need for each VAD is assessed daily for acute inpatient settings and during regular assessment visits in other settings, such as the home, outpatient facility, or skilled nursing facility.

45.2 VADs are removed when clinically indicated (eg, unresolved complication, discontinuation of infusion therapy, or when no longer necessary for the plan of care).

45.3 VADs are not removed based solely on length of dwell time, because there is no known optimal dwell time.

Practice Recommendations

I. Short and Long PIVCs and Midline Catheters

A. Remove if no longer included in the plan of care or if not used for 24 hours or more.[1-4] (I)
B. Remove PIVCs and midline catheters in pediatric and adult patients when clinically indicated, based on findings from site assessment and/or clinical signs and symptoms of systemic complications (refer to Standard 46, *Phlebitis*; Standard 47, *Infiltration and Extravasation*; Standard 48, *Nerve Injury*; Standard 50, *Infection*).
C. Label catheters inserted under suboptimal aseptic conditions in any health care setting (eg, "emergent"). Remove and insert a new catheter as soon as possible, within 24 to 48 hours.[2,5-7] (IV)
D. Notify the health care team of signs and symptoms of suspected CABSI and discuss the need for obtaining cultures (eg, drainage, blood culture, catheter tip) before removing a PIVC (see Standard 50, *Infection*).[8,9] (IV)
E. Detach all administration sets and aspirate from the catheter hub prior to catheter removal in the event of extravasation to remove the vesicant medication from the catheter lumen and as much as possible from the subcutaneous tissue (refer to Standard 47, *Infiltration and Extravasation*).

II. Nontunneled CVADs Including PICCs

A. Assess and discuss with the health care team the continued need for the CVAD on a daily basis and remove when it is no longer needed for the plan of care. Criteria for justification of continued use of a CVAD include, but are not limited to:
    1. Clinical instability of the patient (eg, alteration in vital signs, oxygen saturation).
    2. Prescribed continuous infusion therapy (eg, PN, fluid and electrolytes, medications, blood, or blood products).
    3. Hemodynamic monitoring.

4. Prescribed intermittent infusion therapy (eg, any medication including anti-infectives in patients with a known or suspected infection).
5. Documented history of difficult peripheral venous access.[10-17] (IV)

B. Employ strategies to facilitate timely CVAD removal including, but not limited to:
1. Daily patient rounds by the health care team.
2. Use of a standardized tool including factors to be considered for making the decision to remove the CVAD.
3. Assessment by designated infusion/vascular access specialists or qualified nurse/clinician.
4. Removal within 48 hours if the catheter is inserted under suboptimal aseptic conditions.
5. Consider using an electronic communication tool to facilitate shared decision-making between the patient's health care team and the infusion team/vascular access team (VAT) regarding PICC removal. The infusion team/VAT would provide consultation regarding clinical practice guidelines for appropriate removal, thus decreasing complications and costs and avoiding premature and unnecessary PICC removals.[14,16,18-30] (II)

C. Assess and report signs and symptoms of CVAD complications and changes in catheter function. Consider the need for alternative vascular access if removal is necessary (refer to Section 7, *Vascular Access Device Complications*).

D. Collaborate with the health care team to plan removal and insertion of a new VAD to meet vascular access needs in the presence of unresolved complication(s) and/or a continued need for infusion therapy.
1. Removal of a CVAD may be the goal with changes in patient's infusion needs and/or transfer to another level of care. Continuing needs for vascular access are based on assessment of the condition of the patient's peripheral veins, risk of complications, and characteristics of the remaining infusion therapy. Further research is needed on clinical indications for CVAD removal (see Standard 26, *Vascular Access Device Planning*).[13,26,31-42] (I)
2. Determine the removal or salvage of a CVAD due to suspected or confirmed CABSI on blood culture results, specific cultured organism(s), patient's current condition, available vascular access sites, effectiveness of antimicrobial therapy, and provider direction (see Standard 50, *Infection*).[14,15,17,18,20,22,25,43-49] (I)
3. Do not remove a CVAD in the presence of CA-DVT when the catheter is correctly positioned at the lower third of the superior vena cava (SVC) at or near the cavoatrial junction (CAJ), is functioning properly with a blood return, and has no evidence of any infection. The decision to remove the CVAD should also consider the severity of deep vein thrombosis (DVT)-related symptoms, presence of contraindications for systemic anticoagulation, and the continued need for infusion therapy requiring a CVAD (eg, vesicants, irritants). See Standard 53, *Catheter-Associated Deep Vein Thrombosis*.[10,14,15,27,39,45,50-53] (I)
   a. In a small retrospective study, there were no symptomatic pulmonary emboli upon PICC removal in the presence of upper extremity superficial and DVT.[54] (IV)
4. Remove a CVAD with a primary or secondary catheter tip malposition that cannot be repositioned to the lower third of the SVC at or near the CAJ (see Standard 54, *Central Vascular Access Device Malposition*).[27,55-57] (IV)
5. Consult with the health care team regarding diagnostic imaging studies and the appropriate medical management prior to removal of a CVAD in the event of infiltration or extravasation (refer to Standard 47, *Infiltration and Extravasation*).

E. Implement precautions to prevent air embolism during removal of CVADs including, but not limited to:
1. Place the patient in a supine flat or Trendelenburg position unless contraindicated (Trendelenburg position is contraindicated in premature infants), so that the insertion site is below the level of the heart.
   a. While there are no published cases of air embolism associated with PICC removal, there may be risk due to an intact skin-to-vein tract and fibrin sheath. Position patient so that the exit site is at or below the level of the heart during PICC removal and place an air-occlusive dressing (eg, petroleum gauze) over the insertion site. (A/P; Committee Consensus)
   b. Documentation of air embolism from removal of a CVAD inserted via the femoral vein has not been published, although there is evidence of air entering the femoral catheter during insertion and during other procedures. Because the exit site will be at, or below, the level of the heart, the risk of air embolism on removal would be minimal, unless the patient is in Trendelenburg position.
2. Instruct the patient to perform a Valsalva maneuver at the appropriate point during catheter withdrawal.
   a. The Valsalva maneuver may increase intra-abdominal and intrathoracic pressures and thus be contraindicated in patients with cardiac dysfunction, glaucoma, and retinopathy. If the Valsalva maneuver is contraindicated, use a Trendelenburg or left lateral decubitus position, have the patient hold their breath, or time removal to exhalation.
3. After removal, apply digital pressure with a sterile dry gauze pad at and just above the insertion site until hemostasis is achieved by using manual compression.
4. Apply an air-occlusive dressing to the access site for at least 24 hours for the purpose of occluding the skin-to-vein tract and decreasing the risk of retrograde air emboli.

5. Encourage the patient to remain in a flat or reclining position, if able, for 30 minutes after removal (see Standard 52, *Air Embolism*).[58-67] (IV, A/P)

F. Assess the removed catheter to ensure it is fully intact, after planned or inadvertent CVAD removal. If a retained fragment is suspected, notify the provider immediately. Fracture of a catheter and potential embolization can occur from excessive force during infusion therapy, the force of inadvertent removal, or from adherence to internal structures.
   1. Never forcibly remove a CVAD if resistance is encountered. Contact the provider to discuss appropriate interventions for successful removal.
   2. Catheter pieces retained in the vein should be removed with endovascular techniques to reduce the risk of infection, thrombosis, and migration of the catheter piece.[14,15,58-70] (IV)

III. Surgically Placed CVADs: Tunneled, Cuffed Catheters and Implanted Vascular Access Ports

A. Assess the clinical need for a tunneled, cuffed catheter or implanted vascular access port on a regular basis.[71] (V)

B. Arrange for removal with the provider when infusion therapy is completed, in the presence of an unresolved complication, or when it is no longer needed for the plan of care. Before removal, consider the possibility for infusion therapy to resume in the future (eg, patients with sickle cell anemia, cystic fibrosis, or cancer diagnoses).[14,17,57,71] (IV)

C. Consult with the health care team regarding the decision to remove or salvage a CVAD due to suspected or confirmed CABSI (see Standard 50, *Infection*).[72,73] (V)

D. Immediately report to the health care team cuff or port body exposure and anticipate appropriate interventions (eg, resuture of incision), including CVAD removal.[74] (V)

E. Ensure complete removal of the subcutaneous cuff to prevent subcutaneous abscess and delayed healing. Fluoroscopy and ultrasound guidance may be necessary to verify cuff location and facilitate surgical removal.[75] (V)

IV. Arterial Catheters

A. Remove the catheter on evidence of signs/symptoms of infection, unresolved catheter dysfunction, complication (ie, occlusion, hematoma, altered circulatory status), or when it is no longer needed for the plan of care; recognize the risk of an arterial catheter as a potential source for CABSI.[18,76,77] (V)

B. Apply digital pressure at and just above the insertion site using a sterile gauze pad until hemostasis is achieved by using manual compression. A sterile dressing should be applied to the access site.[78,79] (IV)

C. Assess and document the circulatory status distal to the area of cannulation after removal of the arterial catheter and notify the provider if circulatory and/or sensory abnormalities are noted.[79] (V)

REFERENCES

Note: All electronic references in this section were accessed between June 3, 2020, and September 11, 2020.

1. Ray-Barruel G, Cooke M, Mitchell M, Chopra V, Rickard CM. Implementing the I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: protocol for an interrupted time-series study. *BMJ Open*. 2018;8(6):e021290. doi:10.1136/bmjopen-2017-021290
2. Ray-Barruel G, Xu H, Marsh N, Cooke M, Rickard CM. Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: a systematic review. *Infect Dis Health*. 2019;24(3):152-168. doi:10.1016/j.idh.2019.03.001
3. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health*. 2019;55(10):1214-1223. doi:10.1111/jpc.14384
4. Becerra MB, Shirley D, Safdar N. Prevalence, risk factors, and outcomes of idle intravenous catheters: an integrative review. *Am J Infect Control*. 2016;44(10):e167-e172. doi:10.1016/j.ajic.2016.03.073
5. Ruegg L, Faucett M, Choong K. Emergency inserted peripheral intravenous catheters: a quality improvement project. *Br J Nurs*. 2018;27(14):S28-S30. doi:10.12968/bjon.2018.27.14.S28
6. Carr PJ, Rippey J, Moore T, et al. Reasons for removal of emergency department-inserted peripheral intravenous cannulae in admitted patients: a retrospective medical chart audit in Australia. *Infect Control Hosp Epidemiol*. 2016;37(7):874-876. doi:10.1017/ice.2016.70
7. Mermel LA. Short-term peripheral venous catheter-related bloodstream infections: a systematic review. *Clin Infect Dis*. 2017;65(10):1757-1762. doi:10.1093/cid/cix562
8. Sato A, Nakamura I, Fujita H, et al. Peripheral venous catheter-related bloodstream infection is associated with severe complications and potential death: a retrospective observational study. *BMC Infect Dis*. 2017;17(1):434. doi:10.1186/s12879-017-2536-0
9. Capdevila JA, Guembe M, Barberán J, et al. 2016 Expert consensus document on prevention, diagnosis and treatment of short-term peripheral venous catheter-related infections in adult. *Rev Esp Quimioter*. 2016;29(4):230-238.
10. Chopra V, Flanders SA, Saint S, et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Ann Intern Med*. 2015;163(6 Suppl):S1-S40. doi:10.7326/M15-0744
11. Dumyati G, Concannon C, van Wijngaarden E, et al. Sustained reduction of central line-associated bloodstream infections outside the intensive care unit with a multimodal intervention focusing on central line maintenance. *Am J Infect Control*. 2014;42(7):723-730. doi:10.1016/j.ajic.2014.03.353
12. Weeks KR, Hsu YJ, Yang T, Sawyer M, Marsteller JA. Influence of a multifaceted intervention on central line days in intensive care units: results of a national multisite study. *Am J Infect Control*. 2014;42 (10 Suppl):S197-S202. doi:10.1016/j.ajic.2014.06.003
13. Govindan S, Snyder A, Flanders SA, Chopra V. Peripherally inserted central catheters in the ICU: a retrospective study of adult medical patients in 52 hospitals. *Crit Care Med*. 2018;46(12):e1136-e1144. doi:10.1097/CCM.0000000000003423
14. Duesing LA, Fawley JA, Wagner AJ. Central venous access in the pediatric population with emphasis on complications and prevention strategies. *Nutr Clin Pract*. 2016;31(4):490-501. doi:10.1177/0884533616640454
15. Expert Panel on Interventional Radiology; Shaw CM, Shah S, et al. ACR Appropriateness Criteria® radiologic management of central venous access. *J Am Coll Radiol*. 2017;14(11S):S506-S529. doi:10.1016/j.jacr.2017.08.053
16. Sou V, McManus C, Mifflin N, Frost SA, Ale J, Alexandrou E. A clinical pathway for the management of difficult venous access. *BMC Nurs*. 2017;16:64. doi:10.1186/s12912-017-0261-z

17. Voog E, Campion L, du Rusquec P, et al. Totally implantable venous access ports: a prospective long-term study of early and late complications in adult patients with cancer. *Support Care Cancer*. 2018;26(1):81-89. doi:10.1007/s00520-017-3816-3
18. Centers for Disease Control and Prevention. Summary of recommendations, guidelines for the prevention of intravascular catheter-related infections (2011). Updated February 2017. https://www.cdc.gov/infectioncontrol/guidelines/bsi/recommendations.html
19. Hallam C, Weston V, Denton A, et al. Development of the UK Vessel Health and Preservation (VHP) framework: a multi-organisational collaborative. *J Infect Prev*. 2016;17(2):65-72. doi:10.1177/1757177415624752
20. Lin KY, Cheng A, Chang YC, et al. Central line-associated bloodstream infections among critically-ill patients in the era of bundle care. *J Microbiol Immunol Infect*. 2017;50(3):339-348. doi:10.1016/j.jmii.2015.07.001
21. Ista E, van der Hoven B, Kornelisse RF, et al. Effectiveness of insertion and maintenance bundles to prevent central-line-associated bloodstream infections in critically ill patients of all ages: a systematic review and meta-analysis. *Lancet Infect Dis*. 2016;16(6):724-734. doi:10.1016/S1473-3099(15)00409-0
22. Guenezan J, Drugeon B, Marjanovic N, Mimoz O. Treatment of central line-associated bloodstream infections. *Crit Care*. 2018;22(1):303. doi:10.1186/s13054-018-2249-9
23. Furuya EY, Dick AW, Herzig CT, Pogorzelska-Maziarz M, Larson EL, Stone PW. Central line-associated bloodstream infection reduction and bundle compliance in intensive care units: a national study. *Infect Control Hosp Epidemiol*. 2016;37(7):805-810. doi:10.1017/ice.2016.67
24. Nolan ME, Yadav H, Cawcutt KA, Cartin-Ceba R. Complication rates among peripherally inserted central venous catheters and centrally inserted central catheters in the medical intensive care unit. *J Crit Care*. 2016;31(1):238-242. doi:10.1016/j.jcrc.2015.09.024
25. Lutwick L, Al-Maani AS, Mehtar S, et al. Managing and preventing vascular catheter infections: a position paper of the International Society for Infectious Diseases. *Int J Infect Dis*. 2019;84:22-29. doi:10.1016/j.ijid.2019.04.014
26. Patel PK, Olmsted RN, Hung L, et al. A tiered approach for preventing central line-associated bloodstream infection. *Ann Intern Med*. 2019;171(7 Suppl):S16-S22. doi:10.7326/M18-3469
27. Crawford JD, Liem TK, Moneta GL. Management of catheter-associated upper extremity deep venous thrombosis. *J Vasc Surg Venous Lymphat Disord*. 2016;4(3):375-379. doi:10.1016/j.jvsv.2015.06.003
28. Patel PK, Gupta A, Vaughn VM, Mann JD, Ameling JM, Meddings J. Review of strategies to reduce central line-associated bloodstream infection (CLABSI) and catheter-associated urinary tract infection (CAUTI) in adult ICUs. *J Hosp Med*. 2018;13(2):105-116. doi:10.12788/jhm.2856
29. Hammarskjöld F, Berg S, Hanberger H, Taxbro K, Malmvall BE. Sustained low incidence of central venous catheter-related infections over six years in a Swedish hospital with an active central venous catheter team. *Am J Infect Control*. 2014;42(2):122-128. doi:10.1016/j.ajic.2013.09.023
30. Kim-Saechao SJ, Almario E, Rubin ZA. A novel infection prevention approach: Leveraging a mandatory electronic communication tool to decrease peripherally inserted central catheter infections, complications, and cost. *Am J Infect Control*. 2016;44(11):1335-1345. doi:10.1016/j.ajic.2016.03.023
31. Xu T, Kingsley L, DiNucci S, et al. Safety and utilization of peripherally inserted central catheters versus midline catheters at a large academic medical center. *Am J Infect Control*. 2016;44(12):1458-1461. doi:10.1016/j.ajic.2016.09.010
32. Seo H, Altshuler D, Dubrovskaya Y, et al. The safety of midline catheters for intravenous therapy at a large academic medical center. *Ann Pharmacother*. 2020;54(3):232-238. doi:10.1177/1060028019878794
33. Adams DZ, Little A, Vinsant C, Khandelwal S. The midline catheter: a clinical review. *J Emerg Med*. 2016;51(3):252-258. doi:10.1016/j.jemermed.2016.05.029
34. Mushtaq A, Navalkele B, Kaur M, et al. Comparison of complications in midlines versus central venous catheters: are midlines safer than central venous lines? *Am J Infect Control*. 2018;46(7):788-792. doi:10.1016/j.ajic.2018.01.006
35. Caparas JV, Hung HS. Vancomycin administration through a novel midline catheter: summary of a 5-year 1086-patient experience in an urban community hospital. *J Assoc Vasc Access.* 2017;22(1):38-41. https://doi.org/10.1016/j.java.2016.10.092
36. Anderson J, Greenwell A, Louderback J, Polivka BJ, Herron Behr J. Comparison of outcomes of extended dwell/midline peripheral intravenous catheters and peripherally inserted central catheters in children. *J Assoc Vasc Access.* 2016;21(3):158-164. https://doi.org/10.1016/j.java.2016.03.007
37. Pathak R, Gangina S, Jairam F, Hinton K. A vascular access and midlines program can decrease hospital-acquired central line-associated bloodstream infections and cost to a community-based hospital. *Ther Clin Risk Manag*. 2018;14:1453-1456. doi:10.2147/TCRM.S171748
38. Campagna S, Gonella S, Berchialla P, et al. A retrospective study of the safety of over 100,000 peripherally-inserted central catheters days for parenteral supportive treatments. *Res Nurs Health*. 2019;42(3):198-204. doi:10.1002/nur.21939
39. Norris AH, Shrestha NK, Allison GM, et al. 2018 Infectious Diseases Society of America clinical practice guideline for the management of outpatient parenteral antimicrobial therapy. *Clin Infect Dis*. 2019;68(1):e1-e35. doi:10.1093/cid/ciy867
40. Bahl A, Karabon P, Chu D. Comparison of venous thrombosis complications in midlines versus peripherally inserted central catheters: are midlines the safer option? *Clin Appl Thromb Hemost*. 2019;25:1076029619839150. doi:10.1177/1076029619839150
41. Cawcutt KA, Hankins RJ, Micheels TA, Rupp ME. Optimizing vascular-access device decision-making in the era of midline catheters. *Infect Control Hosp Epidemiol*. 2019;40(6):674-680. doi:10.1017/ice.2019.49
42. Chopra V, Kaatz S, Swaminathan L, et al. Variation in use and outcomes related to midline catheters: results from a multicentre pilot study. *BMJ Qual Saf*. 2019;28(9):714-720. doi:10.1136/bmjqs-2018-008554
43. Parienti JJ, Mongardon N, Mégarbane B, et al. Intravascular complications of central venous catheterization by insertion site. *N Engl J Med*. 2015;373(13):1220-1229. doi:10.1056/NEJMoa1500964
44. Takashima M, Schults J, Mihala G, Corley A, Ullman A. Complication and failures of central vascular access device in adult critical care settings. *Crit Care Med*. 2018;46(12):1998-2009. doi:10.1097/CCM.0000000000003370
45. Blanco-Guzman MO. Implanted vascular access device options: a focused review on safety and outcomes. *Transfusion*. 2018;58(Suppl 1):558-568. doi:10.1111/trf.14503
46. Campbell AJ, Blyth CC, Hewison CJ, et al. Lessons learned from a hospital-wide review of blood stream infections for paediatric central line-associated blood stream infection prevention. *J Paediatr Child Health*. 2019;55(6):690-694. doi:10.1111/jpc.14276
47. Tribler S, Brandt CF, Fuglsang KA, et al. Catheter-related bloodstream infections in patients with intestinal failure receiving home parenteral support: risks related to a catheter-salvage strategy. *Am J Clin Nutr*. 2018;107(5):743-753. doi:10.1093/ajcn/nqy010
48. Burnham JP, Rojek RP, Kollef MH. Catheter removal and outcomes of multidrug-resistant central-line-associated bloodstream infection. *Medicine (Baltimore)*. 2018;97(42):e12782. doi:10.1097/MD.0000000000012782
49. Grau D, Clarivet B, Lotthé A, Bommart S, Parer S. Complications with peripherally inserted central catheters (PICCs) used in hospitalized

patients and outpatients: a prospective cohort study. *Antimicrob Resist Infect Control*. 2017;6:18. doi:10.1186/s13756-016-0161-0

50. Fallouh N, McGuirk HM, Flanders SA, Chopra V. Peripherally inserted central catheter-associated deep vein thrombosis: a narrative review. *Am J Med*. 2015;128(7):722-738. doi:10.1016/j.amjmed.2015.01.027
51. Sheth H, Remtulla R, Moradi A, Smith R. Evaluation of upper extremity deep vein thrombosis risk factors and management. *J Cancer Sci Clin Ther.* 2018;2(1):018-024. doi:10.26502/jcsct.5079005
52. Kearon C, Akl EA, Comerota AJ, et al. Antithrombotic therapy for VTE disease: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141(2 Suppl):e419S-e496S. doi:10.1378/chest.11-2301
53. Debourdeau P, Farge D, Beckers M, et al. International clinical practice guidelines for the treatment and prophylaxis of thrombosis associated with central venous catheters in patients with cancer. *J Thromb Haemost*. 2013;11(1):71-80. doi:10.1111/jth.12071
54. Wasan S, Esponda OL, Feland N, Mathew JL, Smith WJ. The incidence of peripherally inserted central catheter symptomatic pulmonary embolism after line removal: a retrospective analysis. *J Vasc Med Surg.* 2017;5(5):345. doi:10.4172/2329-6925.1000345
55. Costa P, Kimura AF, Brandon DH, Damiani LP. Predictors of nonelective removal of peripherally inserted central catheters in infants. *Biol Res Nurs*. 2016;18(2):173-180. doi:10.1177/1099800415590856
56. Yu X, Yue S, Wang M, et al. Risk factors related to peripherally inserted central venous catheter nonselective removal in neonates. *Biomed Res Int*. 2018;2018:3769376. doi:10.1155/2018/3769376
57. Wang YC, Lin PL, Chou WH, Lin CP, Huang CH. Long-term outcomes of totally implantable venous access devices. *Support Care Cancer*. 2017;25(7):2049-2054. doi:10.1007/s00520-017-3592-0
58. Feil M. Preventing central line air embolism. *Am J Nurs*. 2015;115(6):64-69. doi:10.1097/01.NAJ.0000466327.76934.a0
59. Seong GM, Lee J, Kim M, Choi JC, Kim SW. Massive air embolism while removing a central venous catheter. *Int J Crit Illn Inj Sci*. 2018;8(3):176-178. doi:10.4103/IJCIIS.IJCIIS_14_18
60. McCarthy CJ, Behravesh S, Naidu SG, Oklu R. Air embolism: practical tips for prevention and treatment. *J Clin Med*. 2016;5(11):93. doi:10.3390/jcm5110093
61. Arcinas LA, Liu S, Schacter GI, Kass M. Cerebral air embolism following central venous catheter removal. *Am J Med*. 2017;130(12):e549-e550. doi:10.1016/j.amjmed.2017.07.024
62. Heffner AC, Androes MP. Overview of central venous access in adults. UpToDate.com website. Updated March 19, 2020. https://www.uptodate.com/contents/overview-of-central-venous-access-in-adults
63. Bernard LA, Katzman A, Mathew DK, Oller KL. Prevention of central venous catheter removal-associated air embolization. *Am J Med*. 2018;131(3):e123. doi:10.1016/j.amjmed.2017.10.023
64. Arnott C, Kelly K, Wolfers D, Cranney G, Giles R. Paradoxical cardiac and cerebral arterial gas embolus during percutaneous lead extraction in a patient with a patent foramen ovale. *Heart Lung Circ*. 2015;24(1):e14-e17. doi:10.1016/j.hlc.2014.09.002
65. Jalota L, Aryal MR, Jain S. Iatrogenic venous air embolism from central femoral vein catheterisation. *BMJ Case Rep*. 2013;2013:bcr-2013-008965. doi:10.1136/bcr-2013-008965
66. Dulong C, Frey N. *Peripherally Inserted Central Catheter Removal: Clinical Effectiveness and Guidelines.* Canadian Agency for Drugs and Technologies in Health (CADTH); 2019. https://www.cadth.ca/sites/default/files/pdf/htis/2019/RA1016%20PICC%20Removal%20Final.pdf
67. Cook LS. Infusion-related air embolism. *J Infus Nurs*. 2013;36(1):26-36. doi:10.1097/NAN.0b013e318279a804
68. Shimizu A, Lefor A, Nakata M, Mitsuhashi U, Tanaka M, Yasuda Y. Embolization of a fractured central venous catheter placed using the internal jugular approach. *Int J Surg Case Rep*. 2014;5(5):219-221. doi:10.1016/j.ijscr.2014.02.001
69. Hu M, Ma ZC, Hu F, et al. A peripherally inserted central vein catheter fractured and slid into the right pulmonary artery: a case report. *Chinese Nursing Research.* 2015;2(2-3):86-88. https://doi.org/10.1016/j.cnre.2015.09.005
70. Ullman AJ, Marsh N, Mihala G, Cooke M, Rickard CM. Complications of central venous access devices: a systematic review. *Pediatrics*. 2015;136(5):e1331-e1344. doi:10.1542/peds.2015-1507
71. Schiffer CA, Mangu PB, Wade JC, et al. Central venous catheter care for the patient with cancer: American Society of Clinical Oncology clinical practice guideline. *J Clin Oncol*. 2013;31(10):1357-1370. doi:10.1200/JCO.2012.45.5733
72. Davidson J, Paul A, Patel S, Davenport M, Ade-Ajayi N. Central vein preservation in critical venous access. *Eur J Pediatr Surg*. 2016;26(4):357-362. doi:10.1055/s-0035-1556567
73. Johnson SM, Garnett GM, Woo RK. A technique for re-utilizing catheter insertion sites in children with difficult central venous access. *Pediatr Surg Int*. 2017;33(1):113-117. doi:10.1007/s00383-016-3993-z
74. Burris J, Weis M. Reduction of erosion risk in adult patients with implanted venous access ports. *Clin J Oncol Nurs*. 2014;18(4):403-405. doi:10.1188/14.CJON.403-405
75. Kim SM, Jun HJ, Kim HS, Cho SH, Lee JD. Foreign body reaction due to a retained cuff from a central venous catheter. *Ann Dermatol*. 2014;26(6):781-783. doi:10.5021/ad.2014.26.6.781
76. Hebal F, Sparks HT, Rychlik KL, Bone M, Tran S, Barsness KA. Pediatric arterial catheters: complications and associated risk factors. *J Pediatr Surg*. 2018;53(4):794-797. doi:10.1016/j.jpedsurg.2017.08.057
77. O'Horo JC, Maki DG, Krupp AE, Safdar N. Arterial catheters as a source of bloodstream infection: a systematic review and meta-analysis. *Crit Care Med*. 2014;42(6):1334-1339. doi:10.1097/CCM.0000000000000166
78. Dai N, Xu DC, Hou L, Peng WH, Wei YD, Xu YW. A comparison of 2 devices for radial artery hemostasis after transradial coronary intervention. *J Cardiovasc Nurs*. 2015;30(3):192-196. doi:10.1097/JCN.0000000000000115
79. Khalifeh A, Khashab T, Huffner M, Rezvani ZN, Kwan J, Toursavadkohi S. Radial neuropathy following arterial line removal: a rare complication from a routine ICU procedure. *SAGE Open Med Case Rep*. 2018;6:2050313X18760740. doi:10.1177/2050313X18760740

Section Seven: Vascular Access Device Complications

Section Standards

I. To ensure patient safety, the clinician is competent in the recognition of and appropriate intervention for signs and symptoms of vascular access device (VAD)-related complications during insertion, management, and removal.

II. Prevention, assessment, and management of complications are established in organizational policies, procedures, and/or practice guidelines.

46. PHLEBITIS

Standard

46.1 The clinician assesses the vascular access site for signs and symptoms of phlebitis; determines the need for and type of intervention; educates the patient and/or caregiver about phlebitis, the intervention, and any follow-up; and assesses patient response to treatment.

46.2 The clinician collaborates with the provider about the need for continued or alternative vascular access when the VAD is removed due to phlebitis.

Practice Recommendations

A. Assess regularly, based on patient population, type of therapy, and risk factors, the vascular access sites of peripheral intravenous catheters (PIVCs), midline catheters, and peripherally inserted central catheters (PICCs) for signs and symptoms of phlebitis using a standardized tool or definition (ie, a set of signs and symptoms). Instruct the patient to report pain or tenderness at the vascular access site. Signs and symptoms of phlebitis include pain/tenderness, erythema, swelling, purulence, or palpable venous cord. The type, number, or severity of signs and symptoms that indicate phlebitis differ among published clinicians and researchers. Other methods of assessment and prevention are under investigation (see Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes*).[1-25] (I)

B. Recognize risk factors that can be addressed.
   1. Chemical phlebitis may be related to infusates with dextrose (>10%); extremes of pH or osmolarity; certain medications (depending on dosage and length of infusion) such as potassium chloride, amiodarone, and some antibiotics; particulates in the infusate; too large an outer diameter of a catheter for the vasculature with inadequate hemodilution; excessive infusion rate for a short PIVC; and skin antiseptic solution that is not fully dried and pulled into the vein during catheter insertion. Depending on length of infusion time and anticipated duration of therapy, consider using a PICC or other central vascular access device (CVAD) for infusates identified as causing phlebitis. Allow skin to thoroughly dry after application of antiseptic solution (see Standard 26, *Vascular Access Device Planning*).[11,26-39] (II)
   2. Mechanical phlebitis may be related to vein wall irritation, which can come from too large an outer diameter of a catheter for the vasculature, catheter insertion angle and tip position, catheter movement, insertion trauma, or catheter material and stiffness. Choose the smallest outer diameter of a catheter for therapy, secure catheter with securement technology, avoid areas of flexion, and stabilize joint as needed (see Standard 38, *Vascular Access Device Securement;* Standard 39, *Joint Stabilization*).[20,24,29,32,36,40-43] (III)
   3. Infectious phlebitis may be related to emergent VAD insertions, poor aseptic technique, and contaminated dressings. Plan to replace a catheter inserted emergently under suboptimal aseptic technique when the patient is stabilized and within 48 hours. Move catheter in a lower extremity to an upper extremity in adults; move to a new proximal site or opposite side for pediatric patients if possible.[21,29,44-46] (III)
   4. Patient-related factors differ among published findings. They include current infection, immunodeficiency, and diabetes mellitus; insertion in a lower extremity except for infants; female gender; and age (≥60 years).[29,32,40,43,45] (II)
   5. Postinfusion phlebitis, although rare, occurs after catheter removal through 48 hours due to any of the factors above.[45,47] (IV)

C. If phlebitis is present, determine the possible etiology, such as chemical, mechanical, infectious, or postinfusion; apply warm compress; elevate limb; provide analgesics as needed; and consider other pharmacologic interventions such as anti-inflammatory agents. Topical

gels or ointments to treat phlebitis require further study for efficacy (see Standard 45, *Vascular Access Device Removal*).[3,9,13,40,48-50] (I)

1. Chemical phlebitis: evaluate infusion therapy and need for different vascular access, different medication, slower rate of infusion, or more dilute infusate; if suspected, remove VAD. Provide interventions as above.[27,28,34,51-53] (III)
2. Transient mechanical phlebitis after midline catheter/PICC insertion may be treatable: stabilize catheter, apply heat, elevate limb, and monitor for 24 hours postinsertion; if signs and symptoms persist, remove catheter. (Committee Consensus)
3. Infectious phlebitis: if suspected or purulence present, remove catheter; obtain a culture of the purulent exudate and catheter tip, and monitor for signs of systemic infection (see Standard 45, *Vascular Access Device Removal*; Standard 50, *Infection*).[54] (II)
4. Postinfusion phlebitis: if infectious source is suspected, monitor for signs of systemic infection; if noninfectious, apply warm compress; elevate limb; provide analgesics as needed; and consider other pharmacologic interventions, such as anti-inflammatory agents or corticosteroids as necessary.[46,55] (V)

D. Consider monitoring the PIVC, midline catheter, or PICC access site after removal for 48 hours to detect postinfusion phlebitis, or, upon discharge, give the patient and/or caregiver written instructions about signs and symptoms of phlebitis and the person to contact if this occurs. Postinfusion phlebitis rates range from 0% to 23%.[4,56-58] (IV)

E. Use a standardized phlebitis scale or definition that is valid, reliable, and clinically feasible; consistently use one assessment method within an organization. The population for which the scale is appropriate should be identified as adult or pediatric. Two phlebitis scales, the Phlebitis Scale (Table 1) and the Visual Infusion Phlebitis (VIP) Scale (Table 2), and a set of signs/symptoms have been evaluated for validity and interrater reliability in different populations with insufficient definitions and mixed results. There is often a lack of direction for interventions with a specific clinical finding. Further study is recommended for valid and reliable assessment tools.[4,7,18,32,60-64] (I)

F. Conduct quality improvement projects based on reviews of incident or occurrence reports or health record reviews of phlebitis causing harm or injury (see Standard 6, *Quality Improvement*).[62,65-72] (V)

TABLE 1

Phlebitis Scale

Grade	Clinical Criteria
0	No symptoms
1	Erythema at access site with or without pain
2	Pain at access site with erythema and/or edema
3	Pain at access site with erythema Streak formation Palpable venous cord
4	Pain at access site with erythema Streak formation Palpable venous cord >1 inch in length Purulent drainage

TABLE 2

Visual Infusion Phlebitis Scale[a]

Score	Observation
1	IV site appears healthy
2	One of the following is evident: Slight pain near IV site OR slight redness near IV site
3	Two of the following are evident: • Pain at IV site • Erythema • Swelling
4	All of the following signs are evident: • Pain along path of cannula • Induration
5	All of the following signs are evident and extensive: • Pain along path of cannula • Erythema • Induration • Palpable venous cord
6	All of the following signs are evident and extensive: • Pain along path of cannula • Erythema • Induration • Palpable venous cord • Pyrexia

Abbreviation: IV, intravenous.
[a]Data from Jackson.[59] Reprinted with permission.

REFERENCES

1. Badger J. Long peripheral catheters for deep arm vein venous access: a systematic review of complications. *Heart Lung*. 2019;48(3):222-225. doi:10.1016/j.hrtlng.2019.01.002
2. Carr PJ, Rippey JCR, Cooke ML, et al. From insertion to removal: a multicenter survival analysis of an admitted cohort with peripheral intravenous catheters inserted in the emergency department. *Infect Control Hosp Epidemiol.* 2018;39(10):1216-1221. doi:10.1017/ice.2018.190
3. Chang WP, Peng YX. Occurrence of phlebitis: a systematic review and meta-analysis. *Nurs Res*. 2018;67(3):252-260. doi:10.1097/NNR.0000000000000279
4. Doesburg F, Smit JM, Paans W, Onrust M, Nijsten MW, Dieperink W. Use of infrared thermography in the detection of superficial phlebitis in adult intensive care unit patients: a prospective single-center observational study. *PLoS One*. 2019;14(3):e0213754. doi:10.1371/journal.pone.0213754
5. Dugan S, Le J, Jew RK. Maximum tolerated osmolarity for peripheral administration of parenteral nutrition in pediatric patients. *JPEN J Parenter Enteral Nutr*. 2014;38(7):847-851. doi:10.1177/0148607113495569

6. Gallant P, Schultz AA. Evaluation of a visual infusion phlebitis scale for determining appropriate discontinuation of peripheral intravenous catheters. *J Infus Nurs*. 2006;29(6):338-345. doi:10.1097/00129804-200611000-00004
7. Göransson K, Förberg U, Johansson E, Unbeck M. Measurement of peripheral venous catheter-related phlebitis: a cross-sectional study. *Lancet Haematol*. 2017;4(9):e424-e430. doi:10.1016/S2352-3026(17)30122-9
8. Gorski LA, Hagle ME, Bierman S. Intermittently delivered IV medication and pH: reevaluating the evidence. *J Infus Nurs*. 2015;38(1):27-46. doi:10.1097/NAN.0000000000000081
9. Goulart CB, Custódio CS, Vasques CI, Ferreira EB, Diniz Dos Reis PE. Effectiveness of topical interventions to prevent or treat intravenous therapy-related phlebitis: a systematic review. *J Clin Nurs*. 2020;29(13-14):2138-2149. doi:10.1111/jocn.15266
10. Groll D, Davies B, MacDonald J, Nelson S, Virani T. Evaluation of the psychometric properties of the phlebitis and infiltration scales for the assessment of complications of peripheral vascular access devices. *J Infus Nurs.* 2010;33(6):385-390. doi:10.1097/NAN.0b013e3181f85a73
11. Harris V, Hughes M, Roberts R, Dolan G, Williams EM. The development and testing of a Chemotherapy-Induced Phlebitis Severity (CIPS) scale for patients receiving anthracycline chemotherapy for breast cancer. *J Clin Med*. 2020;9(3):701. doi:10.3390/jcm9030701
12. Indarwati F, Mathew S, Munday J, Keogh S. Incidence of peripheral intravenous catheter failure and complications in paediatric patients: systematic review and meta-analysis. *Int J Nurs Stud*. 2020;102:103488. doi:10.1016/j.ijnurstu.2019.103488
13. Lee S, Kim K, Kim JS. A model of phlebitis associated with peripheral intravenous catheters in orthopedic inpatients. *Int J Environ Res Public Health*. 2019;16(18):3412. doi:10.3390/ijerph16183412
14. Maki DG, Ringer M. Risk factors for infusion-related phlebitis with small peripheral venous catheters. a randomized controlled trial. *Ann Intern Med*. 1991;114(10):845-854. doi:10.7326/0003-4819-114-10-845
15. Palese A, Ambrosi E, Fabris F, et al. Nursing care as a predictor of phlebitis related to insertion of a peripheral venous cannula in emergency departments: findings from a prospective study. *J Hosp Infect*. 2016;92(3):280-286. doi:10.1016/j.jhin.2015.10.021
16. Ray-Barruel G, Polit DF, Murfield JE, Rickard CM. Infusion phlebitis assessment measures: a systematic review. *J Eval Clin Pract.* 2014;20(2):191-202. doi:10.1111/jep.12107
17. Ray-Barruel G, Xu H, Marsh N, Cooke M, Rickard CM. Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: a systematic review. *Infect Dis Health*. 2019;24(3):152-168. doi:10.1016/j.idh.2019.03.001
18. Ray-Barruel G, Cooke M, Chopra V, Mitchell M, Rickard CM. The I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: a clinimetric evaluation. *BMJ Open*. 2020;10(1):e035239. doi:10.1136/bmjopen-2019-035239
19. Roberts R, Hanna L, Borley A, Dolan G, Williams EM. Epirubicin chemotherapy in women with breast cancer: alternating arms for intravenous administration to reduce chemical phlebitis. *Eur J Cancer Care (Engl)*. 2019;28(5):e13114. doi:10.1111/ecc.13114
20. Simin D, Milutinović D, Turkulov V, Brkić S. Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: an observational prospective study. *J Clin Nurs*. 2019;28 (9-10):1585-1599. doi:10.1111/jocn.14760
21. Suliman M, Saleh W, Al-Shiekh H, Taan W, AlBashtawy M. The incidence of peripheral intravenous catheter phlebitis and risk factors among pediatric patients. *J Pediatr Nurs.* 2020;50:89-93. doi:10.1016/j.pedn.2019.11.006
22. Ullman AJ, Mihala G, O'Leary K, et al. Skin complications associated with vascular access devices: a secondary analysis of 13 studies involving 10,859 devices. *Int J Nurs Stud*. 2019;91:6-13. doi:10.1016/j.ijnurstu.2018.10.006
23. Ullman AJ, Takashima M, Kleidon T, Ray-Barruel G, Alexandrou E, Rickard CM. Global pediatric peripheral intravenous catheter practice and performance: a secondary analysis of 4206 catheters. *J Pediatr Nurs*. 2020;50:e18-e25. doi:10.1016/j.pedn.2019.09.023
24. Zhu A, Wang T, Wen S. Peripheral intravenous catheters in situ for more than 96 h in adults: what factors affect removal? *Int J Nurs Pract.* 2016;22(6):529-537. doi:10.1111/ijn.12492
25. Capdevila JA, Guembe M, Barberán J, et al. 2016 expert consensus document on prevention, diagnosis and treatment of short-term peripheral venous catheter-related infections in adult. *Rev Esp Quimioter*. 2016;29(4):230-238.
26. Ayat-Isfahani F, Pashang M, Davoudi B, Sadeghian S, Jalali A. Effects of injection-site splinting on the incidence of phlebitis in patients taking peripherally infused amiodarone: a randomized clinical trial. *J Vasc Nurs*. 2017;35(1):31-35. doi:10.1016/j.jvn.2016.11.001
27. Chau E, Lundberg J, Phillips G, Berger M, Wesolowski R. Updated report on incidence of infusion-site reactions associated with peripheral intravenous administration of fosaprepitant. *J Oncol Pharm Pract*. 2019;25(5):1053-1057. doi:10.1177/1078155218769347
28. Dixon HA, Hort AL, Wright CM. Amiodarone-induced phlebitis remains an issue in spite of measures to reduce its occurrence. *J Vasc Access*. 2019;20(6):786-787. doi:10.1177/1129729819838123
29. Helm RE, Klausner JD, Klemperer JD, Flint LM, Huang E. Accepted but unacceptable: peripheral IV catheter failure. *J Infus Nurs.* 2015;38(3):189-203. doi:10.1097/NAN.0000000000000100
30. Kawada K, Ohta T, Tanaka K, Miyamoto N. Reduction of nicardipine-related phlebitis in patients with acute stroke by diluting its concentration. *J Stroke Cerebrovasc Dis*. 2018;27(7):1783-1788. doi:10.1016/j.jstrokecerebrovasdis.2018.02.013
31. Khalidi N, Papke-O'Donnell L, Ismail WW, Bustami RT. The etiology of potassium chloride-induced phlebitis: how safe and effective is admixed lidocaine? *J Assoc Vasc Access* 2019;24(1):29-37. doi:10.1016/j.java.2018.16.002.
32. Lv L, Zhang J. The incidence and risk of infusion phlebitis with peripheral intravenous catheters: a meta-analysis. *J Vasc Access*. 2020;21(3):342-349. doi:10.1177/1129729819877323
33. Marsh N, Webster J, Larson E, Cooke M, Mihala G, Rickard CM. Observational study of peripheral intravenous catheter outcomes in adult hospitalized patients: a multivariable analysis of peripheral intravenous catheter failure. *J Hosp Med*. 2018;13(2):83-89. doi:10.12788/jhm.2867
34. Meng L, Nguyen CM, Patel S, Mlynash M, Caulfield AF. Association between continuous peripheral i.v. infusion of 3% sodium chloride injection and phlebitis in adults. *Am J Health Syst Pharm*. 2018;75(5):284-291. doi:10.2146/ajhp161028
35. Oragano CA, Patton D, Moore Z. Phlebitis in intravenous amiodarone administration: incidence and contributing factors. *Crit Care Nurse*. 2019;39(1):e1-e12. doi:10.4037/ccn2019381
36. Piper R, Carr PJ, Kelsey LJ, Bulmer AC, Keogh S, Doyle BJ. The mechanistic causes of peripheral intravenous catheter failure based on a parametric computational study. *Sci Rep*. 2018;8(1):3441. doi:10.1038/s41598-018-21617-1
37. Spiering M. Peripheral amiodarone-related phlebitis: an institutional nursing guideline to reduce patient harm. *J Infus Nurs*. 2014;37(6):453-460. doi:10.1097/NAN.0000000000000072
38. Tork-Torabi M, Namnabati M, Allameh Z, Talakoub S. Vancomycin infusion methods on phlebitis prevention in children. *Iran J Nurs Midwifery Res*. 2019;24(6):432-436. doi:10.4103/ijnmr.IJNMR_149_18
39. Villa G, Chelazzi C, Giua R, et al. In-line filtration reduces postoperative venous peripheral phlebitis associated with cannulation: a randomized clinical trial. *Anesth Analg*. 2018;127(6):1367-1374. doi:10.1213/ANE.0000000000003393

40. Dunda SE, Demir E, Mefful OJ, Grieb G, Bozkurt A, Pallua N. Management, clinical outcomes, and complications of acute cannula-related peripheral vein phlebitis of the upper extremity: a retrospective study. *Phlebology*. 2015;30(6):381-388. doi:10.1177/0268355514537254.
41. Pirooz A, Mojalli M, Sajjadi M. The effect of intravenous administration with body temperature on indwelling of peripheral venous catheters. *Int Cardio Res J*. 2019;13(3):e83472.
42. Tanabe H, Murayama R, Yabunaka K, et al. Low-angled peripheral intravenous catheter tip placement decreases phlebitis. *J Vasc Access.* 2016;17(6):542-547. doi:10.5301/jva.5000601.
43. Wallis MC, McGrail M, Webster J, et al. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from a randomized controlled trial. *Infect Control Hosp Epidemiol.* 2014;35(1):63-68. doi:10.1086/674398
44. Corley A, Ullman AJ, Mihala G, Ray-Barruel G, Alexandrou E, Rickard CM. Peripheral intravenous catheter dressing and securement practice is associated with site complications and suboptimal dressing integrity: a secondary analysis of 40,637 catheters. *Int J Nurs Stud*. 2019;100:103409. doi:10.1016/j.ijnurstu.2019.103409
45. Miliani K, Taravella R, Thillard D, et al. Peripheral venous catheter-related adverse events: evaluation from a multicentre epidemiological study in France (the CATHEVAL Project). *PLoS One.* 2017;12(1):e0168637. doi:10.1371/journal.pone.0168637
46. Nickel B. Peripheral intravenous administration of high-risk infusions in critical care: a risk-benefit analysis. *Crit Care Nurse*. 2019;39(6):16-28. doi:10.4037/ccn2019443
47. Webster J, McGrail M, Marsh N, Wallis MC, Ray-Barruel G, Rickard CM. Postinfusion phlebitis: incidence and risk factors. *Nurs Res Pract*. 2015;2015:691934. doi:10.1155/2015/691934
48. Annisa F, Nurhaeni N, Wanda D. Warm water compress as an alternative for decreasing the degree of phlebitis. *Compr Child Adolesc Nurs*. 2017;40(sup1):107-113. doi:10.1080/24694193.2017.1386978
49. Bigdeli Shamloo MB, Nasiri M, Maneiy M, et al. Effects of topical sesame (Sesamum indicum) oil on the pain severity of chemotherapy-induced phlebitis in patients with colorectal cancer: a randomized controlled trial. *Complement Ther Clin Pract*. 2019;35:78-85. doi:10.1016/j.ctcp.2019.01.016
50. Zheng G, Yang L, Chen H, Chu J, Mei L. Aloe vera for prevention and treatment of infusion phlebitis. *Cochrane Database Syst Rev.* 2014;2014(6):CD009162. doi:10.1002/14651858.CD009162.pub2
51. Ahimbisibwe C, Kwizera R, Ndyetukira JF, et al. Management of amphotericin-induced phlebitis among HIV patients with cryptococcal meningitis in a resource-limited setting: a prospective cohort study. *BMC Infect Dis*. 2019;19(1):558. doi:10.1186/s12879-019-4209-7
52. Behnamfar N, Parsa Yekta Z, Mojab F, Kazem Naeini SM. The effect of nigella sativa oil on the prevention of phlebitis induced by chemotherapy: a clinical trial. *Biomedicine (Taipei).* 2019;9(3):20. doi:10.1051/bmdcn/2019090320
53. Jourabloo N, Nasrabadi T, Ebrahimi Abyaneh E. Comparing the effect of warm moist compress and Calendula ointment on the severity of phlebitis caused by 50% dextrose infusion: a clinical trial. *MedSurg Nurs J*. 2017;6(1):e67856.
54. Mermel LA. Short-term peripheral venous catheter-related bloodstream infections: a systematic review. *Clin Infect Dis.* 2017;65(10):1757-1762. doi:10.1093/cid/cix562
55. Liu H, Han T, Zheng Y, Tong X, Piao M, Zhang H. Analysis of complication rates and reasons for nonelective removal of PICCs in neonatal intensive care unit preterm infants. *J Infus Nurs*. 2009;32(6):336-340. doi:10.1097/NAN.0b013e3181bd5668
56. Gunasegaran N, See MTA, Leong ST, Yuan LX, Ang SY. A randomized controlled study to evaluate the effectiveness of 2 treatment methods in reducing incidence of short peripheral catheter-related phlebitis. *J Infus Nurs*. 2018;41(2):131-137. doi:10.1097/NAN.0000000000000271
57. Urbanetto JS, Peixoto CG, May TA. Incidence of phlebitis associated with the use of peripheral IV catheter and following catheter removal. *Rev Lat Am Enfermagem*. 2016;24:e2746. doi:10.1590/1518-8345.0604.2746
58. Urbanetto JS, Muniz FOM, Silva RMD, Freitas APC, Oliveira APR, Santos JCRD. Incidence of phlebitis and post-infusion phlebitis in hospitalised adults. *Rev Gaucha Enferm*. 2017;38(2):e58793. doi:10.1590/1983-1447.2017.02.58793
59. Jackson A. Infection control–a battle in vein: infusion phlebitis. *Nurs Times*. 1998;94(4):68-71.
60. Alexandrou E, Ray-Barruel G, Carr PJ, et al. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *J Hosp Med.* 2018;13(5):10.12788/jhm.3039. doi:10.12788/jhm.3039
61. Büyükyılmaz F, Şahiner NC, Cağlar S, Eren H. Effectiveness of an intravenous protection device in pediatric patients on catheter dwell time and phlebitis score. *Asian Nurs Res (Korean Soc Nurs Sci)*. 2019;13(4):236-241. doi:10.1016/j.anr.2019.09.001
62. Høvik LH, Gjeilo KH, Lydersen S, et al. Monitoring quality of care for peripheral intravenous catheters; feasibility and reliability of the peripheral intravenous catheters mini questionnaire (PIVC-miniQ). *BMC Health Serv Res.* 2019;19(1):636. doi:10.1186/s12913-019-4497-z
63. Marsh N, Mihala G, Ray-Barruel G, Webster J, Wallis MC, Rickard CM. Inter-rater agreement on PIVC-associated phlebitis signs, symptoms and scales. *J Eval Clin Pract.* 2015;21(5):893-899. doi:10.1111/jep.12396
64. Mihala G, Ray-Barruel G, Chopra V, et al. Phlebitis signs and symptoms with peripheral intravenous catheters: incidence and correlation study. *J Infus Nurs.* 2018;41(4):260-263. doi:10.1097/NAN.0000000000000288
65. DeVries M, Strimbu K. Short peripheral catheter performance following adoption of clinical indication removal. *J Infus Nurs*. 2019;42(2):81-90. doi:10.1097/NAN.0000000000000318
66. Gilton L, Seymour A, Baker RB. Changing peripheral intravenous catheter sites when clinically indicated: an evidence-based practice journey. *Worldviews Evid Based Nurs*. 2019;16(5):418-420. doi:10.1111/wvn.12385
67. Maier D. To replace or not to replace? Replacing short peripheral catheters based on clinical indication. *J Infus Nurs*. 2019;42(3):143-148. doi:10.1097/NAN.0000000000000322
68. McGuire R, Coronado A. Evaluation of clinically indicated removal versus routine replacement of peripheral vascular catheters. *Br J Nurs*. 2020;29(2):S10-S16. doi:10.12968/bjon.2020.29.2.S10
69. Oh JH, Shelly M, Nersinger S, Cai X, Olsan T. Implementing clinical practice guidelines for replacing peripheral intravenous catheters. *J Nurs Care Qual.* 2020;35(2):108-114. doi:10.1097/NCQ.0000000000000429
70. Steere L, Ficara C, Davis M, Moureau N. Reaching one peripheral intravenous catheter (PIVC) per patient visit with lean multimodal strategy: the PIV5Rights™ bundle. *J Assoc Vasc Access.* 2019;24(3):31-43. https://doi.org/10.2309/j.java.2019.003.004
71. Stevens C, Milner KA, Trudeau J. Routine versus clinically indicated short peripheral catheter replacement: an evidence-based practice project.*J Infus Nurs*. 2018;41(3):198-204. doi:10.1097/NAN.0000000000000281
72. Villa G, Giua R, Amass T, et al. In-line filtration reduced phlebitis associated with peripheral venous cannulation: focus on cost-effectiveness and patients' perspectives. *J Vasc Access*. 2020;21(2):154-160. doi:10.1177/1129729819861187

47. INFILTRATION AND EXTRAVASATION

Standard

47.1 The risk of infiltration and extravasation is reduced through careful selection of the most appropriate VAD and insertion site and through establishment of VAD patency prior to and during infusion therapy.

47.2 Peripheral and CVAD sites are regularly assessed for signs and/or symptoms of infiltration and extravasation before and during each intermittent infusion and on regular intervals during continuous infusions.

47.3 Appropriate intervention(s) are implemented immediately upon recognition of infiltration/extravasation as determined by the characteristics of the solution or medication escaping from the vein.

Practice Recommendations

A. Select the most appropriate VAD and insertion site to reduce the risk for infiltration/extravasation (see Standard 26, *Vascular Access Device Planning*; Standard 27, *Site Selection*).[1-15] (IV)

B. Recognize the differences among vesicant, nonvesicant, and irritant solutions and medications. Each organization should reach a consensus on what medication is considered to be a vesicant and irritant based on their internal formularies.[2,15-18] (IV)
   1. Identify the vesicant nature of cytotoxic and noncytotoxic medications prior to administration; be prepared to use the correct pharmacologic and nonpharmacologic treatment in the event of extravasation or escalate to a clinician capable of managing these injuries.[19-22] (II)

C. Evaluate for the presence of factors associated with infiltration/extravasation. In the presence of factors that may cause or increase the risk of infiltration/extravasation, increase the frequency of monitoring and consider alternative vascular access options (see Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes*).[1,4,11,23-26] (II)
   1. Identify patient-specific factors associated with an increased risk of infiltration and extravasation, including but not limited to:
      a. Female gender.[27-33] (I)
      b. Current infection.[14,20,23,34] (II)
      c. Patients who have altered sensation in the area of the VAD and/or who have difficulty communicating the onset of pain, tightness, or other discomfort.[14,20,23,34-37] (II)
      d. Patients with altered mental status or cognition (eg, encephalopathy, confusion, sedating medications).[11,14,20,23,38-40] (III)
      e. Age-related changes to vasculature, skin, and subcutaneous tissue.[4,11,14,20,23,28,30,31,35,36,38,39,41,42] (II)
      f. Diseases that produce changes in vasculature or impaired circulation (eg, diabetes mellitus, lymphedema, systemic lupus, Raynaud's disease, peripheral neuropathy, peripheral vascular disease).[11,14,20,23,35,39] (III)
      g. Difficulty with peripheral venous access related to history of multiple venipunctures and obesity.[27,42] (IV)
   2. Assess the risk of mechanical causes of infiltration/extravasation, which include: catheter placement in an area of flexion; catheter size; insertion technique and inserter experience; improper needle placement/needle dislodgement of an implanted vascular access port; partial dislodgement of VAD, including 1 or more lumen exit sites of a multilumen, staggered tip CVAD; inadequate securement; normal body movement (eg, respiratory and cardiac function); vein thrombosis or stenosis proximal to (located above) the insertion site and tip location, limiting blood flow.[1,6,16,28-30,34,38,43-45] (I)
      a. Extravascular CVAD tip malposition or dislodgement can occur in many anatomical locations and at any point during dwell (refer to Standard 54, *Central Vascular Access Device Malposition*).
         i. Measure vessel depth in tissue using ultrasound prior to CVAD insertion to ensure that all lumen exit sites are appropriately placed within the patient's vasculature. Partial dislodgement could result in some lumen exit sites infusing into the subcutaneous tissue.
         ii. Ensure all catheter lumens aspirate for blood return and flush prior to use. Do not assume appropriate intravascular tip position of all lumens when blood aspirate is possible from 1 lumen but not all.[46,47] (V)
      b. Additional PIVC-related factors include:
         i. PIVC sites in the hand, wrist, upper arm, foot, ankle, and antecubital fossa, when compared to sites in the forearm; inadequate catheter securement and joint stabilization if forced to use a site in an area of joint flexion.[11,16,27,29,31,41,48] (IV)
         ii. PIVC dwell time longer than 24 hours.[28,30,32,35,38,42,43,49] (I)
         iii. Increased manipulation of the PIVC at the catheter hub.[27,33,39] (II)
         iv. Subsequent peripheral catheterization after first insertion; recent venipuncture attempts below an existing PIVC insertion site may result in medication infiltration/extravasation from the puncture site.[14,20,23,27,33,39,45] (III)
         v. Ultrasound-guided PIVC insertion of deep veins with less than two-thirds catheter residing within the vein (see Standard 22, *Vascular Visualization*).[39,41,50] (III)
         vi. PIVC administration of contrast media.[35] (V)
   3. Pharmacologic or physiochemical properties associated with infiltration/extravasation and severity of tissue damage include: length of infusion of vesicant

via a PIVC, drug concentration, and volume escaping into the tissue; ability of surrounding tissues to absorb the drug; hyperosmolarity and nonphysiological pH; the medication's ability to bind DNA, kill replicating cells, and/or cause vascular constriction; and excipients, such as alcohol or polyethylene glycol, used in the formulation of some medications.[1,10,14,20,23,27,32,35,37,39,42,48,49,51,52] (IV)

D. Limit the extent of injury through early recognition of signs and symptoms of infiltration/extravasation.
   1. The frequency of VAD site assessment is based upon the specific patient population and characteristics of the infusion therapy (see Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes*).[4,10,14,19,25,26,32,43,49,53,54] (IV)
   2. Promptly recognize and treat compartment syndrome and arterial and nerve damage, which may be caused by infiltration of sufficient volume of vesicant or nonvesicant solutions. Early recognition and treatment will minimize and mitigate further harm, such as development of complex regional pain syndrome or limb amputation.[1,11,17,23,37] (II)
   3. Observe the VAD site for abnormalities. Observe the areas proximal and distal to the insertion site assessing for abnormalities:
      a. Fluid leakage from the puncture site, subcutaneous tunnel, or port pocket, which may be visible or subcutaneous.[1,55] (V)
      b. Skin injury, including vesicle formation, may appear within hours (eg, contrast media) or may be delayed for days (eg, antineoplastic agents); progression to ulceration may vary from a few days to 1 to 2 weeks, depending upon the vesicant administered.[23,56-58] (II)
      c. Rule out phlebitis or flare reactions, which may have similar symptoms.[1] (V)
      d. The use of infiltration/extravasation detection technology may aid in early recognition[25,30,59,60] (IV)
   4. Assess the extremity and areas proximal and distal to insertion site.
      a. Palpate the insertion site to assess for swelling and pain.
      b. Swelling/edema may appear as a raised area under the skin near the peripheral VAD site or as an enlarged and tense extremity due to fluid accumulating in compartments of the extremity. Edema from a CVAD may appear as a raised area on the neck, chest, or groin.
      c. Compare the circumference of both extremities if unilateral edema is noted. Compare to baseline measurement at insertion if available.
      d. Changes in color may include redness and/or blanching; however, infiltration/extravasation into deep tissue may not produce visible color changes.[1,23,56] (IV)
   5. Elicit the patient's report of pain; observe the nonverbal patient for other cues indicating pain.
      a. Pain may be the initial symptom and may be sudden and severe when associated with a rapid injection of solution or medications; may be out of proportion to the injury; or may appear with passive stretching of the muscles in the extremity. Pain intensity may increase over time, which may indicate compartment syndrome.[1,38,55] (V)
   6. Do not rely on the alarm from an electronic infusion pump to identify infiltration/extravasation; alarms are not designed to detect the presence or absence of complications. Electronic infusion pumps do not cause infiltration/extravasation; however, they may mask or exacerbate the problem until the infusion is stopped.[17,23] (II)
   7. Automated power or pressure injectors produce a jet of fluid exiting the catheter tip. Distal tip malposition has been documented following power injection in PICCs. It has also been postulated that this jet could induce vessel perforation and extravasation.[57,61] (V)
   8. Contrast media with a high viscosity requires less force to cause fluid flow when it is warmed to 37°C. Fluid warming may be associated with lower rates of extravasation (see Standard 24, *Flow-Control Devices*; Standard 25, *Blood and Fluid Warming*).[28,35] (II)

E. Immediately stop the infusion upon identification of infiltration/extravasation injury and initiate appropriate intervention(s).[1,11,16,17,31,36,38] (IV)
   1. Aspirate for a blood return from the peripheral catheter as the tip could be inside the vein lumen, yet an additional puncture of the vein wall may have occurred.[11,17,55] (IV)
   2. Do not flush the VAD, as this will inject additional medication into the tissue.[14,20] (V)
   3. Disconnect the administration set from the catheter hub and aspirate from the catheter or implanted port access needle with a small syringe, even though a very small amount of fluid may be retrieved.[14,20,38] (V)
      a. Aspiration is not recommended with extravasation of contrast media.[35] (V)
   4. Remove the peripheral catheter or implanted vascular access port access needle.[14,20] (V)
   5. Avoid application of pressure to the area.[14,20] (V)
   6. Elevate the extremity to encourage lymphatic reabsorption of the solution/medication.[1,11,16,20,21,23,31,38] (II)
   7. Do not use the affected extremity for subsequent VAD insertion until resolved.[62] (V)
   8. Assess the insertion site and surrounding tissue.
      a. Assess the area distal (located below) to the VAD site for capillary refill, sensation, and motor function.[14,20,38] (V)
      b. Using a skin marker, outline the area suspected of infiltration/extravasation to assess progression.[14,20] (V)
      c. Photograph the area to identify progression or exacerbation of the tissue injury in accordance with organizational policy.[14,20] (V)

d. Estimate the volume of solution that has escaped into the tissue based on the original amount of solution in the container, the amount remaining when stopped, and rate and duration of injection or infusion.[14,16,20] (V)

9. Notify the provider about the event and activate the established treatment protocol or the prescribed treatment.
   a. Anticipate use of radiographic tests to identify the CVAD tip location (refer to Standard 54, *Central Vascular Access Device Malposition*).
   b. The need for surgical consultation is based on the clinical signs and symptoms and their progression (eg, compartment syndrome from infiltration of a nonvesicant medication) and/or the tissue-destroying nature of a vesicant medication. Options for treatment include subcutaneous irrigation with or without hyaluronidase, open incision and irrigation, small incisions followed by massage to force drainage, and debridement; skin grafting may be indicated.[11,17,21,23,35,37,56,63] (II)
   c. Timing of CVAD removal depends on the plan of care, which is based on the identified extravascular location of the catheter tip.[1,11,43] (IV)
      i. Assess location of subcutaneous tunnel or port pocket and its proximity to the wound to determine if the long-term CVAD should be removed for healing to occur. (Committee Consensus)

F. Follow the established treatment protocol or provider prescription as appropriate for the solution and medication in the tissue, with the goal of limiting the damage from medication/solution exposure. Provide convenient access to the list of vesicants and irritants, infiltration/extravasation management protocols, electronic order forms, supplies, and other materials needed to manage the event.[1,2,14,20,24,64] (IV)
   1. Avoid wet compresses as they may cause maceration.[14] (V)
   2. Apply dry, cold compresses for DNA-binding agents and valproate because the goal is to cause vasoconstriction to localize the medication in the tissue and reduce inflammation.[14,37] (V)
      a. Do not use cold compresses with extravasation of vinca alkaloids, oxaliplatin, and vasopressors and in the presence of vaso-occlusive events (eg, sickle cell anemia).
      b. Remove the cold compress 15 minutes before the infusion of dexrazoxane begins.[1,16,65] (V)
   3. Apply dry, warm compresses for non-DNA binding agents to encourage vasodilation when the goal is to increase local blood flow and disperse the medication through the tissue.
      a. Do not exceed 42°C in pediatric patients and neonates.[14,16] (V)
   4. Administer the appropriate antidote for the solutions or medication in the tissue.
      a. Daily IV infusion of dexrazoxane over 3 days is the recommended antidote for anthracycline extravasation.
         i. Begin infusion within 6 hours of the extravasation and infuse into the opposite extremity.
         ii. Topical dimethyl sulfoxide (DMSO) should not be applied to patients receiving dexrazoxane as it may diminish dexrazoxane efficacy.[1,11,14,16,20,22,65] (V)
      b. Inject other antidote or dispersal enzyme into the subcutaneous tissue surrounding the extravasated site. Use a small needle (eg, 25-gauge or smaller) and change it for each injection. Follow the specific manufacturers' directions for dose and administration.[66] (V)
         i. Sodium thiosulfate is recommended for mechlorethamine extravasation and has been suggested for calcium and large extravasates of cisplatin.[1,14,20,65] (V)
         ii. Phentolamine is preferred for vasopressor extravasation. Normal perfusion of the area may be seen within 10 minutes. Repeated injection may be necessary if hypoperfusion is still present or if vasoconstriction is extending to a greater area.[8,11,23,31] (II)
         iii. Terbutaline injection has been used for vasopressor extravasation when phentolamine is not immediately available.[17,23,37] (II)
         iv. Topical nitroglycerin 2% may be applied as a 1-inch strip to the site of vasopressor extravasation in absence of phentolamine; repeat every 8 hours as clinically indicated.[8,17,37] (IV)
         v. Hyaluronidase is not considered to be an antidote to a specific vesicant. It is an enzyme that increases absorption and dispersion of the medication or solution in the tissue and its use is reported with cytotoxic and noncytotoxic drugs, including both acidic and alkalotic drugs (eg, amiodarone and phenytoin), as well as hyperosmolar solutions (eg, parenteral nutrition [PN] and calcium salts). Recombinant hyaluronidase is not derived from animals and may have a lower risk of allergic response. Subcutaneous injection within 1 hour of the extravasation event produces the best response. Do not inject by the intravenous (IV) route. Use of dry heat in conjunction with hyaluronidase works synergistically to increase blood flow and disperse the extravasated drug.[11,16,17,24,31,35,37,38,48,56,66] (IV)
         vi. Consider subcutaneous saline irrigation or saline irrigation with prior hyaluronidase administration for vesicant removal/dispersion in neonates.[56] (IV)

vii. Consider use of oral, topical, or intralesional steroid on a case-by-case basis. Single-center studies and case reports have reported reduced inflammation and swelling; however, evidence of benefit is limited and inconsistent.[1,14,16,67] (V)

5. Use nonpharmacologic methods (eg, elevation, surgical washout) for extravasation of acidic and alkaline medications.
   a. Avoid injection of an acidic or alkaline medication in an attempt to neutralize the pH of an extravasated acidic or alkaline vesicant as the resulting chemical reaction could cause gas formation and exacerbate the tissue injury.[11,16,21,23,31,37] (II)

G. Use a standardized tool or definition for assessing infiltration/extravasation from all types of VADs that is valid, reliable, and clinically feasible; consistently use one assessment method within an organization. The population for which the scale is appropriate should be identified as adult or pediatric.
   1. This assessment should occur initially and regularly based on organizational policies and procedures, should continue until resolution, and is appropriate to the patient's size and age.
   2. Several scales have been published; however, only 1 pediatric tool has been tested for validity and interrater reliability. The chosen grading scale should also be accompanied by appropriate interventions to manage each level on the tool.[1,15,68] (IV)

H. Use a standardized format to document initial and ongoing assessment and monitoring of the infiltration/extravasation site and to document all factors involved with the event.[1,38,48] (IV)

I. Continue to monitor the site as needed based on severity of the event and the venue of care. Assess changes of the area by measurement and/or photography; observe skin integrity, level of pain, sensation, and motor function of the extremity.[1,15,16,69] (IV)

J. Educate the patient and caregivers:
   1. Preinfusion: the risks of receiving an infusion prior to administration, emphasizing the signs and symptoms to immediately report.
   2. Postinfusion: the possible progression of the signs and symptoms of infiltration/extravasation; the need to protect the site from sunlight; the frequency of follow-up visits to the provider as needed (see Standard 8, *Patient Education*).[1,10,38,48,53,55] (IV)

K. Review infiltration/extravasation incidents causing harm or injury, using adverse event reports and health record reviews for quality improvement opportunities (see Standard 6, *Quality Improvement*; Standard 11, *Adverse and Serious Adverse Events*).[15] (IV)

REFERENCES

Note: All electronic references in this section were accessed between May 17, 2020, and August 30, 2020.

1. Kreidieh FY, Moukadem HA, El Saghir NS. Overview, prevention and management of chemotherapy extravasation. *World J Clin Oncol*. 2016;7(1):87-97. doi:10.5306/wjco.v7.i1.87
2. Gorski LA, Stranz M, Cook LS, et al. Development of an evidence-based list of noncytotoxic vesicant medications and solutions. *J Infus Nurs*. 2017;40(1):26-40. doi:10.1097/NAN.0000000000000202
3. Vinograd AM, Zorc JJ, Dean AJ, Abbadessa MKF, Chen AE. First-attempt success, longevity, and complication rates of ultrasound-guided peripheral intravenous catheters in children. *Pediatr Emerg Care*. 2018;34(6):376-380. doi:10.1097/PEC.0000000000001063
4. Park SM, Jeong IS, Kim KL, Park KJ, Jung MJ, Jun SS. The effect of intravenous infiltration management program for hospitalized children. *J Pediatr Nurs*. 2016;31(2):172-178. doi:10.1016/j.pedn.2015.10.013
5. Patregnani JT, Sochet AA, Klugman D. Short-term peripheral vasoactive infusions in pediatrics: where is the harm? *Pediatr Crit Care Med*. 2017;18(8):e378-e381. doi:10.1097/PCC.0000000000001230
6. Greenstein YY, Koenig SJ, Mayo PH, Narasimhan M. A serious adult intraosseous catheter complication and review of the literature. *Crit Care Med*. 2016;44(9):e904-e909. doi:10.1097/CCM.0000000000001714
7. Datar S, Gutierrez E, Schertz A, Vachharajani V. Safety of phenylephrine infusion through peripheral intravenous catheter in the neurological intensive care unit. *J Intensive Care Med*. 2018;33(10):589-592. doi:10.1177/0885066617712214
8. Cardenas-Garcia J, Schaub KF, Belchikov YG, Narasimhan M, Koenig SJ, Mayo PH. Safety of peripheral intravenous administration of vasoactive medication. *J Hosp Med*. 2015;10(9):581-585. doi:10.1002/jhm.2394
9. Medlej K, Kazzi AA, El Hajj Chehade A, et al. Complications from administration of vasopressors through peripheral venous catheters: an observational study. *J Emerg Med*. 2018;54(1):47-53. doi:10.1016/j.jemermed.2017.09.007
10. Coyle CE, Griffie J, Czaplewski LM. Eliminating extravasation events: a multidisciplinary approach. *J Infus Nurs*. 2014;37(3):157-164. doi:10.1097/NAN.0000000000000034
11. Gil JA, Shah KN, Suarez L, Weiss AC. Upper-extremity extravasation: evaluation, management, and prevention. *JBJS Rev*. 2017;5(8):e6. doi:10.2106/JBJS.RVW.16.00102
12. Perez CA, Figueroa SA. Complication rates of 3% hypertonic saline infusion through peripheral intravenous access. *J Neurosci Nurs*. 2017;49(3):191-195. doi:10.1097/JNN.0000000000000286
13. Loubani OM, Green RS. A systematic review of extravasation and local tissue injury from administration of vasopressors through peripheral intravenous catheters and central venous catheters. *J Crit Care*. 2015;30(3):653.e9-653.e6.53E17. doi:10.1016/j.jcrc.2015.01.014
14. Boulanger J, Ducharme A, Dufour A, et al. Management of the extravasation of anti-neoplastic agents. *Support Care Cancer*. 2015;23(5):1459-1471. doi:10.1007/s00520-015-2635-7
15. Jackson-Rose J, Del Monte J, Groman A, et al. Chemotherapy extravasation: establishing a national benchmark for incidence among cancer centers. *Clin J Oncol Nurs*. 2017;21(4):438-445. doi:10.1188/17.CJON.438-445
16. Onesti MG, Carella S, Fioramonti P, Scuderi N. Chemotherapy extravasation management: 21-year experience. *Ann Plast Surg*. 2017;79(5):450-457. doi:10.1097/SAP.0000000000001248
17. Le A, Patel S. Extravasation of noncytotoxic drugs: a review of the literature. *Ann Pharmacother*. 2014;48(7):870-886. doi:10.1177/1060028014527820
18. Clark E, Giambra BK, Hingl J, Doellman D, Tofani B, Johnson N. Reducing risk of harm from extravasation: a 3-tiered evidence-based list of pediatric peripheral intravenous infusates. *J Infus Nurs*. 2013;36(1):37-45. doi:10.1097/NAN.0b013e3182798844
19. Ball RD, Henao JP, Ibinson JW, Metro DG. Peripheral intravenous catheter infiltration: anesthesia providers do not adhere to their

own ideas of best practice. *J Clin Anesth*. 2013;25(2):115-120. doi:10.1016/j.jclinane.2012.06.018

20. Kimmel J, Fleming P, Cuellar S, Anderson J, Haaf CM. Pharmacological management of anticancer agent extravasation: a single institutional guideline. *J Oncol Pharm Pract*. 2018;24(2):129-138. doi:10.1177/1078155217690924
21. Harrold K, Gould D, Drey N. The management of cytotoxic chemotherapy extravasation: a systematic review of the literature to evaluate the evidence underpinning contemporary practice. *Eur J Cancer Care (Engl)*. 2015;24(6):771-800. doi:10.1111/ecc.12363
22. Olsen MM, LeFebvre KB, Brassil KJ, eds. *Chemotherapy and Immunotherapy Guidelines and Recommendations for Practice*. Oncology Nursing Society; 2019.
23. Corbett M, Marshall D, Harden M, Oddie S, Phillips R, McGuire W. Treatment of extravasation injuries in infants and young children: a scoping review and survey. *Health Technol Assess*. 2018;22(46):1-112. doi:10.3310/hta22460
24. Restieaux M, Maw A, Broadbent R, Jackson P, Barker D, Wheeler B. Neonatal extravasation injury: prevention and management in Australia and New Zealand-a survey of current practice. *BMC Pediatr*. 2013;13:34. doi:10.1186/1471-2431-13-34
25. Doellman D, Rineair S. The use of optical detection for continuous monitoring of pediatric IV sites. *J Assoc Vasc Access.* 2019;24(2):44-47. https://doi.org/10.2309/j.java.2019.002.003
26. Tofani BF, Rineair SA, Gosdin CH, et al. Quality improvement project to reduce infiltration and extravasation events in a pediatric hospital. *J Pediatr Nurs*. 2012;27(6):682-689. doi:10.1016/j.pedn.2012.01.005
27. Marsh N, Webster J, Larson E, Cooke M, Mihala G, Rickard CM. Observational study of peripheral intravenous catheter outcomes in adult hospitalized patients: a multivariable analysis of peripheral intravenous catheter failure. *J Hosp Med*. 2018;13(2):83-89. doi:10.12788/jhm.2867
28. Heshmatzadeh Behzadi A, Farooq Z, Newhouse JH, Prince MR. MRI and CT contrast media extravasation: a systematic review. *Medicine (Baltimore)*. 2018;97(9):e0055. doi:10.1097/MD.0000000000010055
29. Wallis MC, McGrail M, Webster J, et al. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from a randomized controlled trial. *Infect Control Hosp Epidemiol*. 2014;35(1):63-68. doi:10.1086/674398
30. Ding S, Meystre NR, Campeanu C, Gullo G. Contrast media extravasations in patients undergoing computerized tomography scanning: a systematic review and meta-analysis of risk factors and interventions. *JBI Database System Rev Implement Rep*. 2018;16(1):87-116. doi:10.11124/JBISRIR-2017-003348
31. Beall V, Hall B, Mulholland J, Gephart S. Neonatal extravasation: an overview and algorithm for evidence-based treatment. *Newborn and Infant Nursing Reviews*. 2013;13(4):189-195.
32. Hwang EJ, Shin CI, Choi YH, Park CM. Frequency, outcome, and risk factors of contrast media extravasation in 142,651 intravenous contrast-enhanced CT scans. *Eur Radiol*. 2018;28(12):5368-5375. doi:10.1007/s00330-018-5507-y
33. Marsh N, Larsen E, Genzel J, et al. A novel integrated dressing to secure peripheral intravenous catheters in an adult acute hospital: a pilot randomised controlled trial. *Trials*. 2018;19(1):596. doi:10.1186/s13063-018-2985-9
34. Alami Z, Nasri S, Ahid S, Kacem HH. Extravasation of contrast medium during CT examination: an observational case-control study. *Pan Afr Med J*. 2015;20:89. doi:10.11604/pamj.2015.20.89.3276
35. ACR Committee on Drugs and Contrast Media. *ACR Manual on Contrast Media*. American College of Radiology; 2020. https://www.acr.org/Clinical-Resources/Contrast-Manual
36. Odom B, Lowe L, Yates C. Peripheral infiltration and extravasation injury methodology: a retrospective study. *J Infus Nurs*. 2018;41(4):247-252. doi:10.1097/NAN.0000000000000287
37. Ong J, Van Gerpen R. Recommendations for management of non-cytotoxic vesicant extravasations. *J Infus Nurs*. 2020;43(6):319-343. doi:10.1097/NAN.0000000000000392
38. Nicola R, Shaqdan KW, Aran S, Prabhakar AM, Singh AK, Abujudeh HH. Contrast media extravasation of computed tomography and magnetic resonance imaging: management guidelines for the radiologist. *Curr Probl Diagn Radiol*. 2016;45(3):161-164. doi:10.1067/j.cpradiol.2015.08.004
39. Castillo MI, Larsen E, Cooke M, et al. Integrated versus non-integrated peripheral intravenous catheter. which is the most effective system for peripheral intravenous catheter management? (the OPTIMUM study): a randomised controlled trial protocol. *BMJ Open*. 2018;8(5):e019916. doi:10.1136/bmjopen-2017-019916
40. Blackwood BP, Farrow KN, Kim S, Hunter CJ. Peripherally inserted central catheters complicated by vascular erosion in neonates. *JPEN J Parenter Enteral Nutr*. 2016;40(6):890-895. doi:10.1177/0148607115574000
41. Carr PJ, Rippey JCR, Cooke ML, et al. From insertion to removal: a multicenter survival analysis of an admitted cohort with peripheralintravenous catheters inserted in the emergency department. *Infect Control Hosp Epidemiol*. 2018;39(10):1216-1221. doi:10.1017/ice.2018.190
42. Simin D, Milutinović D, Turkulov V, Brkić S. Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: an observational prospective study. *J Clin Nurs*. 2019;28(9-10):1585-1599. doi:10.1111/jocn.14760
43. Sonis JD, Gottumukkala RV, Glover M 4th, et al. Implications of iodinated contrast media extravasation in the emergency department. *Am J Emerg Med*. 2018;36(2):294-296. doi:10.1016/j.ajem.2017.11.012
44. Marsh N, Webster J, Larsen E, et al. Expert versus generalist inserters for peripheral intravenous catheter insertion: a pilot randomised controlled trial. *Trials*. 2018;19(1):564. doi:10.1186/s13063-018-2946-3
45. Tanabe H, Takahashi T, Murayama R, et al. Using ultrasonography for vessel diameter assessment to prevent infiltration. *J Infus Nurs*. 2016;39(2):105-111. doi:10.1097/NAN.0000000000000159
46. Spencer TR. Subclavian vein catheter extravasation—insufficient catheter length as a probable causal factor. *J Assoc Vasc Access.* 2019;24(1):46-51. https://doi.org/10.1016/j.java.2018.31.006
47. Bronshteyn YS, Bittner EA. Images in anesthesiology: examining the edges of extravasation. *Anesthesiology.* 2017;126(4):716. doi:10.1097/ALN.0000000000001487
48. Pluschnig U, Haslik W, Bayer G, et al. Outcome of chemotherapy extravasation in a large patient series using a standardised management protocol. *Support Care Cancer*. 2015;23(6):1741-1748. doi:10.1007/s00520-014-2535-2
49. Jeong IS, Jeon GR, Lee MS, et al. Intravenous infiltration risk by catheter dwell time among hospitalized children. *J Pediatr Nurs*. 2017;32:47-51. doi:10.1016/j.pedn.2016.08.008
50. Pandurangadu AV, Tucker J, Brackney AR, Bahl A. Ultrasound-guided intravenous catheter survival impacted by amount of catheter residing in the vein. *Emerg Med J*. 2018;35(9):550-555. doi:10.1136/emermed-2017-206803
51. Holden D, Ramich J, Timm E, Pauze D, Lesar T. Safety considerations and guideline-based safe use recommendations for "bolus-dose" vasopressors in the emergency department. *Ann Emerg Med*. 2018;71(1):83-92. doi:10.1016/j.annemergmed.2017.04.021
52. Garbovsky LA, Drumheller BC, Perrone J. Purple glove syndrome after phenytoin or fosphenytoin administration: review of reported cases and recommendations for prevention. *J Med Toxicol*. 2015;11(4):445-459. doi:10.1007/s13181-015-0490
53. Gonzalez T. Chemotherapy extravasations: prevention, identification, management, and documentation. *Clin J Oncol Nurs*. 2013;17(1):61-66. doi:10.1188/13.CJON.61-66
54. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health*. 2019;55(10):1214-1223. doi:10.1111/jpc.14384

55. Kim JT, Park JY, Lee HJ, Cheon YJ. Guidelines for the management of extravasation. *J Educ Eval Health Prof*. 2020;17:21. doi:10.3352/jeehp.2020.17.21
56. Gopalakrishnan PN, Goel N, Banerjee S. Saline irrigation for the management of skin extravasation injury in neonates. *Cochrane Database Syst Rev*. 2017;7(7):CD008404. doi:10.1002/14651858.CD008404.pub3
57. Yurdakul E, Salt O, Durukan P, Duygulu F. Compartment syndrome due to extravasation of contrast material: a case report. *Am J Emerg Med*. 2014;32(9):1155.e3-5. doi:10.1016/j.ajem.2014.02.042
58. van der Pol J, Vöö S, Bucerius J, Mottaghy FM. Consequences of radiopharmaceutical extravasation and therapeutic interventions: a systematic review. *Eur J Nucl Med Mol Imaging*. 2017;44(7):1234-1243. doi:10.1007/s00259-017-3675-7
59. Oya M, Murayama R, Oe M, et al. Continuous thermographic observation may predict extravasation in chemotherapy-treated patients. *Eur J Oncol Nurs*. 2017;28:56-61. doi:10.1016/j.ejon.2017.02.009
60. Matsui Y, Murayama R, Tanabe H, et al. Evaluation of the predictive validity of thermography in identifying extravasation with intravenous chemotherapy infusions. *J Infus Nurs*. 2017;40(6):367-374. doi:10.1097/NAN.0000000000000250
61. Lee JTL, Ricketts J. Displacement of a power-injectable PICC following computed tomography pulmonary angiogram. *Radiol Case Rep*. 2017;12(4):690-692. doi:10.1016/j.radcr.2017.07.016
62. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines.* Pappin Communications; 2019.
63. Maly C, Fan KL, Rogers GF, et al. A primer on the acute management of intravenous extravasation injuries for the plastic surgeon. *Plast Reconstr Surg Glob Open*. 2018;6(4):e1743. doi:10.1097/GOX.0000000000001743
64. Nickel B. Peripheral intravenous administration of high-risk infusions in critical care: a risk-benefit analysis. *Crit Care Nurse*. 2019;39(6):16-28. doi:10.4037/ccn2019443
65. Melo JMA, Oliveira PP, Souza RS, Fonseca DFD, Gontijo TF, Rodrigues AB. Prevention and conduct against the extravasation of antineoplastic chemotherapy: a scoping review. *Rev Bras Enferm*. 2020;73(4):e20190008. doi:10.1590/0034-7167-2019-0008
66. Yan YM, Fan QL, Li AQ, Chen JL, Dong FF, Gong M. Treatment of cutaneous injuries of neonates induced by drug extravasation with hyaluronidase and hirudoid. *Iran J Pediatr*. 2014;24(4):352-358.
67. Roman JW, Ojemuyiwa MA, Cordes LM, Madan RA, Sperling L. Docetaxel extravasation: pathologic correlation and treatment with intralesional steroids. *JAAD Case Rep*. 2017;3(4):322-325. doi:10.1016/j.jdcr.2017.04.013
68. Braga L, Salgueiro-Oliveira A, Henriques M, et al. Transcultural adaptation of the infiltration scale into the Portuguese culture. *Acta Paul Enferm*. 2016;29(1):93-99. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-21002016000100093&lng=pt&tlng=pt
69. Abe-Doi M, Murayama R, Yabunaka K, Tanabe H, Komiyama C, Sanada H. Ultrasonographic assessment of an induration caused by extravasation of a nonvesicant anticancer drug: a case report. *Medicine (Baltimore)*. 2019;98(14):e15043. doi:10.1097/MD.0000000000015043

48. NERVE INJURY

Standard

48.1 A VAD is immediately removed upon patient report of paresthesia-type pain during peripheral venipuncture and during catheter dwell time.

48.2 During the insertion or dwell of CVADs, the possibility of nerve injury is considered and evaluated whenever the patient complains of respiratory difficulty or unusual presentations of pain or discomfort.

Practice Recommendations

A. Recognize that anatomical variations in veins, arteries, and nerves are common and can be complex, thus increasing the risk of temporary or permanent nerve injury during VAD insertion and dwell.[1-15] (IV, A/P)

B. Recognize that some common sites have a greater risk of nerve injury; however, selecting specific peripheral venous and arterial puncture sites for the purpose of avoiding nerves is not always possible. As nerves cross a joint of the upper or lower extremity, there is an increase in neural tissue, increasing the risk of nerve injury in these areas. Motor, sensory, and/or autonomic nerve injury are possible due to direct nerve puncture or nerve compression.
   1. Use caution with the following venous sites due to increased risk of nerve damage:
      a. Cephalic vein at the radial wrist with potential injury to the superficial radial nerve.
      b. Volar (inner) aspect of the wrist with potential injury to the median nerve.
      c. At/above the antecubital fossa with potential injury to the median and anterior interosseous nerve and the lateral and medial antebrachial nerves.
      d. Subclavian and jugular sites with potential injury to nerves of the brachial plexus.
      e. Brachial vein during PICC insertion with potential injury to the median nerve.
   2. Use caution with the following arterial sites associated with risk for nerve damage:
      a. Brachial artery with potential injury to the median nerve.
      b. Radial artery with potential injury to the median and radial nerve.
      c. Axillary artery with potential injury to the brachial plexus.[2,4,8,9,11-13,16-23] (IV, A/P)

C. Reduce the risk for venipuncture-related nerve injury.
   1. Review the patient's medication list for systemic anticoagulant medication(s) prior to making a puncture in a vein or artery. Use appropriate means to control bleeding at attempted and successful sites to reduce the risk of hematoma that can lead to nerve injury due to compression.[24-26] (V)
   2. Use ultrasound guidance to reduce the risk of insertion-related complications when placing short or long peripheral catheters in patients with difficult venous access and when placing CVADs and midline catheters (refer to Standard 22, *Vascular Visualization*).
   3. Insert a peripheral catheter or phlebotomy needle at no more than a 30° angle depending upon vein depth unless using ultrasound guidance; for shallow veins and veins of older adults, use a 5° to 15° angle. Do not use subcutaneous probing techniques or multiple passes of the needle or catheter when performing any puncture procedure.[1,10,27-30] (V)

4. Choose the median cubital vein (first choice) or the cephalic vein for phlebotomy, as these veins are closer to the surface and in an area where nerve damage is least likely; the basilic or median basilic veins are a last choice due to proximity to the median nerve and brachial artery.[2,6,13] (V, A/P)
5. Avoid the cephalic vein in the first quarter of the forearm (ie, above the wrist) for approximately 8.5 cm above the styloid process of the radius due to risk of superficial radial nerve injury.[4,9,11,27] (V, A/P)
6. Minimize the risk of needle movement during phlebotomy procedures while attaching and removing the blood collection tube(s).[1,27,28] (IV)
7. Avoid multiple attempts at venipuncture (refer to Standard 34, *Vascular Access Device Placement*).
8. Stop the VAD insertion procedure immediately and carefully remove the VAD if the patient reports symptoms of paresthesia, such as radiating electrical pain, tingling, burning, prickly feeling, or numbness; stop the procedure upon the patient's request and/or when the patient's actions indicate severe pain.[29,30](V)
9. Inform the provider of the patient's report of symptoms as early recognition of nerve damage produces a better prognosis. Consultation with an appropriate surgeon (eg, hand specialist) may be required. Details of the patient's report of symptoms should be documented in the health record.[24,26,29] (V)
10. Immediately remove a peripheral catheter when a patient reports paresthesia-type pain during the dwell of a peripheral catheter, as fluid accumulating in the tissue can lead to nerve compression injuries. Fluid can originate from infiltrated IV solutions, hematoma, and edema associated with the inflammatory process of phlebitis and thrombophlebitis.[17,28] (V)
11. Limit the amount of solution that enters the tissue through early recognition of signs/symptoms of infiltration/extravasation (refer to Standard 47, *Infiltration/Extravasation*).

D. Monitor neurovascular signs/symptoms, observing for intensification of paresthesia (eg, pain, burning or localized tingling, numbness), as these may indicate advancing nerve damage including:
   1. Neuroma, a mass of connective tissue and nerve fibers that prohibit regeneration of nerves at the injury site. Surgical removal is used to restore function.[20,29] (V)
   2. Compartment syndrome, producing nerve compression resulting in lack of nerve tissue perfusion. Pain progresses from paresthesia to paralysis. Pallor and loss of peripheral pulse indicate an advanced stage of compartment syndrome. Surgical fasciotomy is required within a few hours to prevent loss of the extremity.[15,31-33] (IV)
   3. Complex regional pain syndrome, a chronic, debilitating condition that can result from venipuncture, is characterized by ongoing neuropathic pain over a regional area; is not proportional to the original injury; and progresses to include sensory, motor, and autonomic changes. Frequently this syndrome spreads to nontraumatized extremities. Lifelong management is required, including medications; nerve blocks; and chemical, thermal, or surgical sympathectomy.[34-35] (V)

E. Observe for respiratory difficulties or dyspnea and changes in the eye, such as pupil constriction and upper eyelid drooping in the presence of any CVAD.
   1. Subclavian and jugular insertion sites can produce damage to the phrenic nerve, which is seen on a chest radiograph as an elevated right hemidiaphragm. Right shoulder and neck pain, distended neck veins, and hiccups may also be present. Phrenic nerve injury can come from direct trauma associated with multiple needle insertions, compression due to the presence of the catheter itself, intraventricular tip locations, hematoma, and infiltration/extravasation of infusing solutions. CVAD removal is indicated.[36-39] (V)
   2. PICCs and catheters inserted in the internal jugular vein have been reported to produce eye changes, which are suggestive of inflammation of cervical sympathetic nerves. Known as Horner's syndrome, this has been reported with trauma from insertion technique and vein thrombosis.[40-42] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 17, 2020, and August 30, 2020.

1. Fujii C. Clarification of the characteristics of needle-tip movement during vacuum venipuncture to improve safety. *Vasc Health Risk Manag.* 2013;9:381-390. doi:10.2147/VHRM.S47490
2. Mukai K, Nakajima Y, Nakano T, et al. Safety of venipuncture sites at the cubital fossa as assessed by ultrasonography. 2020;16(1):98-105. doi:10.1097/PTS.0000000000000441.
3. Wongkerdsook W, Agthong S, Amarase C, Yotnuengnit P, Huanmanop T, Chentanez V. Anatomy of the lateral antebrachial cutaneous nerve in relation to the lateral epicondyle and cephalic vein. *Clin Anat*. 2011;24(1):56-61. doi:10.1002/ca.21067
4. Kim KH, Byun EJ, Oh EH. Ultrasonographic findings of superficial radial nerve and cephalic vein. *Ann Rehabil Med.* 2014;38(1):52-56. doi:10.5535/arm.2014.38.1.52
5. Chiavaras MM, Jacobson JA, Billone L, Lawton JM, Lawton J. Sonography of the lateral antebrachial cutaneous nerve with magnetic resonance imaging and anatomic correlation. *J Ultrasound Med.* 2014;33(8):1475-1483. doi:10.7863/ultra.33.8.1475
6. Mikuni Y, Chiba S, Tonosaki Y. Topographical anatomy of superficial veins, cutaneous nerves, and arteries at venipuncture sites in the cubital fossa. *Anat Sci Int.* 2013;88(1):46-57. doi:10.1007/s12565-012-0160-z
7. Troupis TG, Michalinos A, Manou V, et al. Report of an unusual combination of arterial, venous and neural variations in a cadaveric upper limb. *J Brachial Plex Peripher Nerve Inj.* 2014;9:2. doi:10.1186/1749-7221-9-2
8. Voin V, Iwanaga J, Sardi JP, et al. Relationship of the median and radial nerves at the elbow: application to avoiding injury during venipuncture or other invasive procedures of the cubital fossa. *Cureus.* 2017;9(3):e1094. doi:10.7759/cureus.1094
9. Matsuo M, Honma S, Sonomura T, Yamazaki M. Clinical anatomy of the cephalic vein for safe performance of venipuncture. *JA Clin Rep.* 2017;3(1):50. doi:10.1186/s40981-017-0121-6
10. Ramos JA. Venipuncture-related lateral antebrachial cutaneous nerve injury: what to know? *Braz J Anesthesiol.* 2014;64(2):131-133. doi:10.1016/j.bjane.2013.06.003

11. Samarakoon LB, Lakmal KC, Thillainathan S, Bataduwaarachchi VR, Anthony DJ, Jayasekara RW. Anatomical relations of the superficial sensory branches of the radial nerve: a cadaveric study with clinical implications. *Patient Saf Surg.* 2011;5(1):28. doi:10.1186/1754-9493-5-28
12. Wang J, Liu F, Liu S, Wang N. An uncommon cause of contralateral brachial plexus injury following jugular venous cannulation. *Am J Case Rep*. 2018;19:289-291. doi:10.12659/ajcr.908125
13. Yamada K, Yamada K, Katsuda I, Hida T. Cubital fossa venipuncture sites based on anatomical variations and relationships of cutaneous veins and nerves. *Clin Anat*. 2008;21(4):307-313. doi:10.1002/ca.20622
14. Moore AE, Zhang J, Stringer MD. Iatrogenic nerve injury in a national no-fault compensation scheme: an observational cohort study. *Int J Clin Pract*. 2012;66(4):409-416. doi:10.1111/j.1742-1241.2011.02869.x
15. Horowitz SH. Venipuncture-induced causalgia: anatomic relations of upper extremity superficial veins and nerves, and clinical considerations. *Transfusion.* 2000;40(9):1036-1040. doi:10.1046/j.1537-2995.2000.40091036.x
16. Oven SD, Johnson JD. Radial nerve injury after venipuncture. *J Hand Microsurg.* 2017;9(1):43-44. doi:10.1055/s-0037-1599220
17. Wu A, Liu H. Persistent median nerve injury probably secondary to prolonged intravenous catheterization at antecubital fossa. *J Clin Anesth.* 2018;46:61-62. doi:10.1016/j.jclinane.2018.01.024
18. Tsukuda Y, Funakoshi T, Nasuhara Y, Nagano Y, Shimizu C, Iwasaki N. Venipuncture nerve injuries in the upper extremity from more than 1 million procedures. *J Patient Saf.* 2019;15(4):299-301. doi:10.1097/PTS.0000000000000264
19. Rayegani SM, Azadi A. Lateral antebrachial cutaneous nerve injury induced by phlebotomy. *J Brachial Plex Peripher Nerve Inj.* 2007;2:6. doi:10.1186/1749-7221-2-6
20. So E, Sanders GM, Au TK, Hung CT. Radial nerve injury after intravenous cannulation at the wrist–a case report. *Ann Acad Med Singapore.* 1999;28(2):288-289.
21. Brzezinski M, Luisetti T, London MJ. Radial artery cannulation: a comprehensive review of recent anatomic and physiologic investigations. *Anesth Analg.* 2009;109(6):1763-1781. doi:10.1213/ANE.0b013e3181bbd416
22. Hill S. Avoiding complications during insertion. In: Moureau NL, ed. *Vessel Health and Preservation: The Right Approach for Vascular Access*. SpringerOpen; 2019:107-115. https://link.springer.com/content/pdf/10.1007%2F978-3-030-03149-7.pdf
23. Cousins TR, O'Donnell JM. Arterial cannulation: a critical review. *AANA J.* 2004;72(4):267-271.
24. Dawson J, Christie M. 'Just a sharp scratch': permanent radial, median and ulnar neuropathy following diagnostic venepuncture. *Br J Hosp Med (Lond).* 2007;68(3):160-161. doi:10.12968/hmed.2007.68.3.22855
25. Ho KM, Lim HH. Femoral nerve palsy: an unusual complication after femoral vein puncture in a patient with severe coagulopathy. *Anesth Analg.* 1999;89(3):672-673. doi:10.1097/00000539-199909000-00026
26. Spinner RJ, Edwards WD, Amrami KK. Hemorrhagic cystic lesion of the median nerve: an unusual complication of venipuncture. *Clin Anat*. 2013;26(5):540-543. doi:10.1002/ca.22197
27. Boeson MB, Hranchook A, Stoller J. Peripheral nerve injury from intravenous cannulation: a case report. *AANA J*. 2000;68(1):53-57.
28. McCall RE, Tankersley CM. *Phlebotomy Essentials*. 6th ed. Wolters Kluwer; 2016.
29. Gorski LA. *Phillips's Manual of I.V. Therapeutics: Evidence-Based Practice for Infusion Therapy.* 7th ed. F.A. Davis Company; 2018.
30. Coulter K. Successful infusion therapy in older adults. *J Infus Nurs.* 2016;39(6):352-358. doi:10.1097/NAN.0000000000000196
31. Kanj WW, Gunderson MA, Carrigan RB, Sankar WN. Acute compartment syndrome of the upper extremity in children: diagnosis, management, and outcomes. *J Child Orthop.* 2013;7(3):225-233. doi:10.1007/s11832-013-0492-9
32. Blake S, Dean D, Chance EA. Antecubital venipuncture resulting in compartment syndrome of the anterior brachium: a case report. *JBJS Case Connect*. 2013;3(1):e12. doi:10.2106/JBJS.CC.K.00165
33. Kistler JM, Ilyas AM, Thoder JJ. Forearm compartment syndrome: evaluation and management. *Hand Clin.* 2018;34(1):53-60. doi:10.1016/j.hcl.2017.09.006
34. Elahi F, Reddy CG. Venipuncture-induced complex regional pain syndrome: a case report and review of the literature. *Case Rep Med.* 2014;2014:613921. doi:10.1155/2014/613921
35. Pruthi P, Arora P, Mittal M, Nair A, Sultana W. Venipuncture induced complex regional pain syndrome presenting as inflammatory arthritis. *Case Rep Med*. 2016;2016:8081401. doi:10.1155/2016/8081401
36. Aggarwal S, Hari P, Bagga A, Mehta SN. Phrenic nerve palsy: a rare complication of indwelling subclavian vein catheter. *Pediatr Nephrol*. 2000;14(3):203-204. doi:10.1007/s004670050041
37. Takasaki Y, Arai T. Transient right phrenic nerve palsy associated with central venous catheterization. *Br J Anaesth*. 2001;87(3):510-511. doi:10.1093/bja/87.3.510
38. Yang CW, Bae JS, Park TI, et al. Transient right hemidiaphragmatic paralysis following subclavian venous catheterization: possible implications of anatomical variation of the phrenic nerve -a case report. *Korean J Anesthesiol.* 2013;65(6):559-561. doi:10.4097/kjae.2013.65.6.559
39. Shawyer A, Chippington S, Quyam S, Schulze-Neick I, Roebuck D. Phrenic nerve injury after image-guided insertion of a tunnelled right internal jugular central venous catheter. *Pediatr Radiol*. 2012;42(7):875-877. doi:10.1007/s00247-011-2269-y
40. Butty Z, Gopwani J, Mehta S, Margolin E. Horner's syndrome in patients admitted to the intensive care unit that have undergone central venous catheterization: a prospective study. *Eye (Lond).* 2016;30(1):31-33. doi:10.1038/eye.2015.181
41. Links DJ, Crowe PJ. Horner's syndrome after placement of a peripherally inserted central catheter. *JPEN J Parenter Enteral Nutr.* 2006;30(5):451-452. doi:10.1177/0148607106030005451
42. Kornbau C, Lee KC, Hughes GD, Firstenberg MS. Central line complications. *Int J Crit Illn Inj Sci.* 2015;5(3):170-178. doi:10.4103/2229-5151.164940

49. CENTRAL VASCULAR ACCESS DEVICE OCCLUSION

Standard

49.1 CVAD patency is routinely assessed, as defined by the ability to flush all catheter lumens without resistance and the ability to yield a blood return.

49.2 Catheter salvage is preferred over catheter removal for management of CVAD occlusion with choice of clearing agents based on a thorough assessment of potential causes of occlusion.

49.3 When catheter patency cannot be restored and there is continued need for the device, alternative actions, such as radiographic studies to identify catheter tip location or evaluate catheter flow, are implemented.

Practice Recommendations

A. Reduce the risk for CVAD occlusion.
   1. Use proper flushing and locking procedures appropriate for each patient population and type of CVAD (refer to Standard 41, *Flushing and Locking*).

2. Prevent catheter dislodgement through appropriate catheter securement (refer to Standard 38, *Vascular Access Device Securement*; Standard 54, *Central Venous Access Device Malposition*).
3. Avoid incompatible mixtures of IV solutions and/or medications.[1-3] (IV)
   a. Check for incompatibility when 2 or more drugs are infused together (eg, combined in same container, administered as an intermittent solution for a short-term infusion or a manual injection, or administered concomitantly through the same CVAD). Consult with a pharmacist or use an evidence-based compatibility reference when unsure of compatibility; if no compatibility information is found, consider the mixture as incompatible.[1-3] (IV)
   b. Identify medications/solutions at high risk for precipitation. These may include alkaline drugs such as phenytoin, diazepam, ganciclovir, acyclovir, ampicillin, imipenem, and heparin; acidic drugs such as vancomycin and PN solutions; ceftriaxone and calcium gluconate; and mineral precipitate in PN solutions with increased levels of calcium and phosphate.[1-6] (IV)
   c. Perform pulsatile flush between infusions with at least 10 mL of preservative-free 0.9% sodium chloride or use separate catheter lumens if available.[7] (V)
4. Identify risk of lipid residue occlusion when administering total nutrient admixture (TNA), employing preventative strategies (eg, increased flushing) if lipid residue buildup is suspected.[2,8] (V)

B. Assess for signs and symptoms of possible CVAD occlusion:
1. Inability to withdraw blood or sluggish blood return.[2,3] (IV)
2. Sluggish flow; resistance or inability to flush lumen; inability to infuse fluid.[2,3] (IV)
3. Frequent occlusion alarms on electronic infusion pump.[2] (V)
4. Swelling/leaking at infusion site.[2,4,6] (V)
5. No reflow or insufficient blood flow in hemodialysis CVADs.[9] (IV)

C. Assess VAD patency by aspirating for a blood return and flushing each lumen with 0.9% preservative-free sodium chloride prior to administering any solution.[2,8,10,11] (V)
1. If no blood return on aspiration, may alternate gently drawing back and then gently instilling small amounts of saline.[2,4,6,7,12] (III)
2. Use a small-barrel syringe to aspirate blood if no blood return obtained and able to flush catheter. A small-barrel syringe exerts less negative pressure when withdrawing blood and may result in more success.[2] (V)

D. Assess the infusions, injections, flushing procedures, and other events with the CVAD that led to the occlusion to determine the possible cause.[2,6,8] (V)
1. Rule out/resolve external mechanical causes, assessing the entire infusion system from the administration set to the CVAD insertion site under the dressing.[2,3,6,8,10] (IV)
   a. Assess securement device or tight suture for constriction of catheter, kinked/clamped catheter or administration set, obstructed/malfunctioning filter or needleless connector, change in external catheter length, or malposition of an implanted port access needle (refer to Standard 38, *Vascular Access Device Securement*; Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes*).
   b. Remove add-on devices; assess catheter patency by attaching syringe at the hub, and attach new add-on device. External kinks may be resolved by repositioning the catheter and reapplying a sterile dressing. Replace an implanted port access needle that is malpositioned or occluded.[2-4,6,8,9,13-15] (IV)
   c. Attempt short-term resolution to withdrawal occlusion (inability to obtain blood return) by changing the patient's position (eg, raise arm, cough, or breathe deeply) in an attempt to alter catheter position. Further investigation should be initiated for recurrent/persistent withdrawal occlusion.[2-4,15-17] (IV)
   d. Assess for catheter damage (eg, CVAD bulging, leaking, or swelling along CVAD pathway) and repair or replace CVAD (refer to Standard 51, *Catheter Damage [Embolism, Repair, Exchange]*).
2. Assess for internal mechanical causes, such as pinch-off syndrome, secondary CVAD malposition, catheter-associated deep vein thrombosis (CA-DVT), implanted vascular access port failure, and kinks related to the tissue and vasculature (eg, head and neck movement causing kinking of catheters placed in internal or external jugular vein). Refer to Standard 51, *Catheter Damage (Embolism, Repair, Exchange)*; Standard 53, *Catheter-Associated Deep Vein Thrombosis*; Standard 54, *Central Vascular Access Device Malposition*.
   a. Assess external catheter length, arm or shoulder discomfort, arrhythmias, and need to roll shoulder or raise the ipsilateral arm to allow flow or obtain blood return. If pinch-off syndrome is suspected, gently flush the CVAD with 10 mL of 0.9% preservative-free sodium chloride while asking the patient to raise the ipsilateral arm and roll the shoulder backward. If the flow is dependent upon arm position, pinch-off syndrome should be investigated.[6,11] (V)
   b. Collaborate with the provider to manage suspected CVAD malposition, pinch-off syndrome, or CVAD damage.[2,5,6,10,13,16,18] (II)
3. Suspect thrombotic occlusions based on visible blood in catheter or add-on devices, inability to

aspirate blood, or sluggish flow. A thrombotic occlusion may be intraluminal due to fibrin or clot formation, or extraluminal related to a fibrin tail, fibrin sheath or sleeve, or mural thrombus.[1,2,4,8] (V)

4. Suspect chemical occlusion based on the type(s) of medications or solutions administered, duration of contact of drugs, and observation of the catheter or administration set for any visible precipitate, history of infusion rate, dilution properties and sequences, light exposure, and flushing frequency.[2,4-6,8,10,13] (III)
   a. Suspect calcium phosphate precipitation if levels of electrolytes in PN solutions are increased or if calcium phosphate is below 75 mmol/L.[6,19] (V)
   b. Suspect lipid residue if TNA infusing; PN with lipid greater than 10% is also a risk factor.[6,19] (V)
   c. Suspect chemical occlusion if thrombolytic agent unsuccessful.[2] (V)
5. Consider a contrast study for persistent or recurring unresolved CVAD occlusion.[2,3] (IV)

E. Review the patient's medication record and collaborate with the pharmacist for the appropriate intervention/catheter clearance agent.[4] (V)

F. Treat all catheter lumens with partial, withdrawal, or complete occlusion. Do not leave an occluded lumen untreated because another lumen is functional; prolonged fibrin formation is a risk factor for catheter-associated bloodstream infection (CABSI).[2,8] (V)
   1. Avoid applying excessive force when instilling a catheter clearance agent to reduce risk of catheter damage.[2] (V)
   2. Promptly resolve a suspected thrombotic occlusion or occlusion of unknown cause to increase the efficacy of thrombolysis and avoid or at least delay the need for catheter replacement.[2,8,15,20-22] (I)
      a. Assess risks/benefits of thrombolysis. Determine if CVAD removal or replacement is warranted (eg, contraindication for thrombolytic agent, patients with CVAD-associated sepsis due to candidemia or *Staphylococcus aureus*).[2,13,20] (V)
      b. Instill tissue plasminogen activator ([tPA] alteplase) in the catheter lumen in accordance with manufacturers' directions for use and repeat 1 time if first attempt is unsuccessful.[2,16,20,22] (II)
         i. A single study reported effective use of tPA in management of thrombotic occlusions in midline catheters; however, this is off-label practice and requires further evidence.[23] (V)
         ii. Lower doses of tPA (eg, 1 mg/mL) in lumens requiring less than or equal to 1-mL volume and cryopreserved aliquots have been demonstrated to be effective; however, randomized controlled trials (RCTs) are required to determine the efficacy of alternate dosing.[11,12,16,18,24-28] (III)
         iii. For neonatal and pediatric patients weighing 30 kg or less, use a volume equal to 110% of the catheter priming volume.[2,4,8,9] (III)
         iv. tPA may be administered in all health care settings, including the community and long-term care settings.[1,2,4,28,29] (V)
         v. Stop all infusions prior to and during thrombolytic agent dwell time if possible (particularly if treating a suspected fibrin tail/sheath) to optimize thrombolysis and to facilitate maximum contact between the thrombolytic and thrombus/fibrin on the intraluminal and extraluminal surface of the catheter.[2,20] (V)
         vi. Alternative thrombolytic agents such as urokinase, reteplase, tenecteplase, and alfimeprase have been shown to be effective in smaller studies; further safety data are recommended to compare the efficacy, safety, and cost of different thrombolytic agents.[2,9,12-15,18,20,30-34] (III)
         vii. Consider alternative methods to deal with persistent/recurring CVAD occlusions not resolved by instillation of a thrombolytic agent:
            - Push method over 30 minutes.[2,15,35] (IV)
            - Low-dose infusion over 30 minutes to 3 to 4 hours.[2,7,15,36] (IV)
            - Dual syringes and implanted port access needles method.[2,31,37] (V)
         viii. Let thrombolytic agent reside in CVAD lumen for duration recommended in manufacturers' directions for use or as per organizational policies, procedures, and/or practice guidelines.[2,20,25,29] (I)
   3. Consider resolving a suspected chemical occlusion (eg, medication precipitate or lipid residue), using a catheter-clearance agent based on the catheter lumen priming volume and allowing it to dwell for 20 to 60 minutes.[2,4,6,8] (III)
      a. L-cysteine 50 mg/mL or 0.1 N hydrochloric acid (HCl) have been used with acidic drug precipitates (pH 1-5).[2,4,6,16,19,38] (V)
      b. Sodium bicarbonate 8.4% or sodium hydroxide 0.1 mmol/L have been used with alkaline drug precipitates (pH 9-12).[4,5] (V)
      c. Sodium hydroxide 0.1 mmol/L (first attempt) or L-cysteine hydrochloride 50 mg/mL have been reported for PN and calcium phosphate.[2,6,16,19,38] (III)
      d. Sodium hydroxide (0.1 mmol/L) and 70% ethanol (with a systematic review finding the former to be more effective) have been used to treat lipid residue.[2,4,6,16,19,21,38] (IV)
      e. Repeat instillation of catheter-clearance agent once if necessary.[2,6] (V)
   4. After appropriate dwell time of catheter clearance agent, aspirate and discard degradation products prior to flushing the lumen to assess catheter patency.[2,6] (V)

G. If catheter patency is not restored:
    1. Consider alternative actions such as radiography to rule out catheter tip malposition and/or a referral to interventional radiology for contrast study or removal of fibrin using procedures such as an internal snare, ablation of implanted VAD, catheter exchange with fibrin sheath disruption, or angioplasty of central veins.[2,25,31,33,39] (V)
    2. Collaborate with the health care team regarding further investigation to rule out catheter-associated thrombosis, as venous thrombosis is a predictor for ineffective thrombolytic instillation procedures.[2,25] (IV)
    3. Catheter removal may be necessary, with an alternative plan for vascular access.[9,19] (V)

H. Monitor the patient who has received a thrombolytic agent for signs of catheter-related infection or catheter-related thrombosis. Recognize that bacteria may adhere to thrombi in and around the CVAD, leading to potential infection.[3,16,34,40,41] (IV)

I. Monitor outcomes, including causes of occlusions in CVADs, treatment success or failure, and other measures required. Identify barriers to implementing CVAD occlusion prevention and interventions, and implement appropriate strategies including policies and procedures and clinician education and training (refer to Standard 6, *Quality Improvement*).

REFERENCES

Note: All electronic references in this section were accessed between May 17, 2020, and August 30, 2020.

1. Linnemann B. Management of CVC complications in cancer patients: an update. *Semin Thromb Hemost*. 2014;40(3):382-394. doi:10.1055/s-0034-1371005
2. Canadian Vascular Access Association. *Occlusion Management Guideline for Central Venous Access Devices (CVADs*). Canadian Vascular Access Association; 2019.
3. Ullman AJ, Condon P, Edwards R, et al. Prevention of occlusion of central lines for children with cancer: an implementation study [published online ahead of print Aug 17, 2020]. *J Paediatr Child Health.* 2020;10.1111/jpc.15067. doi:10.1111/jpc.15067
4. Gorski LA. *Phillips's Manual of I.V. Therapeutics: Evidence-Based Practice for Infusion Therapy*. 7th ed. F.A. Davis Company; 2018.
5. Ponce D, Mendes M, Silva T, Oliveira R. Occluded tunneled venous catheter in hemodialysis patients: risk factors and efficacy of alteplase. *Artif Organs*. 2015;39(3):741-747. doi:10.1111/aor.12462
6. Ast D, Ast T. Nonthrombotic complications related to central vascular access devices. *J Infus Nurs*. 2014;37(5):349-358. doi:10.1097/NAN.0000000000000063
7. Steere L, Rousseau M, Durland L. Lean Six Sigma for intravenous therapy optimization: a hospital use of lean thinking. *J Assoc Vasc Access*. 2018;23(1):42-50. https://doi.org/10.1016/j.java.2018.01.002
8. Doellman D, Buckner J, Garrett JH Jr, et al. *Best Practice Guidelines in the Care and Maintenance of Pediatric Central Venous Catheters*. 2nd ed. Association for Vascular Access; 2015.
9. de Lorenzo-Pinto A, Sánchez-Galindo AC, Manrique-Rodríguez S, et al. Prevention and treatment of intraluminal catheter thrombosis in children hospitalised in a paediatric intensive care unit. *J Paediatr Child Health*. 2014;50(1):40-46. doi:10.1111/jpc.12404
10. Denton A, Bodenham A, Conquest A, et al. *Standards for Infusion Therapy.* 4th ed. Royal College of Nursing; 2016.
11. Jafari N, Seidl E, Dancsecs K. Evaluation of alteplase 1 mg for the restoration of occluded central venous access devices in a tertiary care hospital. *J Assoc Vasc Access*. 2018;23(1):51-55. https://doi.org/10.1016/j.java.2017.11.001
12. Pollo V, Dionizio D, Bucuvic EM, Castro H, Ponce D. Alteplase vs. urokinase for occluded hemodialysis catheter: a randomized trial. *Hemodial Int*. 2016;20(3):378-384. doi:10.1111/hdi.12391
13. Bolton D. Preventing occlusion and restoring patency to central venous catheters. *Br J Community Nurs*. 2013;18(11):539-544. doi:10.12968/bjcn.2013.18.11.539
14. Mendes ML, Barretti P, da Silva TN, Ponce D. Approach to thrombotic occlusion related to long-term catheters of hemodialysis patients: a narrative review. *J Bras Nefrol.* 2015;37(2):221-227. doi:10.5935/0101-2800.20150035
15. Kumwenda M, Dougherty L, Spooner H, Jackson V, Mitra S, Inston N. Managing dysfunctional central venous access devices: a practical approach to urokinase thrombolysis. *Br J Nurs*. 2018;27(2):S4-S10. doi:10.12968/bjon.2018.27.2.S4
16. Giordano P, Saracco P, Grassi M, et al. Recommendations for the use of long-term central venous catheter (CVC) in children with hemato-oncological disorders: management of CVC-related occlusion and CVC-related thrombosis. *Ann Hematal*. 2015;94(11):1765-1776. doi:10.1007/s00277-015-2481-1
17. Natividad E, Rowe T. Simultaneous rapid saline flush to correct catheter malposition: a clinical overview. *J Assoc Vasc Access*. 2015;20(3):159-166. https://doi.org/10.1016/j.java.2015.03.002
18. Mendes ML, Castro JH, Silva TN, Barretti P, Ponce D. Effective use of alteplase for occluded tunneled venous catheter in hemodialysis patients. *Artif Organs*. 2014;38(5):399-403. doi:10.1111/aor.12186
19. Zheng LY, Xue H, Yuan H, Liu S, Zhang XY. Efficacy of management for obstruction caused by precipitated medication or lipids in central venous access devices: a systematic review and meta-analysis. *J Vasc Access.* 2019;20(6):583-591. doi:10.1177/1129729819836846
20. Schiffer CA, Mangu PB, Wade JC, et al. Central venous catheter care for the patient with cancer: American Society of Clinical Oncology clinical practice guideline. *J Clin Oncol*. 2013;31(10):1357-1370. doi:10.1200/JOP.2012.000780
21. Nephrology Clinical Educators Network (CEN) and Canadian Hemodialysis Access Coordinators Network. *Nursing Recommendations for the Management of Vascular Access in Adult Hemodialysis Patients: 2015 Update.* Vol 25. (Suppl 1). Canadian Association of Nephrology Nurses and Technologists; 2015.
22. Carvalho da Costa A, Ribeiro JM, Vasques CI, De Luca Canto G, Porporatti AL, Diniz dos Reis PE. Interventions to obstructive long-term central venous catheter in cancer patients: a meta-analysis. *Support Care Cancer*. 2019;27:407-421. doi:10.1007/s00520-018-4500-y
23. Hawes ML. Assessing and restoring patency in midline catheters. *J Infus Nurs.* 2020;43(4):213-221. doi:10.1097/NAN.0000000000000376
24. Smith SN, Moureau N, Vaughn VM, et al. Patterns and predictors of peripherally inserted central catheter occlusion: the 3P-O study. *J Vasc Interv Radiol*. 2017;28(5):749-756.e2. doi:10.1016/j.jvir.2017.02.005
25. Massmann A, Jagoda P, Kranzhoefer N, Buecker A. Local low-dose thrombolysis for safe and effective treatment of venous port-catheter thrombosis. *Ann Surg Oncol*. 2015;22(5):1593-1597. doi:10.1245/s10434-014-4129-0
26. Anderson DM, Pesaturo KA, Casavant J, Ramsey EZ. Alteplase for the treatment of catheter occlusion in pediatric patients. *Ann Pharmacother*. 2013;47:405-410. doi:10.1345/aph.1Q483
27. Sapienza SP, Ciaschini DR. Intraluminal volume dose alteplase for the clearance of occluded peripherally inserted central catheter lines at a long-term acute care hospital: efficacy and economic impact. *Hosp Pharm.* 2015;50(3):202-207. doi:10.1310/hpj5003-202

28. Scott DM, Ling CY, MacQueen BC, Baer VL, Gerday E, Christensen RD. Recombinant tissue plasminogen activator to restore catheter patency: efficacy and safety analysis from a multihospital NICU system. *J Perinatol*. 2017;37(3):291-295. doi:10.1038/jp.2016.203
29. Duerksen C. Unblocked: Introducing alteplase to community care. *Vasc Access*. 2016;10(3):15-21.
30. Hitchcock J. Preventing intraluminal occlusion in peripherally inserted central catheters. *Br J Nurs*. 2016;25(19):S12-S18. doi:10.12968/bjon.2016.25.19.S12
31. Muguet S, Couraud S, Perrot E, Claer I, Souquet PJ. Clearing obstructed totally implantable central venous access ports: an efficient protocol using a second needle. *Support Care Cancer*. 2012;20(11):2859-2864. doi:10.1007/s00520-012-1412-0
32. Kennard AL, Walters GD, Jiang SH, Talaulikar GS. Interventions for treating central venous haemodialysis catheter malfunction. *Cochrane Database Syst Rev*. 2017;10(10):CD011953. doi:10.1002/14651858.CD011953.pub2
33. Gallieni M, Giordano A, Rossi U, Cariati M. Optimization of dialysis catheter function. *J Vasc Access*. 2016;17(Suppl 1):S42-S46. doi:10.5301/jva.5000538
34. Westergaard B, Classen V, Walther-Larsen S. Peripherally inserted central catheters in infants and children – indications, techniques, complications and clinical recommendations. *Acta Anaesthesiol Scand*. 2013;57(3):278-287. doi:10.1111/aas.12024
35. Kumwenda MJ, Mitra S, Khawaja A, Inston, N, Nightingale P. Prospective audit to study urokinase use to restore patency in occluded central venous catheters (PASSPORT 1). *J Vasc Access*. 2019;20(6) 752-759. doi:10.1177/1129729819869095
36. Ragsdale CE, Oliver MR, Thompson AJ, Evans MC. Alteplase infusion versus dwell for clearance of partially occluded central venous catheters in critically ill pediatric patients. *Pediatr Crit Care Med*. 2014;15(6):e253-e260. doi:10.1097/PCC.0000000000000125
37. Tsuboi Y, Yamagami T, Tsuboi N. A dual-needle pumping techniaue for unblocking an obstructed central venous access port. *Interv Radiol.* 2017;2(3):59-63. https://doi.org/10.22575/interventionalradiology.2016-0017
38. Pai VB, Plogsted S. Efficacy and safety of using L-cysteine as a catheter-clearing agent for nonthrombotic occlusions of central venous catheters in children. *Nutr Clin Pract*. 2014;29(5):636-636. doi:10.1177/0884533614539177
39. Niyyar VD, Chan MR. Interventional nephrology: catheter dysfunction—prevention and troubleshooting. *Clin J Am Soc Nepthrol*. 2013;8(11):1234-1243. doi:10.2215/CJN.00960113
40. Rowan CM, Miller KE, Beardsley AL, et al. Alteplase use for malfunctioning central venous catheters correlates with catheter-associated bloodstream infections. *Pediatr Crit Care Med*. 2013;14(3):306-309. doi:10.1097/PCC.0b013e318271f48a
41. Thakarar K, Collins M, Kwong L, Sulis C, Korn C, Bhadelia N. The role of tissue plasminogen activator use and systemic hypercoagulability in central line-associated blood stream infections. *Am J Infect Control*. 2014;42(4):417-420. doi:10.1016/j.ajic.2013.11.016

50. INFECTION

KEY DEFINITIONS

Catheter-Associated Bloodstream Infection (CABSI): Given variability in international definitions, outcome reporting, and application of the terms catheter-related bloodstream infection (CR-BSI) and central line-associated bloodstream infection (CLABSI), the INS Standards of Practice Committee is using the terminology *Catheter-Associated Bloodstream Infection* (CABSI) to refer to bloodstream infections (BSIs) originating from either peripheral intravenous catheters (PIVCs) and/or central vascular access devices (CVADs). Both are equally injurious and can occur from 4 possible sources:

1. During catheter insertion/during catheter dwell time through migration of microbes down the catheter tract.
2. Via the catheter hub/lumen during routine administration and manipulation at the hub/lumen.
3. Due to endogenous microorganisms within the bloodstream.
4. From contaminated infusates.

When CABSI is used within a standard, refer to the respective references in that standard to understand the terminology and definitions used in the cited studies.

Catheter-Related Bloodstream Infection (CR-BSI): The recognized diagnostic criterion that more accurately confirms the catheter as the source of the infection. It is diagnosed if the same organism is isolated from a blood culture and the tip culture, and the quantity of organisms isolated from the tip is greater than 15 colony forming units (CFUs). Alternatively, differential time to positivity (DTP) requires the same organism to be isolated from a peripheral vein and a catheter lumen blood culture, with growth detected 2 hours sooner (ie, 2 hours less incubation) in the sample drawn from the catheter.

Central Line-Associated Bloodstream Infection (CLABSI): This is most commonly reported as a surveillance term; however, it is not an established diagnostic criterion. CLABSI is a primary BSI in a patient who had a central line within the 48-hour period before the development of the BSI and is not related to an infection at another site. However, since some BSIs are secondary to sources other than the central line (eg, pancreatitis, mucositis) and may not be easily recognized, the CLABSI surveillance definition may overestimate the true incidence of CR-BSI.

Standard

50.1 Infection prevention measures are implemented with the goal of preventing infusion- and VAD-related infections.
50.2 The patient with a VAD is assessed for signs and/or symptoms of infection and is educated about infection, risks, interventions, and any required follow-up.

Practice Recommendations

A. Implement a care bundle in conjunction with a culture of safety and quality to reduce the risk of infection associated with VADs during insertion and during daily care and management.[1-9] (IV)
B. Assess the VAD insertion and/or exit site for signs and symptoms of a VAD-related infection. This includes, but is not limited to, erythema, edema, pain, tenderness or drainage, fluid in the subcutaneous pocket and/or tunnel of a totally implanted intravascular device or tunneled catheter, induration at the exit site or over the pocket, drainage or skin breakdown at the VAD insertion site, and/or body temperature elevation. When signs and symptoms of a VAD-related infection are present, immediately notify the provider and implement appropriate interventions.[1,10-12] (IV)
C. Evaluate site selection for VAD placement as a strategy to prevent infection.[13] (IV)
    1. A low lateral approach to the neck vessels is recommended in adult patients, rather than a medial, high-neck, or femoral approach, to minimize the risk of catheter-related infection with a nontunneled CVAD (refer to Standard 27, *Site Selection*).
D. Perform skin antisepsis at the VAD site prior to placement and as part of routine site care (refer to Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*; Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes*).
E. Use an antimicrobial catheter to reduce the risk of CABSI in at-risk patients such as those in intensive care units (ICUs).[14-16] (I)
F. Use chlorhexidine-impregnated dressings for all patients 18 years and older with short-term, nontunneled CVADs. Use for arterial catheters and other CVADs when all other CABSI prevention strategies have proven ineffective. Use with caution among patients with fragile skin and/or complicated skin pathologies; monitor for erythema and dermatitis at the dressing site.[17-27] (I)
    1. For premature neonates, chlorhexidine-impregnated dressings are not recommended to protect the site of short-term, nontunneled CVADs due to the risk of serious adverse skin reactions.
    2. For pediatric patients less than 18 years of age and nonpremature neonates, no recommendation can be made about the use of chlorhexidine-impregnated dressings to protect the site of short-term, nontunneled CVADs due to the lack of enough evidence. More large clinical trials are needed to confirm the clinical efficacy and safety in this patient population.[20,28,29] (III)
G. Consider the use of daily chlorhexidine bathing in patients in the ICU with a CVAD in situ, including infants more than 2 months of age, as a strategy to reduce CABSI if other CABSI prevention strategies have not been effective.[22,27,30-37] (I)
H. Remove a PIVC if the patient develops symptoms of complication and failure such as infection (eg, erythema extending at least 1 cm from the insertion site, induration, exudate, fever with no other obvious source of infection) or the patient reports any pain or tenderness associated with the catheter.[1,10,11,38-42] (II)
I. Do not remove a functioning CVAD solely on suspicion of infection, when there is no other confirmatory evidence of catheter-related infection other than an elevation in core body temperature.[1,10,11,38,39,43] (II)
J. Assess the risk and benefit of CVAD removal or catheter salvage based on the type of CVAD (long-term vs short-term), infecting organism, and ability to insert replacement CVAD if necessary.[44-48] (II)
    1. Attempt catheter salvage, in collaboration with the provider, in hemodynamically stable patients when a CABSI is confirmed.
    2. Attempt catheter salvage of a short-term CVAD (in situ ≤14 days) in patients with an uncomplicated CABSI and treat with systemic antibiotics for at least 7 to 14 days based on the pathogen.
    3. Attempt catheter salvage in patients with an uncomplicated CABSI in a long-term CVAD that is colonized with coagulase-negative *Staphylococcus* or *Enterococcus.* Treat the patient with a course of systemic antibiotics and antibiotic lock therapy.
    4. Closely monitor and evaluate the clinical status of pediatric patients where catheter salvage is attempted. This might include additional blood cultures and the use of systemic antibiotics and antibiotic lock therapy.[48,49] (V)
K. Remove the CVAD if there is clinical deterioration or persisting or relapsing bacteremia. The timing of insertion of a new CVAD at a new site should be a collaborative decision based on the specific risks, benefits, and need for central vascular access for each patient.[1,10,40,48,49] (II)
    1. Immediately remove short-term CVADs colonized with *Staphylococcus aureus*, gram-negative bacilli, or *Candida* and treat with a defined course of systemic antibiotic therapy, except in rare circumstances when no alternative vascular access is possible.
    2. Remove a CVAD from a patient with CABSI associated with any of the following conditions: severe sepsis; suppurative thrombophlebitis; endocarditis; BSI that continues despite more than 72 hours of antimicrobial therapy to which the infecting microbes are susceptible; or infections due to *S aureus, Pseudomonas aeruginosa*, fungi, or mycobacteria following collaboration with the provider.[1,10,43,44] (IV)
L. Evaluate the use of a prophylactic antimicrobial, catheter lock solution in a patient with a long-term CVAD who has a history of multiple CABSIs despite optimal maximal adherence to Aseptic Non Touch Technique (ANTT).[48,50-53] (III)

M. Do not use a guidewire exchange to replace a nontunneled catheter suspected of infection.[38] (V)
N. Assess risk benefit of a catheter exchange procedure when other vascular access sites are limited and/or bleeding disorders are present. Consider using an antimicrobial-impregnated catheter for catheter exchange.[1,10,11] (IV)
O. Collect and culture a specimen of purulent exudate from a peripheral or CVAD exit site to determine the presence of fungi or gram-negative or gram-positive bacteria and initiate empirical antibiotic therapy as ordered by the provider.[1,10,11] (IV)
P. Do not routinely culture the VAD tip upon removal unless the patient has a suspected CABSI. False-positive catheter colonization may be detected, resulting in inappropriate use of anti-infective medications and increasing the risk of emergence of antimicrobial resistance. Recognize that the catheter tip culture will identify microorganisms on the extraluminal surface and not microorganisms located on the intraluminal surface.[1,10,11,54] (IV)
Q. Culture the tip of short-term CVADs, PIVCs, and arterial catheters suspected of being the source of a CABSI using a semiquantitative (roll-plate) method or quantitative (sonication) method upon removal. Culture the introducer/sheath tip from a pulmonary artery catheter when a CABSI is suspected.[1,10,11,55,56] (IV)
R. Culture the reservoir contents of a port body of an implanted vascular access port and the catheter tip when it is removed for suspected CABSI.[1,10,11] (IV)
S. Consider contamination of the infusate (eg, parenteral solution, IV medications, or blood products) as a source of infection. This is a rare event, but an infusate can become contaminated during the manufacturing process (intrinsic contamination) or during its preparation or administration (eg, antibiotics) in the patient care setting (extrinsic contamination).[38] (IV)
T. When CABSI is suspected, in order to definitively diagnose CR-BSI, obtain paired blood samples for culture, drawn from the catheter and a peripheral vein, before initiating antimicrobial therapy; CR-BSI is the likely diagnosis when clinical signs of sepsis are present in the absence of another obvious source with 1 of the following:
    1. Positive semiquantitative (>15 colony forming units [CFUs]) or quantitative ($\geq 10^3$ CFUs) culture from a catheter segment with the same organisms isolated peripherally.
    2. Simultaneous quantitative blood cultures with a ratio of ≥3:1 (CVAD vs peripheral).
    3. Time to culture positivity difference no more than 2 hours between CVAD cultures and peripheral cultures (see Standard 44, *Blood Sampling*).[1,10,12,57-59] (IV)
        a. Early PICC insertion in *S aureus* BSI appears safe in 1 retrospective audit. Further prospective studies are needed to validate these findings; however, early establishment of safe, reliable vascular access in patients with *S aureus* bacteremia should be considered.[60] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 17, 2020, and August 30, 2020.

1. Marschall J, Mermel LA, Fakih M, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol.* 2014;35(7):753-771. doi:10.1086/676533
2. O'Neil C, Ball K, Wood H, et al. A central line care maintenance bundle for the prevention of central line-associated bloodstream infection in non-intensive care unit settings. *Infect Control Hosp Epidemiol.* 2016;37(6):692-698. doi:10.1017/ice.2016.32
3. Ray-Barruel G, Xu H, Marsh N, Cooke M, Rickard CM. Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: a systematic review. *Infect Dis Health.* 2019;24(3):152-168. doi:10.1016/j.idh.2019.03.001
4. Rhodes D, Cheng AC, McLellan S, et al. Reducing *Staphylococcus aureus* bloodstream infections associated with peripheral intravenous cannulae: successful implementation of a care bundle at a large Australian health service. *J Hosp Infect.* 2016;94(1):86-91. doi:10.1016/j.jhin.2016.05.020
5. Borg MA, Hulscher M, Scicluna EA, et al. Prevention of meticillin-resistant *Staphylococcus aureus* bloodstream infections in European hospitals: moving beyond policies. *J Hosp Infect.* 2014;87(4):203-211. doi:10.1016/j.jhin.2014.05.003
6. Aminzadeh Z, Simpson P, Athan E. Central venous catheter associated blood stream infections (CVC-BSIs) in the non-intensive care settings: epidemiology, microbiology and outcomes. *Infect Dis Health.* 2019;24(4):222-228. doi:10.1016/j.idh.2019.07.003
7. Garcia-Gasalla M, Arrizabalaga-Asenjo M, Collado-Giner C, et al. Results of a multi-faceted educational intervention to prevent peripheral venous catheter-associated bloodstream infections. *J Hosp Infect.* 2019;102(4):449-453. doi:10.1016/j.jhin.2019.02.004
8. Kleidon T, Illing A, Fogarty G, Edwards R, Tomlinson J, Ullman AJ. Improving the central venous access devices maintenance process to reduce associated infections in paediatrics: evaluation of a practical, multi-faceted quality-improvement initiative. *Healthcare Infection.* 2015;20(2):46-53. https://doi.org/10.1071/HI14038
9. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: a quality improvement initiative. *J Paediatr Child Health.* 2019;55(10):1214-1223. doi:10.1111/jpc.14384
10. Mermel LA, Allon M, Bouza E, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update by the Infectious Diseases Society of America. *Clin Infect Dis.* 2009;49:1-45. doi:10.1086/599376
11. Timsit JF, Rupp M, Bouza E, et al. A state of the art review on optimal practices to prevent, recognize, and manage complications associated with intravascular devices in the critically ill. *Intensive Care Med.* 2018;44(6):742-759. doi:10.1007/s00134-018-5212
12. Nickel B. Hiding in plain sight: the burden of peripheral intravenous catheter infections. *Crit Care Nurse.* 2020;40(5):57-66. doi:10.4037/ccn2020439
13. Choudhury MA, Sidjabat HE, Zowawi HM, et al. Skin colonization at peripheral intravenous catheter insertion sites increases the risk of catheter colonization and infection. *Am J Infect Control.* 2019;47(12):1484-1488. doi:10.1016/j.ajic.2019.06.002
14. Kramer RD, Rogers MA, Conte M, Mann J, Saint S, Chopra V. Are antimicrobial peripherally inserted central catheters associated with reduction in central line-associated bloodstream infection? a systematic review and meta-analysis. *Am J Infect Control.* 2017;45(2):108-114. doi:10.1016/j.ajic.2016.07.021
15. Storey S, Brown J, Foley A, et al. A comparative evaluation of antimicrobial coated versus nonantimicrobial coated peripherally inserted central catheters on associated outcomes: a randomized controlled trial. *Am J Infect Control.* 2016;44(6):636-641. doi:10.1016/j.ajic.2015.11.017

16. DeVries M, Lee J, Hoffman L. Infection free midline catheter implementation at a community hospital (2 years). *Am J Infect Control.* 2019;47(9):1118-1121. doi:10.1016/j.ajic.2019.03.001
17. Safdar N, O'Horo JC, Ghufran A, et al. Chlorhexidine-impregnated dressing for prevention of catheter-related bloodstream infection: a meta-analysis. *Crit Care Med.* 2014;42(7):1703-1713. doi:10.1097/CCM.0000000000000319
18. Ullman AJ, Cooke ML, Mitchell M, et al. Dressings and securement devices for central venous catheters (CVC). *Cochrane Database Syst Rev.* 2015;2015(9):CD010367. doi:10.1002/14651858.CD010367.pub2
19. Apata IW, Hanfelt J, Bailey JL, Niyyar VD. Chlorhexidine-impregnated transparent dressings decrease catheter-related infections in hemodialysis patients: a quality improvement project. *J Vasc Access*. 2017;18(2):103-108. doi:10.5301/jva.5000658
20. Talbot TR 3rd, Stone EC, Irwin K, et al. *2017 Recommendations on Use of Chlorhexidine-Impregnated Dressings for Prevention of Intravascular Catheter-Related Infections*. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of Healthcare Quality and Promotion; 2017. https://www.cdc.gov/infectioncontrol/pdf/guidelines/c-i-dressings-H.pdf
21. Chan RJ, Northfield S, Larsen E, et al. Central venous access device securement and dressing effectiveness for peripherally inserted central catheters in adult acute hospital patients (CASCADE): a pilot randomised controlled trial. *Trials.* 2017;18(1):458. doi:10.1186/s13063-017-2207-x
22. Huang HP, Chen B, Wang HY, He M. The efficacy of daily chlorhexidine bathing for preventing healthcare-associated infections in adult intensive care units. *Korean J Intern Med.* 2016;31(6):1159-1170. doi:10.3904/kjim.2015.240
23. Jenks M, Craig J, Green W, Hewitt N, Arber M, Sims A. Tegaderm CHG IV securement dressing for central venous and arterial catheter insertion sites: a NICE medical technology guidance. *Appl Health Econ Health Policy.* 2016;14(2):135-149. doi:10.1007/s40258-015-0202-5
24. Wang HX, Xie SY, Wang H, Chu HK. The effects of chlorhexidine dressing on health care-associated infection in hospitalized patients: a meta-analysis. *Iran J Public Health.* 2019;48(5):796-807.
25. Ullman AJ, Cooke ML, Mitchell M, et al. Dressings and securement devices for central venous catheters (CVC). *Cochrane Database Syst Rev*. 2015;2015(9):CD010367. doi:10.1002/14651858.CD010367.pub2
26. Ullman AJ, Long D, Williams T, et al. Innovation in central venous access device security: a pilot randomized controlled trial in pediatric critical care. *Pediatr Crit Care Med.* 2019;20(10):e480-e488. doi:10.1097/PCC.0000000000002059
27. Loveday HP, Wilson JA, Prieto J, Wilcox MH. epic3: revised recommendation for intravenous catheter and catheter site care. *J Hosp Infect.* 2016;92(4):346-348. doi:10.1016/j.jhin.2015.11.011
28. Düzkaya DS, Sahiner NC, Uysal G, Yakut T, Çitak A. Chlorhexidine-impregnated dressings and prevention of catheter-associated bloodstream infections in a pediatric intensive care unit. *Crit Care Nurse.* 2016;36(6):e1-e7. doi:10.4037/ccn2016561
29. Levy I, Katz J, Solter E, et al. Chlorhexidine-impregnated dressing for prevention of colonization of central venous catheters in infants and children: a randomized controlled study. *Pediatr Infect Dis J*. 2005;24(8):676-679. doi:10.1097/01.inf.0000172934.98865.14
30. Quach C, Milstone AM, Perpête C, Bonenfant M, Moore DL, Perreault T. Chlorhexidine bathing in a tertiary care neonatal intensive care unit: Impact on central line-associated bloodstream infections. *Infect Control Hosp Epidemiol.* 2014;35(2):158-163. doi:10.1086/674862.
31. Frost SA, Hou YC, Lombardo L, et al. Evidence for the effectiveness of chlorhexidine bathing and health care-associated infections among adult intensive care patients: a trial sequential meta-analysis. *BMC Infect Dis.* 2018;18(1):679. doi:10.1186/s12879-018-3521-y
32. Pallotto C, Fiorio M, De Angelis V, et al. Daily bathing with 4% chlorhexidine gluconate in intensive care settings: a randomized controlled trial. *Clin Microbiol Infect*. 2019;25(6):705-710. doi:10.1016/j.cmi.2018.09.012
33. Cleves D, Pino J, Patiño JA, Rosso F, Vélez JD, Pérez P. Effect of chlorhexidine baths on central-line-associated bloodstream infections in a neonatal intensive care unit in a developing country. *J Hosp Infect.* 2018;100(3):e196-e199. doi:10.1016/j.jhin.2018.03.022
34. Choi EY, Park DA, Kim HJ, Park J. Efficacy of chlorhexidine bathing for reducing healthcare associated bloodstream infections: a meta-analysis. *Ann Intensive Care*. 2015;5(1):31. doi:10.1186/s13613-015-0073-9
35. Fan CY, Lee WT, Hsu TC, et al. Effect of chlorhexidine bathing on colonization or infection with Acinetobacter baumannii: a systematic review and meta-analysis. *J Hosp Infect.* 2019;103(3):284-292. doi:10.1016/j.jhin.2019.08.004
36. Lewis SR, Schofield-Robinson OJ, Rhodes S, Smith AF. Chlorhexidine bathing of the critically ill for the prevention of hospital-acquired infection. *Cochrane Database Syst Rev.* 2019;8(8):CD012248. doi:10.1002/14651858.CD012248.pub2
37. Musuuza JS, Guru PK, O'Horo JC, et al. The impact of chlorhexidine bathing on hospital-acquired bloodstream infections: a systematic review and meta-analysis. *BMC Infect Dis.* 2019;19(1):416. doi:10.1186/s12879-019-4002-7
38. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis.* 2011;52(9):e162-e193. doi:10.1093/cid/cir257
39. Rickard CM, Webster J, Wallis MC, et al. Routine versus clinically indicated replacement of peripheral intravenous catheters: a randomised controlled equivalence trial. *Lancet.* 2012;380(9847):1066-1074. doi:10.1016/S0140-6736(12)61082-4
40. Chopra V, Flanders SA, Saint S, et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Ann Intern Med.* 2015;163(6 Suppl):S1-S40. doi:10.7326/M15-0744
41. Blanco-Mavillard I, Rodriguez-Calero MA, de Pedro-Gomez J, Parra-Garcia G, Fernandez-Fernandez I, Castro-Sanchez E. Incidence of peripheral intravenous catheter failure among inpatients: variability between microbiological data and clinical signs and symptoms. *Antimicrob Resist Infect Control.* 2019;8(1):124. doi:10.1186/s13756-019-0581-8
42. Webster J, Osborne S, Rickard CM, Marsh N. Clinically-indicated replacement versus routine replacement of peripheral venous catheters. *Cochrane Database Syst Rev*. 2019;1(1):CD007798. doi:10.1002/14651858.CD007798.pub5
43. Takashima M, Schults J, Mihala G, Corley A, Ullman A. Complication and failures of central vascular access device in adult critical care settings. *Crit Care Med*. 2018;46(12):1998-2009. doi:10.1097/CCM.0000000000003370
44. Corkum KS, Jones RE, Reuter CH, Kociolek LK, Morgan E, Lautz TB. Central venous catheter salvage in children with *Staphylococcus aureus* central line-associated bloodstream infection. *Pediatr Surg Int.* 2017;33(11):1201-1207. doi:10.1007/s00383-017-4165-5
45. Kleidon TM, Rickard CM, Schults JA, et al. Development of a paediatric central venous access device database: a retrospective cohort study of practice evolution and risk factors for device failure. *J Paediatr Child Health.* 2020;56(2):289-297. doi:10.1111/jpc.14600
46. Mermel, Allon M, Bouza E, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update by the Infectious Diseases Society of America. *Clin Infect Dis.* 2009;49(1):1-45. doi:10.1086/599376
47. Raad I, Chaftari AM, Zakhour R, et al. Successful salvage of central venous catheters in patients with catheter-related or central line-associated bloodstream infections by using a catheter lock solution consisting of Minocycline, EDTA, and 25% ethanol. *Antimicrob Agents Chemother.* 2016;60(6):3426-3432. doi:10.1128/AAC.02565-15
48. Vassallo M, Dunais B, Roger PM. Antimicrobial lock therapy in central-line associated bloodstream infections: a systematic review. *Infection.* 2015;43(4):389-398. doi:10.1007/s15010-015-0738-1
49. Huang EY, Chen C, Abdullah F, et al. Strategies for the prevention of central venous catheter infections: an American Pediatric Surgical Association

Outcomes and Clinical Trials Committee systematic review. *J Pediatr Surg.* 2011;46(10):2000-2011. doi:10.1016/j.jpedsurg.2011.06.017

50. Clark JE, Graham N, Kleidon T, Ullman A. Taurolidine-citrate line locks prevent recurrent central line-associated bloodstream infection in pediatric patients. *Pediatr Infect Dis J.* 2019;38(1):e16-e18. doi:10.1097/INF.0000000000002191
51. Chaftari AM, Viola GM, Rosenblatt J, Hachem R, Raad I. Advances in the prevention and management of central-line-associated bloodstream infections: the role of chelator-based catheter locks. *Infect Control Hosp Epidemiol*. 2019;40(9):1036-1045. doi:10.1017/ice.2019.162
52. Chong CY, Ong RY, Seah VX, et al. Taurolidine-citrate lock solution for the prevention of central line-associated bloodstream infection in paediatric haematology-oncology and gastrointestinal failure patients with high baseline central-line associated bloodstream infection rates. *J Paediatr Child Health.* 2020;56(1):123-129. doi:10.1111/jpc.14506
53. Zanwar S, Jain P, Gokarn A, Devadas SK. Antibiotic lock therapy for salvage of tunneled central venous catheters with catheter colonization and catheter-related bloodstream infection. *Transpl Infect Dis.* 2019;21(1):e13017. doi:10.1111/tid.13017
54. Lai YL, Adjemian J, Ricotta EE, Mathew L, O'Grady NP, Kadri SS. Dwindling utilization of central venous catheter tip cultures: an analysis of sampling trends and clinical utility at 128 US hospitals, 2009-2014. *Clin Infect Dis.* 2019;69(10):1797-1800. doi:10.1093/cid/ciz218
55. Capdevila JA, Guembe M, Barberán J, et al. 2016 Expert consensus document on prevention, diagnosis and treatment of short-term peripheral venous catheter-related infections in adult. *Rev Esp Quimioter*. 2016;29(4):230-238.
56. Sato A, Nakamura I, Fujita H, et al. Peripheral venous catheter-related bloodstream infection is associated with severe complications and potential death: a retrospective observational study. *BMC Infect Dis.* 2017;17(1):434. doi:10.1186/s12879-017-2536-0
57. Garcia RA, Spitzer ED, Beaudry J, et al. Multidisciplinary team review of best practices for collection and handling of blood cultures to determine effective interventions for increasing the yield of true-positive bacteremias, reducing contamination, and eliminating false-positive central line-associated bloodstream infections. *Am J Infect Control.* 2015;43(11):1222-1237. doi:10.1016/j.ajic.2015.06.030
58. Septimus E. Collecting cultures: a clinican guide. CDC.gov. Updated August 1, 2019. https://www.cdc.gov/antibiotic-use/core-elements/collecting-cultures.html#p1
59. Bell T, O'Grady NP. Prevention of central line-associated bloodstream infections. *Infect Dis Clin North Am.* 2017;31(3):551-559. doi:10.1016/j.idc.2017.05.007
60. Stewart JD, Runnegar N. Early use of peripherally inserted central catheters is safe in Staphylococcus aureus bacteraemia. *Intern Med J.* 2018;48(1):44-49. doi:10.1111/imj.13616.

51. CATHETER DAMAGE (EMBOLISM, REPAIR, EXCHANGE)

Standard

51.1 Preventative strategies are implemented to maintain catheter integrity and reduce the risk for catheter damage.
51.2 Assessment of the individual patient's risk-to-benefit ratio is performed prior to undertaking catheter repair or exchange.

Practice Recommendations

I. General

A. Prevent catheter damage.
   1. Use a 10-mL barrel syringe to assess VAD function; do not forcibly push against resistance.
   2. Limit contrast power injections to VAD and add-on devices with labeled indication for power injection.
   3. Do not withdraw the catheter or guidewire from the needle during insertion and maintain control of guidewire at all times.
   4. Avoid frequent bending or friction against the catheter (eg, rotate location of integrated clamp(s) on CVADs, if required).
   5. Consider ultrasound-guided internal jugular approach or, if necessary, a lateral subclavian approach for implanted vascular access port placement, to reduce risk of pinch-off syndrome and avoid acute angle of catheters inserted into the internal jugular vein (see Standard 34, *Vascular Access Device Placement*).
      a. Consider an annual chest radiograph assessment of implanted vascular access port position and integrity.
   6. Avoid inadvertent catheter damage during insertion/removal, such as accidental puncture with needle/scalpel, overly tight sutures, placement of CVAD in the subclavian vein in position prone to pinch-off syndrome, incorrect attachment of catheter to a port body, and pulling against resistance when removing CVAD.
   7. Protect and secure catheter.
      a. Educate the patient/caregiver in how to prevent catheter damage/embolism (eg, avoid flushing against resistance, use of sharp objects).
      b. Cover catheter with clothing and avoid friction of heavy items (eg, backpacks, straps, stiff collars, and jewelry) over external CVADs.
      c. Use clamps only at clamping sleeve, if present.
      d. Attach luer-lock connectors carefully to the catheter hub.[1-11] (IV)

B. Suspect catheter damage/embolism if assessment reveals signs and symptoms such as: visible catheter or fractured hub, leaking at the site, catheter dysfunction (eg, inability to aspirate blood, frequent infusion pump alarms), localized pain and/or swelling along CVAD pathway during infusion, parasthesia in the arm, radiographic findings, respiratory distress, or arrhythmias (although patient may be asymptomatic).[2,4-6,11] (V)
   1. Before using the VAD for infusions or blood sampling, evaluate catheter integrity for the presence of signs and symptoms of catheter damage. Catheter separation may occur at the lumen–hub junction or other external connections, with resultant bleeding. Verify all connections are secure and ensure all connections are visible during hemodialysis to enable assessment of connections.[4,6] (V)
   2. Assess the patient for signs or symptoms of catheter damage and embolism when VAD removal is difficult (refer to Standard 45, *Vascular Access Device Removal*).
   3. Recognize early signs and symptoms of pinch-off syndrome in patients with catheters in the subclavian vein, such as resistance with flushing, infusion or blood return that may be relieved by specific postural change (eg, rolling shoulder, raising arm, neck movement),

frequent occlusion alarms, infraclavicular pain, pain during flushing or infusion, possible swelling at the insertion site, and a change in the clinical picture with arm or shoulder movement.[4,5,11] (V)

4. Investigate signs of internal damage to the catheter through radiographic or fluoroscopic examination. Consider regular chest radiograph assessments and upon signs and symptoms of catheter damage or pinch-off syndrome for implanted CVADs inserted via the subclavian vein (indicating on radiology requisition "to rule out pinch-off syndrome" to ensure proper arm positioning).[4,5,9,12] (V)

C. Manage catheter damage (eg, ballooning, fracturing, rupturing, and cracking of the hub) in a timely manner to reduce the risk of catheter fracture and embolization, air emboli, bleeding, catheter-lumen occlusion, BSIs, and treatment interruption or failure, as well as to prolong catheter longevity.[3,7,13,14] (IV)

1. Stop any infusions. Clamp or seal a damaged catheter (eg, close an existing clamp, add a clamp, cover the damaged area with adhesive dressing material, or fold the external segment and secure) between the catheter exit site and the damaged area to prevent air embolism or bleeding from the device immediately upon discovery of catheter damage. Label the damaged catheter "Do Not Use" while waiting for the repair procedure to be performed.[6,15,16] (V)
2. Determine appropriate intervention, considering patient and health care team preference for these options:
   a. Catheter repair that may promote catheter longevity and limit loss of vascular access sites; appears to be associated with lower infection risk than catheter exchanges.
   b. Catheter exchange:
      i. Associated with reduced risk for technical complications of new catheter insertion (eg, pneumothorax, hemothorax, arterial puncture)
      ii. May also be indicated for the need for a different type of CVAD due to catheter complications such as malfunction, displacement or infection, unsuccessful catheter repair, or lack of available venous sites
      iii. PICC exchanges have been associated with a 2-fold increased risk of thromboses compared to those without exchanges.
   c. Catheter removal and replacement.[1,7-9,11,14,15,17-26] (I)
3. Assess risks vs benefits of the procedure.
   a. Consider factors such as the patient's age, venous integrity, and condition (eg, compromised immune systems, burns, transplants, confirmed or suspected infection); length of time remaining and characteristics (eg, osmolarity) of infusion therapy; availability of alternative vascular access options; and catheter status and history (eg, femoral catheterization, patency, external length, material [eg, silicone, polyurethane], possible exposure of catheter to microorganisms due to the catheter damage, resulting changes in proper tip location with repair, damage located near exit site [eg, within 3.0 cm of exit site or <2.5 to 5.0 cm of undamaged length proximal to bifurcation of catheter], persistent leakage postrepair attempts, and previous catheter repairs or exchanges).[3,6,7,13-15,22,24-26] (III)
   b. Consider exceptions to catheter repair/exchange, such as sepsis, endocarditis, and suppurative thrombophlebitis.[17,26] (IV)
4. Confirm tip location radiographically or by other imaging technology prior to initiating or resuming prescribed therapies after catheter repair (if CVAD was withdrawn as a result of damage or repair) and after catheter exchange (see Standard 23, *Central Vascular Access Device Tip Location*).[5,21] (IV)
5. If unable to repair/exchange catheter, collaborate with health care team for replacement or removal, as required.[5] (V)
6. Monitor for signs of postprocedural complications (eg, catheter-related infection, leakage, migration of metallic stent, occlusion, or thrombosis).[3,7,13,15,22,26] (IV)

II. Catheter and Guidewire Embolism

A. Suspect catheter/guidewire embolism when patient exhibits symptoms such as palpitations, arrhythmias, dyspnea, cough, or thoracic pain that are not associated with the patient's primary disease or comorbidities. In some cases, there are no signs or symptoms, but damage often occurs after lengthy usage.[6] (V)

B. Examine guidewire and catheter tip and length after removal, comparing the removed length to the inserted length for damage and possible fragmentation. If damage is seen or suspected, a chest radiograph or further evaluation may be warranted.[5] (V)

C. Promptly manage catheter or guidewire embolism.

1. Place patient on left side in Trendelenburg position unless contraindicated (eg, increased intracranial pressure, eye surgery, or severe cardiac or respiratory disease); minimize movement of patient and involved limb; reassure patient; call immediately for emergency medical assistance.[1,5] (V)
2. Pressing the limb over the target vein may decrease the chance of migration of the fracture; consider immediate application of a tourniquet above site when catheter or guidewire embolization is observed.[5] (V)
3. Notify health care team; percutaneous interventional/surgical procedures are likely required for fragment/catheter removal to prevent further complications.[1,4,6,27] (IV)

III. Catheter Repair

A. Repair catheter with catheter-specific repair kit, according to the manufacturers' directions for use. If no device-specific repair kit is available, consider alternative

strategies, such as catheter exchange or removal and replacement.[3,13-15,22] (IV)

B. Maintain Surgical-ANTT for catheter repair procedures (refer to Standard 18, *Aseptic Non Touch Technique*).
C. Do not use the catheter for the time indicated on the repair instructions to allow adhesive to bond catheter segments; inspect the catheter for patency and leakage before catheter use.[3,13,15] (IV)
D. Assess the catheter regularly after repair to confirm the integrity of the repair and identify potential problems. The repaired catheter may not have the same strength as the original catheter.[13,22] (IV)
E. Consider a catheter exchange or replacement after performing a risk–benefit analysis if the catheter repair fails.[7] (IV)

IV. Catheter Exchange

A. Avoid routine exchanges for CVADs that are functioning and without evidence of local or systemic complications.[26,28] (IV)
B. Consider CVAD exchange including tunneled, cuffed catheters and implanted vascular access ports if there is no evidence of infection.
    1. Consider CVAD exchange in the setting of an actual or suspected infection (excluding septic shock or metastatic infection) when there is limited vascular access. Consider use of an antimicrobial impregnated, coated, or bonded catheter and prophylactic antimicrobials. Limited evidence suggests hemodialysis catheter revision with a new tunnel, new exit site, and the same venotomy site may result in a lower infection rate compared to catheter exchanges (see Standard 50, *Infection*).[17,21,25,27,29-32] (III)
C. Maintain Surgical-ANTT and use techniques to reduce the risk of air embolism during the catheter exchange (see Standard 18, *Aseptic Non Touch Technique*; Standard 52, *Air Embolism*).[28,33] (V)
D. Monitor postprocedure for complications such as bleeding or hematoma, infection, or recurrence of malfunction due to intact fibrin sheath.[18] (I)

REFERENCES

1. Wang Q, Xiong B, Zheng CS, Feng GS, Liang M, Liang HM. Percutaneous retrieval of PICC fractures via the femoral vein in six cancer patients. *J Vasc Access*. 2015;16(1):47-51. doi:10.5301/jva.5000308
2. Nagasawa Y, Shimizu T, Sonoda H, Chou H, Mekata E, Tani T. Is catheter rupture rare after totally implantable access port implantation via the right internal jugular vein? Report of a case. *Surg Today*. 2014;44(7):1346-1349. doi:10.1007/s00595-013-0631-4
3. Wouters Y, Vissers RK, Groenewoud H, Kievit W, Wanten GJA. Repair of damaged central venous catheters is safe and doubles catheter survival: a home parenteral nutrition patient cohort study. *Clin Nutr*. 2019;38(4):1692-1699. doi:10.1016/j.clnu.2018.08.005
4. Xiao SP, Xiong B, Chu J, Li XF, Yao Q, Zheng CS. Fracture and migration of implantable venous access port catheters: cause analysis and management of 4 cases. *J Huazhong Univ Sci Technol Med Sci*. 2015;35(5):763-765. doi:10.1007/s11596-015-1504-4
5. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines*. Pappin Communications; 2019.
6. Doellman D, Buckner J, Garrett JH Jr. *Best Practice Guidelines in the Care and Maintenance of Pediatric Central Venous Catheters*. 2nd ed. Association for Vascular Access; 2015.
7. Gnannt R, Patel P, Temple M, et al. Peripherally inserted central catheters in pediatric patients: to repair or not repair. *Cardiovasc Intervent Radiol*. 2017;40(6):845-851. doi:10.1007/s00270-017-1580-x
8. Tamura A, Sone M, Ehara S, et al. Is ultrasound-guided central venous port placement effective to avoid pinch-off syndrome? *J Vasc Access*. 2014;15(4):311-316. doi:10.5301/jva.5000201
9. Li H, Jen, S, Keshavamurthy JH, Bowers GH, Vo HA, Rotem E. Imaging evaluation of catheter integrity prevent potentially fatal complication of pinch-off syndrome: illustration of two cases. *Quant Imaging Med Surg*. 2017;7(3):369-372. doi:10.21037/qims.2017.05.01
10. Guan S, Zhang K, Liang, X, Wang Y. Prevention of pinch-off syndrome in postoperative complications of totally implantable central venous access ports. *Int J Surg*. 2017;44(3):182-184.
11. Ben Kridis W, Toumi N, Khanfir A. Causes of fracture of catheter of totally implantable venous access port: a systematic review. *Acta Med Iran*. 2020;57(12):686-689. https://doi.org/10.18502/acta.v57i12.3463
12. Ko SY, Park SC, Hwang JK, Kim SD. Spontaneous fracture and migration of a totally implantable venous access port via internal jugular vein- a case report. *J Cardiothorac Surg*. 2016;11:50. doi:10.1186/s13019-016-0450-y
13. Salonen BR, Bonnes SL, Mundi MS, Lal S. Repair of central venous catheters in home parenteral nutrition patients. *Nutr Clin Pract*. 2019;34(2):210-215. doi:10.1002/ncp.10262
14. Zens T, Nichol P, Leys C, Haines K, Brinkman A. Fractured pediatric central venous catheters — repair or replace? *J Pediatr Surg*. 2019;54(1):165-169. doi:10.1016/j.jpedsurg.2018.10.023
15. Chan AP, Baldivia PS, Reyen LE, et al. Central venous catheter repair is highly successful in children with intestinal failure. *J Pediatr Surg*. 2019;54(3):517-520. doi:10.1016/j.jpedsurg.2018.06.006
16. Gorski LA. *Phillips's Manual of I.V. Therapeutics: Evidence-Based Practice for Infusion Therapy*. 7th ed. F.A. Davis Company; 2018.
17. Fernandez-Pineda I, Ortega-Laureano L, Wu H, et al. Guidewire catheter exchange in pediatric oncology: indications, postoperative complications, and outcomes. *Pediatr Blood Cancer*. 2016;63(6):1081-1085. doi:10.1002/pbc.25947
18. Kennard A, Walters G, Jiang S, Talaulikar G. Interventions for treating central venous haemodialysis catheter malfunction. *Cochrane Database Syst Rev*. 2017;10(10):CD011953. doi:10.1002/14651858.CD011953.pub2
19. Park HS, Choi J, Kim HW, et al. Exchange over the guidewire from non-tunneled to tunneled hemodialysis catheters can be performed without patency loss. *J Vasc Access*. 2018;19(3):252-257. doi:10.1177/1129729817747541
20. McCoy M, Bedwell S, Noori S. Exchange of peripherally inserted central catheters is associated with an increased risk for bloodstream infection. *Am J Perinatol*. 2011;28(6):419-424. doi:10.1055/s-0030-1268709
21. Wang L, Wei F, Chen H, Sun G, Yu H, Jiang A. A modified de novo insertion technique for catheter replacement in elderly hemodialysis patients: a single clinic retrospective analysis. *J Vasc Access*. 2016;17(6):506-511. doi:10.5301/jva.5000600
22. McNiven C, Switzer N, Wood M, et al. Central venous catheter repair is not associated with an increased risk of central line infection or colonization in intestinal failure pediatric patients. *J Pediatr Surg*. 2016;51(3):395-397. doi:10.1016/j.jpedsurg.2015.08.003
23. Pabon-Ramos W, Soyinka O, Smith TP, Ronald J, Suhocki PV, Kim CY. Management of port occlusions in adults: different-site replacement versus same-site salvage. *J Vasc Interv Radiol*. 2019;30(7):1069-1074. doi:10.1016/j.jpedsurg.2015.08.003
24. Rus RR, Battelino N, Ponikvar R, Premru V, Novljan G. Does guidewire exchange influence infection rate related to catheters used for

vascular access in children on chronic hemodialysis? *Ther Apher Dial*. 2017;21(1):57-61. doi:10.1111/1744-9987.12481

25. Saleh HA, Abouellail H. Prospective, randomized study of tunneled cuffed hemodialysis catheter removal and delayed insertion, versus guidewire exchange to treat catheter related blood stream infection. interim results of first 100 cases. *Life Sci J*. 2017;14(3):45-49. doi:10.7537/marslsj140317.07
26. Chopra V, Kaatz S, Grant P, et al. Risk of venous thromboembolism following peripherally inserted central catheter exchange: an analysis of 23,000 hospitalized patients. *Am J Med*. 2018;131(6):651-660. doi:10.1016/j.amjmed.2018.01.017
27. Suleman A, Agnot-Johnston T, McDiarmid S. Clinical outcomes related to over-the-wire catheter exchange for peripherally inserted central catheter re-insertion: a two-centre retrospective study. *Vasc Access*. 2018;12(3):6-12.
28. O'Grady N, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis*. 2011;52(9):e162-e193. doi:10.1093/cid/cir257
29. Chaftari AM, Zakhem A El, Jamal MA, Jiang Y, Hachem R, Raad I. The use of minocycline-rifampin coated central venous catheters for exchange of catheters in the setting of staphylococcus aureus central line associated bloodstream infections. *BMC Infect Dis*. 2014;14:518. doi:10.1186/1471-2334-14-518
30. Ibeas J, Roca-Tey R, Vallespín J, et al. Spanish clinical guidelines on vascular access for haemodialysis. *Nefrologia*. 2017;37(suppl 1):1-191. doi:10.1016/j.nefro.2017.11.004
31. Jamal MA, Rosenblatt J, Jiang Y, Hachem R, Chaftari AM, Raad II. Prevention of transmission of multidrug-resistant organisms during catheter exchange using antimicrobial catheters. *Antimicrob Agents Chemother*. 2014;58(9):5291-5296. doi:10.1128/AAC.02886-14
32. Zakhour R, Chaftari AM, Raad II. Catheter-related infections in patients with haematological malignancies: novel preventive and therapeutic strategies. *Lancet Infect Dis*. 2016;16(11):e241-e250. doi:10.1016/S1473-3099(16)30213-4
33. Hsu M, Trerotola S. Air embolism during insertion and replacement of tunneled dialysis catheters: a retrospective investigation of the effect of aerostatic sheaths and over-the-wire exchange. *J Vasc Interv Radiol*. 2015;26(3):366-371. doi:10.1016/j.jvir.2014.11.035

52. AIR EMBOLISM

Standard

52.1 All infusion connections are of a luer-lock design to ensure a secure connection (eg, IV administration sets, syringes, needleless connectors, extension sets, and any add-on devices).

52.2 Air is always purged/removed from any administration device (eg, IV administration sets, syringes, needleless connectors, extension sets, and any add-on devices) prior to connection or initiating an infusion.

52.3 Clinicians, patients, and/or caregivers initiating and managing infusion therapy are instructed in air embolism recognition, prevention, and implementation of critical actions in the event an air embolism is suspected.

Practice Recommendations

A. Instruct the patient and/or caregivers not to disconnect or reconnect any IV administration sets or connectors from the catheter hub unless they have been instructed in IV administration and evaluated as competent in the procedure, such as with patients in the home care setting.[1,2] (IV)
B. Never use scissors, hemostats, or razors near the catheter.[1,3] (IV)
C. For all VADs, use the following techniques to prevent air embolism:
    1. Prime and purge air from all administration sets.
    2. Use patient positioning and air-occlusive techniques during and following VAD removal.
    3. Use luer-lock connections and equipment with safety features designed to detect or prevent air embolism, such as administration sets with air-eliminating filters and electronic infusion pumps with air sensor technology.
    4. Do not leave unprimed administration sets attached to solution containers.
    5. Ensure the VAD is clamped before changing administration sets or needleless connectors.[4-6] (V, A/P)
D. Implement special precautions to prevent air embolism during placement of CVADs and other procedures involving entry into the vascular system, such as catheter exchange and extracorporeal membrane oxygenation.
    1. Air embolic events have occurred related to contrast administration, endoscopy, guidewire-assisted procedures, sheath exchange, and unsecured connections.[7-17] (IV)
E. Implement precautions to prevent air embolism during removal of CVADs including, but not limited to:
    1. Placing the patient in a supine position during CVAD removal, or Trendelenburg position if tolerated (contraindicated in premature infants), so that the CVAD insertion site is at or below the level of the heart.[18-21] (V, A/P)
    2. Instructing the patient to perform a Valsalva maneuver at the appropriate point during catheter withdrawal. The Valsalva maneuver may be contraindicated because it increases intra-abdominal and intrathoracic pressure, which reduces cardiac output and affects blood pressure. Contraindications include, but are not limited to, patients with cardiac dysfunction, recent myocardial infarction, glaucoma, and retinopathy.[1,2] (IV)
        a. When the Valsalva maneuver is contraindicated, use a Trendelenburg or left lateral decubitus position or have the patient hold their breath as able to take and follow direction.[2,19] (A/P)
    3. After removal of a CVAD, apply digital pressure until hemostasis is achieved by using manual compression with a sterile, dry gauze pad.[1,2] (I)
    4. Apply an air-occlusive dressing (eg, petroleum gauze) to the access site for at least 24 hours for the purpose of occluding the skin-to-vein tract and decreasing the risk of retrograde air emboli.[1,2,22] (IV)
    5. Encourage the patient to remain in a flat or reclining position, if able, for 30 minutes after removal. While documentation of air embolism during removal of a PICC has not been reported, the exit site could be at the same level as the patient's heart, increasing the risk of air entering through an intact skin-to-vein tract and fibrin sheath (see Standard 45, *Vascular Access Device Removal*).[2,19] (IV, A/P)

F. Suspect air embolism with the sudden onset of dyspnea, gasping, continued coughing, breathlessness, chest pain, hypotension, tachyarrhythmias, wheezing, tachypnea, altered mental status, altered speech, changes in facial appearance, numbness, or paralysis as clinical events from air emboli produce cardiopulmonary and neurological signs and symptoms.[4,6,11,23,24] (V)
   1. Immediately take the necessary action to prevent more air from entering the bloodstream by closing, folding, clamping, or covering the existing catheter or by covering the puncture site with an air-occlusive dressing or pad if the catheter has been removed.[1,2,19] (IV)
   2. Immediately place the patient on the left side in the Trendelenburg position or in the left lateral decubitus position if not contraindicated by other conditions, such as increased intracranial pressure, eye surgery, or severe cardiac or respiratory diseases. The goal is to trap the air in the lower portion of the right ventricle.[11,19] (V)
   3. Implement additional actions:
      a. Initiate code team if in acute care setting or call emergency medical services if in patient's home or alternative care setting.
      b. Notify provider.
      c. Ensure adequate vascular access.
      d. Provide 100% oxygen if available and further support actions as needed.[12,19,25] (V)

REFERENCES

1. Broadhurst D. Death by air: how much is too much? *Vasc Access.* 2013:7(1):16-26.
2. Cook LS. Infusion-related air embolism. *J Infus Nurs.* 2013;36(1):26-36. doi:10.1097/NAN.0b013e318279a804
3. Pearson F, Browell C, Duggan J. Air embolism caused by a laceration to central venous catheter during shaving. *Anaesthesia.* 2011;66(3):229. doi:10.1111/j.1365-2044.2011.06638.x
4. Kumar A, Keshavamurthy S, Abraham JG, Toyoda Y. Massive air embolism caused by a central venous catheter during extracorporeal membrane oxygenation. *J Extra Corpor Technol*. 2019;51(1):9-11.
5. Mohanty CR, Ahmad SR, Jain M, Sriramka B. Air embolism through open hub of external jugular vein intravenous cannula. *Turk J Emerg Med*. 2019;19(3):117-119. doi:10.1016/j.tjem.2019.06.002
6. Abramson TM, Sanko S, Kashani S, Eckstein M. Prime the line! A case report of air embolism from a peripheral IV line in the field. *Prehosp Emerg Care*. 2020;24(4):576-579. doi:10.1080/10903127.2019.1671564
7. Lanfranco J, Romero Legro I, Freire AX, Nearing K, Ratnakant S. Pulmonary air embolism: an infrequent complication in the radiology suite. *Am J Case Rep*. 2017;18:80-84. doi:10.12659/ajcr.901098
8. Lorentzen K, Vester-Andersen M. Air embolism during venous sheath replacement. *Eur J Anaesthesiol*. 2019;36(9):712-713. doi:10.1097/EJA.0000000000001060
9. Sodhi KS, Saxena AK, Chandrashekhar G, et al. Vascular air embolism after contrast administration on 64 row multiple detector computed tomography: a prospective analysis. *Lung India.* 2015;32(3):216-219. doi:10.4103/0970-2113.156216
10. Wong SS, Kwaan HC, Ing TS. Venous air embolism related to the use of central catheters revisited: with emphasis on dialysis catheters. *Clin Kidney J.* 2017;10(6):797-803. doi:10.1093/ckj/sfx064
11. Louis D, Amer R, Elsayed YN. Cardiac air embolism in neonates: a hemodynamic perspective. *Am J Perinatol*. 2018;35(7):611-615. doi:10.1055/s-0037-1606633
12. Malik N, Claus PL, Illman JE, et al. Air embolism: diagnosis and management. *Future Cardiol*. 2017;13(4):365-378. doi:10.2217/fca-2017-0015
13. Prielipp RC, Brull SJ. Vascular air embolism and endoscopy: every bubble matters. *Anesth Analg*. 2018;127(2):333-335. doi:10.1213/ANE.0000000000003329
14. Ahmed J, Balasubramanian H, Ansari V, Kabra NS. Neonatal cerebral air embolism. *Indian Pediatr*. 2018;55(12):1089-1090.
15. Chuang DY, Sundararajan S, Sundararajan VA, Feldman DI, Xiong W. Accidental air embolism. *Stroke*. 2019;50(7):e183-e186. doi:10.1161/STROKEAHA.119.025340
16. McCarthy CJ, Behravesh S, Naidu SG, Oklu R. Air embolism: diagnosis, clinical management and outcomes. *Diagnostics (Basel)*. 2017;7(1):5. doi:10.3390/diagnostics7010005
17. Brull SJ, Prielipp RC. Vascular air embolism: a silent hazard to patient safety. *J Crit Care*. 2017;42:255-263. doi:10.1016/j.jcrc.2017.08.010
18. Martin RJ, Fanaroff AA, Walsh MC. *Fanaroff & Martin's Neonatal-Perinatal Medicine: Diseases of the Fetus and Infant*. 11th ed. Elsevier; 2020.
19. McCarthy CJ, Behravesh S, Naidu SG, Oklu R. Air embolism: practical tips for prevention and treatment. *J Clin Med.* 2016;5(11):93. doi:10.3390/jcm5110093
20. Jnah A, Trembath A, eds. *Fetal and Neonatal Physiology for the Advanced Practice Nurse*. Springer Publishing Company; 2019.
21. Blackburn ST. *Maternal, Fetal & Neonatal Physiology: A Clinical Perspective.* 5th ed. Elsevier; 2018.
22. Clark DK, Plaizier E. Devastating cerebral air embolism after central line removal. *J Neurosci Nurs.* 2011;43(4):193-196.
23. Shaik S, Burad J, Al-Ismaili M. Quick diagnosis of venous air embolism. *Intensive Care Med*. 2017;43(5):700-701. doi:10.1007/s00134-016-4660-5
24. Vinan-Vega MN, Rahman MR, Thompson J, et al. Air embolism following peripheral intravenous access. *Proc (Bayl Univ Med Cent)*. 2019;32(3):433-434. doi:10.1080/08998280.2019.1609154
25. Brodbeck A, Bothma P, Pease J. Venous air embolism: ultrasonographic diagnosis and treatment with hyperbaric oxygen therapy. *Br J Anaesth.* 2018;121(6):1215-1217. doi:10.1016/j.bja.2018.09.003

53. CATHETER-ASSOCIATED DEEP VEIN THROMBOSIS

Standard

53.1 The clinician identifies risk factors, implements preventative strategies, assesses the patient for sign/symptoms of suspected catheter-associated deep vein thrombosis (CA-DVT), and assesses patient response to treatment.

Practice Recommendations

A. Identify risk factors for CA-DVT in patients who require a VAD.
   1. Older age (>60 years), malignancy, diabetes mellitus, obesity, chemotherapy administration, thrombophilia (eg, Factor V Leiden, protein C deficiency, protein S deficiency), critical illness, and history of thrombosis are identified in multiple studies as significant risk factors.[1-4] (I)
   2. Other cited risk factors include presence of adult/pediatric chronic diseases including inflammatory bowel disease, congenital heart disease, sickle cell

disease, end-stage renal failure, surgery/trauma patients, pregnancy, hyperglycemia in nondiabetic children in critical care; history of prior CVADs; repeated PICC insertion in the same arm in pediatric patients.[1,5-19] (II)

B. Evaluate the risk of CA-DVT during the process of VAD selection (see Standard 26, *Vascular Access Device Planning*).
   1. Employ risk reduction interventions when choosing and inserting a PICC; while PICCs have been associated with higher rates of deep vein thrombosis (DVT) than other CVADs, the risk of CA-DVT was not increased when compared to non-PICC CVADs when smaller diameter and single-lumen PICCs were placed.[3,11,20,21] (I)
   2. Consider use of a risk scoring system when evaluating PICC placement; the Michigan Risk Score identified risk for PICC-associated CA-DVT based on 5 risk factors: history of DVT, a multilumen PICC, active cancer, presence of another CVAD at the time of PICC insertion, and white blood cell count greater than 12 000. There was a 5-fold greater risk for CA-DVT for those patients in the highest risk class as compared to those at the lowest risk.[22] (III)
   3. Consider the risks of CA-DVT associated with implanted vascular access ports placed in the chest vs the arm.
      a. Total complications associated with arm ports were not significantly different between arm- and chest-placed implanted ports in patients with cancer based upon a meta-analysis; another study found that placement of an implanted port in the arm vs placement in the chest was associated with a significant increase in symptomatic, radiologically confirmed upper extremity DVT in patients with breast cancer.[23,24] (II)
   4. Consider the risks of non-PICC CVADs.
      a. CVADs placed via the subclavian sites are associated with a lower risk of symptomatic, ultrasound-confirmed CA-DVT than jugular or femoral sites in adult patients in ICUs.[25] (III)
      b. The subclavian and internal jugular routes were similar in risks, including thrombosis, stenosis, and infection, for long-term catheterization in patients with cancer; for short-term catheterization, the subclavian route is preferred over the femoral route as the risk of thrombotic complications was lower; the subclavian route should be avoided in patients with chronic kidney disease (CKD) due to increased risk of stenosis.[26-28] (III)
   5. Consider risk for CA-DVT with midline catheters.
      a. Midline catheters are associated with a significant risk for CA-DVT, as well as superficial venous thrombophlebitis; the average time from catheter insertion to CA-DVT diagnosis was 8.84 days and 10.00 days; the odds of CA-DVT were increased with double-lumen catheters and with increasing catheter gauge size from 4 Fr to 5 Fr.[29,30] (IV)

C. Implement preventative interventions for CA-DVT.
   1. Ensure proper placement of all CVAD tips in the lower third of the superior vena cava (SVC) or cavoatrial junction as tips located in the mid-to-upper portion of the SVC are associated with greater rates of DVT (see Standard 23, *Central Vascular Access Device Tip Location*).[20,27,31-34] (A/P)
   2. Measure the catheter-to-vessel ratio prior to insertion; ensure minimally no more than 45% ratio (see Standard 34, *Vascular Access Device Placement*).[35,36] (A/P)
   3. Avoid placement of multilumen PICCs unless necessary for patient infusion requirements; place small-diameter catheters; small-diameter catheters (eg, 4 Fr) are associated with reduced risk of CA-DVT; in adults CA-DVT developed more rapidly with 5 Fr and 6 Fr PICCs when compared to small-diameter PICCs.[21,27,33,37] (II)
   4. Avoid placement of multilumen midline catheters or those greater than 4 Fr diameter.[29,30] (IV)
   5. Evaluate the need and appropriateness of PICC catheter exchange; an association between CA-DVT and PICC exchange was reported in a retrospective study; however, patients who experienced exchanges were more likely to have had multilumen PICCs (see Standard 51, *Catheter Damage [Embolism, Repair, Exchange]*).[38] (V)
   6. Consider upper extremity exercise to reduce venous stasis; handgrip exercise using an elastic ball 3 or 6 times per day for 3 weeks was associated with a lower incidence of ultrasound-confirmed CA-DVT in patients with cancer who had a PICC; more research is needed for postinsertion nursing interventions.[39] (IV)
   7. Prophylactic anticoagulation for CA-DVT prevention is not established.
      a. Low-molecular-weight heparin (LMWH) was associated with a reduction in symptomatic CA-DVT for patients with cancer; however, the effect of LMWH on mortality is inconclusive; evaluate the risks of bleeding and thrombocytopenia and the burden associated with anticoagulant management vs the benefit of reducing CA-DVT risk.[40] (I)
      b. Hospitalized pediatric patients with inflammatory bowel disease treated with an anticoagulant prophylaxis protocol (enoxaparin) upon PICC placement had a decreased risk of CA-DVT with no increased risk of bleeding.[8] (IV)

D. Monitor for signs, symptoms, and potential consequences of CA-DVT; recognize that CA-DVT is often clinically silent and does not produce overt signs and symptoms. Clinical signs and symptoms are related to obstruction of venous blood flow and may include, but are not limited to, pain/edema/erythema in the extremity, shoulder, neck, or chest and engorged peripheral veins of the extremity.[27] (III)
   1. Measure baseline circumference of the extremity with a PICC or a midline catheter upon insertion, noting location for future measurements and assess circumference

when edema or signs and symptoms of DVT present, noting the location and characteristics of edema; a 3-cm increase in midarm circumference in adults with PICCs was associated with CA-DVT (see Standard 10, *Documentation in the Health Record*).[29,30,41] (IV)

2. Pulmonary emboli may occur but are less commonly associated with CA-DVT.[11] (I)
3. Recognize post-thrombotic syndrome as a potential long-term consequence of CA-DVT characterized by pain, swelling, and skin changes.[42-43] (I)

E. Diagnose and confirm CA-DVT using color-flow Doppler ultrasound by the presence of at least 2 of the following: noncompressability of the vein, abnormal color Doppler vein pattern, and/or IV filling defect. Venography with contrast injection may also be used to assess more proximal veins (eg, brachiocephalic) that are obscured by the clavicle or ribs.[3,27,44] (II)

F. Do not remove a CVAD in the presence of CA-DVT when the catheter is correctly positioned, functional, and necessary for infusion therapy.[3,10,27,45] (II)

1. Catheter removal and replacement in a new site are associated with a high rate of new-site CA-DVT.[46] (IV)
2. Treat CA-DVT with anticoagulant medication for at least 3 months after CVAD removal. For CVADs with a longer dwell time, continue the treatment for as long as the CVAD is in situ; catheter-directed thrombolysis may be of benefit to patients with severe symptoms, thrombus involving most of the axillary/subclavian vein, with symptoms for less than 14 days, good functional status, life expectancy greater than 1 year, and low risk for bleeding.[3,47,48] (II)
3. For patients with cancer and CA-DVT, LMWH is recommended; for patients who do not have cancer, dabigatran, rivaroxaban, apixaban, or edoxaban is recommended over vitamin K antagonists (eg, warfarin).[40] (I)
4. Reduced dosages of LMWH or fondaparinux were found to be safe and effective in adult patients with hematological malignancies and moderate thrombocytopenia.[49] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 17, 2020, and August 30, 2020.

1. Baumann Kreuziger L, Jaffray J, Carrier M. Epidemiology, diagnosis, prevention and treatment of catheter-related thrombosis in children and adults. *Thromb Res.* 2017;157:64-71. doi:10.1016/j.thromres.2017.07.002
2. Leung A, Heal C, Perera M, Pretorius C. A systematic review of patient-related risk factors for catheter-related thrombosis. *J Thromb Thrombolysis.* 2015;40(3):363-373. doi:10.1007/s11239-015-1175-9
3. Fallouh N, McGuirk HM, Flanders SA, Chopra V. Peripherally inserted central catheter-associated deep vein thrombosis: a narrative review. *Am J Med.* 2015;128(7):722-738. doi:10.1016/j.amjmed.2015.01.027
4. Neshat-Vahid S, Pierce R, Hersey D, Raffini LJ, Faustino EV. Association of thrombophilia and catheter-associated thrombosis in children: a systematic review and meta-analysis. *J Thromb Haemost.* 2016;14(9):1749-1758. doi:10.1111/jth.13388
5. Faustino EVS. Central venous catheter-associated deep venous thrombosis in critically ill children. *Semin Thromb Hemost.* 2018;44(1):52-56. doi:10.1055/s-0037-1603938
6. Gunawansa N, Sudusinghe DH, Wijayaratne DR. Hemodialysis catheter-related central venous thrombosis: clinical approach to evaluation and management. *Ann Vasc Surg.* 2018;51:298-305. doi:10.1016/j.avsg.2018.02.033
7. Refaei M, Fernandes B, Brandwein J, Goodyear MD, Pokhrel A, Wu C. Incidence of catheter-related thrombosis in acute leukemia patients: a comparative, retrospective study of the safety of peripherally inserted vs. centrally inserted central venous catheters. *Ann Hematol.* 2016;95(12):2057-2064. doi:10.1007/s00277-016-2798-4
8. Diamond CE, Hennessey C, Meldau J, et al. Catheter-related venous thrombosis in hospitalized pediatric patients with inflammatory bowel disease: incidence, characteristics, and role of anticoagulant thromboprophylaxis with enoxaparin. *J Pediatr.* 2018;198:53-59. doi:10.1016/j.jpeds.2018.02.039
9. Winters JP, Callas PW, Cushman M, Repp AB, Zakai NA. Central venous catheters and upper extremity deep vein thrombosis in medical inpatients: the Medical Inpatients and Thrombosis (MITH) study. *J Thromb Haemost*. 2015;13(12):2155-2160. doi:10.1111/jth.13131
10. Mandel-Shorer N, Tzvi-Behr S, Harvey E, Revel-Vilk S. Central venous catheter-related venous thrombosis in children with end-stage renal disease undergoing hemodialysis. *Thromb Res.* 2018;172:150-157. doi:10.1016/j.thromres.2018.10.031
11. Chopra V, Anand S, Hickner A, et al. Risk of venous thromboembolism associated with peripherally inserted central catheters: a systematic review and meta-analysis. *Lancet.* 2013;382(9889):311-325. doi:10.1016/S0140-6736(13)60592-9
12. Stone RH, Bress AP, Nutescu EA, Shapiro NL. Upper-extremity deep-vein thrombosis: a retrospective cohort evaluation of thrombotic risk factors at a university teaching hospital antithrombosis clinic. *Ann Pharmacother*. 2016;50(8):637-644. doi:10.1177/1060028016649601
13. Jaffray J, Bauman M, Massicotte P. The impact of central venous catheters on pediatric venous thromboembolism. *Front Pediatr.* 2017;5:5. doi:10.3389/fped.2017.00005
14. Noailly Charny PA, Bleyzac N, Ohannessian R, Aubert E, Bertrand Y, Renard C. Increased risk of thrombosis associated with peripherally inserted central catheters compared with conventional central venous catheters in children with leukemia. *J Pediatr.* 2018;198:46-52. doi:10.1016/j.jpeds.2018.03.026
15. Boechat Tde O, do Nascimento EM, Lobo CL, Ballas SK. Deep venous thrombosis in children with sickle cell disease. *Pediatr Blood Cancer.* 2015;62(5):838-841. doi:10.1002/pbc.25431
16. Tala JA, Silva CT, Pemira S, Vidal E, Faustino EV. Blood glucose as a marker of venous thromboembolism in critically ill children. *J Thromb Haemost*. 2014;12(6):891-896. doi:10.1111/jth.12583
17. Gnannt R, Waespe N, Temple M, et al. Increased risk of symptomatic upper-extremity venous thrombosis with multiple peripherally inserted central catheter insertions in pediatric patients. *Pediatr Radiol.* 2018;48(7):1013-1020. doi:10.1007/s00247-018-4096-x
18. Jaffray J, Witmer C, O'Brien SH, et al. Peripherally inserted central catheters lead to a high risk of venous thromboembolism in children. *Blood.* 2020;135(3):220-226. doi:10.1182/blood.2019002260
19. Frolova AI, Shanahan MA, Tuuli MG, Simon L, Young OM. Complications of peripherally inserted central catheters in pregnancy: a systematic review and meta-analysis [published online ahead of print May 22, 2020]. *J Matern Fetal Neonatal Med*. 2020;1-8. doi:10.1080/14767058.2020.1769591
20. Balsorano P, Virgili G, Villa G, et al. Peripherally inserted central catheter-related thrombosis rate in modern vascular access era-when insertion technique matters: a systematic review and meta-analysis. *J Vasc Access*. 2020;21(1):45-54. doi:10.1177/1129729819852203
21. Schears GJ, Ferko N, Syed I, Arpino JM, Alsbrooks K. Peripherally inserted central catheters inserted with current best practices have low deep vein thrombosis and central line-associated bloodstream infection risk compared with centrally inserted central

catheters: a contemporary meta-analysis [published online ahead of print May 1, 2020]. *J Vasc Access*. 2020;1129729820916113. doi:10.1177/1129729820916113

22. Chopra V, Kaatz S, Conlon A, et al. The Michigan risk score to predict peripherally inserted central catheter-associated thrombosis. *J Thromb Haemost.* 2017;15(10):1951-1962. doi:10.1111/jth.13794
23. Li G, Zhang Y, Ma H, Zheng J. Arm port vs chest port: a systematic review and meta-analysis. *Cancer Manag Res.* 2019;11:6099-6112. doi:10.2147/CMAR.S205988
24. Tippit D, Siegel E, Ochoa D, et al. Upper-extremity deep vein thrombosis in patients with breast cancer with chest versus arm central venous port catheters. *Breast Cancer (Auckl).* 2018;12:1178223418771909. doi:10.1177/1178223418771909
25. Parienti JJ, Mongardon N, Megarbane B, et al. Intravascular complications of central venous catheterization by insertion site. *N Engl J Med.* 2015;373(13):1220-1229. doi:10.1056/NEJMoa1500964
26. Ge X, Cavallazzi R, Li C, Pan SM, Wang YW, Wang FL. Central venous access sites for the prevention of venous thrombosis, stenosis and infection. *Cochrane Database Syst Rev*. 2012;2012(3):CD004084.
27. Crawford JD, Liem TK, Moneta GL. Management of catheter-associated upper extremity deep venous thrombosis. *J Vasc Surg Venous Lymphat Disord*. 2016;4(3):375-379. doi:10.1016/j.jvsv.2015.06.003
28. Mitchell MD, Agarwal R, Hecht TE, Umscheid CA. Nonpharmacologic interventions for prevention of catheter-related thrombosis: a systematic review. *J Crit Care*. 2013;28(3):316. e9-316.e3.16E16. doi:10.1016/j.jcrc.2012.07.007
29. Bahl A, Karabon P, Chu D. Comparison of venous thrombosis complications in midlines versus peripherally inserted central catheters: are midlines the safer option? *Clin Appl Thromb Hemost*. 2019;25:1076029619839150. doi:10.1177/1076029619839150
30. Lisova K, Hromadkova J, Pavelková K, Zauška V, Havlin J, Charvat J. The incidence of symptomatic upper limb venous thrombosis associated with midline catheter: prospective observation. *J Vasc Access.* 2018;19(5):492-495. doi:10.1177/1129729818761276
31. Ballard DH, Samra NS, Gifford KM, Roller R, Wolfe BM, Owings JT. Distance of the internal central venous catheter tip from the right atrium is positively correlated with central venous thrombosis. *Emerg Radiol.* 2016;23(3):269-273. doi:10.1007/s10140-016-1393-2
32. Wang K, Sun W, Shi X. Upper extremity deep vein thrombosis after migration of peripherally inserted central catheter (PICC): a case report. *Medicine (Baltimore).* 2017;96(51):e9222. doi:10.1097/MD.0000000000009222
33. Crocoli A, Cesaro S, Cellini M, et al. In defense of the use of peripherally inserted central catheters in pediatric patients [published online ahead of print Jun 27, 2020]. *J Vasc Access*. 2020;1129729820936411. doi:10.1177/1129729820936411
34. Chopra V, Ratz D, Kuhn L, Lopus T, Lee A, Krein S. Peripherally inserted central catheter-related deep vein thrombosis: contemporary patterns and predictors. *J Thromb Haemost.* 2014;12(6):847-854. doi:10.1111/jth.12549
35. Nifong TP, McDevitt TJ. The effect of catheter to vein ratio on blood flow rates in a simulated model of peripherally inserted central venous catheters. *Chest*. 2011;140(1):48-53. doi:10.1378/chest.10-2637
36. Spencer TR, Mahoney KJ. Reducing catheter-related thrombosis using a risk reduction tool centered on catheter to vessel ratio. *J Thromb Thrombolysis*. 2017;44(4):427-434. doi:10.1007/s11239-017-1569-y
37. Mermis JD, Strom JC, Greenwood JP, et al. Quality improvement initiative to reduce deep vein thrombosis associated with peripherally inserted central catheters in adults with cystic fibrosis. *Ann Am Thorac Soc*. 2014;11(9):1404-1410. doi:10.1513/AnnalsATS.201404-175OC
38. Chopra V, Kaatz S, Grant P, et al. Risk of venous thromboembolism following peripherally inserted central catheter exchange: an analysis of 23,000 hospitalized patients. *Am J Med*. 2018;131(6):651-660. doi:10.1016/j.amjmed.2018.01.017
39. Liu K, Zhou Y, Xie W, et al. Handgrip exercise reduces peripherally-inserted central catheter-related venous thrombosis in patients with solid cancers: a randomized controlled trial. *Int J Nurs Stud*. 2018;86:99-106. doi:10.1016/j.ijnurstu.2018.06.004
40. Kahale LA, Tsolakian IG, Hakoum MB, et al. Anticoagulation for people with cancer and central venous catheters. *Cochrane Database Syst Rev*. 2018;6(6):CD006468. doi:10.1002/14651858.CD006468.pub6
41. Maneval RE, Clemence BJ. Risk factors associated with catheter-related upper extremity deep vein thrombosis in patients with peripherally inserted central venous catheters: a prospective observational cohort study: part 2. *J Infus Nurs*. 2014;37(4):260-268. doi:10.1097/NAN.0000000000000042
42. Polen E, Weintraub M, Stoffer C, Jaffe DH, Burger A, Revel-Vilk S. Post-thrombotic syndrome after central venous catheter removal in childhood cancer survivors: a prospective cohort study. *Pediatr Blood Cancer.* 2015;62(2):285-290. doi:10.1002/pbc.25302
43. Thiyagarajah K, Ellingwood L, Endres K, et al. Post-thrombotic syndrome and recurrent thromboembolism in patients with upper extremity deep vein thrombosis: a systematic review and meta-analysis. *Thromb Res*. 2019;174:34-39. doi:10.1016/j.thromres.2018.12.012
44. Li S, Silva CT, Brudnicki AR, et al. Diagnostic accuracy of point-of-care ultrasound for catheter-related thrombosis in children. *Pediatr Radiol.* 2016;46(2):219-228. doi:10.1007/s00247-015-3467-9
45. Norris AH, Shrestha NK, Allison GM, et al. 2018 Infectious Diseases Society of America clinical practice guideline for the management of outpatient parenteral antimicrobial therapy. *Clin Infect Dis.* 2019;68(1):e1-e35. doi:10.1093/cid/ciy745
46. Jones MA, Lee DY, Segall JA, et al. Characterizing resolution of catheter-associated upper extremity deep venous thrombosis. *J Vasc Surg.* 2010;51(1):108-113. doi:10.1016/j.jvs.2009.07.124
47. Kearon C, Akl EA, Ornelas J, et al. Antithrombotic therapy for VTE disease: CHEST guideline and expert panel report. *Chest.* 2016;149(2):315-352. doi:10.1016/j.chest.2015.11.026
48. Kearon C, Kahn SR. Long-term treatment of venous thromboembolism. *Blood*. 2020;135(5):317-325. doi:10.1182/blood.2019002364
49. Scamuffa MC, Morano SG, Serrao A, et al. PICC-related upper deep venous thrombosis in patients with hematological malignancies: management of anticoagulant therapy according to the platelet count. *J Thromb Thrombolysis*. 2020;49(3):426-430. doi:10.1007/s11239-020-02040-8

54. CENTRAL VASCULAR ACCESS DEVICE MALPOSITION

Standard

54.1 The clinician assesses for CVAD malposition and uses appropriate interventions when suspected.

Practice Recommendations

A. Correlate normal vascular anatomy and the acceptable CVAD tip location to aberrant locations in the thorax, abdomen, and neck on insertion (ie, primary malposition) and during dwell (ie, secondary malposition).
   1. Primary intravascular malposition of CVADs occurs during or immediately after the insertion procedure and includes locations in the aorta, lower portion of the right atrium and right ventricle, ipsilateral and contralateral brachiocephalic (innominate) and subclavian veins, ipsilateral and contralateral internal jugular veins, azygous vein, and many other smaller tributary veins. Femoral insertion sites may produce malposition of the catheter in the lumbar, iliolumbar,

and common iliac veins. Causes of malposition include:
   a. Inadequate catheter length and insertion depth.
   b. Patient position changes (eg, from supine to upright).
   c. Respiratory movement of the diaphragm and use of mechanical ventilation.
   d. Upper extremity and shoulder movement.
   e. Body habitus (eg, obesity, breast size).
   f. Congenital venous abnormalities including persistent left superior vena cava and variations of the inferior vena cava, azygous vein, and pulmonary veins. Many of these anatomical variations are undiagnosed until placement of a CVAD is required. Cardiac imaging studies are needed as blood flow into the left atrium and the presence of right-to-left cardiac shunting pose significant risks for air or thrombotic emboli to a variety of anatomical locations (eg, brain, kidney).
   g. Acquired venous changes including thrombosis, stenosis, and malignant or benign lesions compressing the vein.[1-7] (IV)
2. Secondary intravascular malposition of CVADs, also known as tip migration, occurs any time during the dwell and is related to sporadic changes in intrathoracic pressure (eg, coughing, vomiting); original tip located high in the SVC; DVT; congestive heart failure; neck or arm movement; and positive pressure ventilation.[4,8-10] (IV)
3. Primary and secondary extravascular CVAD malposition includes location in the:
   a. Mediastinum producing infiltration/extravasation.
   b. Thoracic duct producing chylothorax.
   c. Pleura producing hemothorax or pleural effusion.
   d. Pericardium producing pericardial effusion and cardiac tamponade, especially in infants.
   e. Peritoneum producing intra-abdominal bleeding and abdominal compartment syndrome.
   f. Trachea and other structures due to fistula formation.
   g. Epidural space in neonates.[4,6,7,11-15] (IV)

B. Recognize and control the risk of malposition during insertion if possible.
1. Insertions on a patient's left side are more prone to malposition due to a longer left brachiocephalic (innominate) vein and a more diagonal pathway to the heart. Left-sided insertions are more prone to abut the contralateral side of the SVC, leading to vessel erosion.
2. Bevel orientation during guidewire insertion may reduce malposition. For internal jugular sites, medial bevel orientation, and for subclavian sites, caudal bevel orientation facilitates guidewire advancement and subsequent tip location.
3. Tip location in the lower right atrium is associated with infective endocarditis due to abrasion of the tricuspid valve or cardiac wall from the catheter tip and subsequent organisms introduced into the bloodstream causing infection.[4,7,16-18] (IV)

C. Use tip location technology to enhance awareness of primary CVAD malposition during the insertion procedure (refer to Standard 23, *Central Vascular Access Device Tip Location*).

D. Use real-time ultrasound during the insertion procedure to reduce the risk of inadvertent arterial insertion. Ultrasound is also useful to rule out cephalad tip orientation in the jugular vein prior to removal of the sterile field (refer to Standard 22, *Vascular Visualization*).

E. Maintain a high degree of clinical suspicion for inadvertent arterial CVAD placement when the patient presents with a stroke or other neurological injury, hematoma, or hemothorax at insertion or during the dwell time.
1. Confirm arterial or venous placement by assessing waveforms using a pressure transducer, blood gas values from a sample taken from the CVAD, or computed tomography (CT) angiogram. Pulsatile flow and color of the blood are not always reliable indicators for arterial placement due to low blood pressure or the length of the catheter.
2. Consult with interventional radiology and/or surgeon to develop a plan for urgent removal. Delay can increase the risk of thrombosis.[6,7,19,20] (II)

F. Monitor the growth of infants and children with CVADs as growth can produce suboptimal intravascular tip location when a CVAD is indwelling over extended periods of time. Correlate growth to tip location, and plan for CVAD changes as needed.[11] (IV)

G. Use only a CVAD labeled for power injection of contrast agents. Power injection is reported to produce mediastinal extravasation if the tip is malpositioned and may be the cause of malposition due to force of injection. Assess for clinical signs and symptoms and patency of the CVAD by manual flushing and aspirating for a blood return and confirming the correct tip location before and after power injection. Questions about tip position or catheter patency should be assessed with a scout scan or topogram before power injection.[19-22] (IV)

H. Identify CVAD dislodgement, another cause of secondary malposition, by monitoring and measuring the external CVAD length with dressing changes and compare to the documented external length at insertion.
1. Dislodgement alters tip location and is associated with arm movement, body habitus, patient manipulation (eg, Twiddler's syndrome), inadequate catheter securement and/or incorrect dressing, and securement device removal.
2. Never advance any external portion of the CVAD that has been in contact with skin into the insertion site. No antiseptic agent or technique applied to skin or the external catheter will render skin or the catheter to be sterile, and no studies have established an acceptable length of time after insertion for such catheter manipulation.

3. Management may require an exchange over a guidewire or removal and insertion at a new site.[21,23] (V)

I. Assess the patient and the CVAD for signs and symptoms of catheter dysfunction and associated complications before each CVAD infusion as these factors will be the first indication of malposition:
   1. Absence of blood return from all catheter lumens.
   2. Changes in blood color and pulsatility of the blood return from all catheter lumens.
   3. Difficulty or inability to flush the CVAD.
   4. Arterial vs venous waveform from an attached pressure transducer.
   5. Atrial and ventricular dysrhythmias.
   6. Changes in blood pressure and/or heart rate.
   7. Shoulder, chest, or back pain during insertion or dwell time.
   8. Edema in the neck or shoulder.
   9. Changes in respiration.
   10. Complaints of hearing gurgling or flow stream sounds on the ipsilateral side.
   11. Paresthesia and neurological effects due to retrograde infusion into the intracranial venous sinuses.[4,23-27] (IV)

J. Withhold infusion through a malpositioned catheter until proper tip position has been established. Assess the prescribed infusion therapy and, if possible, insert a short PIVC to continue therapy. If the infusion therapy is not possible through a peripheral vein, assess the potential risk for discontinuing therapy and consult with the provider regarding changing the infusion therapy until the proper CVAD tip location can be reestablished.[27] (V)

K. Obtain diagnostic tests including chest radiograph with or without contrast injection, fluoroscopy, echocardiogram, CT scan, and/or magnetic resonance imaging (MRI) to diagnose CVAD malposition based on clinical signs and symptoms and problems with catheter function.
   1. Provide the radiology department with clinical information to enhance their ability to identify the problem.
   2. Chest radiographs at specific intervals may not identify tip migration because of the sporadic and unpredictable nature of malposition. Each acute care facility should assess the need for chest radiograph when patients with a CVAD are admitted.
   3. Collaborate with the radiology department to have chest radiographs or other diagnostic radiographic procedures include catheter tip location. Establish and follow organizational policy for reporting and management of malpositioned catheters found during these procedures.[4,6,7] (IV)

L . Manage malposition depending upon the location of the CVAD, the continued need for infusion therapy, and the patient's acuity. Consult with the provider and/or radiology department as needed.
   1. Noninvasive or minimally invasive techniques are preferred as the initial step to reposition a CVAD.
   2. Intracardiac location in the lower two-thirds of the right atrium or right ventricle should have the CVAD retracted based on electrocardiogram results or measurement of the specific distance on the chest radiograph.
   3. CVADs angling cephalad into the internal jugular vein, the contralateral subclavian or brachiocephalic (innominate) vein, or other tributary veins may be repositioned by a high-flow flush technique involving elevating the patient's head to a 60° to 90° angle (ie, high Fowler's position) and flushing the catheter. Instructing the patient to cough while flushing may also change intrathoracic pressures allowing catheter movement.
   4. Invasive techniques include catheter exchange over a guidewire and other radiological techniques under fluoroscopy.
   5. For a PICC inadvertently placed in an artery, remove the catheter, and apply and maintain direct manual pressure on the arterial puncture site until hemostasis is achieved. Inform primary clinicians of arterial placement for continuing close observation.
   6. For PICC malposition in neonates, attempt noninvasive repositioning by elevating the head of bed for internal jugular placement, lying on the opposite side with head elevated for brachiocephalic placement, or gentle flushing or fluid infusion. Secondary intravascular malposition may be corrected by abduction, adduction, flexion, or extension of the extremity.
   7. For axillosubclavian or jugular insertion sites, consult with the provider and/or radiology department to develop a plan for removal. Withdrawal of large catheters from an accessed artery (eg, carotid) with site compression increases risk of brain ischemia from lack of blood flow, hematoma, or emboli. Endovascular techniques or open surgical repair may be needed.
   8. Repositioning of long-term CVADs may require using a diagnostic catheter inserted via the femoral vein under fluoroscopy and manipulating the tip using a snaring technique.
   9. Fluid aspiration from the CVAD before removal may be indicated if cardiac tamponade is suspected. Consult with the provider and/or radiology department.
   10. Removal when an infiltration/extravasation has occurred will require a treatment plan for the specific medication involved (see Standard 47, *Infiltration and Extravasation*).[24,28-30] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 17, 2020, and August 30, 2020.

1. Wallace JA, Afonso E, Yu H, Birchard K, Isaacson A. Factors that predict increased catheter tip movement in left internal jugular vein implantable venous access ports upon standing. *J Vasc Access.* 2015;16(3):223-226. doi:10.5301/jva.5000331

2. Hade AD, Beckmann LA, Basappa BK. A checklist to improve the quality of central venous catheter tip positioning. *Anaesthesia.* 2019;74(7):896-903. doi:10.1111/anae.14679
3. Struck MF, Ewens S, Schummer W, et al. Central venous catheterization for acute trauma resuscitation: tip position analysis using routine emergency computed tomography. *J Vasc Access*. 2018;19(5):461-466. doi:10.1177/1129729818758998
4. Roldan CJ, Paniagua L. Central venous catheter intravascular malpositioning: causes, prevention, diagnosis, and correction. *West J Emerg Med*. 2015;16(5):658-664. doi:10.5811/westjem.2015.7.26248
5. Gish J, Wright T, Gadepalli S, Jarboe M. Avoiding postoperative malposition of upper body tunneled central venous catheters in children: evaluating technique and depth of placement. *J Pediatr Surg.* 2016;51(8):1336-1340. doi:10.1016/j.jpedsurg.2016.01.010
6. Ge BH, Copelan A, Scola D, Watts MM. Iatrogenic percutaneous vascular injuries: clinical presentation, imaging, and management. *Semin Intervent Radiol*. 2015;32(2):108-122. doi:10.1055/s-0035-1549375
7. Raptis DA, Neal K, Bhalla S. Imaging approach to misplaced central venous catheters. *Radiol Clin North Am.* 2020;58(1):105-117. doi:10.1016/j.rcl.2019.08.011
8. Wang K, Sun W, Shi X. Upper extremity deep vein thrombosis after migration of peripherally inserted central catheter (PICC): a case report. *Medicine (Baltimore)*. 2017;96(51):e9222. doi:10.1097/MD.0000000000009222
9. Wang YH, Su CS, Chang KH, Went CJ, Lee WL, Lai CH. Percutaneous intervention to correct central venous port catheter malposition. *Perfusion*. 2018;33(5):404-406. doi:10.1177/0267659117747376
10. Beccaria P, Silvetti S, Mucci M, Battini I, Brambilla P, Zangrillo A. Contributing factors for a late spontaneous peripherally inserted central catheter migration: a case report and review of literature. *J Vasc Access*. 2015;16(3):178-182. doi:10.5301/jva.5000337
11. Sertic AJ, Connolly BL, Temple MJ, Parra DA, Amaral JG, Lee KS. Perforations associated with peripherally inserted central catheters in a neonatal population. *Pediatr Radiol*. 2018;48(1):109-119. doi:10.1007/s00247-017-3983-x
12. Blackwood BP, Farrow KN, Kim S, Hunter CJ. Peripherally inserted central catheters complicated by vascular erosion in neonates. *JPEN J Parenter Enteral Nutr.* 2016;40(6):890-895. doi:10.1177/0148607115574000
13. Mysona DP, Lassiter RL, Walters KC, Pipkin WL, Hatley RM. Azygos vein erosion: a potential complication of central venous access. *J Pediatr Surg Case Rep*. 2017;24:1-4. https://doi.org/10.1016/j.epsc.2017.05.013
14. Pafitanis G, Spyridon K, Theodorakopoulou E, Mason K, Ygropoulou O, Mousafiri O. A case report of abdominal compartment syndrome caused by malposition of a femoral venous catheter. *Int J Surg Case Rep*. 2015;12:84-86. doi: 10.1016/j.ijscr.2015.05.002
15. Lachowska M, Lachowski K, Królak-Olejnik B. Parenteral nutrition solution in cerebrospinal fluid in preterm newborn – a case report and review of the literature. *J Vasc Access.* 2016;17(4):e82-e84. doi:10.5301/jva.5000552
16. Dornbos DL 3rd, Nimjee SM, Smith TP. Inadvertent arterial placement of central venous catheters: systematic review and guidelines for treatment. *J Vasc Interv Radiol.* 2019;30(11):1785-1794. doi:10.1016/j.jvir.2019.05.017
17. Garg N, Noheria A, McPhail IR, Ricotta JJ 2nd. Embolic strokes after peripherally inserted central catheter placement. *Ann Vasc Surg*. 2010;24(8):1133.e1-1133.e11334. doi:10.1016/j.avsg.2010.05.024
18. Craigie M, Meehan L, Harper J. Tip migration post-contrast pressure injection through pressure-injectable peripherally inserted central catheters causing vascular injury: a report of 3 cases. *Cardiovasc Intervent Radiol*. 2018;41(3):509-512. doi:10.1007/s00270-017-1828-5
19. Lozano LA, Marn C, Goodman LR. Power injectable peripherally inserted central venous catheter lines frequently flip after power injection of contrast. *J Comput Assist Tomogr.* 2012;36(4):427-430. doi:10.1097/RCT.0b013e3182575b88
20. Morden P, Sokhandon F, Miller L, et al. The role of saline flush injection rate in displacement of CT-injectable peripherally inserted central catheter tip during power injection of contrast material. *AJR Am J Roentgenol.* 2014;202(1):W13-W18. doi:10.2214/AJR.13.10625
21. Kang J, Chen W, Sun W, et al. Peripherally inserted central catheter-related complications in cancer patients: a prospective study of over 50,000 catheterdays. *J Vasc Access.* 2017;18(2):153-157. doi:10.5301/jva.5000670
22. ACR Committee on Drugs and Contrast Media. *ACR Manual on Contrast Media*. American College of Radiology; 2020. https://www.acr.org/Clinical-Resources/Contrast-Manual
23. Chen W, He L, Yue L, Park M, Deng H. Spontaneous correction of misplaced peripherally inserted central catheters. *Int J Cardiovasc Imaging*. 2018;34(7):1005-1008. doi:10.1007/s10554-018-1321-5
24. Massmann A, Jagoda P, Kranzhoefer N, Buecker A. Percutaneous re-positioning of dislocated port-catheters in patients with dysfunctional central-vein port-systems. *Ann Surg Oncol*. 2015;22(13):4124-4129. doi:10.1245/s10434-015-4549-5
25. Mauri D, Zafeiri G, Tsali L, et al. Identification of catheter misplacement in early port CVC dysfunction. *Contemp Oncol (Pozn).* 2018;22(2):129-134. doi:10.5114/wo.2018.77044
26. Pereira S, Preto C, Pinho C, Vasconcelos P. When one port does not return blood: two case reports of rare causes for misplaced central venous catheters. *Braz J Anesthesiol.* 2016;66(1):78-81. doi:10.1016/j.bjane.2014.02.007
27. Gorski LA. Complications of infusion therapy. In: Gorski LA, ed. *Phillips's Manual of I.V. Therapeutics: Evidence-Based Practice for Infusion Therapy.* 7th ed. F.A. Davis Company; 2018.
28. Spencer TR. Repositioning of central venous access devices using a high-flow flush technique - a clinical practice and cost review. *J Vasc Access.* 2017;18(5):419-425. doi:10.5301/jva.5000748
29. Gautam PL, Kundra S, Jain K, Monga H. Repositioning of misplaced central venous catheter with saline injection under C-arm imaging. *J Clin Diagn Res*. 2015;9(12):UD01-UD2. doi:10.7860/JCDR/2015/15694.6930
30. Wyckoff MM, Sharpe EL. *Peripherally Inserted Central Catheters: Guideline for Practice.* 3rd ed. National Association of Neonatal Nurses; 2015.

55. CATHETER-ASSOCIATED SKIN INJURY

Editor's Note:
This Standard includes recommendations from the article, "Management of Central Venous Access Device-Associated Skin Impairment: An Evidence-Based Algorithm." The CVAD-Associated Skin Impairment (CASI) algorithm is shown in **Appendix C** to provide more detailed guidance; terms used to describe skin damage are included in the glossary.

Standard

55.1 VAD sites are routinely assessed for signs and symptoms of skin injury.

55.2 Appropriate intervention(s) are implemented to reduce the risk of, and manage, skin injury.

Practice Recommendations

A . Assess the patient and skin at the VAD site to promptly recognize signs and symptoms of skin impairment.[1-5] (V)
   1. Assess color, texture, uniformity of appearance, and integrity of skin.[1,5,6] (V)
   2. Determine type and severity of skin damage (no published assessment scale available):
      a. Contact dermatitis, including redness lasting more than 30 minutes after dressing removal/application.
      b. Skin injury, including skin stripping, skin tears, and tension blisters.
      c. Weeping, oozing drainage.
      d. Exit site infection.[6] (V)
   3. Describe skin damage based upon:
      a. Color (eg, pink, red, purple, tan, white).
      b. Shape (eg, papule, vesicle, pustule).
      c. Arrangement (eg, linear, ring-like).
      d. Size and depth (eg, superficial, partial thickness, or full thickness).
      e. Distribution or extent of skin disruption (eg, confined to dressing surface area or found on other body sites).[1,5,6,7] (V)
   4. Assess exudate if present for:
      a. Color (eg, clear, amber, cloudy, pink or red, green, yellow or brown).
      b. Consistency (eg, high viscosity: thick, sometimes sticky, or low viscosity: thin, "runny").
      c. Odor of the exudate (eg, unpleasant).
      d. Dressing leakage.
      e. Noninfectious exudate.[1,8] (V)
   5. Rule out presence of infiltration, extravasation, thrombophlebitis, and skin conditions related to other body regions (eg, eczema, impetigo, cellulitis, erysipelas, or drug eruptions) and treat accordingly (see Standard 46, *Phlebitis;* Standard 47, *Infiltration and Extravasation*).[1,4] (V)
   6. Assess for signs of localized or systemic infection, including fungal infection (eg, *Candida*; whitish or raised red areas unresponsive to other treatment). Refer to Standard 50, *Infection.*
   7. Obtain patient's history of known or suspected allergies or episodes of contact dermatitis, including the type of skin antiseptic agent, skin barrier, and previous use of products.[1,4,6,9] (V)

B. Identify and promptly avoid suspected irritant/allergen and substitute products (eg, antiseptic agent, adhesive securement, dressing).[1,2,4,6,10] (V)
   1. Assess if damage may be due to the product (eg, antiseptic solution, dressing) or the technique of product use.[1] (V)
   2. Consider use of an open application patch test, applying product to unaffected skin (eg, anterior forearm; 1 product per site; recognizing that this is not a true test of allergy).[1,2] (V)
   3. Consider referral for allergy testing (eg, patch or scratch testing) to investigate symptoms of suspected allergy. Do not label as an allergic reaction until this has been confirmed.[4,6,11] (V)
   4. Assess for sensitivity to the antiseptic solution.[1,3] (V)
      a. Ensure the solution completely dries, following manufacturers' directions for use, prior to barrier film/dressing application.[1,3,5] (V)
      b. Consider changing the concentration or type of solution.[1,3] (V)
      c. Consider use of sterile 0.9% sodium chloride if no resolution, recognizing the lack of antiseptic properties and need for assessing for signs of infection.[1,3,12] (V)
   5. Assess for sensitivity to the dressing.[1,6,13] (V)
      a. Consider changing dressing brand as dressings have different composite materials.[1,3] (V)
      b. Rule out dressing-related factors, such as frequent dressing changes, improper application technique (eg, tension on application, application to moist/wet skin, excessive use of tackifiers or bonding agents), or removal technique (rapid and/or vertical pulling or insufficient support of the skin at the peel line when removing adhesive product).[6,14] (V)
      c. Ensure any residual adhesive is removed from the skin during skin antisepsis.[15] (V)
   6. Avoid subsequent exposure to identified or suspected factors contributing to the impaired skin.[1] (V)

C. Employ strategies to promote skin regeneration and site protection.[1,5,6] (V)
   1. Consider use of a sterile, medical adhesive removal product to minimize discomfort and skin damage associated with removal of dressings.[3,6] (V)
   2. Apply sterile, alcohol-free skin barrier product, compatible with the antiseptic solution, to protect at-risk skin and allow barrier to dry. Silicone-based skin barrier films have been reported in use with neonate and premature infants, although this practice is off-label and further research required.[1,2,5,6] (V)
   3. Apply a hypoallergenic, sterile dressing to clean, dry skin to manage exudate, promote wound healing,

and protect VAD site (refer to the Dressing Usage Guide in *Appendix C*).[1,4,6,16] (IV)

4. For skin tears, if skin flap is present, realign viable skin flap edges prior to dressing application.[1,3] (V)
   a. Avoid use of transparent semipermeable membrane (TSM) dressings, adhesive strips, and hydrocolloid dressings for the management of skin tears due to the risk of epidermal stripping if not removed properly.[1,17] (V)
   b. If skin damage/drainage is away from the exit site, isolate wound and exudate from the exit site, apply absorbent dressing over injury, and apply transparent dressing over the exit site. A published protocol recommends application of a silicone mesh to broken skin and a TSM dressing, ensuring the dressing is applied over a healthy skin border.[1,3] (V)
   c. Address catheter securement if using dressing system with no securement properties; more frequent monitoring may be required (see Standard 38, *Vascular Access Device Securement*).[1,5,6] (V)
5. Promote patient comfort.[1,2,4,17] (V)
   a. Assess pain using a standardized, validated assessment tool (eg, Visual Analogue Scale or Numeric Rating Scale).[1,18] (V)
   b. Consider anti-inflammatory, antipruritic, antihistamine and/or analgesic agents, and cool compresses applied on top of the dressing.[1,2,19] (V)
6. Assess site with impaired skin integrity regularly and monitor for signs and symptoms of skin damage or infection.[1] (V)
   a. If no improvement with inflammation and pruritus at the site, consider short-term use of topical low- to-moderate potency corticosteroid (do not apply directly on exit site; agent is nonsterile) and consider obtaining swab of site for culture and sensitivity.[1,3,4] (V)
   b. If no improvement in skin condition within 3 to 7 days or skin condition deteriorates with above measures, seek expert advice (eg, consult wound/skin specialist).[1,2,4,6] (V)
   c. For premature infants with signs of a chemical burn or irritation, take immediate action, removing potential source of irritation; treat, and if necessary, promptly consult with other specialists, including dermatology and surgery specialists.[20] (V)
   d. Consider device removal and reassess plan for vascular access.[3] (V)
7. Employ strategies to maintain skin health at VAD sites.[1,2] (V)
   a. Avoid insertion of a VAD in area of impaired skin, whenever possible.[2] (V)
   b. Apply skin barrier film at each dressing change, particularly for high-risk patients.[2,6] (V)
   c. Weigh the risk and benefits of use of chlorhexidine-impregnated dressings in patients with complicated skin disorders (eg, Stevens-Johnson syndrome, graft-vs-host disease, burns, and anasarca) and highly exudative sites; immunosuppressed patients; young children; and as indicated by the product directions for use. Consider more frequent site assessment in patients with fluid exudate at site.[2,21,22] (V)
   d. Maintain proper nutrition and hydration.[3,6] (V)
   e. Consider use of gum mastic liquid adhesive to select adult patients when enhanced adhesive adherence is needed; consider use of skin barrier film prior to application of liquid adhesive and ensure correct technique in dressing removal to prevent catheter-associated skin injury due to increased bonding of adhesives to skin.[6,23-25] (IV)
   f. Consider use of a hemostatic agent/dressing for patients at risk of bleeding post-VAD insertion (refer to Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes*).
   g. Prevent risk of pressure injury from catheter/add-on device in patients with fragile skin.[9] (IV)
   h. Change dressing promptly if soiled or not intact or upon initial signs/symptoms of skin impairment.[14] (V)
   i. Educate staff and patients on VAD site care, as well as early recognition and prompt management of catheter-associated skin injury.[1,3,4] (V)
      i. Educate clinicians/patients/caregivers on antiseptic solutions and atraumatic dressing application (eg, clip hair if necessary; allow prep solutions to dry; apply dressing without tension, pulling, or stretching and smooth the adhesive product into place with firm gentle pressure, avoiding gaps and wrinkles) and removal (eg, slow removal while keeping the adhesive product horizontal to the skin and folded onto itself).[1,5,6] (V)
      ii. Ensure patient experiencing catheter-associated skin injury understands suspected irritant and preventative strategies to prevent recurrence.[1,3,5,17] (V)
8. Employ quality improvement measures to monitor and address increases in the incidence of catheter-associated skin injury (eg, audits, preprinted order sets, documentation of signs and symptoms). Further research in products, technologies, and care practices is needed to evaluate prevention, management, and incidence of catheter-associated skin injury.[1,3,4,6,25,26] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 17, 2020, and August 30, 2020.

1. Broadhurst D, Moureau N, Ullman AJ; The World Congress of Vascular Access (WoCoVA) Skin Impairment Management Advisory Panel. Management of central venous access device-associated skin impairment: an evidence-based algorithm. *J Wound Ostomy Continence Nurs*. 2017;44(3):211-220. doi:10.1097/WON.0000000000000322

2. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines.* Pappin Communications; 2019.
3. Hitchcock J, Savine L. Medical adhesive-related skin injuries associated with vascular access. *Br J Nurs.* 2017;26(8):S4-S12. doi:10.12968/bjon.2017.26.8.S4
4. Kutzscher L. Management of irritant contact dermatitis and peripherally inserted central catheters. *Clin J Oncol Nurs.* 2012;16(2):E48-E58. doi:10.1188/12.CJON.E48-E55
5. Thayer D. Skin damage associated with intravenous therapy: common problems and strategies for prevention. *J Infus Nurs.* 2012;35(6):390-401. doi:10.1097/NAN.0b013e318270a91e
6. McNichol L, Lund C, Rosen T, Gray M. Medical adhesives and patient safety: state of the science: consensus statements for the assessment, prevention, and treatment of adhesive-related skin injuries. *J Wound Ostomy Continence Nurs*. 2013;40(4):365-E2. doi:10.1097/WON.0b013e3182995516
7. Spruce P, Warriner L, Keast D, Kennedy A. Exit site wounds made easy. *Wounds Int.* 2012;3(2):1-6. http://www.woundsinternational.com
8. World Union of Wound Healing Societies. *Wound Exudate and the Role of Dressings. A Consensus Document*. Medical Education Partnership Ltd; 2007. https://www.cardinalhealth.com/content/dam/corp/web/documents/case-study/wound-exudate-and-the-role-of-dressings-consensus-document.pdf
9. Zhao H, He Y, Huang H, et al. Prevalence of medical adhesive-related skin injury at peripherally inserted central catheter insertion site in oncology patients. *J Vasc Access.* 2018;9(1):23-27. doi:10.5301/jva.5000805
10. Weitz NA, Lauren CT, Weiser JA, et al. Chlorhexidine gluconate–impregnated central access catheter dressings as a cause of erosive contact dermatitis. *JAMA Dermatol.* 2013;149(2):195-199. doi:10.1001/jamadermatol.2013.903
11. Aalto-Korte K, Mäkinen-Kiljunen S. Symptoms of immediate chlorhexidine hypersensitivity in patients with a positive prick test. *Contact Dermatitis.* 2006;55(3):173-177. doi:10.1111/j.1600-0536.2006.00900.x
12. Gavin N, Webster J, Chan R, Rickard CM. Frequency of dressing changes for central venous access devices on catheter-related infections. *Cochrane Database Syst Rev.* 2016;2:CD009213. doi:10.1002/14651858.CD009213.pub2
13. Farris MK, Petty M, Hamilton J, Walters SA, Flynn MA. Medical adhesive-related skin injury prevalence among adult acute care patients: a single-center observational study. *J Wound Ostomy Continence Nurs*. 2015;42(6):589-598. doi:10.1097/WON.0000000000000179
14. dos Santos B, de Oliveira MC, Braga F, Margatho A, Esparrachiari L, Silveira de Campos Pereira R. Local cutaneous effects associated with chlorhexidine-impregnated gel dressing in hematopoietic stem cell transplantation patients. *Open J Nurs*. 2018;8(2):115-129. doi:10.4236/ojn.2018.82010
15. Cheng CE, Kroshinsky D. Iatrogenic skin injury in hospitalized patients. *Clin Dermatol.* 2011;29(6):622-632. doi:10.1016/j.clindermatol.2011.08.006
16. Ullman AJ, Cooke M, Rickard CM. Examining the role of securement and dressing products to prevent central venous access device failure: a narrative review. *J Assoc Vasc Access*. 2015;20(2):99-110. https://doi.org/10.1016/j.java.2015.03.001
17. LeBlanc K, Baranoski S; Skin Tear Consensus Panel Members. Skin tears: state of the science: consensus statements for the prevention, prediction, assessment, and treatment of skin tears. *Adv Skin Wound Care*. 2011;24(9 suppl):2-15. doi:10.1097/01.ASW.0000405316.99011.95
18. Hjermstad MJ, Fayers PM, Haugen DF, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. *J Pain Symptom Manage.* 2011;41(6):1073-1093. doi:10.1016/j.jpainsymman.2010.08.016
19. Langner MD, Maibach HI. Pruritus measurement and treatment. *Clin Exp Dermatol.* 2009;34(3):285-288. doi:10.1111/j.1365-2230.2009.03218.x
20. Paternoster M, Niola M, Graziano V. Avoiding chlorhexidine burns in preterm infants. *J Obstet Gynecol Neonatal Nurs.* 2017;46(2):267-271. doi.10.1016/j.jogn.2016.10.007
21. Wall JB, Divito SJ, Talbot SG. Chlorhexidine gluconate-impregnated central-line dressings and necrosis in complicated skin disorder patients. *J Crit Care.* 2014;29(6):1130.e1-1130.e11304.
22. Ullman AJ, Cooke ML, Mitchell M, et al. Dressing and securement for central venous access devices (CVADs): a Cochrane systematic review. *Int J Nurs Stud.* 2016;59:177-196. doi:10.1016/j.ijnurstu.2016.04.003
23. Ryder M, Duley C. Evaluation of compatibility of a gum mastic liquid adhesive and liquid adhesive remover with an alcoholic chlorhexidine gluconate skin preparation. *J Infus Nurs*. 2017;40(4):245-252. doi:10.1097/NAN.0000000000000230
24. DeVries M, Sarbenoff J, Scott N, Wickert M, Hayes LM. Improving vascular access dressing integrity without increased skin complications. *J Wound Ostomy Continence Nurs.* Forthcoming; 2020.
25. Yates S, McNichol L, Heinecke SB, Gray M. Embracing the concept, defining the practice, and changing the outcome: setting the standard for medical adhesive-related skin injury interventions in WOC nursing practice. *J Wound Ostomy Continence Nurs.* 2017;44(1):13-17. doi:10.1097/WON.0000000000000290
26. Ullman AJ, Mihala G, O'Leary K, et al. Skin complications associated with vascular access devices: a secondary analysis of 13 studies involving 10,859 devices. *Int J Nurs Stud.* 2019;91:6-13. doi.10.1016/j.ijnurstu.2018.10.006

Section Eight: Other Infusion Devices

Section Standards

I. The clinician is competent in the management of intraspinal, intraosseous (IO), and subcutaneous devices, including knowledge of anatomy, physiology, infusion administration, and management techniques aimed at maintaining access and reducing risk of complications.

II. Insertion, care and management, and complication management for intraspinal, IO, and subcutaneous access are established in organizational policies, procedures, and/or practice guidelines.

56. INTRASPINAL ACCESS DEVICES

Standard

56.1 Intraspinal access devices and administration sets are identified and labeled as a specialized infusion administration system and differentiated from other infusion administration and access systems.

56.2 Medications administered via an intraspinal route are free of preservatives.

56.3 Intraspinal infusion solutions are filtered using a 0.2-micron, surfactant-free, particulate-retentive, and air-eliminating filter.

56.4 Intraspinal access device placement, removal, and medication administration are performed either by or upon the order of the provider in accordance with regulations established by regulatory and accrediting bodies and in accordance with organizational policies and procedures.

Practice Recommendations

A. Anticipate intraspinal (epidural/intrathecal) medication infusions for patients across practice settings from acute care to outpatient and home care. Indications include:
   1. Management of short-term acute pain associated with surgical procedures, trauma pain, and during labor in hospitalized patients; a temporary intraspinal catheter is placed for analgesic/anesthetic medication administration.[1-4] (IV)
   2. Chronic cancer and non–cancer-related pain refractory to medical management and/or intolerable side effects associated with systemically administered analgesics. Infusions may include opioids alone, opioids in combination with dilute local anesthetics, and opioids in combination with local anesthetics and clonidine. Options for intraspinal access for chronic pain include long-term tunneled catheters, implanted ports with epidural/intrathecal catheters, and implanted pumps with an epidural/intrathecal catheter.[4-9] (IV)
   3. Spasticity treated with intrathecal baclofen.[4] (IV)
   4. Treatment of primary central nervous system cancers and leptomeningeal metastases.[10-11] (IV)
   5. For patients with chronic refractory pain, the use of intrathecal infusions is increasing; the benefits of intrathecal infusion, as compared to epidural infusion, include higher analgesic efficacy and lower rates of treatment failures and technical complications.[5,6,7] (III)

B. Assess the patient's current anticoagulation therapy; anticoagulants must be withheld before intraspinal insertion and before removal due to risk for epidural hematoma and paralysis.
   1. Obtain dosage, route, date, and time of last anticoagulant administration.
   2. Review coagulation panel results.
   3. Consult with provider regarding how long to withhold anticoagulants before the planned procedure.[1,2,12] (IV)

C. Titrate analgesic medications carefully during medication initiation, when converting from one route to another (eg, intravenous [IV] to epidural to intrathecal), one medication to another, and when adding adjuvant medications. Dosing and opioid conversion guidelines should be used, and dosing should start low when converting from one medication to another.[5,6,7] (II)
   1. The clinical site for trialing and dosing for patients with chronic pain generally requires hospital admission, which allows for flexibility in trialing different intrathecal medications and regimens. Low-dose opioid trialing may be considered in the outpatient setting with a shorter observation period before releasing the patient; however, an overnight hospital admission is recommended with high starting doses.[5] (V)

D. Implement specific practices to prevent antineoplastic medication errors; errors from inadvertent administration of IV antineoplastic medications administered via the intrathecal route have resulted in profound toxicity and death.
   1. Recognize that antineoplastic medications administered via an intraspinal route are administered by physicians and advanced practice providers in conjunction with local and national regulations and organizational policy.

2. Use different delivery devices, systems, and connectors for medications to be administered via an intraspinal vs other parenteral routes; IV vinca alkaloid administration should be prepared in a small volume infusion bag and administered as an infusion, not in a syringe.
3. Prepare and store intrathecal medications separately. These should be clearly labeled "For Intrathecal Use."
4. Perform an independent double check with another qualified nurse, pharmacist, or physician prior to administration (including when syringe/medication container, rate, and/or concentration is changed) including verification of the safety of intraventricular/intrathecal route and its mixture with preservative-free 0.9% sodium chloride or Elliotts B solution (used for methotrexate sodium and cytarabine).
5. Use a time-out procedure prior to medication administration.[10,11,13,14] (IV)

E. Maintain Surgical-Aseptic Non Touch Technique (Surgical-ANTT) using a Critical Aseptic Field during catheter placement and implanted intraspinal port access; wear a mask during all intraspinal medication injections to reduce the risk of droplet transmission of oropharyngeal flora (see Standard 18, *Aseptic Non Touch Technique*).[1,2,4,15] (IV)

F. Confirm placement of the intraspinal access device before any infusion or medication administration.
1. Aspirate epidural access devices prior to medication administration to ascertain the absence of spinal fluid and blood; if greater than 0.5 mL of serous fluid is aspirated, notify the provider, and do not administer the medication as this finding is indicative of catheter migration into the intrathecal space.
2. Aspirate intrathecal and ventricular access devices prior to medication administration to ascertain the presence of spinal fluid and the absence of blood.[2,4] (A/P)

G. Use an electronic infusion pump with anti–free-flow protection to administer continuous infusions. Patient-controlled analgesia may be used with epidural infusions.
1. Use an administration set without any injection ports to reduce the risk of inadvertent intraspinal access.[2,4] (V)

H. Perform the access procedure and medication filling of an implanted intraspinal delivery system with a medication reservoir at regular intervals only by competent and skilled clinicians and in accordance with the manufacturers' directions for use.
1. Never allow the pump to be completely empty.
2. Ensure strict attention to needle placement to avoid accidental injection into surrounding tissue.
3. Consider use of ultrasound to access the pump septum.
4. Observe patients for at least 30 minutes after a pump refill.
5. Ensure availability of naloxone to treat inadvertent overdoses.[4,8,9,16-19] (III)

I. Apply and maintain a sterile dressing that is clean, dry, and intact over the insertion site and secure the access site.
1. Use a securement product or tape a tension loop of tubing to the patient's body to reduce the risk of accidental dislodgement (see Standard 38, *Vascular Access Device Securement*).[2,4] (V)
2. Subcutaneous tunneling and sutures resulted in fewer incidents of premature dislodgement of thoracic epidural catheters when compared to taping.[20] (III)
3. Perform site care and dressing changes over a tunneled and accessed implanted epidural device in accordance with organizational policy; there are no evidence-based recommendations for routine site care and dressing changes. (Committee Consensus)
4. Avoid use of alcohol with device access and when site care is performed; use aqueous chlorhexidine solution or povidone iodine solution; however, allow any skin antiseptic agent to fully dry as all antiseptic agents have the potential to be neurotoxic.[2,4] (V)
5. Use a transparent semipermeable dressing to allow for site visualization; consider the use of chlorhexidine-impregnated dressings for patients with an epidural access device. A significant reduction in epidural skin colonization and catheter tip colonization has been demonstrated with their use.[4,21-23] (I)

J. Reduce the risk for administration set misconnections.
1. Trace all catheters/administration sets/add-on devices between the patient and the container before connecting or reconnecting any infusion/device, at each care transition to a new setting or service, and as part of the handoff process.
2. Use International Organization for Standardization (ISO)–approved connectors to prevent misconnections among IV, enteral, and intraspinal infusions (ie, neuraxial [NRFit] and enteral [EnFit]) when available (see Standard 13, *Medication Verification*).[24] (V)

K. Maintain peripheral IV access for at least 24 hours due to the potential need for naloxone administration in the event of respiratory depression.[6] (V)

L. Assess and monitor patients after initiating or restarting an intraspinal infusion for at least the first 24 hours; assess every 1 to 2 hours until stable, then every 4 hours, or with each home visit. Include the following assessment parameters:
1. Pain rating using a validated, appropriate pain scale based on the patient's age and condition (eg, 0-10), both at rest and with activity.
2. Blood pressure, pulse, respiratory rate, temperature.
3. Level of sedation if opioid is being administered.
4. Number of bolus doses, if used (eg, patient-controlled epidural analgesia).
5. Fetal status and response to intraspinal infusion for the patient in labor.

6. Presence of any side/adverse effects, such as pruritus, nausea, urinary retention, orthostatic hypotension, motor block, ringing in the ears.
7. Signs of catheter insertion site infection or epidural abscess, such as back pain, tenderness, erythema, swelling, drainage, fever, malaise, neck stiffness, progressive numbness, or motor block.
8. Signs of catheter tip migration, such as a change in external catheter length, decrease in pain control, or increased side effects.
9. Dressing for intactness and absence of moisture/leakage.
10. Catheter and administration set connections.
11. Changes in sensory or motor function that may indicate an epidural hematoma, including unexplained back pain, leg pain, bowel or bladder dysfunction, and motor block.
12. Electronic infusion pump for history of analgesic use and correct administration parameters.[2,4] (V)
13. Oxygen saturation levels via pulse oximeter and end-tidal carbon dioxide levels (capnography) in accordance with organizational policy; use of capnography is more sensitive in identifying respiratory depression than oxygen saturation monitoring.[2,4,25] (I)

M. Address the following patient education topics:
1. Principles of intraspinal access device placement and what to expect during the insertion procedure.
2. The importance of reporting alcohol use and all medications used, including prescription, over-the-counter, and complementary medications.
3. Signs and symptoms to report, including changes in pain perception, new or worsening side effects, and fever.
4. Clinical signs of overdose, including dizziness, sedation, euphoria, anxiety, seizures, and respiratory depression.
5. Patients with implanted infusion pump systems: no bending/twisting at the waist for 6 weeks and overall caution with active repetitive bending or twisting of spine as these may increase the risk for catheter damage or dislodgement; increased pain and withdrawal symptoms may be indicative of problems.[2,4] (V)

REFERENCES

Note: All electronic references in this section were accessed between March 6, 2020, and August 13, 2020.

1. Sawhney M, Chambers S, Hysi F. Removing epidural catheters: a guide for nurses. *Nursing.* 2018;48(12):47-49. doi:10.1097/01.NURSE.0000546459.86617.2a
2. Williams K. Epidural catheters: assisting with insertion and pain management. In: Weigand DL, ed. *AACN Procedure Manual for High Acuity, Progressive, and Critical Care*. 7th ed. Elsevier; 2017:929-940.
3. Maitra S, Baidya DK, Pawar DK, Arora MK, Khanna P. Epidural anesthesia and analgesia in the neonate: a review of current evidences. *J Anesth.* 2014;28(5):768-779. doi:10.1007/s00540-014-1796-8
4. Elledge CM, Stovall M. Epidural and intrathecal access devices. In: Camp-Sorrell D, Matey L, eds. *Access Device Standards of Practice for Oncology Nursing*. Oncology Nursing Society; 2017:119-129.
5. Deer TR, Pope JE, Hayek SM, et al. The Polyanalgesic Consensus Conference (PACC): recommendations on intrathecal drug delivery systems best practices and guidelines. *Neuromodulation.* 2017;20(2):96-132. doi:10.1111/ner.12538
6. Ver Donck A, Vranken JH, Puylaert M, Hayek S, Mekhail N, Zundert JV. Intrathecal drug administration in chronic pain syndromes. *Pain Pract.* 2014;14(5):461-476. doi:10.1111/papr.12111
7. Gulati A, Puttanniah V, Hung J, Malhotra V. Considerations for evaluating the use of intrathecal drug delivery in the oncologic patient. *Curr Pain Headache Rep*. 2014;18(2): 391. doi:10.1007/s11916-013-0391-2
8. Textor LH. CE: intrathecal pumps for managing cancer pain. *Am J Nurs.* 2016;116(5):36-44. doi:10.1097/01.NAJ.0000482955.78306.b1
9. Hayek SM, Hanes MC. Intrathecal therapy for chronic pain: current trends and future needs. *Curr Pain Headache Rep*. 2014;18:388. doi:10.1007/s11916-013-0388-x
10. Olsen MM, LeFebvre KB, Brassil KJ. Administration considerations. In: Olsen MM, LeFebvre KB, Brassil KJ, eds. *Chemotherapy and Immunotherapy Guidelines and Recommendations for Practice*. Oncology Nursing Society; 2019:193-233.
11. Gilbar PJ. Intrathecal chemotherapy – potential for medication error. *Cancer Nurs.* 2014;37(4):299-309. doi:10.1097/NCC.0000000000000108
12. Horlocker TT, Vandermeuelen E, Kopp SL, Gogarten W, Leffert LR, Benzon HT. Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy – American Society of Regional Anesthesia and Pain Medicine evidence-based guidelines (fourth edition). *Reg Anesth Pain Med*. 2018;43(3):263-309. doi:10.1097/AAP.0000000000000763
13. Beaver C. Vincristine minibag administration: a quality improvement project to minimize medical errors. *Clin J Oncol Nurs*. 2018;22(6):669-672. doi:10.1188/18.CJON.669-672
14. Institute for Safe Medication Practices. Top 10 medication errors and hazards. Published January 16, 2020. https://www.ismp.org/resources/start-new-year-right-preventing-these-top-10-medication-errors-and-hazards
15. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. 2007 guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. Centers for Disease Control and Prevention; 2007. Updated July 2019. https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines-H.pdf
16. Gofeld M, McQueen CK. Ultrasound-guided intrathecal pump access and prevention of the pocket fill. *Pain Med.* 2011;12(4):607-611. doi:10.1111/j.1526-4637.2011.01090.x
17. Saulino M, Gofeld M. "Sonology" of programmable intrathecal pumps. *Neuromodulation.* 2014;17(7):696-698. doi:10.1111/ner.12159
18. Maino P, van Kuijk SMJ, Perez RSGM, Koetsier E. Ease of fill port access during the ultrasound-guided vs. the blind refill technique of intrathecal drug delivery systems with a raised septum, a prospective comparison study. *Neuromodulation.* 2018;21(7):641-647. doi:10.1111/ner.12736
19. Maino P, Perez RSGM, Koetsier E. Intrathecal pump refills, pocket fills, and symptoms of drug overdose: a prospective, observational study comparing the injected drug volume vs. the drug volume effectively measured inside the pump. *Neuromodulation.* 2017;20(7):733-739. doi:10.1111/ner.12597
20. Sellmann T, Bierfischer V, Schmitz A, et al. Tunneling and suture of thoracic epidural catheters decrease the incidence of catheter dislodgement. *Sci World J.* 2014. doi:10.1155/2014/610635
21. Ho KM, Litton E. Use of chlorhexidine-impregnated dressing to prevent vascular and epidural catheter colonization and infection: a meta-analysis. *J Antimicrob Chemother*. 2006;58(2):281-287. doi:10.1093/jac/dkl234

22. Kerwat K, Eberhart L, Kerwat M, et al. Chlorhexidine gluconate dressings reduce bacterial colonization rates in epidural and peripheral regional catheters. *Biomed Res Int.* 2015;2015:149785. doi:10.1155/2015/1149785
23. Scheithauer S, Möller M, Höllig A, et al. Are chlorhexidine-containing dressings safe for use with ventricular drainages? *Infection*. 2014;42(3):545-548. doi:10.1007/s15010-014-0596-2
24. International Organization for Standardization (ISO). ISO 80369-6:2016: small bore connectors for liquids and gases in healthcare applications—part 6: connectors for neuraxial applications. ISO; 2016. https://www.iso.org/standard/50734.html
25. Lam T, Nagappa M, Wong J, Singh M, Wong D, Chung F. Continuous pulse oximetry and capnography monitoring for postoperative respiratory depression and adverse events: a systematic review and meta-analysis. *Anesth Analg*. 2017;125(6):2019-2029. doi:10.1213/ANE.0000000000000255757.

57. INTRAOSSEOUS ACCESS DEVICES

Standard

57.1 The clinician evaluates the patient and anticipates appropriate use of the IO route in the event of difficult vascular access for emergent, urgent, and medically necessary situations.

Practice Recommendations

A. Anticipate use of the IO route in the event of adult or pediatric cardiac arrest if IV access is not available or cannot be obtained quickly. Pediatric advanced life support guidelines recommend the use of the IO route as the initial vascular access route in case of cardiac arrest.[1-17] (II)
   1. IO access has a reported high rate of first-time insertion success with low complications. Insertion of an IO device may avoid delays to delivery of necessary medication and fluid.[8,11,12,15,16,18-27] (II)
   2. The clinical impact of IO delivery on patient survival in cardiac arrest requires further investigation, as recent studies have found IO access associated with a decreased rate of return of spontaneous circulation, decreased survival to hospital admission, and poorer neurologic outcomes when compared to IV access.[2,9,12,14,23,28,29] (II)

B. Consider the IO route for emergent and nonemergent use in patients with limited or no vascular access; when the patient may be at risk of increased morbidity or mortality if access is not obtained, such as during shock, life-threatening or status epilepticus, extensive burns, major traumatic injuries, transfusion, or severe dehydration, and/or when delay of care is compromised without rapid vascular access.[12,15,23,27,30-36] (II)
   1. IO infusion has been successfully used in administration of anesthesia, rapid sequence intubation, neonatal resuscitation, hypertonic saline administration in acute intracranial hypertension, and for radiologic imaging with radiologic confirmation of placement prior to contrast administration.[23,30,31,35,37-43] (IV)

C. Restrict IO access in the following sites/situations:
   1. Absolute contraindications (related to anatomic issues): compartment syndrome in target extremity, previously used IO site or recent failed IO attempt, fractures at or above the site, previous orthopedic surgery/hardware, presence of infection or severe burns near the insertion site, and local vascular compromise.[1,17,30,31,35,37,42,44-47] (IV)
   2. Avoid use of IO access in the presence of bone diseases, such as osteogenesis imperfecta, osteopetrosis, and osteoporosis.[1,17,30,31] (IV)

D. Improve appropriate use of the IO route through education and competency programs; underuse of the IO route in multiple settings is reported.[1,22,34,48-53] (III)
   1. Include the following in competency programs: initial and ongoing validation of safe insertion knowledge and skills through demonstration; demonstration of appropriate device management; ability to recognize complications related to IO access (see Standard 5, *Competency and Competency Assessment*).[12,21,52-54] (II)

E. Use an appropriate IO device for the patient's age and condition. Performance (success rates, time of placement, ease of use, user preference) of different IO devices is dependent on training and user preference. There is no clear evidence of superiority of 1 device over another.
   1. Consider the use of a safety-engineered IO device (see Standard 21, *Medical Waste and Sharps Safety*).[1,3,8,12,25,35,55] (II)

F. Select an appropriate IO site based on the clinical situation and in accordance with manufacturers' directions for use.[12,20,35] (II)
   1. Consider sites most commonly reported in the literature for use in both adults and children, including the proximal and distal tibia and the proximal humerus, the distal femur for children, and the sternum in adults.[12,20,35] (II)
   2. Sites less commonly reported in the literature include the medial surface of the ankle, radius, ulna, pelvis, and clavicle.[1,3,12,17,21,22,44] (II)
   3. Ensure proper landmarks are identified prior to insertion, when clinically possible, to avoid complications related to improper placement.[45,54] (IV)
   4. When using a drill or driver to place the IO device, a 25-mm needle is recommended for obese patients who have a nonpalpable tibial tuberosity and body mass index (BMI) less than or equal to 43; a 45-mm needle is recommended in patients with a BMI greater than 43 and for humeral head insertion in the obese patient.[56] (IV)
      a. Obesity is identified as a common factor for insertion failure due to difficulty identifying landmarks.[12,45,56] (II)

G. Consider the use of subcutaneous lidocaine as a local anesthetic prior to insertion at the intended site. For infusion-related pain, consider IO administration of 2%

preservative-free and epinephrine-free lidocaine given slowly prior to infusion initiation; however, a systematic review reports lack of evidence of its efficacy.[1,12,16,17,22,30,35] (II)

H. Adhere to ANTT during IO placement and infusion; consider the complexity of placement of the IO access device; use Standard-ANTT if there is no need to touch Key-Parts directly; for more complex insertion techniques and/or need to touch Key-Parts, use Surgical-ANTT (see Standard 18, *Aseptic Non Touch Technique*).[17,57] (V)
   1. Perform skin antisepsis using an appropriate solution (eg, alcohol-based chlorhexidine, povidone-iodine, 70% alcohol) based on organizational policies and procedures. There is no evidence addressing the optimal antiseptic solution.[1,17] (IV)

I. Confirm correct placement of the IO device by assessing the following: correct needle position, sensation of loss of resistance upon bone penetration, and absence of any signs of infiltration upon flushing with 5- to 10-mL (adult) or 2- to 5-mL (pediatric) preservative-free 0.9% sodium chloride. The ability to aspirate blood or bone marrow also assists in confirmation but may be difficult in certain patients (eg, severe dehydration) and therefore is not an indication of improper placement if other indications of placement confirmation are present. Consider the use of color Doppler ultrasound to confirm initial placement and confirm position after patient movement.[1,17,22,26,31,35,37,56] (IV)

J. Consider reserving IO aspirate for laboratory analysis when there are no other options and interpret results with caution.[58] (IV)
   1. Use caution in interpretation of laboratory results of IO aspirate prior to any infusion; a systematic review found weak evidence of correlation between IO and venous and arterial samples in the critically ill.[59] (II)

K. Apply a sterile dressing over the IO access site and secure the device.[1,37] (IV)
   1. Ensure that securement is intact prior to transport to prevent dislodgement.[31,42] (V)

L. Use an external pressure device (300 mm Hg) or infusion pump for consistent solution/medication delivery. IO infusion can be administered via gravity; however, significant variability in flow rates (lower than IV administration) based on the device and site of insertion have been demonstrated.[1,9,17,19,22,24,25,29,33,42,60,61] (IV)

M. Evaluate for placement of a vascular access device as soon as the IO device is placed as it is considered temporary access (see Standard 26, *Vascular Access Device Planning*).[17,20,22,23,26,31,35,37,42,44,46,61] (IV)

N. Monitor for complications associated with IO access.
   1. Occurrence of immediate complications is very low. Data on long-term complications are lacking. Infiltration/extravasation from dislodgement, which may result in compartment syndrome, is the most common complication. Infants and young children may be at greater risk for extravasation and subsequent compartment syndrome due to small bone size and excessively long needle length.[1,12,17,21-23,26,27,30,42,44-47,57] (II)
   2. Reduce risk for infiltration/extravasation by avoiding multiple attempts at IO access at the same site; ensuring proper needle placement; securing IO device; rechecking IO placement with transport or repositioning of the patient and before infusing highly irritating solutions/known vesicants and large-volume infusions; ongoing and frequent assessment of the IO site and extremity, including palpation and calf circumference for tibial placement; and limiting infusion time to less than 24 hours.[17,26,30,31,37,45] (IV)
   3. Observe patients for rare complications, including iatrogenic fracture, infection, fat emboli, air emboli, and osteomyelitis. Infectious complications are more likely to occur with prolonged infusion or if bacteremia was present during the time of insertion. Risk of IO-related fat emboli may be increased with rapidly repeated infusions or high flow rates.[1,12,17,23,27,62,63] (II)

O. Promptly remove the IO device within 24 hours, when therapy is complete, or if signs of dysfunction occur. Dwell time for specific devices may be extended (not to exceed 48 hours total) in instances where alternative vascular access is not successfully established. Follow manufacturers' directions for use and removal of IO device to reduce risk of complications.[1,26,37,47,64,65] (IV)

REFERENCES

Note: All electronic references in this section were accessed June 4, 2020.

1. Petitpas F, Guenezan J, Vendeuvre T, et al. Use of intra-osseous access in adults: a systematic review. *Crit Care.* 2016;20:102. doi:10.1186/s12054-016-1277-6
2. Mody P, Brown S, Kudenchuk P, et al. Intraosseous versus intravenous access in patients with out-of-hospital cardiac arrest: insights from the resuscitation outcomes consortium continuous chest compression trial. *Resuscitation*. 2019;134:69-75. doi:10.1016/j.resuscitation.2018.10.031
3. Kurowski A, Timler D, Evrin T, Szarpak L. Comparison of 3 different intraosseous access devices for adult during resuscitation. Randomized crossover manikin study. *Am J Emerg Med.* 2014;32(12):1490-1493. doi:10.1016/j.ajem.2014.09.007
4. American Heart Association. Part 12: pediatric advanced life support. In: *Web-based Integrated Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*. American Heart Association; 2015. https://ecctemp.wpengine.com/circulation/cpr-ecc-guidelines/part-12-pediatric-advanced-life-support/
5. American Heart Association. Part 7: adult advanced cardiovascular life support. In: *Web-based Integrated Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*. American Heart Association; 2015. https://ecctemp.wpengine.com/circulation/cpr-ecc-guidelines/part-7-adult-advanced-cardiovascular-life-support/
6. Soar J, Nolan JP, Böttiger BW, et al. European Resuscitation Council guidelines for resuscitation 2015: section 3. adult advanced life support. *Resuscitation.* 2015;95:100-147. doi:10.1016/j.resuscitation.2015.07.016

7. Maconochie IK, Bingham R, Eich C, et al. European Resuscitation Council guidelines for resuscitation 2015: section 6. paediatric life support. *Resuscitation*. 2015;95:223-248. doi:10.1016/j.resuscitation.2015.07.028
8. Bielski K, Szarpak L, Smereka J, Ladny JR, Leung S, Ruetzler K. Comparison of four different intraosseous access devices during simulations pediatric resuscitation: a randomized, crossover manikin trial. *Eur J Pediatr*. 2017;176(7):865-871. doi:10.1007/s00431-017-2922-z
9. Feinstein BA, Stubbs BA, Rea T, Kudenchuk PJ. Intraosseous compared to intravenous drug resuscitation in out-of-hospital cardiac arrest. *Resuscitation*. 2017;117:91-96. doi:10.1016/j.resuscitation.2017.06.014
10. Clemency B, Tnaka K, May P, et al. Intravenous vs. intraosseous access and return of spontaneous circulation during out of hospital cardiac arrest. *Am J Emerg Med.* 2017;35(2):222-226. doi:10.1016/j.ajem.2016.10.052
11. Chreiman KM, Dumas RP, Seamon MJ, et al. The intraosseous have it: a prospective observational study of vascular access success rates in patients in extremis using video review. *J Trauma Acute Care Surg*. 2018;84(4):558-563. doi:10.1097/TA.0000000000001795
12. Garside J, Prescott S, Shaw S. Intraosseous vascular access in critically ill adults—a review of the literature. *Nurs Crit Care*. 2016;21(3):167-177. doi:10.1111/nicc.12163
13. Johnson D, Garcia-Blanco J, Burgert J, et al. Effects of humeral intraosseous versus intravenous epinephrine on pharmakokinetics and return of spontaneous circulation in a porcine cardiac arrest model: a randomized control trial. *Ann Med Surg (Lond).* 2015;4(3):306-310. doi:10.1016/j.amsu.2015.08.005
14. Fulkerson J, Lowe R, Anderson T, Moore H, Craig W, Johnson D. Effect of intraosseous tibial vs intravenous vasopressin in a hypovolemic cardiac arrest model. *West J Emerg Med.* 2016;17(2):222-228. doi:10.5811/westjem.2015.12.28825
15. Sheils M, Ross M, Eatough N, Caputo ND. Intraosseous access in trauma by air medical retrieval teams. *Air Med J.* 2014;33(4):161-164. doi:10.1016/j.amj.2014.03.005
16. Horigan A, Vanhoy M, Kaiser J, et al. *Clinical Practice Guideline: Difficult Intravenous Access.* Emergency Nurses Association; 2018.
17. Dev SP, Stefan R, Saun T, Lee S. Videos in clinical medicine. Insertion of an intraosseous needle in adults. *N Engl J Med*. 2014;370(24):e35. doi:10.1056/NEJMvcm1211371
18. Voigt J, Waltzman M, Lottenberg L. Intraosseous vascular access for in-hospital emergency use: a systematic clinical review of the literature and analysis. *Pediatr Emerg Care*. 2012;28(2):185-199. doi:10.1097/PEC.0b013e3182449edc
19. Szarpak L, Truszewski Z, Fudalej M, Krajewski P. The intraosseous access devices as a method of vascular access during cardiopulmonary resuscitation. *Am J Emerg Med.* 2016;34(2):321-322. doi:10.1016/j.ajem.2015.11.013
20. Lee PM, Lee C, Rattner P, Wu X, Gershengorn H, Acquah S. Intraosseous versus central venous catheter utilization and performance during inpatient medical emergencies. *Crit Care Med.* 2015;43(6):1233-1238. doi:10.1097/CCM.0000000000000942
21. Reades R, Studnek JR, Vandeventer S, Garrett J. Intraosseous versus intravenous vascular access during out of hospital cardiac arrest: a randomized controlled trial. *Ann Emerg Med*. 2011;58(6):509-516. doi:10.1016/j.annemergmed.2011.07.020
22. Hunsaker S, Hillis D. Intraosseous vascular success for alert patients. *Am J Nurs*. 2013;113(11):34-40. doi:10.1097/01.NAJ.0000437110.65929.70
23. Johnson M, Inaba K, Byerly S, et al. Intraosseous infusion as a bridge to definitive access. *Am Surg.* 2016; 82(10):876-880.
24. Sørgjerd R, Sunde GA, Heltne JK. Comparison of two different intraosseous access methods in a physician-staffed helicopter emergency medical service–a quality assurance study. *Scand J Trauma Resusc Emerg Med.* 2019;27(1):15. doi:10.1186/s13049-0594-6
25. Hammer N, Möbius R, Gries A, Hossfeld B, Bechmann I, Bernhard M. Comparison of the fluid resuscitation rate with and without external pressure using two intraosseous infusion systems for adult emergencies, the CITRIN (Comparison of InTRaosseous infusion systems in emergency medicINe) study. *PLoS One*. 2015;10(12):e0143726. doi:10.1371/journal.pone.0143726
26. Greenstein YY, Koenig SJ, Mayo PH, Narasimhan M. A serious adult intraosseous catheter complication and review of the literature. *Crit Care Med.* 2016;44(9):e904-909. doi:10.1097/CCM.0000000000001714
27. Lewis P, Wright C. Saving the critically injured trauma patient: a retrospective analysis of 1000 uses of intraosseous access. *Emerg Med J*. 2015;32(6):463-467. doi:10.1136/emermed-2014-203588
28. Nguyen L, Suarez S, Daniels J, Sanchez C, Landry K, Redfield C. Effect of intravenous versus intraosseous access in prehospital cardiac arrest. *Air Med J.* 2019;38(3):147-149. doi:10.1016/j.amj.2019.02.005
29. Kawano T, Grunau B, Scheuermeyer FX, et al. Intraosseous vascular access is associated with lower survival and neurological recovery among patients with out-of-hospital arrest. *Ann Emerg Med.* 2018;71(5):588-596. doi:10.1016/j.annemergmed.2017.11.015
30. Anson JA, Sinz EH, Swick JT. The versatility of intraosseous vascular access in perioperative medicine: a case series. *J Clin Anesth*. 2015;27(1):63-67. doi:10.1016/j.jclinane.2014.10.002
31. Neuhaus D. Intraosseous infusion in elective and emergency anesthesia: when should we use it? *Curr Opin Anesthesiol*. 2014;27(3):282-287. doi:10.1097/ACO.0000000000000069
32. El-Nawawy AA, Omar OM, Khalil M. Intraosseuous versus intravenous access in pediatric septic shock patients admitted to Alexandria University Pediatric Intensive Care Unit. *J Trop Pediatr.* 2018;64(2):132-140. doi:10.1093/tropej/fmx061
33. Bjerkvig CK, Fousse TK, Apelseth TO, et al. Emergency sternal intraosseous access for warm fresh whole blood transfusion in damage control resuscitation. *J Trauma Acute Care Surg*. 2018;84(6S Suppl 1):S120-S124. doi:10.1097/TA.0000000000001850
34. Paterson ML, Callahan CW. The use of intraosseous fluid resuscitation in a pediatric patient with Ebola virus disease. *J Emerg Med*. 2015;49(6):962-964. doi:10.1016/j.jemermed.2015.06.010
35. Burgert JM. A primer on intraosseous access: history, clinical considerations, and current devices. *Am J Disaster Med.* 2016;11(3):167-173. doi:10.5055/ajdm.2016.0236
36. Schauer SG, Naylor JF, April MD, et al. The prehospital trauma registry experience with intraosseous access. *J Spec Oper Med*. 2019;19(1):52-55.
37. Oesterlie GE, Petersen KK, Knudsen L, Henriksen TB. Crural amputation of a newborn as a consequence of intraosseous needle insertion and calcium infusion. *Pediatr Emerg Care*. 2014;30(6):413-414. doi:10.1097/PEC.0000000000000150
38. Schwindt EM, Hoffmann F, Deindl P, Waldhoer TJ, Schwindt JC. Duration to establish an emergency vascular access and how to accelerate it: a simulation based study performed in real-life neonatal resuscitation rooms. *Pediatr Crit Care Med.* 2018;19(5):468-476. doi:10.1097/PCC.0000000000001508
39. Wagner M, Olischar M, O'Reilly M, et al. Review of routes to administer medication during prolonged neonatal resuscitation. *Pediatr Crit Care Med.* 2018;19(4):332-338. doi:10.1097/PCC.0000000000001493
40. Wang J, Fang Y, Ramesh S, et al. Intraosseous administration of 23.4% NaCl for treatment of intracranial hypertension. *Neurocrit Care*. 2019;30(2):364-371. doi:10.1007/s12028-018-0637-2
41. Farrokh S, Cho SM, Lefebvre AT, Zink EK, Schiavi A, Puttgen HA. Use of intraosseous hypertonic saline in critically ill patients. *J Vasc Access.* 2019;20(4):427-432. doi:10.1177/1129729818805958
42. Baadh AS, Singh A, Choi A, Baadh PK, Katz DS, Harcke HT. Intraosseous vascular access in radiology: review of clinical status. *AJR Am J Roentgenol.* 2016;207(2):241-247. doi:10.2214/AJR.15.15784
43. Cohen J, Duncan L, Triner W, Rea J, Siskin G, King C. Comparison of computed tomography image quality using intravenous vs. intraosseous contrast administration in swine. *J Emerg Med.* 2015;49(5):771-777. doi:10.1016/j.jemermed.2014.06.036

44. Santos AP, Conkin R, Dowd K. Needle break: complication and management of intraosseous vascular access. *Am Surg*. 2017;83(1):e18-e20.
45. Grabel Z, DePasse JM, Lareau CR, Born CT, Daniels AH. Intra-articular placement of an intraosseous catheter. *Prehosp Disaster Med.* 2015;30(1):89-92. doi:10.1017/S1049023X14001290
46. Ginsberg-Peltz J. Time to bone healing after intraosseous placement in children is ill defined. *Pediatr Emerg Care.* 2016;32(11):799-800. doi:10.1097/PEC.0000000000000652
47. Barlow B, Kuhn K. Orthopedic management of complications of using intraosseous catheters. *Am J Orthop (Belle Mead NJ).* 2014;43(4):186-190.
48. Gendron B, Cronin A, Monti J, Brigg A. Military medic performance with employment of a commercial intraosseous infusion device: a randomized, crossover study. *Mil Med.* 2018;183(5-6):e216-e222. doi:10.1093/milmed/usx078
49. Droszd A, Madziala M. Nurses' attitudes and beliefs concerning intraosseous access in pediatric patients. *Am J Emerg Med*. 2016;34(9):1890. doi:10.1016/j.ajem.2016.06.064
50. Smereka A, Stawicka I, Czyzewski L. Nurses' knowledge and attitudes toward intraosseous access: preliminary data. *Am J Emerg Med*. 2016;34(8):1724. doi:10.1016/j.ajem.2016.06.031
51. Wolfson DL, Tandoh MA, Jindal M, Forgione PM, Harder VS. Adult intraosseous access by advanced EMTs: a statewide non-inferiority study. *Prehosp Emerg Care*. 2017;21(1):7-13. doi:10.1080/10903127.2016.1209262
52. Afzali M, Kvisselgaard AD, Viggers S. Early introduction of intraosseous access ought to emphasized. *Am J Emerg Med*. 2017;35(2):355-356. doi:10.1016/j.ajem.2016.10.062
53. Leutscher SA, Gerritse BM, van der Meer NJ, Schuitemaker FJ, Scohy TV. Need of intraosseous access in advanced life support in the in-hospital setting: evaluation of difficult vascular access in cardiac arrest. *Resuscitation*. 2017;112:e7. doi:10.1016/j.resuscitation.2016.11.026
54. Polat O, Oğuz AB, Cömert A, Demirkan A, Günalp M, Tüccar E. Intraosseous access learning curve: is it really practical? *Am J Emerg Med.* 2014;32(12):1534-1544. doi:10.1016/j.ajem.2014.09.018
55. Dymond M, O'Dochartaigh D, Douma MJ. Insights from a tertiary care intraosseous insertion practice improvement registry: a 2-year descriptive analysis. *J Emerg Nurs.* 2019;45(2):155-160. doi:10.1016/j.jen.2018.08.013
56. Kehrl T, Becker BA, Simmons DE, Broderick EK, Jones RA. Intraosseous access in the obese patient: assessing the need for extended needle length. *Am J Emerg Med.* 2016;34(9):1831-1834. doi:10.1016/j.ajem.2016.06.055
57. Chalopin T, Lemaignen A, Guillon A. et al. Acute tibial osteomyelitis caused by intraosseous access during initial resuscitation: a case report and literature review. *BMC Infect Dis.* 2018;18(1):665. doi:10.1186/s12879-018-3577-8
58. Jousi M, Saikko S, Nurmi J, Intraosseous blood samples for point-of-care analysis: agreement between intraosseous and arterial analyses. *Scand J Trauma Resusc Emerg Med.* 2017;25(1):92. doi:10.1186/s13049-017-0435-4
59. Jousi M, Laukkanen-Nevala P, Nurmi J. Analyzing blood from intraosseous access: a systematic review. *Eur J Emerg Med.* 2019;26(2):77-85.
60. Pasley J, Miller C, DuBose JJ, et al. Intraosseous infusion rates under high pressure: a cadvaric comparison of anatomic sites. *J Trauma Acute Care Surg*. 2015;78(2):295-299. doi:10.1097/TA.0000000000000516
61. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines.* Pappin Communications; 2019.
62. Rubal BJ, Meyers BL, Kramer SA, Hanson MA, Andrews JM, DeLorenzo RA. Fat intravasation from intraosseous flush and infusion procedures. *Prehosp Emerg Care.* 2015;19(3):376-390. doi:10.3109/10903127.2014.980475
63. Azan B, Teran F, Nelson B, Andrus P. Point-of-care ultrasound diagnosis of intravascular air after lower extremity intraosseous access. *J Emerg Med.* 2016;51(5):680-683. doi:10.1016/j.jemermed.2016.05.064
64. Danz M, Schulz G, Hinkelbein J, Braunecker S. Breaking the needle: a rare complication of EZ-IO removal. *Eur J Anesthesiol*. 2014;31(3):176-177. doi:10.1097/EJA.0b013e328364fe51
65. Infusion Nurses Society and Emergency Nurses Association. The role of the registered nurse in the use of intraosseous vascular access devices [position statement]. *J Infus Nurs*. 2020;43(3):117-120. doi:10.1097/NAN.0000000000000036958.

58. SUBCUTANEOUS INFUSION AND ACCESS DEVICES

Standard

58.1 The subcutaneous route is evaluated as an alternative to IV access as part of a vessel health and preservation strategy.

58.2 The patient is assessed for appropriateness of the subcutaneous route in relation to the prescribed medication or solution, the patient's clinical condition, and the presence of adequate subcutaneous tissue.

Practice Recommendations

A. Administer isotonic solutions (eg, 0.9% sodium chloride or dextrose/sodium chloride solutions) via a subcutaneous access device (hypodermoclysis) for treatment of mild-to-moderate dehydration when the oral route is not feasible.[1-7] (I)
   1. The use of subcutaneous hydration for palliative support at end-of-life (eg, opioid-induced delirium, hypercalcemia, and thirst) is unresolved, with the suggested indication for comfort, rather than providing optimal hydration.[7-9] (IV)

B. Consider the subcutaneous infusion of medications such as opioids, nonvesicant antineoplastic agents, immunoglobulins, certain antibiotics (eg, ceftriaxone, ertapenem), endocrine medications (eg, hydrocortisone, pamidronate, parathormone), gastrointestinal medications (eg, granisetron, metoclopramide, ondansetron, palonosetron), monoclonal antibodies (eg, alemtuzumab, trastuzumab), and other medications (eg, midazolam and furosemide).[1,7] (IV)

C. Adjust the rate and volume/dosage of continuous subcutaneous infusions based on the patient's age, weight, clinical condition, individual subcutaneous absorption, laboratory values, and as recommended by the drug manufacturer. Do not exceed those employed for IV infusion.
   1. For subcutaneous hydration, a systematic review reported the following mean daily volumes:
      a. Older adults: 1340 mL or a bolus of 500 mL over 2 to 6 hours for a mean total of 5 days.
      b. Pediatric patients: 365 mL of hyaluronidase-facilitated isotonic solution infused for a mean of 3.1 hours.
      c. Palliative care patients: 1068 mL.[7,10,11] (II)

2. Reported hydration infusion rates:
   a. Older adults: 5 to 167 mL/h or boluses of 500 mL over 2 to 6 hours.
   b. Pediatric patients: 15.4 mL/kg/h.
   c. Palliative care patients: 42 to 72 mL/h.[1,2,7,12] (II)
3. Reported medication infusion rates range up to 5 mL/h.[7,10] (V)
4. May use 2 sites, as required for high-volume solutions (eg, up to 1 L/d per site).[1,13] (IV)

D. Consider the use of hyaluronidase for continuous subcutaneous infusions in the pediatric and adult populations to facilitate the dispersion and absorption of the infusate, particularly if the infusion is not well-tolerated due to swelling or pain.[1,2,4,7,11,12] (III)

E. Select a site for subcutaneous access.
1. Consider patient's comfort, mobility, and site preference.[10] (V)
2. Select areas with intact skin and adequate subcutaneous tissue (eg, 1.0-2.5 cm), abdomen (at least 4 fingers-width away from the umbilicus), left iliac fossa (considered the preferred zone due to maximal distance between colon and abdominal wall), infraclavicular, deltoid, intrascapular, flank, hips, thighs, and/or as recommended by the drug manufacturer.[2,7] (IV)
3. Avoid sites near bony prominences, joints, previous surgical incisions, radiotherapy, damaged skin, intercostal space in patients with cachexia (due to high risk of pneumothorax), mastectomy, tumors, ascites, lymphedema, inner thigh if urinary catheter present, or thigh if peripheral vascular insufficiency exists.[1,7,13,14] (IV)

F. Adhere to Standard-ANTT during subcutaneous access device placement and infusion; perform skin antisepsis prior to inserting the subcutaneous access device (refer to Standard 18, *Aseptic Non Touch Technique*; Standard 33, *Vascular Access Site Preparation and Skin Antisepsis*).

G. Use a small-gauge (eg, 24- to 27-gauge) and short-length nonmetal cannula with luer-lock design for infusions. A metal-winged needle is not recommended for infusions; however, use a subcutaneous needle labeled for high flow rates when indicated by the drug manufacturer.[1,2,7,11] (IV)

H. Remove and insert new device at a new site if blood return is present during device placement.[10] (V)
1. Due to a lack of data and the low likelihood of injecting subcutaneous immunoglobulin (SCIg) into a small blood vessel, assessment of blood return prior to SCIg varies by manufacturer.[15] (V)

I. Apply a transparent semipermeable membrane (TSM) dressing over the site to allow for continuous observation and assessment. Change the TSM dressing with each subcutaneous site rotation or immediately if the integrity of the dressing is compromised.[10,11] (V)

J. Assess the subcutaneous access site and rotate the site:
1. As clinically indicated based on access site assessment findings (eg, erythema, swelling, leaking, local bleeding, bruising, burning, abscess, or pain).[10,11] (V)
2. For hydration solutions, reported dwell times range from 24 to 48 hours or after 1.5 to 2.0 liters of solution have infused.[1,9] (IV)
3. For continuous medication infusion, every 2 to 7 days; for intermittent infusions (eg, SCIg), the site is changed with each infusion; site reactions from SCIg (eg, swelling and site erythema, pain, and pruritus) are common and tend to decrease over time, with persistent reactions possibly requiring a slower infusion rate or decreased volume per site, longer needle, or site change.[2,7,10,15] (V)

K. Regulate the flow rate of the infusion; the following devices have been reported for use with:
1. Hydration: gravity infusion set, electronic infusion pump.[1,4,7,12,14,16] (IV)
2. Medications: mechanical infusion device, electronic infusion pump.[1,4,7,17,18] (V)

L. Monitor patient and access site regularly (eg, every shift/visit). See Standard 42, *Vascular Access Device Assessment, Care, and Dressing Changes*.[10,11] (V)

M. Address the following patient education topics:
1. Signs/symptoms of access site complications and how/where to report.
2. Activity limitations/protecting the subcutaneous access site (refer to Standard 8, *Patient Education*).

REFERENCES

1. Duems-Noriega O, Arino-Blasco S. Subcutaneous fluid and drug delivery: safe, efficient and inexpensive. *Rev Clin Gerontol*. 2015;25(2):117-146. doi:10.1017/S095925981500012X
2. Caccialanza R, Constans T, Cotogni P, Zaloga GP, Pontes-Arruda A. Subcutaneous infusion of fluids for hydration or nutrition: a review. *JPEN J Parenter Enteral Nutr.* 2018;42(2):296-307. doi:10.1177/0148607116676593
3. Rouhani S, Meloney L, Ahn R, Nelson BD, Burke TF. Alternative rehydration methods: a systematic literature review and lessons for resource-limited care. *Pediatrics*. 2011;127(3):e748-e757. doi:10.1542/peds.2010-0952
4. Marikar D, Reynolds C, Rich J. Question 1: are subcutaneous fluids a viable alternative to intravenous therapy in rehydrating children with gastroenteritis and moderate dehydration? *Arch Dis Child*. 2014;99(8):783-785. doi:10.1136/archdischild-2013-305735
5. Esmeray G, Senturan L, Doventas A. A study on the efficacy of hydration administered by subcutaneous infusion in geriatric patients. *Turkish J Geriatr*. 2018;21(3):438-445.
6. Wheaton T, Schlichting C, Madhavarapu S, Koncicki ML. A novel use of long-term subcutaneous hydration therapy for a pediatric patient with intestinal failure and chronic dehydration: a case report. *J Infus Nurs*. 2020;43(1):20-22. doi:10.1097/NAN.0000000000000350
7. Broadhurst D, Cooke M, Sriram D, Grey B. Subcutaneous hydration and medication infusion (effectiveness, safety, acceptability): a systematic review of systematic reviews. *PLoS One*. 2020;15(8):e0237572. doi:10.1371/journal.pone.0237572
8. Good P, Richard R, Syrmis W, Jenkins-Marsh S, Stephens J. Medically assisted hydration for adult palliative care patients. *Cochrane Database Syst Rev*. 2014;(4):CD006274. doi:10.1002/14651858.CD006274.pub3
9. Bruera E, Hui D, Dalal S, et al. Parenteral hydration in patients with advanced cancer: a multicenter, double-blind, placebo-controlled randomized trial. *J Clin Oncol*. 2013;31(1):111-118. doi:10.1200/JCO.2012.44.6518

10. Canadian Vascular Access Association. *Canadian Vascular Access and Infusion Therapy Guidelines*. Pappin Communications; 2019.
11. Denton A, Bodenham A, Conquest A, et al. *Standards for Infusion Therapy.* 4th ed. Royal College of Nursing; 2016.
12. Spandorfer PR, Mace SE, Okada PJ, et al. A randomized clinical trial of recombinant human hyaluronidase-facilitated subcutaneous versus intravenous rehydration in mild to moderately dehydrated children in the emergency department. *Clin Ther.* 2012;34(11):2232-2245. doi:10.1016/j.clinthera.2012.09.011
13. Gomes NS, Silva AMBD, Zago LB, Silva ÉCLE, Barichello E. Nursing knowledge and practices regarding subcutaneous fluid administration. *Rev Bras Enferm*. 2017;70(5):1096-1105. doi:http://dx.doi.org/10.1590/0034-7167-2016-0424
14. Forbat L, Kunicki N, Chapman M, Lovell C. How and why are subcutaneous fluids administered in an advanced illness population: a systematic review. *J Clin Nurs*. 2017;26(9-10):1204-1216. doi:10.1111/jocn.13683
15. Schleis T, Clarke AE, Vaughan L, et al. *Immunoglobulin Therapy Standards of Practice.* 2nd ed. Immunoglobulin National Society; 2019.
16. Vidal M, Hui D, Williams J, Bruera E. A prospective study of hypodermoclysis performed by caregivers in the home setting. *J Pain Symptom Manage*. 2016;52(4):570-574.e9. doi:10.1016/j.jpainsymman.2016.04.009
17. Gaudet LM, Singh K, Weeks L, Skidmore B, Tsertsvadze A, Ansari MT. Effectiveness of terbutaline pump for the prevention of preterm birth. a systematic review and meta-analysis. *PLoS One*. 2012;7(2):e31679. doi:10.1371/journal.pone.0031679
18. Stoner KL, Harder H, Fallowfield LJ, Jenkins VA. Intravenous versus subcutaneous drug administration. which do patients prefer? a systematic review. *Patient*. 2015;8:145-153. doi:10.1007/s40271-014-0075-y

Section Nine: Infusion Therapies

Section Standards

I. Current references and resources on infusion medications and solutions are readily available to the clinician at the point of care.

II. At least 2 patient identifiers are used to ensure accurate patient identification before administering medications and infusion solutions.

III. Aseptic Non Touch Technique (ANTT) is applied to all infusion-related procedures as a critical aspect of infection prevention.

59. INFUSION MEDICATION AND SOLUTION ADMINISTRATION

Standard

59.1 The prescribed medication/solution including indications, dosing/diluent, acceptable infusion routes/rates, compatibility data, and adverse/side effects is reviewed for appropriateness prior to administration.

59.2 Medications and infusion solutions are identified, compared against the medication order, and verified by reviewing the label for the name (brand and generic); dosage and concentration; beyond-use date (BUD); expiration date; sterility state; route, rate, and frequency of administration; and any other special instructions.

59.3 Concerns about the appropriateness of orders are addressed with the pharmacist, provider, supervisor, and/or risk management or as defined in organizational policy.

59.4 The infusion system is inspected for clarity of the solution and integrity of the system (ie, leakage, secure connections), accurate flow rate, and for expiration date and BUD of the infusate and administration set prior to infusion.

Practice Recommendations

A. Recognize physiologic characteristics and effects on drug dosage and volume limitations, pharmacologic actions, interactions, side effects/toxicities, monitoring parameters, and response to infusion therapy when administering solutions and medications to special patient populations (refer to Standard 2, *Special Patient Populations: Neonatal, Pediatric, Pregnant, and Older Adults*).

B. Administer the first dose of medications with an appreciable risk of a severe allergic/anaphylactic reaction or other unknown response (eg, antimicrobials, immunoglobulins [Igs]) in nonacute care settings (eg, home, skilled nursing facility) only if conditions for safe administration are evaluated and verified.
   1. Patient has no history of allergy to medications in the same class.
   2. Patient is alert, cooperative, and able to respond appropriately.
   3. There is reasonable geographic access to emergency services should a severe reaction occur.
   4. The first dose is administered under clinician supervision with ability to respond to a life-threatening immediate hypersensitivity or anaphylactic reaction; the patient is observed for at least 30 minutes after infusion of the first dose is completed.
      a. Recognize that the first exposure may not result in or cause a reaction and that the risk exists with subsequent exposures. Educate the patient/caregiver in signs and symptoms of reactions and actions to take.
   5. Medications are available in the home and there are orders for their use (eg, epinephrine) and clinicians have completed a basic life-support provider course and are competent in managing an anaphylactic reaction (see Standard 61, *Biologic Therapy*).[1-4] (IV)

C. Administer solutions and medications prepared and dispensed from the pharmacy or as commercially prepared solutions and medications whenever possible; do not add medications to infusing solution containers (refer to Standard 20, *Compounding and Preparation of Parenteral Solutions and Medications*).

D. Prepare solutions and medications for administration as close as possible to the time of administration (eg, spiking infusion container, priming administration set).[5] (V)

E. Limit the use of add-on devices (eg, extension sets) to only those clinically indicated due to increased risk for contamination from manipulation, increased risk for accidental disconnections and misconnections, delay in medications reaching the bloodstream, and need for additional fluids for flushing the medication from the administration set (refer to Standard 37, *Other Add-on Devices*).

F. Reduce the risk for errors related to administering multiple infusions by employing strategies such as:
   1. Labeling
      a. When there are different access sites (eg, intraspinal, intraosseous, subcutaneous) or multiple solution containers connected to a vascular access device (VAD), label the administration set with the route and/or medication/solution near the connection to the solution container and near the patient's access site.

b. Standardize labels using a consistent format for the information.
c. Distinguish the injection site where intravenous (IV) push medications are to be administered by applying a visually prominent label that is different in format from other labels.[6,7] (V)

2. Organizing the infusion administration system
   a. Separate IV infusions and minimize tangling of tubings.
   b. Align the solution container/bag with the corresponding IV pump/channel.
   c. Avoid connecting a continuous IV medication to a central venous pressure (CVP) monitoring port/cardiac output measurement port to reduce the risk for unintended boluses or interrupted infusions when calibrating or measuring CVP/cardiac output.[6,7] (V)
3. Minimizing the amount of "shared infusion volume/space" and ensuring compatibility when 2 or more continuous infusions are connected to a single injection port
   a. Connect IV infusions as close as possible to the hub of the VAD.
   b. Avoid using 3-way stopcocks to join multiple infusions; rather use an extension set with parallel lumens (see Standard 37, *Other Add-On Devices*).[6,7] (V)
4. Setting up secondary intermittent IV infusions
   a. Use a primary continuous administration set with a back-check valve to prevent retrograde flow of the medication into the primary solution container and connect to a port above the electronic infusion pump.
   b. When high-risk medications are given through the primary infusion system concurrently with the primary infusion, attach the administration set below the electronic infusion pump controlling the primary fluid flow and use a separate electronic infusion pump to control the rate of the high-risk medication.
   c. When administering a secondary intermittent medication, check compatibility with the primary solution; this avoids the need to disconnect the secondary administration set or replace the secondary administration set. If compatible, use the secondary administration set and back prime from the primary infusion container.
      i. If disconnection of a continuous or an intermittent infusion administration set is unavoidable, aseptically attach a new, sterile, compatible covering device to protect male luer ends on administration sets, ensuring correct connection of catheters/administration sets/add-on devices.
      ii. If the secondary administration set is disconnected from the primary set, the secondary administration set is now considered a primary intermittent administration set and is changed every 24 hours.
      iii. Follow manufacturers' directions for use for the heights of the primary and secondary solution containers and the needed differences between these containers (ie, head height differential). Alterations in flow rate may occur due to differences in the level of solution in each container (eg, bag, glass bottle), the height of the IV pole, and the position of the pump (see Standard 13, *Medication Verification*; Standard 24, *Flow-Control Devices*; Standard 43, *Administration Set Management*).[6-8] (V)
5. Setting up multiple infusions 1 at a time; set up each infusion as completely as possible before beginning preparation of the next infusion (ie, label set and pump, spike and hang solution container, connect set to pump and program pump).[6-7] (V)

G. Perform disinfection of connection surfaces (ie, needleless connectors, injection ports) before medication administration, flushing, and locking procedures (refer to Standard 36, *Needleless Connectors*).

H. Assess VAD function and patency prior to administration of parenteral solutions and medications and during continuous infusions as clinically indicated.
   1. Assess patency during a continuous infusion when the following are present: sluggish infusion (eg, gravity infusion), frequent infusion pump alarms, leakage of fluid from the insertion site, pain during infusion, and/or signs/symptoms of infiltration/extravasation (see Standard 41, *Flushing and Locking*).[9] (V)
      a. Assess the risk of interrupting the continuous infusion of critical drugs (eg, inotropic agents) against the risk of serious complications (eg, infiltration/extravasation, thrombosis) in the presence of these clinical indications. (Committee Consensus)
   2. Assess patency during a continuous infusion by attaching a syringe to the lowest injection port on the administration set; do not disconnect administration set from the VAD hub. (Committee Consensus)

I. Minimize risk of medication loss when delivering small-volume IV infusions.
   1. Recognize significant potential loss of medication with 50- and 100-mL solutions of up to 35% of medication loss due to residual volume in the administration set; greatest percentage loss was with 50-mL volumes.
   2. Ensure that antimicrobial medications are infused with minimal loss of drug as a component of antimicrobial stewardship.
   3. Deliver intermittent IV infusions as a secondary infusion through a primary infusion administration set with a continuous infusion; if administering an intermittent infusion as a primary infusion via gravity or via an infusion pump, consider infusion of approximately

25 mL of a primary solution (eg, 0.9% NaCl) at the conclusion of the medication to ensure all of the medication is flushed through the administration set.[10-12] (IV)

J. Administer IV push medication at the rate recommended by the drug manufacturer and/or in accordance with organization policy, procedures, and/or practice guidelines; follow with an appropriate volume of flush solution at the same injection rate to ensure the entire dose has reached the bloodstream.
   1. Administer IV push medications through the injection port closest to the patient in an existing IV infusion to allow the medication to reach the circulatory system as soon as possible.[13] (V)

K. Reduce the risk for administration set misconnections.
   1. Trace all catheters/administration sets/add-on devices between the patient and the container before connecting or reconnecting any infusion/device, at each care transition to a new setting or service, and as part of the handoff process.
   2. Instruct the patient, caregivers, and unlicensed assistive personnel to ask for assistance whenever there is a real or perceived need to connect or disconnect devices or infusions unless the patient or caregiver is independently administering infusion medications, as in a home care setting.
   3. Route tubing having different purposes in different directions (eg, IV catheters routed toward the head; feeding tubes routed toward the feet)
   4. Use ISO-approved connectors for enteral (EnFit) and neuraxial (NRFit) infusions to prevent misconnections among parenteral, enteral, and neuraxial (intraspinal) infusions (see Standard 43, *Administration Set Management*).[14,15] (V)

L. Replace IV solution containers in accordance with organizational policy, procedures, and/or practice guidelines.
   1. There is insufficient evidence to recommend the frequency of routine replacement of IV solution containers, with the exception of parenteral nutrition (PN) solutions, which are replaced every 24 hours. Extending the life of a solution container beyond 24 hours may be considered in times of product shortages, but such decisions are weighed against the risk of infection. Factors influencing this decision include, but are not limited to, use of commercially prepared solution, addition of medications, and where those additions were made (eg, laminar airflow workbench, bedside). One study found no relationship between length of time used and likelihood of colonization and suggests routine replacement at regular time intervals may not be necessary. Further research is needed (see Standard 63, *Parenteral Nutrition*).[16] (III)

M. Provide patient/caregiver education including, but not limited to, infusion administration method, and signs and symptoms to report, including those that may occur after the patient leaves the health care setting (refer to Standard 8, *Patient Education*).

N. Evaluate and monitor response to and effectiveness of prescribed therapy; documenting patient response, adverse events, and interventions; communicating the results of laboratory tests; and achieving effective delivery of the prescribed therapy.[9] (V)

O. Discontinue infusion medications/solutions:
   1. Upon provider order.
   2. In the event of a severe reaction (eg, anaphylactic reaction, speed shock, circulatory overload); notify code or rapid response team as available and provider immediately.[9] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 17, 2020, and August 30, 2020.

1. Norris AH, Shrestha NK, Allison GM, et al. 2018 Infectious Diseases Society of America clinical practice guideline for the management of outpatient parenteral antimicrobial therapy. *Clin Infect Dis.* 2019;68(1):1-4. doi:10.1093/cid/ciy867
2. American Academy of Allergy Asthma and Immunology. Allergic reaction definition. https://www.aaaai.org/conditions-and-treatments/conditions-dictionary/allergic-reaction
3. Schleis T, Clarke AE, Vaughan L, et al. *Immunoglobulin Therapy Standards of Practice.* 2nd ed. Immunoglobulin National Society; 2019.
4. Gorski LA. *Fast Facts for Nurses About Home Infusion Therapy: The Expert's Best Practice Guide in a Nutshell.* Springer Publishing Company; 2017.
5. Dolan S, Arias KM, Felizardo G, et al. APIC position paper: safe injection, infusion, and medication vial practices in health care (2016). Association for Professionals in Infection Control and Epidemiology; 2016. https://www.apic.org/Resource_/TinyMceFileManager/Position_Statements/2016APICSIPPositionPaper.pdf
6. AAMI Foundation. Quick guide: improving the safe use of multiple medications. AAMI Foundation; 2016. https://www.aami.org/docs/default-source/foundation/infusion/infusion_therapy_quick_guide2.pdf
7. Ontario Health Technology Advisory Committee. Multiple intravenous infusions phases 2a and 2b: OHTAC recommendation. Health Quality Ontario; 2014. https://www.hqontario.ca/Portals/0/Documents/evidence/reports/recommendation-mivi-140505-en.pdf
8. Institute for Safe Medication Practices. Guidelines for optimizing safe implementation and use of smart infusion pumps. Institute for Safe Medication Practices; 2020. https://www.ismp.org/guidelines/safe-implementation-and-use-smart-pumps
9. Gorski LA. *Phillips's Manual of I.V. Therapeutics: Evidence-Based Practice for Infusion Therapy*. 7th ed. F.A. Davis; 2018.
10. Harding M, Stefka S, Bailey M, Morgan D, Anderson A. Best practice for delivering small-volume intermittent intravenous infusions. *J Infus Nurs.* 2020;43(1):47-52. doi:10.1097/NAN.0000000000000355
11. Thoele K, Piddoubny M, Ednalino R, Terry CL. Optimizing drug delivery of small-volume infusions. *J Infus Nurs.* 2018;41(2):113-117. doi:10.1097/NAN.0000000000000268
12. Morgan SA. The infusion nurse's role in antibiotic stewardship. *J Infus Nurs.* 2019;42(2):75-80. doi:10.1097/NAN.0000000000000315
13. Institute for Safe Medication Practices. ISMP safe practice guidelines for adult iv push medications: a compilation of safe practices from the ISMP Adult IV Push Medication Safety Summit. Institute for Safe Medication Practices; 2015. https://www.ismp.org/sites/default/files/attachments/2017-11/ISMP97-Guidelines-071415-3.%20FINAL.pdf

14. Institute for Safe Medication Practices. Ongoing risk: misconnections of tracheostomy pilot balloon ports with iv infusions can result in fatal outcomes. Published September 20, 2018. https://ismp.org/resources/ongoing-risk-misconnections-tracheostomy-pilot-balloon-ports-iv-infusions-can-result
15. Institute for Safe Medication Practices. NRFit: a global "fit" for neuraxial medication safety. Published July 20, 2020. https://ismp.org/resources/nrfit-global-fit-neuraxial-medication-safety
16. Rickard CM, Vannapraseuth B, McGrail MR, et al. The relationship between intravenous infusate colonisation and fluid container hang time. *J Clin Nurs.* 2009;18(21):3022-3028. doi:10.1111/j.1365-2702.2009.02870.x

60. ANTINEOPLASTIC THERAPY

Standard

60.1 Antineoplastic agents are administered only upon written orders by a physician or other provider in accordance with laws, rules, and regulations established by regulatory and accrediting bodies in each jurisdiction (eg, countries, states, provinces). Verbal orders are acceptable only if antineoplastic agents are to be placed on hold or discontinued.

60.2 Antineoplastic agents are prepared and administered with attention to ensuring the safety of patients and health care workers and providing environmental protection.

60.3 Clinicians who prepare and administer antineoplastic medications are educated about potential hazards and special handling to reduce the risk of occupational exposure and risk for significant adverse health effects.

Practice Recommendations

A. Use personal protective equipment (PPE) and engineering controls when working with antineoplastic drugs in all health care settings as there is no known level of exposure that is considered to be safe.[1-5] (III)
   1. Provide access to PPE, safety data sheets, spill kits, containment bags, and designated waste disposal containers in all areas where hazardous drugs are prepared and administered.[2-7] (V)
   2. Use appropriate PPE and safe techniques in managing hazardous drugs during all stages of handling including receipt and storage, compounding and preparation, administration, spill control, and waste disposal.[2,5-13] (IV)
   3. Employ safe precautions during transportation of hazardous drugs (refer to Standard 15, *Hazardous Drugs and Waste*).
   4. Employ safety precautions when handling a patient's body fluids for at least 48 hours after drug administration; however, some antineoplastic agents may be present for longer; consult with pharmacy for questions regarding metabolism and excretion time for a drug in question (refer to Standard 15, *Hazardous Drugs and Waste*).

B. Ensure that only qualified clinicians administer antineoplastic therapy based on completion of a specialized education and competency program (see Standard 5, *Competency and Competency Assessment*).[1,3,5,14,15] (III)

C. Ensure that informed consent was obtained prior to initiation of antineoplastic therapy, which should include a description of risks, benefits, and treatment alternatives; an opportunity to ask questions; and the right to accept or refuse treatment. A variety of approaches may be used to obtain informed consent (see Standard 9, *Informed Consent*).[1,16] (V)

D. Assess patient's level of understanding of treatment and provide patient/caregiver education related to antineoplastic therapy, including mechanism of action, potential side effects, signs and symptoms to report/whom to call, physical and psychological effects, and schedule of administration/treatment plan.[1,3,5,16] (IV)
   1. Educate the patient and caregivers in the home about safe disposal of all items in contact with antineoplastic agents, management of body waste and laundry, and skin and eye care if exposed to these agents (see Standard 8, *Patient Education*).[1,3,5] (IV)

E. Assess patient prior to each treatment cycle, including:
   1. A review of current laboratory data, diagnostic tests, and current medication list (including over-the-counter and complementary and alternative therapies).
   2. The patient's medical history, including comorbidities such as diabetes mellitus, liver and renal disease, alcohol and substance abuse, immunizations, pretreatment vital signs, and weight.
   3. Risk factors for adverse reactions, expected side effects of therapy, presence of new signs or symptoms of toxicity, and allergies.
   4. Psychosocial assessment, including patient and caregiver comprehension of the disease and planned cancer treatment, therapy goals, and planned frequency of future visits.[1,14,16] (V)

F. Implement safeguards to reduce the risk of medication errors with antineoplastic drugs. Antineoplastic drugs are high-alert medications.
   1. Review laboratory values prior to each treatment. Laboratory tests may be ordered to calculate doses, assess for toxicity from prior treatments, and ensure that the agent will be adequately metabolized and excreted. Examples of laboratory tests include: complete blood count, serum creatinine and creatinine clearance, total bilirubin and liver function tests, electrolytes, hepatitis B antibodies, and thyroid function tests.[1] (V)
   2. Use standardized orders, standardized dosage calculation, established dosage limits, computerized prescriber order entry (CPOE), barcode technology, and electronic infusion pumps with dose-error reduction systems ([DERS]; ie, smart pumps). See Standard 13, *Medication Verification*.[17] (V)
   3. Consult with the pharmacist to review drug interactions with any changes in the patient's medication list.[16] (V)

4. Perform an independent double check to verify the antineoplastic order.[15,18,19] (V)
5. Involve the patient and family members in medication identification; patients often observe and report errors and adverse events. Strategies to involve patients in the process of medication verification should be considered a risk-reduction strategy.[1,14,15] (IV)
6. Monitor cumulative chemotherapy dose, as appropriate, to ensure that the drug is discontinued if the maximum lifetime dose is reached.[3,13,17-19] (V)

G. Administer cytotoxic vesicant medications safely via a short peripheral intravenous catheter (PIVC).
1. Limit to IV push or infusions lasting less than or equal to 30 minutes and remain with the patient to assess for blood return during the infusion.
2. Do not use an infusion pump for peripheral vesicant administration.
3. Do not use scalp veins in the neonate and pediatric patient.
4. Choose a vein that is large, smooth, and palpable, or if technology-assisted insertion is necessary, choose a vein with a straight venous pathway (see Standard 27, *Site Selection*).
5. Avoid the following sites: ventral and dorsal surface of the hand, wrist, antecubital fossa, near a joint, lower extremities, areas distal to a recent venipuncture, including laboratory draws, and in the limb where there is impaired sensation, circulation or lymphatic drainage, and/or history of lymph node dissection.
6. Do not use an established IV site that is greater than 24 hours old. If a new IV site is initiated, use the smallest-gauge catheter possible. If the IV attempt is unsuccessful, additional attempts should be proximal to the previous attempt or on the opposite arm.
7. Instruct patient in the importance of immediately reporting any pain, burning, sensation changes, or feeling of fluid on skin during the infusion.
8. Confirm and document a blood return prior to vesicant administration. Do not administer in the absence of a blood return (see Standard 47, *Infiltration and Extravasation*).
9. Provide dilution by administering through a free-flowing infusion of a compatible solution.
10. Assess and verify blood return every 2 to 5 mL for IV push and every 5 minutes during an infusion; remain with the patient during the entire infusion.
11. Discontinue infusion at first sign of extravasation (see Standard 47, *Infiltration and Extravasation*).[1,13,17-19] (V)

H. Administer vesicant medications safely via a central vascular access device (CVAD).
1. Confirm and document a blood return prior to vesicant administration. Do not administer in the absence of a blood return (see Standard 47, *Infiltration and Extravasation*).
2. Do not administer if signs of inflammation, swelling, or venous thrombosis are present (see Standard 53, *Catheter-Associated Deep Vein Thrombosis*).
3. Ensure proper placement and adequately secure and stabilize the noncoring needle within implanted vascular access ports.
4. Provide dilution by administering through a free-flowing infusion of a compatible solution.
5. Assess and verify blood return every 2 to 5 mL for IV push; for infusions: assess and verify blood return before infusion, during the infusion in accordance with organizational policy, and after the infusion.
6. Discontinue infusion at first sign of extravasation (see Standard 47, *Infiltration and Extravasation*).[1,14,15] (V)

I. Safely dispose of hazardous waste and materials contaminated with hazardous drugs (refer to Standard 15, *Hazardous Drugs and Waste*).

J. Contain, manage, and treat any cytotoxic spill as soon as possible to reduce the risk of environmental contamination and exposure to health care workers.[1,3] (V)

K. Monitor for adverse reactions, which can include hypersensitivity, anaphylaxis, and cytokine release syndrome (CRS).[1,20-24] (V)

REFERENCES

Note: All electronic references in this section were accessed between May 5, 2020, and August 30, 2020.

1. Olsen MM, LeFebvre KB, Brassil KJ, eds. *Chemotherapy and Immunotherapy Guidelines and Recommendations for Practice*. Oncology Nursing Society; 2019.
2. Rioufol C, Ranchon F, Schwiertz V, et al. Administration of anticancer drugs: exposure in hospital nurses. *Clin Ther*. 2014;36(3):401-407. doi:10.1016/j.clinthera.2014.01.016
3. Crickman R, Finnell D. Systematic review of control measures to reduce hazardous drug exposure for health care workers. *J Nurs Care Qual*. 2016;31(2):183-190. doi:10.1097/NCQ.0000000000000155
4. Hennessy KA, Dynan J. Improving compliance with personal protective equipment use through the model for improvement and staff champions. *Clin J Oncol Nurs*. 2014;18(5):497-500. doi:10.1188/14.CJON.497-500
5. Huff C. Hazardous drug residues in the home setting: worker safety concerns. *J Infus Nurs*. 2020;43(1):15-18. doi:10.1097/NAN.0000000000000354
6. Connor TH, MacKenzie BA, DeBord DG, Trout DB, O'Callaghan JP. NIOSH list of antineoplastic and other hazardous drugs in healthcare settings. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2016. DHHS (NIOSH) Publication No. 2016-161. https://www.cdc.gov/niosh/docs/2016-161/pdfs/2016-161.pdf
7. Zhang J, Bao J, Wang R, et al. A multicenter study of biological effects assessment of pharmacy workers occupationally exposed to antineoplastic drugs in pharmacy intravenous admixture services. *J Hazard Mater*. 2016;315:86-92. doi:10.1016/j.jhazmat.2016.04.008
8. Eisenberg S, Pacheco L. Applying hazardous drug standards to antineoplastics used for ophthalmology surgery. *AORN J*. 2018;107(2):199-213. doi:10.1002/aorn.12022
9. García SV, Clérigues NV, Ferrer VF, Briz EL, Andrés JLP. Use and handling safety of Mini-Spike 2® chemo and puresite for safe chemotherapy compounding in a hospital pharmacy. *Regul Toxicol Pharmacol*. 2018;100:1-6. doi:10.1016/j.yrtph.2018.10.002

10. National Institute for Occupational Safety and Health. NIOSH alert: preventing occupational exposures to antineoplastic and other hazardous drugs in health care settings. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2004. DHHS (NIOSH) Publication No. 2004−165. https://www.cdc.gov/niosh/docs/2004-165/
11. United States Pharmacopeial Convention. USP general chapter <797> pharmaceutical compounding–sterile preparations. United States Pharmacopeial Convention; 2020. https://www.uspnf.com/sites/default/files/usp_pdf/EN/USPNF/revisions/gc-797-rb-notice-20200424.pdf
12. Valero S, López-Briz E, Vila N, Solana A, Melero M, Poveda JL. Pre and post intervention study of antiblastic drugs contamination surface levels at a pharmacy department compounding area using a closed system drug transfer device and a decontamination process. *Regul Toxicol Pharmacol*. 2018;95:1-7. doi:10.1016/j.yrtph.2018.03.001
13. Kreidieh FY, Moukadem HA, El Saghir NS. Overview, prevention and management of chemotherapy extravasation. *World J Clin Oncol*. 2016;7(1):87-97. doi:10.5306/wjco.v7.i1.87
14. Kalo K, Karius D, Bena JF, Morrison SL, Albert NM. Chemotherapy safety: reducing errors with a nurse-led time-out process. *Clin J Oncol Nurs*. 2019;23(2):197-202. doi:10.1188/19.CJON.197-202
15. Redmond M. Chemotherapy and biotherapy: what nurses need to know when administering to nononcologic patients. *J Contin Educ Nurs*. 2016;47(2):52-54. doi:10.3928/00220124-20160120-03
16. Neuss MN, Gilmore TR, Belderson KM, et al. 2016 Updated American Society of Clinical Oncology/Oncology Nursing Society chemotherapy administration safety standards, including standards for pediatric oncology. *J Oncol Pract*. 2016;12(12):1262-1271. doi:10.1200/JOP.2016.017905
17. Goldspiel B, Hoffman JM, Griffith NL, et al. ASHP guidelines on preventing medication errors with chemotherapy and biotherapy. *Am J Health Syst Pharm*. 2015;72(8):e6-e35. doi:10.2146/sp150001
18. Boulanger J, Ducharme A, Dufour A, et al. Management of the extravasation of anti-neoplastic agents. *Support Care Cancer*. 2015;23(5):1459-1471. doi:10.1007/s00520-015-2635-7
19. Corbett M, Marshall D, Harden M, Oddie S, Phillips R, McGuire W. Treating extravasation injuries in infants and young children: a scoping review and survey of UK NHS practice. *BMC Pediatr*. 2019;19(1):6. doi:10.1186/s12887-018-1387-1
20. Nawaz Khan A, Irion KL, Nagarajaiah CP. Imaging in drug-induced lung disease. Medscape.com. Published July 7, 2016. https://emedicine.medscape.com/article/357574-overview
21. Castells MC, Matulonis UA, Horton TM. Infusion reactions to systemic chemotherapy. UpToDate.com website. Updated August 18, 2020. https://www.uptodate.com/contents/infusion-reactions-to-systemic-chemotherapy
22. Giavina-Bianchi P, Patil SU, Banerji A. Immediate hypersensitivity reaction to chemotherapeutic agents. *J Allergy Clin Immunol Pract*. 2017;5(3):593-599. doi:10.1016/j.jaip.2017.03.015
23. Boulanger J, Boursiquot JN, Cournoyer G, et al. Management of hypersensitivity to platinum- and taxane-based chemotherapy: cepo review and clinical recommendations. *Curr Oncol*. 2014;21(4):e630-e641. doi:10.3747/co.21.1966
24. Kroschinsky F, Stölzel F, von Bonin S, et al. New drugs, new toxicities: severe side effects of modern targeted and immunotherapy of cancer and their management. *Crit Care*. 2017;21(1):89. doi:10.1186/s13054-017-1678-1

61. BIOLOGIC THERAPY

Standard

61.1. Biologic infusion therapies, such as colony-stimulating factors, gene therapy, monoclonal antibodies, fusion proteins, interleukin inhibitors, and Igs, are administered in a setting in which the clinician is prepared to recognize and manage severe adverse reactions.

61.2 Patients are assessed for contraindications before beginning a biologic infusion therapy and prior to each subsequent administration.

Practice Recommendations

A. Implement safeguards to reduce the risk of medication adverse reactions and errors with biologic therapies; immunosuppressant therapies are high-alert medications.[1,2] (V)
   1. Standardize prescribing, storage, dispensing, and medication administration (refer to Standard 13, *Medication Verification*).
   2. Determine the most appropriate care setting for biologic infusion administration.
      a. Care settings include hospital inpatient, hospital outpatient, physician office, free-standing infusion suite, long-term care, and the patient's home.
      b. Patients who have not received the infusion previously and/or those who have a prior history of adverse drug reactions should receive therapy in a setting that ensures safety and the ability to respond to adverse reactions.
      c. First doses administered in the home are provided by highly educated clinicians and when there is availability of medications to treat an adverse reaction and rapid access to emergency medical services (see Standard 59, *Infusion Medication and Solution Administration*).[3] (V)
   3. Ensure clinician access to drug information.[1,3-5] (V)
   4. Collaborate with the health care team regarding serious risks associated with some biologic agents; risk evaluation and mitigation strategies (REMS) may be required.[2,6-8] (V)
   5. Anticipate potential orders for premedications, such as acetaminophen/paracetamol and diphenhydramine, which may help to prevent infusion reactions common to many biologics. Nonsteroidal anti-inflammatory agents may help prevent fevers when interleukin-2 is administered.[3,9-11] (V)
   6. Ensure availability of drugs for treatment of adverse reactions and anaphylaxis; consider patient safety as a primary factor when selecting the treatment setting.[3,12,13] (V)

B. Store, prepare, and administer biologic infusion products according to the manufacturers' directions for use and dispose of biologic waste in accordance with regulations established by regulatory bodies in each jurisdiction (eg, countries, states, provinces).
   1. Do not use Ig products that have been frozen.
   2. Reconstitute or prepare liquid products in a clean environment (refer to Standard 20, *Compounding and Preparation of Parenteral Solutions and Medications*).
   3. Ensure that biologic products are at room temperature before infusing.

4. Avoid switching Ig brands, as this puts the patient at greater risk for adverse reactions.[14] (V)

C. Assess patients before initiation of therapy.
   1. Identify risk factors including, but not limited to, comorbidities; infections (viral, fungal, or bacterial); allergy profile (food, medications, drug-drug interactions); history of any previous treatment with and reaction to biologicals; tuberculosis testing; history of malignancies; weight changes; and hepatitis B and C screenings.
   2. Evaluate vaccine status and requirements relative to the biologic agent; follow recommended intervals for vaccination administration.
   3. Identify any significant changes in health status prior to each infusion, such as disease progression, changes in weight, presence of any acute illness, infection, or presence of diarrhea.
   4. Check vital signs prior to infusion and as indicated during and after the infusion.
   5. Review laboratory data specific to the biologic therapy prior to initiation and during subsequent infusions as indicated.[3,9,14-16] (IV)

D. Inform the patient and caregiver about all aspects of the biologic agent, including physical and psychological effects, and side and adverse effects, including potential toxicities and delayed reactions. Educate patients about how to manage adverse effects and when to escalate concerns or notify the health care team for further assessment (see Standard 8, *Patient Education*).[3,14,15,17] (V)

E. Select the most appropriate flow-control device for the biologic infusion therapy, considering factors such as:
   1. Manufacturers' recommendations for rate control, dosing considerations, volume, duration; age, acuity, and mobility of the patient; health care setting; and the potential for side effects or adverse effects of the therapy (refer to Standard 24, *Flow-Control Devices*).
   2. Identify if filtration is required (see Standard 35, *Filtration*).[3,15] (V)

F. Consider the option for self-administered subcutaneous immunoglobulin (SCIg) infused at various intervals, usually weekly or biweekly, using a subcutaneous pump and needle set, or daily as a subcutaneous push infusion; self-administered hyaluronidase-facilitated SCIg is infused at 3- or 4-week intervals using a subcutaneous infusion pump.[3,16-18] (II)
   1. Ensure that the first SCIg dose is administered in a controlled setting under medical supervision.[16] (V)
   2. Limit infusion volume of standard SCIg to no more than a 30-mL volume per site. For hyaluronidase-facilitated SCIg, follow manufacturers' recommendations for site volume limits (see Standard 58, *Subcutaneous Infusion and Access Devices*).[16,18] (V)
   3. Identify the best method for flow control. This is generally via a syringe pump; however, a manual push can be utilized for some patients. Consider patient preference and health care team recommendation.[2,14,19] (V)
   4. Educate the patient/caregiver about drug preparation, subcutaneous administration, the importance of site rotation, adherence to therapy, and what to monitor or report during or after the injection.[16,18,19] (V)

G. Consider the option for nurse-administered home administration of intravenous immunoglobulin (IVIg) in long-term, stable patients who require extended therapy for primary immune deficiency diseases.[20] (IV)
   1. Data suggest that treatment outcomes were enhanced by home administration, as reflected by improved adherence to therapy as measured by infusion frequency and decreased cost per infusion.[19,21] (IV)

REFERENCES

Note: All electronic references in this section were accessed between April 6, 2020, and August 30, 2020.

1. Institute for Safe Medication Practices. ISMP list of high-alert medications in community/ambulatory healthcare. Published 2011. https://www.ismp.org/sites/default/files/attachments/2017-11/highAlert-community.pdf
2. Roughead L, Semple S, Rosenfeld E. *Literature Review: Medication Safety in Australia*. Australian Commission on Safety and Quality in Health Care; 2013. https://www.safetyandquality.gov.au/sites/default/files/migrated/Literature-Review-Medication-Safety-in-Australia-2013.pdf
3. Schleis T, Clarke AE, Vaughan L, et al. *Immunoglobulin Therapy Standards of Practice*. 2nd ed. Immunoglobulin National Society; 2019.
4. Balian JD, Wherry JC, Malhotra R, Perentesis V. Roadmap to risk evaluation and mitigation strategies (REMS) success. *Ther Adv Drug Saf.* 2010;1(1):21-38. doi:10.1177/2042098610381419
5. Basset L, Lassale B, Succamiele L, Moya-Macchi M. Intravenous lines in transfusion and their medical devices [article in French]. *Transfus Clin Biol.* 2018;25(4):276-280. doi:10.1016/j.tracli.2018.08.003
6. US Food and Drug Administration. Approved risk and mitigation strategies (REMS). https://www.accessdata.fda.gov/scripts/cder/rems/index.cfm
7. Australian Commission on Safety and Quality in Health Care. Medication safety standard. In: *The National Safety and Quality Health Service (NSQHS) Standards.* ACSQHC; 2019. https://www.safetyandquality.gov.au/standards/nsqhs-standards/medication-safety-standard
8. Jokanovic N, Tan EC, Sudhakaran S, et al. Pharmacist-led medication review in community settings: an overview of systematic reviews. *Res Social Adm Pharm.* 2017;13(4):661-685. doi:10.1016/j.sapharm.2016.08.005
9. Rosman Z, Shoenfeld Y, Zandman-Goddard G. Biologic therapy for autoimmune diseases: an update. *BMC Med.* 2013;11:88. doi:10.1186/1741-7015-11-88
10. Moroncini G, Calogera G, Benfaremo D, Gabrielli A. Biologics in inflammatory immune-mediated systemic diseases. *Curr Pharm Biotechnol.* 2017;18(12):1008-1016.
11. Wolfe RM, Ang DC. Biologic therapies for autoimmune and connective tissue diseases. *Immunol Allergy Clin North Am.* 2017;37(2):283-299. doi:10.1016/j.iac.2017.01.005

12. Yun H, Xie F, Beyl RN, et al. Risk of hypersensitivity to biologic agents among Medicare patients with rheumatoid arthritis. *Arthritis Care Res (Hoboken).* 2017;69(10):1526-1534. doi:10.1002/acr.23141
13. Matucci A, Nencini F, Pratesi S, Maggi E, Vultaggio A. An overview on safety of monoclonal antibodies. *Curr Opin Allergy Clin Immunol.* 2016;16(6):576-581. doi:10.1097/ACI.0000000000000315
14. Younger EM, Buckley RH, Belser C, Moran K, eds. *IDF Guide for Nurses: Immunoglobulin Therapy for Primary Immunodeficiency Diseases.* 4th ed. Immune Deficiency Foundation; 2016.
15. Czaplewski L. Antineoplastic and biologic therapy. In: Alexander M, Corrigan A, Gorski LA, Phillips L, eds. *Core Curriculum for Infusion Nursing.* 4th ed. Wolters Kluwer/Lippincott Williams & Wilkins; 2014:258-308.
16. Younger ME, Blouin W, Duff C, Epland KB, Murphy E, Sedlak D. Subcutaneous immunoglobulin replacement therapy: ensuring success. *J Infus Nurs.*2015;38(1):70-79. doi:10.1097/NAN.0000000000000087
17. Bayer V, Amaya B, Baniewicz D, Callahan C, Marsh L, McCoy AS. Cancer immunotherapy: an evidence-based overview and implications for practice. *Clin J Oncol Nurs.* 2017;21(2 Suppl):13-21. doi:10.1188/17.CJON.S2.13-21
18. Olsen MM, LeFebvre KB, Brassil KJ, eds. *Chemotherapy and Immunotherapy Guidelines and Recommendations for Practice.* Oncology Nursing Society; 2019.
19. Health Quality Ontario. Home-based subcutaneous infusion of immunoglobulin for primary and secondary immunodeficiencies: a health technology assessment. *Ont Health Technol Assess Ser.* 2017;17(16):1-86.
20. Zuizewind CA, van Kessel P, Kramer CM, Muijs MM, Zwiers JC, Triemstra M. Home-based treatment with immunoglobulins: an evaluation from the perspective of patients and healthcare professionals. *J Clin Immunol.* 2018;38(8):876-885. doi:10.1007/s10875-018-0566-z
21. Wasserman RL, Ito D, Xiong Y, Ye X, Bonnet P, Li-McLeod J. Impact of site of care on infection rates among patients with primary immunodeficiency diseases receiving intravenous immunoglobulin therapy. *J Clin Immunol.* 2017;37(2):180-186. doi:10.1007/s10875-017-0371-0

62. PATIENT-CONTROLLED ANALGESIA

Standard

62.1 The clinician is knowledgeable of the appropriate drugs used with patient-controlled analgesia (PCA), including pharmacokinetics and equianalgesic dosing, contraindications, side effects and their management, appropriate administration modalities, and anticipated outcomes.

62.2 The decision to initiate PCA occurs in collaboration with the patient and the health care team based on assessment of PCA risk factors and the patient's level of understanding and ability to use PCA.

62.3 Pain management is comprehensive and individualized and involves the patient and caregiver in developing a treatment plan and setting realistic and measurable goals.

Practice Recommendations

A. Assess the patient for the appropriateness of PCA therapy and the patient's comprehension of and ability to participate in the intended therapy.[1,2] (V)
   1. PCA use for pain control outside of the acute care setting (eg, home care), including treatment of cancer-related pain in adults and children, has been found to be safe and effective when patient safety measures are appropriately addressed.[3-5] (II)

B. Assess the patient and caregiver for appropriateness of using authorized agent-controlled analgesia (AACA) if the patient is unable to actively participate in PCA or patient/nurse-controlled analgesia (PNCA) for infants and children.[1,6-8] (IV)
   1. Provide caregiver education and evaluate competency prior to AACA, including patient assessment, what to report to provider, operating instructions for electronic infusion pump, appropriate actions to take if therapy is not meeting patient needs, and contact information for support services.[1,2,5,7,9] (IV)

C. Use standardized medication concentrations and standardized or preprinted order sets for PCA and AACA that allow for individualization of dose.[2,10-12] (V)
   1. Range orders must have objective measures to direct correct medication dose adjustment.[11,13] (V)
   2. Dosing should be based on comprehensive patient assessment and should not be based solely on pain assessment score (numeric or behavioral).[11,13-17] (V)

D. Identify patient risk factors that include, but are not limited to, older age, morbid obesity, known/suspected sleep disorder breathing problems, pre-existing pulmonary and/or cardiac disease, renal insufficiency, impaired liver function, and continuous basal infusions.[9,12-15,17-24] (I)
   1. Additional risks specific to infants include prematurity, developmental delays, age (<1 year), underweight.[25] (IV)
   2. Carefully evaluate patient safety in the setting of concomitant use of sedation medications.[11,13,14,18,21-23,26] (I)

E. Perform an independent double check by 2 clinicians prior to initiation of the PCA and when the syringe, solution container, drug, or rate is changed.[2,10] (V)
   1. Give special attention to drug, concentration, dose, and rate of infusion according to the order and as programmed into the electronic infusion pump in order to reduce the risk of adverse outcomes and medication errors (see Standard 13, *Medication Verification*).
   2. Validate that the administration set is correctly connected for immediate delivery of analgesic and is configured to prevent retrograde flow of medication.[15,27,28] (V)

F. Provide individualized patient and caregiver education appropriate to duration of therapy and care setting, treatment options, the purpose of PCA therapy, frequency of monitoring, expected outcomes, precautions, potential side effects, symptoms to report, and how dose will be adjusted.[2,9,11-13,16-18,29,30] (I)

G. Evaluate the effectiveness of PCA/AACA/PNCA and potential adverse events, using valid and reliable monitoring and assessment methods for pain (eg, scales) and documentation tools, through:

1. Regular assessment and reassessment of patient self-report of pain or objective measure of pain using a valid, reliable, developmentally appropriate pain assessment tool individualized to the patient.[1,9,11-13,16,27,29-32] (I)
2. Monitoring for potential adverse effects based on type of opioid therapy, individual patient risk factors, and response to therapy including, but not limited to, sedation and respiratory depression.[1-3,9,11,13,16,18-20,22-24,27,29,30,33-37] (I)
    a. Use a validated sedation scale and direct assessment of quality and adequacy of respirations.[2,9,15,18-20,22,23,26,27,33,38] (I)
3. In the presence of risk factors, use continuous monitoring of capnography, pulse oximetry, and/or other clinically effective methods.[15,19,23,26,27,38-41] (I)
    a. Continuous capnography monitoring provides an earlier warning of respiratory depression as compared to continuous oximetry and is associated with a significant reduction in the incidence of opioid-induced respiratory depression (OIRD), duration in opioid treatment, and opioid-related severe adverse events.[33,40,42] (I)
    b. Consider nurse-worn or centralized monitoring of respiratory devices to improve alarm recognition.[15,22,33,39] (II)
    c. Recognize the risk of supplementary oxygen delivery in masking reduced respiratory drive.[18,19,25,27,33,38,40] (I)
4. Regular evaluation of PCA device function, number of injections and attempts, potential for patient manipulations.[2,43] (IV)
5. Regular assessment of the VAD path and patency to assure correct delivery of dose.[44,45] (IV)
6. Consideration of the need for change in treatment methods as necessary. Adjust pain management plan based on pain relief and presence of adverse effects.[9,11,12,14,17,18,31] (I)

H. Ensure clinicians receive education that addresses pain assessment, safe use of opioids, risk of concomitant use of sedating medications, operation of electronic infusion pump, and the need to individualize pain management based on individual needs of the patient.[6,9,10-16,18,20,22,24,26,29,30,35,43,44,46] (I)

I. Assure adequacy of the pain management plan and patient stability during handoffs to different clinicians and/or settings.[1,12,14,18] (I)

J. Participate in selection and evaluation of PCA electronic infusion pump and monitoring equipment and in quality processes to promote patient safety, which include review of administration of opioid reversal and opioid-related resuscitation, DERS, technology/decision support, barcoding technology, root cause analysis, Healthcare Failure Mode and Effect Analysis (HFMEA), and prescription drug monitoring programs to evaluate opioid utilization.[10-12,14-16,18-21,24-26,29,30,35,39,43-45,47,48] (I)

REFERENCES

Note: All electronic references in this section were accessed between February 5, 2019, and August 31, 2020.

1. Cooney MF, Czarnecki M, Dunwoody C, et al. American Society for Pain Management Nursing position statement with clinical practice guidelines: authorized agent controlled analgesia. *Pain Manag Nurs*. 2013;14(3): 176-181. doi:10.1016/j.pmn.2013.07.003
2. Surprise JK, Simpson MH. PCA: is that patient or provider-controlled analgesia? *J Radiol Nurs.* 2014;33(1):18-22. https://doi.org/10.1016/j.jradnu.2013.10.002
3. Nijland L, Schmidt P, Frosch M, et al. Subcutaneous or intravenous opioid administration by patient-controlled analgesia in cancer pain: a systematic literature review. *Support Care Cancer*. 2019;27(1):33-42. doi:10.1007/s00520-018-4368-x
4. Anghelescu DL, Zhang K, Faughnan LG, Pei D. The safety and effectiveness of patient-controlled analgesia in outpatient children and young adults with cancer: a retrospective study. *J Pediatr Hematol Oncol.* 2015;37(5):378-382. doi:10.1097/MPH.0000000000000354
5. Mherekumombe MF, Collins JJ. Patient-controlled analgesia for children at home. *J Pain Symptom Manage.* 2015;49(5):923-927. doi:10.1016/j.jpainsymman.2014.10.007
6. Muirhead R, Kynoch K. Safety and effectiveness of parent/nurse controlled analgesia on patient outcomes in the neonatal intensive care unit: a systematic review protocol. *JBI Database System Rev Implement Rep.* 2018;16(10):1959-1964. doi:10.11124/JBISRIR-2017-003711
7. Webb RJ, Shelton CP. The benefits of Authorized Agent Controlled Analgesia (AACA) to control pain and other symptoms at the end of life. *J Pain Symptom Manage.* 2015;50(3):371-374. doi:10.1016/j.jpainsymman.2015.03.015
8. Czarnecki ML, Hainsworth K, Simpson PM, et al. Is there an alternative to continuous opioid infusion for neonatal pain control? a preliminary report of parent/nurse-controlled analgesia in the neonatal intensive care unit. *Paediatr Anaesth.* 2014;24(4):377-385. doi:10.1111/pan.12332
9. Chou R, Gordon DB, de Leon-Casasola OA, et al. Management of postoperative pain: a clinical practice guideline from the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. *J Pain*. 2016;17(2):131-157. doi:10.1016/j.jpain.2015.12.008
10. Institute for Safe Medication Practices. Smart pump custom concentrations without hard "low concentration" alerts can lead to patient harm. Published May 31, 2018. https://www.ismp.org/resources/smart-pump-custom-concentrations-without-hard-low-concentration-alerts-can-lead-patient
11. Pasero C, Quinlan-Colwell A, Rae D, Broglio K, Drew D. American Society for Pain Management Nursing position statement: prescribing and administering opioid doses based solely on pain intensity. *Pain Manag Nurs.* 2016;17(3):170-180. doi:10.1016/j.pmn.2016.08.002
12. Surprise JK, Simpson MH. One hospital's initiatives to encourage safe opioid use. *J Infus Nurs*. 2015;38(4):278-283. doi:10.1097/NAN.0000000000000110
13. Drew DJ, Gordon DB, Morgan B, Manworren RCB. ''As-needed'' range orders for opioid analgesics in the management of pain: a consensus statement of the American Society for Pain Management Nursing and the American Pain Society. *Pain Manag Nurs.* 2018;19(3):207-210. doi:10.1016/j.pmn.2018.03.003
14. Meisenberg B, Ness J, Rao S, Rhule J, Ley C. Implementation of solutions to reduce opioid-induced oversedation and respiratory depression. *Am J Health Syst Pharm*. 2017;74(3):162-169. doi:10.2146/ajhp160208
15. Jungquist CR, Willens JS, Dunwoody DR, Klingman KJ, Polomano RC. Monitoring for opioid-induced advancing sedation and respiratory

depression: ASPMN membership survey of current practice. *Pain Manag Nurs*. 2014;15(3):682-693. doi:10.1016/j.pmn.2013.12.001

16. The Joint Commission. Pain assessment and management standards for nursing care centers. *R*[3] *Report: Requirement, Rationale, Reference*. Issue 21. Published December 21, 2018. https://www.jointcommission.org/assets/1/18/3_21_Pain_standards_NCC_12_21_18_FINAL.pdf
17. The Joint Commission. Safe use of opioids in hospitals. *The Joint Commission Sentinel Event Alert*. Issue 49. Published August 8, 2012. https://www.jointcommission.org/assets/1/18/SEA_49_opioids_8_2_12_final.pdf
18. Jarzyna D, Jungquist CR, Pasero C, et al. American Society for Pain Management Nursing guidelines on monitoring for opioid-induced sedation and respiratory depression. *Pain Manag Nurs*. 2011;12(3):118-145.e10. doi:10.1016/j.pmn.2011.06.008
19. Curry JP, Jungquist CR. A critical assessment of monitoring practices, patient deterioration, and alarm fatigue on inpatient wards: a review. *Patient Saf Surg.* 2014; 8:29. doi:10.1186/1754-9493-8-29
20. Jungquist CR, Correll DJ, Fleisher LA, et al. Avoiding adverse events secondary to opioid-induced respiratory depression: implications for nurse executives and patient safety. *J Nurs Adm.* 2016;46(2):87-94. doi:10.1097/NNA.0000000000000301
21. Weingarten TN, Herasevich V, McGlinch MC, et al. Predictors of delayed postoperative respiratory depression assessed from naloxone administration. *Anesth Analg.* 2015;121(2):422-429. doi:10.1213/ANE.0000000000000792
22. Lee LA, Caplan RA, Stephens LS, et al. Postoperative opioid-induced respiratory depression: a closed claims analysis. *Anesthesiology.* 2015;122(3):659-665. doi:10.1097/ALN.0000000000000564
23. Gupta K, Prasad A, Nagappa M, Wong J, Abrahamyan L, Chung FF. Risk factors for opioid-induced respiratory depression and failure to rescue: a review. *Curr Opin Anaesthesiol.* 2018;31(1):110-119. doi:10.1097/ACO.0000000000000541
24. Paul JE, Buckley N, McLean RF, et al. Hamilton acute pain service safety study: using root cause analysis to reduce the incidence of adverse events. *Anesthesiology.* 2014;120(1):97-109. doi:10.1097/ALN.0b013e3182a76f59
25. Chidambaran V, Olbrecht V, Hossain M, Sadhasivam S, Rose J, Meyer MJ. Risk predictors of opioid-induced critical respiratory events in children: naloxone use as a quality measure of opioid safety. *Pain Med.* 2014;15(12):2139-2149. doi:10.1111/pme.12575
26. Overdyk FJ, Dowling O, Marino J, et al. Association of opioids and sedatives with increased risk of in-hospital cardiopulmonary arrest from an administrative database. *PLoS One.* 2016;11(2):e0150214. doi:10.1371/journal.pone.0150214
27. Institute for Safe Medication Practice. Fatal PCA adverse events continue to happen…better patient monitoring is essential to prevent harm. Published May 30, 2013. https://www.ismp.org/resources/fatal-pca-adverse-events-continue-happen-better-patient-monitoring-essential-prevent-harm
28. Giuliano KK. Intravenous smart pumps: usability issues, intravenous medication administration error, and patient safety. *Crit Care Nurs Clin North Am*. 2018;30(2):215-224. doi:10.1016/j.cnc.2018.02.004
29. The Joint Commission. Pain assessment and management standards for hospitals. *R*[3] *Report: Requirement, Rationale, Reference*. Issue 11. Published August 29, 2017. https://www.jointcommission.org/assets/1/18/R3_Report_Issue_11_Pain_Assessment_8_25_17_FINAL.pdf
30. The Joint Commission. Pain assessment and management standards for home health services. *R*[3] *Report: Requirement, Rationale, Reference*. Issue 22. Published December 21, 2018. https://www.jointcommission.org/assets/1/18/R3_22_Pain_standards_HC_12_21_18_FINAL.pdf
31. Crosta QR, Ward TM, Walker AJ, Peters LM. A review of pain measures for hospitalized children with cognitive impairment. *J Spec Pediatr Nurs.* 2014;19(2):109-118. doi:10.1111/jspn.12069
32. McNicol ED, Ferguson MC, Hudcova J. Patient controlled opioid analgesia versus non-patient controlled opioid analgesia for post-operative pain. *Cochrane Database Syst Rev.* 2015;(6):CD003348. doi:10.1002/14651858.CD003348.pub3
33. Lam T, Nagappa M, Wong J, Singh M, Wong D, Chung F. Continuous pulse oximetry and capnography monitoring for postoperative respiratory depression and adverse events: a systematic review and meta-analysis. *Anesth Analg*. 2017;125(6):2019-2029. doi:10.1213/ANE.0000000000002557
34. Davis C, Geik C, Arthur K, et al. A multisite retrospective study evaluating the implementation of the Pasero Opioid-Induced Sedation Scale (POSS) and its effect on patient safety outcomes. *Pain Manag Nurs*. 2017;18(4):193-201. doi:10.1016/j.pmn.2017.03.006
35. Rosenfeld DM, Betcher JA, Shah RA, et al. Findings of a Naloxone database and its utilization to improve safety and education in a tertiary care medical center. *Pain Pract.* 2016;16(3):327-333. doi:10.1111/papr.12277
36. Sousa AM, de Santana Neto J, Guimaraes GM, Cascudo GM, Neto JO, Ashmawi HA. Safety profile of intravenous patient-controlled analgesia for breakthrough pain in cancer patients: a case series study. *Support Care Cancer*. 2014;22(3):795-801. doi:10.1007/s00520-013-2036-8
37. Hayes J, Dowling JJ, Peliowski A, Crawford MW, Johnston B. Patient-controlled analgesia plus background opioid infusion for postoperative pain in children: a systematic review and meta-analysis of randomized trials. *Anesth Analg.* 2016;123(4):991-1003. doi:10.1213/ANE.0000000000001244
38. Miller KM, Kim AY, Yaster M, et al. Long-term tolerability of capnography and respiratory inductance plethysmography for respiratory monitoring in pediatric patients treated with patient-controlled analgesia. *Paediatr Anaesth*. 2015;25(10):1054-1059. doi:10.1111/pan.12702
39. Blankush JM, Freeman R, McIlvaine J, Tran T, Nassani S, Leitman IM. Implementation of a novel postoperative monitoring system using automated Modified Early Warning Scores (MEWS) incorporating end-tidal capnography. *J Clin Monit Comput.* 2017;31(5):1081-1092. doi:10.1007/s10877-016-9943-4
40. Stites M, Surprise J, McNiel J, Northrop D, De Ruyter M. Continuous capnography reduces the incidence of opioid-induced respiratory rescue by hospital rapid resuscitation team [published online ahead of print Jul 20, 2017]. *J Patient Saf.* 2017;10.1097/PTS.0000000000000408. doi:10.1097/PTS.0000000000000408
41. Khanna AK, Bergese SD, Jungquist CR, et al. Prediction of opioid-induced respiratory depression on inpatient wards using continuous capnography and oximetry: an international prospective, observational trial. *Anesth Analg*. 2020;131(4):1012-1024. doi:10.1213/ANE.0000000000004788
42. Steele T, Eidem L, Bond J. Impact of adoption of smart pump system with continuous capnography monitoring on opioid-related adverse event rates: experience from a tertiary care hospital. *J Patient Saf*. 2020;16(3):e194-e198. doi:10.1097/PTS.0000000000000584
43. Lawal OD, Mohanty M, Elder H, et al. The nature, magnitude, and reporting compliance of device-related events for intravenous patient-controlled analgesia in the FDA Manufacturer and User Facility Device Experience (MAUDE) database. *Expert Opin Drug Saf.* 2018;17(4):347-357. doi:10.1080/14740338.2018.1442431
44. Mohanty M, Lawal OD, Skeer M, Lanier R, Erpelding N, Katz N. Medication errors involving intravenous patient-controlled analgesia: results from the 2005-2015 MEDMARX database. *Ther Adv Drug Saf.* 2018;9(8):389-404. doi:10.1177/2042098618773013
45. Foinard A, Décaudin B, Barthélémy C, Lebuffe G, Debaene B, Odou P. Impact of infusion set characteristics on the accuracy of patient-controlled morphine administration: a controlled in-vitro study. *Anaesthesia*. 2014;69(2):131-136. doi:10.1111/anae.12523
46. Drake G, de C Williams AC. Nursing education interventions for managing acute pain in hospital settings: a systematic review of clinical outcomes and teaching methods. *Pain Manag Nurs*. 2017;18(1):3-15. doi:10.1016/j.pmn.2016.11.001

47. Herzig SJ, Rothberg MB, Cheung M, Ngo LH, Marcantonio ER. Opioid utilization and opioid-related adverse events in nonsurgical patients in US hospitals. *J Hosp Med.* 2014;9(2):73-81. doi:10.1002/jhm.2102
48. Faerber J, Zhong W, Dai D, et al. Comparative safety of morphine delivered via intravenous route vs. patient-controlled analgesia device for pediatric inpatients. *J Pain Symptom Manage.* 2017;53(5):842-850. doi:10.1016/j.jpainsymman.2016.12.328

63. PARENTERAL NUTRITION

Standard

63.1 The decision to implement PN occurs in collaboration with the patient/caregiver and the health care team based on the projected treatment plan.
63.2 PN is administered using filtration appropriate to the type of solution.
63.3 PN is administered using an electronic infusion pump with anti–free-flow-control and appropriate alarms.
63.4 Medications are not added or co-infused with the PN solution before or during infusion without consultation with a pharmacist regarding compatibility and stability.

Practice Recommendations

A. Prescribe PN safely and appropriately.
   1. Use the enteral route in preference to the parenteral route for nutrition support whenever feasible.[1-5] (IV)
   2. For patients who will transition from an acute care setting to a home care setting, include the following factors in the discharge planning process: insurance coverage, appropriate VAD, home safety, and a physical, nutritional, and psychological needs assessment.[1,5-8] (IV)
   3. Use standardized order forms or templates and CPOE whenever feasible, as they have been found to prevent errors related to prescriptions for PN.[1] (IV)
   4. Develop written protocols for PN component substitution or conservation methods in the event of drug/component shortage.[1] (IV)

B. Administer PN safely.
   1. Filter PN solutions with the correct filter pore size. Place the filter as close to the patient as possible on the administration set.
      a. Use a 0.2-micron filter for PN solutions without lipid injectable emulsions (ILE).
      b. Use a 1.2-micron filter for PN solutions containing ILE (also known as total nutrient admixture [TNA]).
      c. Use a separate 1.2-micron filter for separately infused ILE; attach to an injection site below the 0.2-micron filter used for dextrose/amino acid solution or administer via a separate VAD/lumen.
      d. Change all filters used for PN solutions in accordance with manufacturers' directions for use, which is generally every 24 hours (often an integral part of the administration set). Change all filters used for lipid emulsions every 12 hours. Prime filters immediately before use.[1,8,9] (IV)
   2. Replace administration sets for PN solutions (TNA and amino acid/dextrose formulations) with each new PN container, which is typically every 24 hours; replace administration sets used for ILE with each new infusion; hang time for ILE should not exceed 12 hours (see Standard 43, *Administration Set Management*).[1] (IV)
   3. Use administration sets free of Di[2-ethylhexyl] phthalate (DEHP) to administer lipid-based solutions, such as ILE or PN solution containing ILE. DEHP is lipophilic and is extracted into the lipid solution with commonly used polyvinyl chloride administration sets and containers. DEHP is considered a toxin, and studies have demonstrated increased DEHP levels in lipid solutions, which is especially a risk with neonatal, pediatric, and long-term home care patients (see Standard 43, *Administration Set Management*).[10-12] (IV)
   4. Consider the osmolarity when administering via a CVAD vs a PIVC.
      a. Administer PN solutions/emulsions containing final concentrations that result in an osmolarity greater than 900 mOsm/L through a CVAD (see Standard 26, *Vascular Access Device Planning*).[1] (IV)
      b. Reserve the administration of peripheral PN solutions/emulsions with a final concentration of 10% dextrose or lower through a short PIVC for situations in which a CVAD is not currently feasible and delay of feeding would be detrimental to the patient. Consider dextrose and other additives that affect osmolarity and do not exceed an osmolarity of 900 mOsm/L for peripheral PN solutions.
         i. The osmolarity limit for peripheral PN is an area of needed research.
         ii. Use peripheral PN as a bridge to central PN, when oral intake or enteral nutrition is suboptimal, or when the patient's clinical condition does not justify CVAD placement.
         iii. The use of midline catheters for peripheral PN has not been studied; the location of midline catheters in a deeper vein may mask early signs of phlebitis.
            - Do not use midline catheters for continuous vesicant therapy, PN, or solutions with extremes of pH or osmolarity (refer to Standard 26, *Vascular Access Device Planning*).
         iv. Recognize the increased risk for phlebitis with peripheral PN; weigh the risks vs benefits for peripheral PN administration and limit duration of therapy to no more than 14 days.[1,5,8,12-15] (IV)
      c. Peripheral infusion therapies should ideally be isotonic and of physiological pH. When this is not achievable, peripheral IV infusion of extremes of pH and osmolarity should be

avoided to reduce vascular endothelial damage. In clinical practice, many parameters including VAD location, number of infusion therapies, vein selected, related venous blood flow, infusion volume, and infusion duration, contribute to vessel damage. There is no well-defined and generally recognized pH and osmolarity limit (refer to Standard 26, *Vascular Access Device Planning*).

5. Use electronic infusion pumps with anti–free-flow protection and alarms for occlusion. Consider the use of electronic infusion pumps with DERS (ie, smart pumps), as they are associated with reduced risk for infusion-related medication errors, including error interceptions (eg, wrong rate), and reduced adverse drug events (see Standard 24, *Flow-Control Devices*).[1] (IV)
6. Reduce the risk of catheter-associated bloodstream infection when administering PN.
   a. Avoid blood sampling via the CVAD used for PN (see Standard 34, *Vascular Access Device Placement*; Standard 44, *Blood Sampling*).[1] (V)
   b. Consider dedication of a single lumen to PN administration when a multilumen CVAD has been placed; this remains an area of needed research (see Standard 26, *Vascular Access Device Planning*).[1] (IV)
   c. Avoid attaching administration sets until the time of infusion.[1] (I)

C. Monitor the patient and provide patient and clinical staff education.
1. Include physiological, sociological, and psychological aspects of response to therapy for patients who are on long-term PN.[1,6,7] (I)
2. Monitor patient receiving PN for the following: body weight; fluid and electrolyte balance; metabolic tolerance, especially glucose control; organ function; nutrition therapy-related complications; functional performance; and psychological responses. Educate the home patient/caregiver about signs and symptoms of metabolic intolerance, infection, and access device complications to report to the health care team.[1,6,7] (IV)
3. Monitor blood glucose on and off PN during initial cycling in the acute care or home setting.[1] (V)
4. Teach patients or family members of patients who receive home PN about access device care, weight and hydration monitoring, blood/urine glucose monitoring, electronic infusion pump use and troubleshooting, and signs and symptoms to report, and assist patients on how to fit PN into their lifestyles (see Standard 8, *Patient Education*).[1,6,7] (I)

REFERENCES

1. Ayers P, Bobo ES, Hurt RT, Mays AA, Worthington PH, eds. *ASPEN Parenteral Nutrition Handbook*. 3rd ed. ASPEN; 2020.
2. McClave SA, Taylor BE, Martindale RG, et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). *JPEN J Parenter Enteral Nutr.* 2016;40(2):159-211. doi:10.1177/0148607115621863
3. Mehta NM, Skillman HE, Irving SY, et al. Guidelines for the provision and assessment of nutrition support therapy in the pediatric critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. *JPEN J Parenter Enteral Nutr*. 2017;41(5):706-742. doi:10.1177/0148607117711387
4. Singer P, Blaser AR, Berger MM, et al. ESPEN guideline on clinical nutrition in the intensive care unit. *Clin Nutr.* 2019;38(1):48-79. doi:10.1016/j.clnu.2018.08.037
5. Worthington P, Balint J, Bechtold M, et al. When is parenteral nutrition appropriate? *JPEN J Parenter Enteral Nutr*. 2017;41(3):324-377. doi:10.1177/0148607117695251
6. Kovacevich DS, Corrigan M, Ross VM, McKeever L, Hall AM, Braunschweig C. American Society for Parenteral and Enteral Nutrition guidelines for the selection and care of central venous access devices for adult home parenteral nutrition administration. *JPEN J Parenter Enteral Nutr*. 2019;43(1):15-31. doi:10.1002/jpen.1455
7. Pironi L, Boeykens K, Bozzetti F, et al. ESPEN guideline on home parenteral nutrition. *Clin Nutr*. 2020;39(6):1645-1666. doi:10.1016/j.clnu.2020.03.005
8. Ayers P, Adams S, Boullata J, et al. A.S.P.E.N. parenteral nutrition safety consensus recommendations. *JPEN J Parenter Enteral Nutr.* 2014;38(3):296-333. doi:10.1177/0148607113511992
9. Boullata JI, Berlana D, Pietka M, Klek S, Martindale R. Use of intravenous lipid emulsions with parenteral nutrition: practical handling aspects. *JPEN J Parenter Enteral Nutr.* 2020;44(Suppl 1):S74-S81. doi:10.1002/jpen.1737
10. Puntis J, Hojsak I, Ksiazyk J; ESPGHAN/ESPEN/ESPR/CSPEN working group on pediatric parenteral nutrition. ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: organisational aspects. *Clin Nutr*. 2018;37(6 Pt B):2392-2400. doi:10.1016/j.clnu.2018.06.953
11. Iribarne-Duran LM, Artacho-Cordon F, Pena-Caballero M, et al. Presence of Bisphenol A and parabens in a neonatal intensive care unit: an exploratory study of potential sources of exposure. *Environ Health Perspect.* 2019;127(11):117004. doi:10.1289/EHP5564
12. Snell JR, Monticello CR, Her C, et al. DEHP nanodroplets leached from polyvinyl chloride IV bags promote aggregation of IVIG and activate complement in human serum. *J Pharm Sci*. 2020;109(1):429-442. doi:10.1016/j.xphs.2019.06.015
13. Kolaček S, Puntis JWL, Hojsak I; ESPGHAN/ESPEN/ESPR/CSPEN working group on pediatric parenteral nutrition. ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: venous access. *Clin Nutr*. 2018;37(6 Pt B):2379-2391. doi:10.1016/j.clnu.2018.06.952
14. Sugrue D, Jarrell AS, Kruer R, et al. Appropriateness of peripheral parenteral nutrition use in adult patients at an academic medical center. *Clin Nutr ESPEN*. 2018;23:117-121. doi:10.1016/j.clnesp.2017.11.004
15. Dugan S, Le J, Jew RK. Maximum tolerated osmolarity for peripheral administration of parenteral nutrition in pediatric patients. *JPEN J Parenter Enteral Nutr*. 2014;38(7):847-851. doi:10.1177/014860711349556964.

64. BLOOD ADMINISTRATION

Standard

64.1 Administration of blood and blood components, including the use of infusion devices and ancillary equipment, and the identification, evaluation, and reporting of adverse events related to transfusion are established in organizational policies, procedures, and/or practice guidelines.

64.2 Verification of the correct patient and blood product is performed in the presence of the patient prior to transfusion.
64.3 Blood and blood components are transfused through a transfusion administration set that has a filter designed to retain potentially harmful particles.

Practice Recommendations

A. Assess benefits vs the risks of transfusion prior to administering human blood and blood components (whole blood, red blood cells [RBCs], plasma and plasma components, platelets, granulocytes, cryoprecipitate).
   1. Patient blood management (PBM) is an evidence-based, multidisciplinary approach aimed at optimizing the care of patients who might require a blood transfusion. PBM programs assist clinicians to make decisions about appropriate use of transfusions and elimination of unnecessary transfusions across all patient populations. Strategies include management/prevention of anemia, optimizing coagulation/hemostasis, and implementation of evidence-based indications for transfusion.[1-10] (II)

B. Provide patient/caregiver education and ensure that informed consent is obtained.
   1. Include a description of risks, benefits, and treatment alternatives; an opportunity to ask questions; and the right to accept or refuse the transfusion.
   2. Allow the opportunity for patients to discuss their religious/cultural beliefs regarding blood transfusion.
   3. Include the following in the educational process:
      a. Elements of the transfusion procedure (eg, compatibility testing, vascular access)
      b. Signs/symptoms associated with complications of transfusion therapy (eg, vague uneasy feeling, pain, breathing difficulties, chills/flushing/fever, nausea, dizziness, rash/urticaria, dark/red urine); (see Standard 8, *Patient Education;* Standard 9, *Informed Consent*).[9-12] (IV)

C. Perform a baseline physical assessment prior to obtaining blood for transfusion, including vital signs, lung assessment, identification of conditions that may increase the risk of transfusion-related adverse reactions (eg, current fever, heart failure, renal disease, and risk of fluid volume excess), the presence of an appropriate and patent VAD, and current laboratory values.
   1. Identify and report any symptoms to the health care team that may later be mistaken for a transfusion reaction.
   2. Recognize that fever may be a cause for delay in transfusion.[9-11,13] (V)

D. Choose an appropriate VAD based on patient condition and transfusion needs.
   1. PIVCs:
      a. Adults: Use 20- to 24-gauge based on vein size and patient preference. Use a large-size catheter gauge when rapid transfusion is required (eg, 18- to 20-gauge).
      b. Infants/children: Options include the umbilical vein (neonates) or a vein large enough to accommodate a 22- to 24-gauge catheter.
      c. Transfuse RBCs at a slower rate when using small-gauge catheters; the pressure with rapid transfusion via a small-gauge catheter may cause hemolysis.
   2. CVADs are acceptable for blood administration.[9-11,13-15] (IV)

E. Perform patient and blood product identification and inspect blood component for abnormalities at the time the blood component is released from the transfusion service and in the presence of the patient before preparing the transfusion.
   1. Verify the following: provider order for transfusion; patient's 2 independent identifiers, ABO group and Rh type, donation identification number, crossmatch test interpretation if performed, special transfusion requirements, expiration date/time, and date/time of issue.
   2. Use an independent double check by 2 adults in the presence of the patient (eg, hospital/outpatient setting: 2 persons trained in the identification of the recipient and blood components; in home setting: nurse and responsible adult); automated identification technologies may be used and are successful in improving the identification system (eg, barcode identification, radio frequency identification devices, biometric scanning).
   3. Inspect each blood component prior to transfusion and do not use if container is not intact or if the appearance is not normal (eg, abnormal color, presence of clots, excessive air/bubbles, unusual odor) and return it to the transfusion service.[9-11,13] (IV)

F. Administer blood or blood components with 0.9% sodium chloride.
   1. Do not add or infuse any other solutions or medications through the same administration set with blood or blood components (do not piggyback blood administration sets into other infusion administration sets).[9-11,13] (IV)

G. Filter all blood components and follow the manufacturers' directions for filter use.
   1. Use a filter designed to remove blood clots and harmful particles; standard blood administration sets include a 170- to 260-micron filter.
   2. Do not use microaggregate filters routinely; these may be used for reinfusion of blood shed during high blood loss surgical procedures.
   3. Leukocyte reduction filtration is generally preferred "prestorage" or shortly after blood collection. Bedside leukocyte reduction is a less efficient method and has been associated with dramatic hypotension in some patients. Use of leukocyte-reduced blood products (RBCs and platelets) decreases the risk of febrile transfusion reactions, risk of human leukocyte antigen (HLA) alloimmunization, and transmission of cytomegalovirus (CMV).

4. Never use leukocyte filtration when transfusing granulocyte or hematopoietic progenitor cells.[9-11,13] (IV)

H. Change the transfusion administration set in conjunction with manufacturers' directions for use.
   1. Clinical studies establishing the maximum time for set use are lacking; in accordance with the AABB, if the first unit requires 4 hours for transfusion, the administration set and filter is not reused. Transfusion guidelines from other countries recommend changing the administration set every 12 hours.
   2. Note that most standard filters have a 4-unit maximum capacity; follow manufacturers' directions for use.[9-11,16] (IV)

I. Administer and complete each unit of blood or blood component within 4 hours.
   1. Ask the transfusion service to divide a unit of RBCs or whole blood into smaller aliquots when it is anticipated that the unit cannot be transfused within 4 hours (eg, pediatric patients or adult patients at risk for fluid overload).
   2. Administer platelets over 1 to 2 hours.
   3. Administer plasma as quickly as tolerated by the patient or over 15 to 60 minutes.
   4. Electronic infusion pumps that have a labeled indication for blood transfusion should be used. Electronic infusion pumps can be used to deliver blood or blood components without significant risk of hemolysis of RBCs or platelet damage. Follow the manufacturers' directions for use (see Standard 24, *Flow-Control Devices*).
   5. Manual pressure cuffs can be used to increase RBC flow rate when rapid transfusion is required. Externally applied compression devices should be equipped with a pressure gauge, totally encase the blood bag, and apply uniform pressure against all parts of the blood container. Pressure should not exceed 300 mm Hg. A standard sphygmomanometer is never used for this purpose. For rapid infusion, a large-gauge catheter may be more effective than a pressure device.[9-11,13] (IV)

J. Use blood and fluid warmers when warranted by patient history, clinical condition, and prescribed therapy including, but not limited to, avoiding or treating intraoperative hypothermia, trauma management, exposure, plasma exchange for therapeutic apheresis, patients known to have clinically significant cold agglutinins, neonate exchange transfusions, and replacement of large blood volumes (refer to Standard 25, *Blood and Fluid Warming*).

K. Monitor for adverse transfusion reactions.
   1. Check the patient's vital signs within 30 minutes prior to transfusion, 15 minutes after initiating transfusion, upon completion of the transfusion, 1 hour after the transfusion has been completed, and as needed if warranted by clinical observation of the patient's condition. Assess the patient for any adverse reactions at least every 30 minutes throughout the transfusion.
   2. Initiate nonemergent transfusions slowly and remain near the patient; major reactions usually appear before the first 50 mL have been transfused; increase the transfusion rate after 15 minutes when there are no signs of a reaction and to ensure the completion of the unit within 4 hours.
   3. Stop the transfusion immediately if signs and symptoms of a transfusion reaction are present; notify the provider and transfusion service and administer emergency medications as prescribed.
      a. Do not administer emergency medications through the blood administration set; prime a new administration set with 0.9% sodium chloride for infusion through the VAD.
   4. Monitor patients for transfusion reactions for at least 4 to 6 hours to detect febrile or pulmonary reactions associated with the transfusion; for patients not under direct observation after the transfusion, provide patient education about signs and symptoms of a delayed transfusion reaction and importance of reporting.[9-11,13] (IV)

L. Ensure safe transfusion practice if transfusing in an out-of-hospital setting (eg, dialysis, skilled nursing facilities, home, outpatient surgery).
   1. Develop well-planned programs that incorporate all relevant aspects for hospital transfusion.
   2. Employ the following when transfusing in a home setting: documentation showing no identified adverse events during previous transfusions; immediate access to the provider by phone during the transfusion; presence of another competent adult in the home who is available to assist with patient identification and summon for medical assistance if needed; ability to transport blood product in appropriate containers; and the ability to appropriately dispose of medical waste.[13] (V)

REFERENCES

Note: All electronic references in this section were accessed between April 9, 2020, and August 31, 2020.

1. Mueller MM, Van Remoortel H, Meybohm P, et al. Patient blood management: recommendations from the 2018 Frankfurt Consensus Conference. *JAMA.* 2019;321(10):983-997. doi:10.1001/jama.2019.0554
2. Muñoz M, Stensballe J, Ducloy-Bouthors AS, et al. Patient blood management in obstetrics: prevention and treatment of postpartum haemorrhage. A NATA consensus statement. *Blood Transfus.* 2019;17(2):112-136. doi:10.2450/2019.0245-18
3. Cholette JM, Faraoni D, Goobie SM, Ferraris V, Hassan N. Patient blood management in pediatric cardiac surgery: a review. *Anesth Analg.* 2018;127(4):1002-1016. doi:10.1213/ANE.0000000000002504
4. Delaforce A, Duff J, Munday J, Hardy J. Overcoming barriers to evidence-based patient blood management: a restricted review. *Implement Sci.* 2020;15(1):6. doi:10.1186/s13012-020-0965-4
5. Goel R, Cushing MM, Tobian AA. Pediatric patient blood management programs: not just transfusing little adults. *Transfus Med Rev.* 2016;30(4):235-241. doi:10.1016/j.tmrv.2016.07.004
6. Shander A, Javidroozi M, Lobel G. Patient blood management in the intensive care unit. *Transfus Med Rev.* 2017;31(4):264-271. doi:10.1016/j.tmrv.2017.07.007

7. Murphy MF, Palmer A. Patient blood management as the standard of care. *Hematology Am Soc Hematol Educ Program.* 2019;2019(1):583-589. https://doi.org/10.1182/hematology.2019000063
8. Puca KE. Patient blood management. In: Fung MK, Eder AF, Spitalnik SL, Westhoff CM, eds. *Technical Manual.* 19th ed. AABB; 2017:527-545.
9. Clinical Practice Improvement Committee, Australian & New Zealand Society of Blood Transfusion. *Guideline for the Administration of Blood Products.* 3rd ed. Australian & New Zealand Society of Blood Transfusion Ltd; 2018. https://anzsbt.org.au/wp-content/uploads/2018/06/ANZSBT_Guidelines_Administration_Blood_Products_3rdEd_Jan_2018.pdf
10. De Biasio L, Rymer T. Blood administration. In: Clarke G, Chargé S, eds. *Clinical Guide to Transfusion.* Canadian Blood Services; 2017: chap 9. https://professionaleducation.blood.ca/en/transfusion/guide-clinique/blood-administration
11. AABB. *AABB Primer of Blood Administration (2018).* AABB; 2019.
12. Scharman CD, Burger D, Shatzel JJ, Kim E, DeLoughery TG. Treatment of individuals who cannot receive blood products for religious or other reasons. *Am J Hematol.* 2017;92(12):1370-1381. doi:10.1002/ajh.24889
13. Jorgenson M. Administration of blood components. In: Fung MK, Eder AF, Spitalnik SL, Westhoff CM, eds. *Technical Manual.* 19th ed. AABB; 2017:489-503.
14. Stupnyckyj C, Smolarek S, Reeves C, McKeith J, Magnan M. Changing blood transfusion policy and practice. *Am J Nurs.* 2014;114(12):50-59. doi:10.1097/01.NAJ.0000457412.68716.3b
15. Wong EC, Punzalan, Rowena C. Neonatal and pediatric transfusion practice. In: Fung MK, Eder AF, Spitalnik SL, Westhoff CM, eds. *Technical Manual.* 19th ed. AABB; 2017:613-640.
16. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect.* 2014;86(Suppl 1):S1-S70. doi:10.1016/S0195-6701(13)60012-2

65. MODERATE SEDATION/ANALGESIA USING INTRAVENOUS INFUSION

Standard

65.1 IV infusion of moderate sedation/analgesia is provided in accordance with laws, rules, and regulations established by regulatory and accrediting bodies in each jurisdiction and in accordance with organizational policy.

65.2 An emergency cart and reversal agents are immediately accessible, and clinicians with expertise in patient age and size appropriate airway management, emergency intubation, advanced cardiopulmonary life support, and management of potential complications are immediately available.

Practice Recommendations

A. Identify a list of medications that may be administered by the clinician. Medications for moderate sedation that may be administered include benzodiazepines (midazolam, diazepam), narcotics (fentanyl, meperidine), propofol, neuroleptic tranquilizers (droperidol), and antihistamines (diphenhydramine).[1-7] (IV)
B. Ensure that informed consent was obtained according to organizational policy and procedure (refer to Standard 9, *Informed Consent*).
C. Establish the discharge plan prior to the procedure, including the need to have a family member/caregiver/friend drive the patient home and observe the patient after the procedure.[1,2,4,5,7-10] (IV)
D. Perform a comprehensive preprocedural assessment to include medical history/current condition, current medications, allergies, previous sedation experience, drug/alcohol/tobacco use, and verification of nothing by mouth (NPO) status.[11] (IV)
    1. Consult with an anesthesia provider for any problematic issues identified during the assessment, such as significant opioid use, history of intolerance to moderate sedation, airway issues, allergies, sleep apnea, morbid obesity, gastric outlet obstruction, gastroparesis, and significant comorbidities.[1-10] (IV)
E. Initiate and maintain vascular access throughout the procedure and recovery for administration of medications and for potential need for emergency resuscitative medications and/or reversal agents; moderate sedation may convert to deep sedation and loss of consciousness due to the types of agents used, the patient's physical status, and drug sensitivities.[1-3,6-10,12,13] (IV)
F. Monitor the patient continuously throughout the procedure, including blood pressure, respiratory rate, oxygen saturation, cardiac rate and rhythm, and level of consciousness.[1,3-7,10,12,14-16] (IV)
    1. Use of advanced monitoring techniques such as acoustic respiratory monitoring and processed electroencephalography may be useful in early detection of oxygen desaturation and respiratory depression.[14] (II)
    2. Consider the use of capnography to measure adequacy of ventilation.[1,2,4-7,10,14] (IV)
    3. Observe the patient for at least 90 minutes after the procedure if reversal agent administration is required.[2,7,10] (IV)
G. Address the following patient/caregiver education topics prior to, and reinforce teaching after, the procedure:
    1. Sedation/analgesia infusion and procedure and what to expect.
    2. Postprocedural restrictions.
    3. Potential complications related to the VAD site and the procedure, emergency instructions, and 24-hour contact phone number.[1,2,4-6] (IV)

REFERENCES

Note: All electronic references in this section were accessed between April 9, 2020, and August 31, 2020.

1. Caperilli-White L, Urman RD. Developing a moderate sedation policy: essential elements and evidence-based considerations. *AORN J.* 2014;99(3):416-430. doi:10.1016/j.aorn.2013.09.015
2. Amornyotin S. Registered nurse-administered sedation for gastrointestinal endoscopic procedure. *World J Gastrointest Endosc.* 2015;7(8):769-776. doi:10.4253/wjge.v7.i8.769

3. Lin OS. Sedation for routine gastrointestinal endoscopic procedures: a review on efficacy, safety, efficiency, cost and satisfaction. *Intest Res*. 2017;15(4):456-466. doi:10.5217/ir.2017.15.4.456
4. Spruce L. Back to basics: procedural sedation. *AORN J.* 2015;101(3):345-353. doi:10.1016/j.aorn.2014.09.011
5. Fencl JL. Guideline implementation: moderate sedation/analgesia. *AORN J.* 2016;103(5):500-511. doi:10.1016/j.aorn.2016.03.001
6. Conway A, Rolley J, Page K, Fulbrook P. Clinical practice guidelines for nurse-administered procedural sedation and analgesia in the cardiac catheterization laboratory: a modified Delphi study. *J Adv Nurs*. 2014;70(5):1040-1053. doi:10.1111/jan.12337
7. Practice guidelines for moderate procedural sedation and analgesia 2018: a report by the American Society of Anesthesiologists task force on moderate procedural sedation and analgesia, the American Association of Oral and Maxillofacial Surgeons, American College of Radiology, American Dental Association, American Society of Dentist Anesthesiologists, and Society of Interventional Radiology. *Anesthesiology.* 2018;128(3):437-479. doi:10.1097/ALN.0000000000002043
8. American Association of Moderate Sedation Nurses. Registered nurse scope of practice, Certified Sedation Registered Nurse (CSRN) scope of practice. Published 2008. Updated 2017. https://aamsn.org/resources/pdfs/sedation-related-pdfs/registered-nurse-csrn-scope-of-practice
9. Society of Gastroenterology Nurses and Associates. Statement on the use of sedation and analgesia in the gastrointestinal endoscopy setting [position statement]. Updated 2017. https://www.sgna.org/Portals/0/Practice/Sedation/Sedation_FINAL.pdf?ver=2017-10-09-110940-983
10. Coté CJ, Wilson S, American Academy of Pediatrics, American Academy of Pediatric Dentistry. Guidelines for monitoring and management of pediatric patients before, during, and after sedation for diagnostic and therapeutic procedures: update 2016. *Pediatrics*. 2016;138(1):e20161212. doi:10.1542/peds.2016-1212
11. Kothari D, Feuerstein JD, Moss L, et al. An open-access endoscopy screen correctly and safely identifies patients for conscious sedation. *Gastroenterol Rep (Oxf).* 2016;4(4):281-286. doi:10.1093/gastro/gow020
12. Vargo JJ, Niklewski PJ, Williams JL, Martin JF, Faigel DO. Patient safety during sedation by anesthesia professionals during routine upper endoscopy and colonoscopy: an analysis of 1.38 million procedures. *Gastrointest Endosc.* 2017;85(1):101-108. doi:10.1016/j.gie.2016.02.007
13. Ward DS, Williams MR, Berkenbosch JW, et al. Evaluating patient centered outcomes in clinical trials of procedural sedation, part 2 safety: sedation consortium on endpoints and procedures for treatment, education and research recommendations. *Anesth Analg.* 2018;127(5):1146-1154. doi:10.1213/ANE.0000000000003409
14. Applegate RL 2nd, Lenart J, Malkin M, et al. Advanced monitoring is associated with fewer alarm events during planned moderate sedation procedure-related sedation. a 2-part pilot trial. *Anesth Analg.* 2016;122(4):1070-1078. doi:10.1213/ANE.0000000000001160
15. Varndell W, Elliott D, Fry M. Assessing, monitoring and managing continuous intravenous sedation for critically ill adult patients and implications for emergency nursing practice: a systematic literature review. *Australas Emerg Nurs J.* 2015;18(2):59-67. doi:10.1016/j.aenj.2014.08.002
16. Dorfman TL, Sumamo Schellenberg E, Rempel GR, Scott SD, Hartling L. An evaluation of instruments for scoring physiological and behavioral cues of pain, non-pain related distress, and adequacy of analgesia and sedation in pediatric mechanically ventilated patients: a systematic review. *Int J Nurs Stud.* 2014;51(4):654-676. doi:10.1016/j.ijnurstu.2013.07.00966.

66. THERAPEUTIC PHLEBOTOMY

Standard

66.1 Selection of the most appropriate type of VAD for therapeutic phlebotomy occurs in collaboration with the patient/caregiver and the health care team based on the projected treatment plan.

66.2 Interventions to reduce the risk for side effects and/or adverse reactions associated with therapeutic phlebotomy are implemented.

66.3 All medical waste, including the blood from the therapeutic phlebotomy, is disposed of in accordance with organizational policies, procedures, and/or practice guidelines.

Practice Recommendations

A. Establish parameters for therapeutic phlebotomy: laboratory values to be assessed specific to the patient's diagnosis, parameters for laboratory values guiding the indication for phlebotomy, frequency of phlebotomy, type of VAD, and volume of blood to be withdrawn.[1-3] (V)
B. Prevent, manage, and recognize common side effects such as hypovolemia and nausea/vomiting or rare adverse events by using a reclining chair or exam table/bed for the procedure; monitor vital signs before and after the procedure; encourage oral hydration before and after the procedure; ask about fear of needles or blood; and administer parenteral solution replacement if prescribed, indicating the type of solution, amount, and rate of infusion.[1-10] (IV)
C. Select the most appropriate VAD based on patient condition, anticipated duration of treatment, and other infusion therapies:
    1. Short PIVC using a 16- to 20-gauge device and inserted before phlebotomy and removed upon completion.
    2. CVAD (including implanted vascular access port), if already placed, and therapeutic phlebotomy will not compromise other infusion therapies.[11] (V)
D. Blood collection receptacles may include collection bags used for volunteer blood donation or bags specifically designed for therapeutic phlebotomy; syringes may also be used based on the VAD. Do not use vacuum bottles to facilitate blood flow due to risk of air embolism.[11] (V)
E. Instruct the patient to remain in a reclining position for several minutes after the procedure, then instruct to rise slowly.[3,5] (V)
F. Address the following topics in patient education: potential side effects such as a hematoma, dizziness, syncope, headache, nausea/vomiting, and fatigue. Instructions should include the type and amount of physical activity for specified time period(s) before and after the procedure.[7-9,12] (V)

REFERENCES

1. Barbui T, Passamonti F, Accorsi P, et al. Evidence- and consensus-based recommendations for phlebotomy in polycythemia vera. *Leukemia.* 2018;32(9):2077-2081. doi:10.1038/s41375-018-0199-5

2. Zubair A. Therapeutic phlebotomy. *Clin Liver Dis (Hoboken).* 2014;4(5):102-105. doi:10.1002/cld.408
3. Hagle ME, Mikell M. Peripheral venous access. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Wolters Kluwer/Lippincott Williams & Wilkins; 2014:303-334.
4. Hy L, Ho HW. Performing therapeutic venesection in a doctor's surgery. *Aust Fam Physician.* 2017;46(3):132-138.
5. Morand C, Coudurier N, Rolland C, et al. Prevention of syncopal-type reactions after whole blood donation: a cluster-randomized trial assessing hydration and muscle tension exercise. *Transfusion.* 2016;56(10):2412-2421. doi:10.1111/trf.13716
6. Kurtin S, Lyle L. The role of advanced practitioners in optimizing clinical management and support of patients with polycythemia vera. *J Adv Pract Oncol.* 2018;9(1):56-66.
7. Panch SR, Yau YY, West K, Diggs K, Sweigart T, Leitman SF. Initial serum ferritin predicts number of therapeutic phlebotomies to iron depletion in secondary iron overload. *Transfusion.* 2015;55(3):611-622. doi:10.1111/trf.12854
8. Aygun B, Mortier NA, Kesler K, et al. Therapeutic phlebotomy is safe in children with sickle cell anaemia and can be effective treatment for transfusional iron overload. *Br J Haematol.* 2015;169(2):262-266. doi:10.1111/bjh.13280
9. Holsworth RE Jr, Cho YI, Weidman JJ, Sloop GD, St Cyr JA. Cardiovascular benefits of phlebotomy: relationship to changes in hemorheological variables. *Perfusion.* 2014;29(2):102-116. doi:10.1177/0267659113505637
10. Powden S. Blood-injection-injury phobia: preventive intervention for syncope. *J Contin Educ Topics & Issues.* 2014;16(1):18-22.
11. Kim KH, Oh KY. Clinical applications of therapeutic phlebotomy. *J Blood Med.* 2016;7:139-144. doi:10.2147/JBM.S108479
12. Ozkaraman A, Babadag B, Tuna HI. Nursing care in polycythemia vera: a review article. *J Pat Care.* 2016;2(3):1-6. doi:10.4172/2573-4598.1000121

Appendix A

Infusion Teams/Vascular Access Teams in Acute Care Facilities

Infusion therapy and the appropriate vascular access for its delivery is required for patients of all ages in all areas and departments within an acute care facility. This is an invasive, high-risk, problem-prone therapy that requires close attention to safe delivery processes, outcome monitoring, and quality improvement (QI). The infusion team/vascular access team (VAT) is a group of clinicians centrally structured within the facility charged with the goal of accuracy, efficiency, and consistency for the delivery of infusion and vascular access services. Attention to this goal will reduce and/or eliminate complications, lower costs, decrease length of stay, and reduce liability while promoting vascular preservation and greater patient satisfaction.

The team consists of a staff mix of licensed and unlicensed assistive personnel who have met identified qualifications to function in the infusion specialty practice. INS believes that registered nurses specializing in this practice provides the most appropriate leadership for the team. A physician serving as a medical advisor may also complement the team. Unlicensed team members work under the direction of the licensed staff. The most appropriate department for location of the team has not been identified, however teams may function as part of nursing, pharmacy, infection prevention or radiology, or as an independent department.

This team provides guidance for establishing policy and evidence-based practices for all facility departments according to applicable standards and guidelines. While this team may not be directly administering each infusion, they provide the advanced knowledge for safe practices to support the primary care staff. Consequently, the roles of the infusion team/VAT members include direct care providers, educators, consultants, coaches, mentors, advocates, coordinators, and managers.

The scope of services for the infusion team/VAT includes selection of the most appropriate vascular access device (VAD) based on shared decision-making with the patient and health care team; safe VAD insertion and management during its dwell; and delivery of all infusion therapies including solutions, medications, biologic agents, blood and blood components, and parenteral nutrition. The specific services provided by the team should be based on the infusion therapy needs and risks of patient populations served, the clinical outcomes identified through QI and risk management processes, and the complexity of knowledge and skills required to perform each intervention. Roles and responsibilities for the primary staff members should be clearly identified and differentiated from those of the infusion team/VAT.

Appendix B

Aseptic Non Touch Technique (ANTT®) Clinical Practice Framework

INS recognizes the historical and contemporary problems with aseptic technique and the consequential risks to patient safety. It is widely noted that variable and ambiguous terminology for this critical clinical practice has inhibited effective education, standardized practice, and ultimately patient safety.[1-4]

In consideration of these problems and challenges, this edition of the *Infusion Therapy Standards of Practice* (the *Standards*) has introduced a new dedicated standard for aseptic technique. It features the original and explicitly defined ANTT Clinical Practice Framework that is used widely as a de facto international standard. All reference to aseptic technique throughout the *Standards* is therefore articulated using unique practice terms and principles of ANTT as outlined below.

WHY HAS INS ADOPTED ANTT AS A SPECIFIC STANDARD FOR ASEPTIC TECHNIQUE?

Although recognizing problems with practice, stakeholder organizations over recent years have typically only "prescribed aseptic technique" with virtually no meaningful description. Such "prescription without description" of aseptic technique, and the lack of consistent education and competency assessment, does not provide the level of clinical oversight and attention to quality improvement that this critical clinical competency demands.

INS provides global leadership for infusion practice and ultimately patient advocacy by developing and disseminating standards of practice. Establishing standards of aseptic technique are a global concern, and standardizing practice internationally with ANTT as a universal approach will help improve patient safety. The best example of a standardized approach to an important clinical competency is basic life support. Internationally, the health care community shares common clinical guidelines, recommendations, and practice terminology for resuscitation, thus supporting consistent practice across the globe.[5]

INS seeks to promote research inquiry for practice advancement, and aseptic technique is integral to a wide range of research in infusion practices. It is clear from an increasing number of international publications that the common and standardized language in the ANTT Clinical Practice Framework is being used to support more meaningful and generalizable research.[6-9]

Some clinicians may find ANTT terminology a change. Therefore, it is useful to remember it reflects a rationalization of the inaccurate, interchangeable, and variable practice terms that exist, and a step forward to a more universal approach for the ultimate benefit of consistent patient care.

THE ANTT FRAMEWORK EXPLAINED

Originated by Rowley[10] and defined by the National Institute for Health and Care Excellence (NICE),[11] *ANTT* is a specific type of aseptic technique with a unique theory and Clinical Practice Framework. The Framework is designed for use with all invasive clinical procedures and management of indwelling medical devices in all patients. As well as robustly defining the different elements of aseptic practice, it better explains the necessary integration of these elements for different clinical situations. To this end, maintaining asepsis during infusion therapy is a diverse and challenging practice and applying ANTT principles supports clinical decision-making.

The Aim Is Always Asepsis

ANTT is fundamentally based on the practice aim of asepsis for all invasive clinical procedures. This is because:

- The practice aim of ***clean*** technique is not appropriate for invasive procedures as it is a visual standard of hygiene applied to invisible microorganisms.
- The practice aim of ***sterile*** technique, free of ALL microorganisms, is not achievable in typical health care settings due to the ever presence of microorganisms in the air environment.

- The practice aim of ***asepsis*** or ***aseptic*** technique, the absence of pathogenic organisms, in sufficient quantity to cause infection, is achievable. ANTT includes the words 'non-touch' to be descriptive, as non-touch technique is a critical component of this practice.

How Asepsis Is Achieved

To achieve asepsis in practice and support education and research, ANTT uses a novel approach termed ***Key-Part and Key-Site Protection***.[3,11] This model educates the clinician to always identify and protect the most important parts of the equipment and the vulnerable sites on the patient during any clinical procedure.

- **Key-Parts**
  Key-Parts are the parts of equipment that if touched or contaminated are most likely to contaminate and potentially infect the patient. Examples include the syringe tip, male luer end/spike of administration set, needleless connector, injection needle, or the open lumen of a central vascular access device (CVAD).
- **Key-Sites**
  Key-Sites are any portal of entry for microorganisms into the patient. Examples include any vascular access device (VAD) site, injection site, or open wound.

The Key-Part and Key-Site Rule

Safe practice is assured when clinicians always adhere to this rule: *Key-Parts must only come into contact with other aseptic Key-Parts and Key-Sites.*

ANTT Needs to Be Efficient as Well as Safe

The ANTT Clinical Practice Framework establishes two ANTT approaches to efficiently accommodate simple and complex procedures:

- **Standard-ANTT**
  Key-Parts are protected individually. It is used for procedures where it is simple to achieve and maintain asepsis. Such procedures, for example intravenous (IV) medication administration, will typically have few small Key-Parts, be minimally invasive, have a short duration of less than 20 minutes and require low levels of personal protective equipment (PPE). Two types of aseptic fields are used in Standard-ANTT to protect Key-Parts independently.
  - ➢ **General Aseptic Field:** A decontaminated and disinfected surface, or single-use procedure kit/barrier. Used to provide a controlled work space, promoting, but not ensuring asepsis.
  - ➢ **Micro Critical Aseptic Field:** A small protective sterile surface/housing (eg, sterile caps, covers, or the inside of recently opened sterile equipment packaging). Used to protect Key-Parts individually and placed/transported within a General Aseptic Field.
- **Surgical-ANTT**
  Key-Parts are protected together. It is used for procedures that are technically complex to achieve and maintain asepsis. Such procedures, for example peripherally inserted central catheter (PICC) insertion, will typically involve many and/or large Key-Parts, a relatively large open Key-Site, have a long duration of more than 20 minutes, be significantly invasive, and require high levels of PPE. One type of aseptic field is used in Surgical-ANTT to protect Key-Parts together as a group.
  - ➢ **Critical Aseptic Field:** A large sterile drape/barrier. Used to ensure asepsis; all procedure equipment is placed upon the drape and protects multiple and often large Key-Parts collectively.

ANTT RISK ASSESSMENT

Infusion therapy is a diverse specialty ranging from relatively simple to very complex clinical procedures. Often, the most suitable type of ANTT for any particular procedure is defined in organizational policy. In other situations, the ANTT Risk Assessment should be used to determine the type of ANTT approach to use. The decision is guided by asking the question:

Is it technically easy to protect and maintain the asepsis of the Key-Parts and Key-Sites during this procedure?

If yes, then Standard-ANTT is used. If no, then Surgical-ANTT would be selected. To help make this clinical judgment the clinician will consider a number of practice variables, including:

- The number and size of Key-Parts and Key-Sites.
- The invasiveness of the procedure.
- The duration of the procedure.
- The environment within which the procedure will take place.
- The level of PPE required.

APPLYING ANTT TO PRACTICE

Example 1: IV Drug Preparation and Administration

By applying the ANTT Risk Assessment above, the clinician would likely determine the use of Standard-ANTT due to asepsis being relatively easy to establish and maintain. This is due to the following factors:

- Few and small Key-Parts are used.
- The Key-Parts are relatively easy to protect individually with a combination of Micro Critical Aseptic Fields (eg, sterile caps and the inside of recently opened sterile packaging) and use of a non-touch technique within a General Aseptic Field (eg, a procedure tray).
- The procedure is short in duration (typically <20 minutes) and minimally invasive.

Preparation

The clinician performs hand hygiene and selects the appropriate PPE. The procedure tray is disinfected providing a clean

work space or a barrier is used (General Aseptic Field). While the work space dries, all required equipment is gathered and placed around the procedure tray. Immediately prior to equipment assembly, hand hygiene is repeated and nonsterile gloves donned according to organizational policy. Once opened and assembled, immediately protect individual Key-Parts with Micro Critical Aseptic Fields, and place onto the work space. Waste and sharps are safely disposed, PPE removed, and hand hygiene performed.

Administration

With clean hands and fresh nonsterile gloves (as required), the clinician will disinfect the injection port/needleless connector and allow to dry fully. Syringes are removed from the procedure tray/barrier (General Aseptic Field). The protective syringe cap is removed or the syringe is removed from its packaging (both Micro Critical Aseptic Fields) and connected immediately and directly to the injection port/needleless connector (ie, aseptic Key-Part to aseptic Key-Part).

Example 2: PICC Placement

By applying the ANTT Risk Assessment, the provider would determine the use of Surgical-ANTT due to asepsis being more difficult to achieve and maintain. This is due to the following factors:

- Many, and some large, Key-Parts and one small but invasive Key-Site are used.
- The Key-Parts are not easily managed and all Key-Parts need to be protected.
- The procedure is typically 30 to 60 minutes or more in duration, relatively invasive, and is associated with a risk for infection.

Preparation

The clinician performs hand hygiene and selects appropriate PPE. The procedural area is disinfected providing a clean work space. While the work space dries, all required equipment is gathered. Immediately prior to opening sterile drapes/procedure pack, hand hygiene is repeated, creating a Critical Aseptic Field. The equipment and sterile supplies are placed onto the Critical Aseptic Field using a non-touch technique.

Procedure

After a surgical hand scrub is performed the clinician dons a sterile gown and sterile gloves. Using a non-touch technique, equipment is assembled and local anesthesia is prepared. Although wearing sterile gloves, Key-Parts such as syringe tips and the PICC, are not touched where practical not to do so. At all times, all equipment must stay on and within the Critical Aseptic Field(s).

ANTT QUALITY IMPROVEMENT

Like any critical clinical competency that is integral to patient safety, ANTT must be supported as part of a comprehensive quality improvement program. Namely, effective clinician education, training, competency assessment, and the ongoing monitoring of standards of practice through periodic audit.

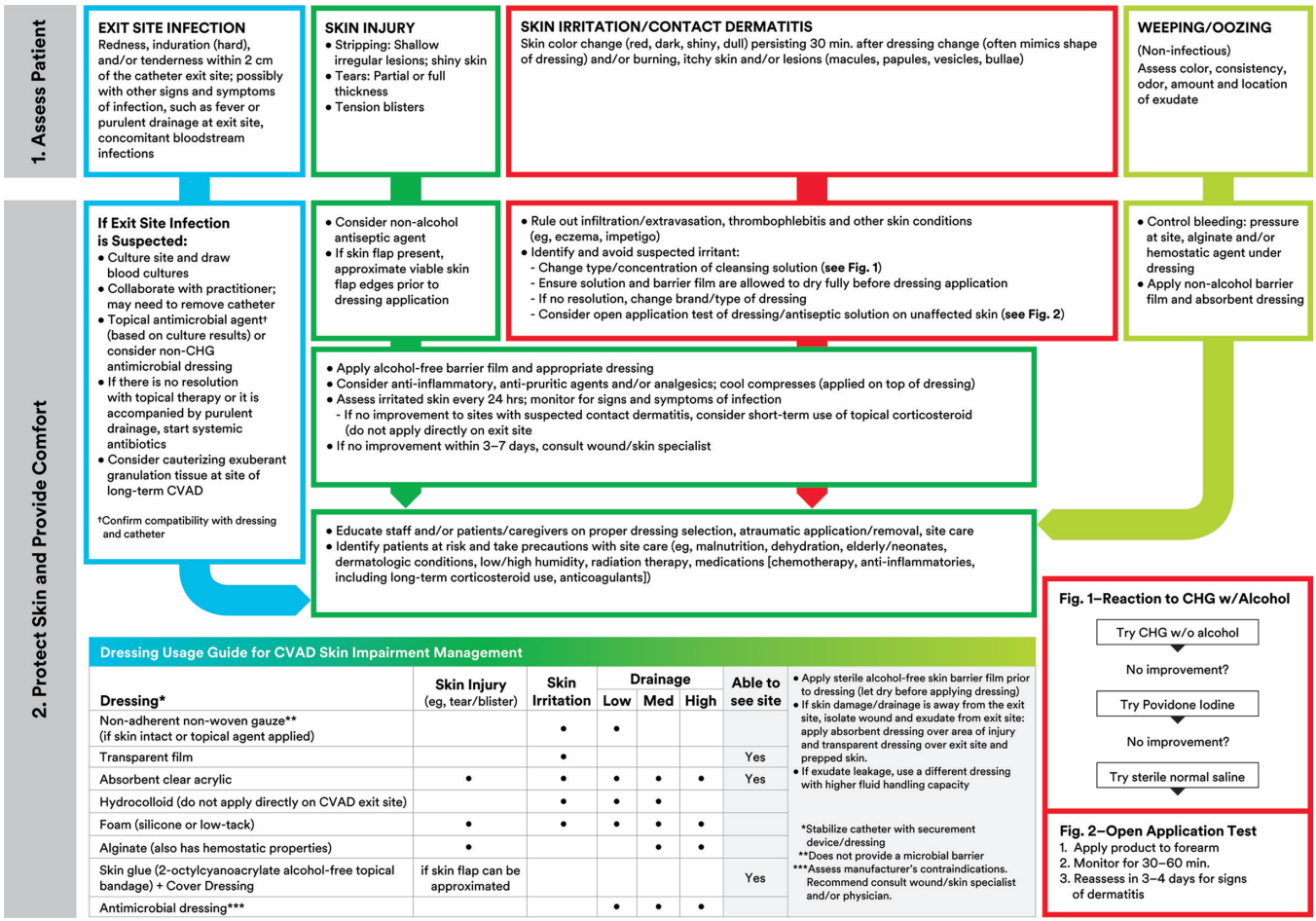
ANTT is overseen and disseminated internationally by the Association for Safe Aseptic Practice (ASAP), providing free support, advice and resources to help with ANTT implementation and maintenance at ANTT.org. Although ANTT® is trademarked and is copyrighted material, this is to protect the integrity of ANTT, and not inhibit its free utilization for educational noncommercial activities.

REFERENCES

1. Preston RM. Aseptic technique: evidence-based approach for patient safety. *Br J Nurs*. 2005;14(10):540-542, 544-546. doi:10.12968/bjon.2005.14.10.18102
2. Aziz AM. Variations in aseptic technique and implications for infection control. *Br J Nurs*. 2009;18(1):26-31. doi:10.12968/bjon.2009.18.1.32073
3. Rowley S, Clare S, Macqueen S, Molyneux R. ANTT® v2: an updated practice framework for aseptic technique. *Br J Nurs*. 2010:19(Suppl 1):S5-S11. doi:10.12968/bjon.2010.19.Sup1.47079
4. Unsworth J, Collins J. Performing an aseptic technique in a community setting: fact or fiction? *Prim Health Care Res Dev*. 2011;12(1):42-51. doi:10.1017/S1463423610000198
5. Perkins GD, Neumar R, Monsieurs KG, et al. The International Liaison Committee on Resuscitation (ILCOR): review of the last 25 years and vision for the future. *Resuscitation*. 2017;121:104-116. doi:10.1016/j.resuscitation.2017.09.029
6. Clare S, Rowley S. Implementing the Aseptic Non Touch Technique (ANTT®) clinical practice framework for aseptic technique: a pragmatic evaluation using a mixed methods approach in two London hospitals. *J Infect Prev*. 2018;19(1):6-15. doi:10.1177/1757177417720996
7. Mulalib M, Evans V, Hughes A, Hill S. Aseptic non touch technique and catheter related blood stream infection in children receiving total parental nutrition at home. *United European Gastroenterol J*. 2015;3(4):393-398. doi:10.1177/2050640615576444
8. Taylor JE, McDonald SJ, Earnest A, Buttery J, et al. A quality improvement initiative to reduce central line infection in neonates using checklists. *Eur J Pediatr*. 2017;176(5):639-646. doi:10.1007.s00431-017-2888-x
9. Balachander B, Rajesh D, Pinto BV, Stevens S, Rao S. Simulation training to improve aseptic non-touch technique and success during intravenous cannulation—effect on hospital-acquired blood stream infection and knowledge retention after 6 months: The snowball effect theory. *J Vasc Access*. 2020;Jul 15:1129729820938202 [Epub ahead of print]. doi:10.1177/1129729820938202
10. Rowley S. Theory to practice. Aseptic non-touch technique. *Nurs Times*. 2001;97(7):6-8.
11. National Institute for Health and Care Excellence (NICE). Healthcare-associated infections: prevention and control in primary and community care. NICE; 2012. Revised February 2017. Accessed October 23, 2020. https://www.nice.org.uk/guidance/cg139

Appendix C

CVAD-Associated Skin Impairment (CASI) Algorithm



Dressing Usage Guide for CVAD Skin Impairment Management

Dressing*	Skin Injury (eg, tear/blister)	Skin Irritation	Drainage Low	Drainage Med	Drainage High	Able to see site
Non-adherent non-woven gauze** (if skin intact or topical agent applied)		•	•			
Transparent film		•				Yes
Absorbent clear acrylic	•	•	•	•	•	Yes
Hydrocolloid (do not apply directly on CVAD exit site)		•	•	•		
Foam (silicone or low-tack)	•	•	•	•	•	
Alginate (also has hemostatic properties)	•			•	•	
Skin glue (2-octylcyanoacrylate alcohol-free topical bandage) + Cover Dressing	if skin flap can be approximated					Yes
Antimicrobial dressing***			•	•	•	

- Apply sterile alcohol-free skin barrier film prior to dressing (let dry before applying dressing)
- If skin damage/drainage is away from the exit site, isolate wound and exudate from exit site: apply absorbent dressing over area of injury and transparent dressing over exit site and prepped skin.
- If exudate leakage, use a different dressing with higher fluid handling capacity

*Stabilize catheter with securement device/dressing
**Does not provide a microbial barrier
***Assess manufacturer's contraindications. Recommend consult wound/skin specialist and/or physician.

Abbreviations: CASI, CVAD-associated skin impairment; CHG, chlorhexidine gluconate; CVAD, central vascular access device; w, with; w/o, without.
Reprinted with permission from Broadhurst D, Moureau N, Ullman AJ; The World Congress of Vascular Access (WoCoVA) Skin Impairment Management Advisory Panel. Management of central venous access device-associated skin impairment: an evidence-based algorithm. *J Wound Ostomy Continence Nurs.* 2017;44(3):211-220. doi:10.1097/WON.0000000000000322.

Glossary

A

Accreditation. A quality assurance process under which health care services and operations are evaluated and verified by an external body to determine if recognized standards are met.

Active Disinfection. Use of a disinfectant to physically scrub the injection site/port before each access; often referred to as "scrub the hub."

Add-on Device. Additional components, such as an in-line filter, stopcock (3-way tap), Y-site, extension set, manifold set, and/or needleless connector, that is added to the administration set or vascular access device

Adhesive Securement Device (ASD). An adhesive-backed device that adheres to the skin with a mechanism to hold the vascular access device (VAD) in place; a separate dressing is placed over the ASD. Both the dressing and ASD must be removed and replaced at specific intervals during the VAD dwell time.

Adjuvant Medication. Additional medications given to facilitate or enhance a primary drug or medical treatment.

Administration Set. A tubing set composed of plastic components that is used to deliver infusions and typically includes a spike, a drip chamber, injection ports, and a male luer end. Variations may include a Y-set, integrated filter, and microbore tubing.

Admixture. To mix; combine 2 or more medications.

Advanced Practice Registered Nurse (APRN). US state boards of nursing recognize 4 types of APRNs, including certified registered nurse anesthetist, certified nurse midwife, certified nurse practitioner, and clinical nurse specialist, with practice occurring in all health care settings with patients of all ages.

Adverse Event. Any unintended or untoward event that occurs with a patient receiving medical treatment that is related to a medication, product, equipment, procedure, etc.

Air Embolism. The presence of air in the vascular system that obstructs blood flow primarily to the lungs or brain.

Airborne Precautions. A type of isolation precaution to reduce the risk of infection from airborne transmission of airborne droplet nuclei that may remain suspended in the air.

Alarm/Alert Fatigue. Exposure to frequent alarms (alerts) from multiple sources can result in desensitization; desensitization can lead to delayed response times which could potentiate missed critical early warning signs.

Allen Test. A test performed on the radial and ulnar artery of the hand prior to arterial puncture to ascertain adequate arterial perfusion.

Alternative Site. A health care setting outside of the acute care hospital that includes, but is not limited to, the home, long-term care/assisted living facility, outpatient center/clinic, and physician office.

Ambulatory Infusion Pump. An electronic infusion pump designed to be worn on the body to promote patient mobility and independence. See *Electronic Infusion Pump.*

Amino Acids. Organic components of protein.

Ampoule. Hermetically sealed glass medication container that must be broken at the neck to access the medication.

Anaphylaxis. A severe, potentially life-threatening allergic reaction with immunologic and nonimmunologic causes.

Ante Area. A buffer zone of laminar or displacement airflow near a clean work area, such as a pharmaceutical compounding space.

Antibiotic Stewardship. A concerted effort to measure and manage appropriate antibiotic use; to improve judicious antibiotic prescribing by clinicians and use by patients so that antibiotics are only prescribed and used when clinically appropriate; to minimize misdiagnoses or delayed diagnoses leading to underuse of antibiotics; and to ensure that the right drug, dose, and duration are selected when an antibiotic is needed.

Anti–Free-Flow Protection. Administration set technology that prevents intravenous solutions from flowing into the patient when the administration set is removed from the flow-control device.

Anti-infective Vascular Access Device. A vascular access device whereby the catheter has been coated or impregnated with antiseptic or antimicrobial agents; or the base catheter material has been engineered to inhibit bacterial attachment and biofilm formation.

Antimicrobial Locking Solutions. Solutions of supratherapeutic concentrations of antibiotic, or a variety of antiseptic agents, to lock the central vascular access device lumen for a prescribed period of time for prevention or treatment of catheter-associated bloodstream infection.

Antineoplastic Agent. Medication that prevents the development, growth, or proliferation of malignant cells.

Antiseptic. A substance used to reduce the risk of infection by killing or inhibiting the growth of microorganisms.

Apheresis. Process of separating blood into 4 components: plasma, platelets, red blood cells, and white blood cells, removing 1 of the components, and then reinfusing the remaining components.

Arterial Pressure Monitoring. Use of an indwelling arterial catheter connected to an electronic monitor that displays continuous information about arterial pressure.

Arteriovenous Fistula (AVF). Surgical anastomosis between an artery and vein.

Arteriovenous Graft (AVG). Surgical structure created between an artery and a vein, usually of a manufactured synthetic material.

Asepsis. Is the absence of pathogenic organisms in sufficient quantity to cause infection and is achievable through aseptic technique.

Aseptic Non Touch Technique (ANTT®). A specific and comprehensively defined type of aseptic technique with a unique theory-practice framework based on an original concept of Key-Part and Key-Site Protection; achieved by integrating Standard Precautions such as hand hygiene and use of personal protective equipment with appropriate aseptic field management, non-touch technique and sterilized supplies. It is designed for all invasive clinical procedures and management of invasive medical devices. In the context of infusion therapy, this includes vascular access device (VAD) placement and management and infusion administration. The 5 practice terms to using ANTT:

- **Key-Site.** Any portal of entry into the patient (eg, VAD site, injection site, open wound).
- **Key-Part.** The part of the procedure equipment that, if contaminated, is likely to contaminate the patient (eg, syringe tip, male luer end/spike of administration set, injection needle).
- **General Aseptic Field.** A decontaminated and disinfected procedure tray or single-use procedure kit/barrier. Used to promote, but not ensure, asepsis.
- **Critical Aseptic Field.** A sterile drape/barrier. Used to ensure asepsis; all procedure equipment is placed upon the drape and managed collectively.
- **Micro Critical Aseptic Field.** A small, protective sterile surface/housing (eg, sterile caps, covers, and the inside of recently opened sterile equipment packaging) that protects Key-Parts individually.

Aseptic Technique. A set of infection prevention actions aimed at protecting patients from infection during invasive clinical procedures and management of indwelling medical devices.

Assent. Agreement by an individual not competent to give legally valid informed consent (eg, a child or cognitively impaired person).

Authorized Agent-Controlled Analgesia. A competent person authorized and educated by the prescriber to activate the analgesic dose when a patient is not able to do so.

B

Backcheck Valve. An accessory to an intravenous administration set that allows for uni-directional fluid flow.

Bacteria. Microorganisms that may be nonpathogenic (normal flora) or pathogenic (disease-causing).

Barcode Scan. Barcode medication administration (BCMA); the barcode is scanned on the patient's wristband and on the medication to be administered as a safeguard to reduce the risk of medication errors.

Beyond-Use Date (BUD). The date added to a product label during the compounding process after which a product may not be used, based on the fact that the manufacturer's original container has been opened, exposed to ambient atmospheric conditions, and may not have the integrity of the original packaging.

Biofilm. A community of microorganisms that form on and coat the surfaces of an implanted or indwelling device.

Biologic Therapy. Treatments for disease by the administration of substances that produce a biological reaction in the organism and include the use of sera, antitoxins, vaccines, cells, tissues, and organs. Examples of biologic therapies include immunoglobulins, monoclonal antibodies, interferons, interleukins, and vaccines.

Biological Safety Cabinet (BSC). A ventilated cabinet used for preparation of hazardous drugs for the purpose of controlling airflow to protect personnel and the product being prepared; environmental protection is provided by exhaust air passing through a high-efficiency particulate air (HEPA)/ultra-low particulate air (ULPA) filter.

Blood Return. A component of vascular access device patency assessment; blood that is the color and consistency of whole blood flows readily into the syringe upon aspiration.

Blood/Fluid Warmer. An electronic device with adequate temperature controls that raises refrigerated blood or parenteral solutions to a desired temperature during administration.

Body Surface Area. Surface area of the body expressed in square meters. Used in calculating pediatric dosages, managing burn patients, and determining radiation and other classes of drug dosages.

Bolus. Concentrated medication and/or solution given over a short period of time.

C

Catheter. A hollow, flexible tube made of thermoplastic polyurethane, silicone elastomer, or metal; inserted into the body and used for injecting or evacuating fluids.

Catheter-Associated Bloodstream Infection (CABSI). Given variability in international definitions, outcome reporting, and application of the terms catheter-related bloodstream infection (CR-BSI) and central line-associated bloodstream infection (CLABSI), the INS Standards of Practice Committee is using the terminology "Catheter Associated Bloodstream Infection" (CABSI) to refer to bloodstream

infections originating from either peripheral intravenous catheters and/or central vascular access devices. See *Catheter-Related Bloodstream Infection (CR-BSI)* and *Central Line-Associated Bloodstream Infection (CLABSI).*

Catheter-Associated Deep Vein Thrombosis (CA-DVT). Thrombosis (blood clot) formation associated with the presence of a vascular access device occurring in the deep veins of the upper extremity (radial, ulnar, brachial, axillary) that may extend into the subclavian, brachiocephalic, superior vena cava, and/or the internal jugular. Central vascular devices placed in the femoral vein may result in an iliofemoral DVT.

Catheter-Associated Skin Injury (CASI). An occurrence of drainage, erythema, and/or other manifestation of cutaneous abnormality, including but not limited to, vesicle, bulla, erosion or tear, at a vascular access device site in the underlying area of a dressing, which persists 30 minutes or more after removal of the dressing.

Catheter Clearance. The process to re-establish catheter lumen patency using medications or chemicals instilled into the lumen for a specific period of time.

Catheter Dislodgement. Catheter movement into or out of the insertion site indicating tip movement to a suboptimal position; may be partial (catheter tip still remains within the venous system, but is in a suboptimal location) or total (catheter tip is removed completely from the venous system).

Catheter Exchange. Replacement of existing central vascular access device (CVAD) with a new CVAD using the same catheter tract.

Catheter-Related Bloodstream Infection (CR-BSI). The recognized diagnostic criterion that more accurately confirms the catheter as the source of the infection. It is diagnosed if the same organism is isolated from a blood culture and the tip culture, and the quantity of organisms isolated from the tip is greater than 15 colony forming units (CFUs). Alternatively, differential time to positivity (DTP) requires the same organism to be isolated from a peripheral vein and a catheter lumen blood culture, with growth detected 2 hours sooner (ie, 2 hours less incubation) in the sample drawn from the catheter.

Central Line-Associated Bloodstream Infection (CLABSI). Is most commonly reported as a surveillance term; however, it is not an established diagnostic criterion. CLABSI is a primary bloodstream infection (BSI) in a patient who had a central line within the 48-hour period before the development of the BSI and is not related to an infection at another site. However, since some BSIs are secondary to sources other than the central line (eg, pancreatitis, mucositis) and may not be easily recognized, the CLABSI surveillance definition may overestimate the true incidence of a catheter-related bloodstream infection (CR-BSI).

Central Vascular Access Device (CVAD). A catheter that is inserted into a peripheral or large vein of the chest or groin with the tip advanced to a central position, either the superior or inferior vena cava.

Central Vascular Access Device (CVAD) Malposition. CVAD tip located in an aberrant position and no longer located in the original vena cava or cavoatrial junction.

- **Extravascular Malposition.** CVAD tip located outside of the vein in subcutaneous tissue or nearby anatomical structures such as mediastinum, pleura, pericardium, or peritoneum.
- **Intravascular Malposition.** CVAD tip located in a suboptimal or aberrant position inside a vein; occurs as primary or secondary malposition.
- **Primary Malposition.** CVAD tip positioned in a suboptimal or unacceptable location occurring during the insertion procedure.
- **Secondary Malposition.** CVAD tip found to be in a suboptimal or unacceptable location at any time during the catheter dwell time; commonly referred to as tip migration.

Certification/Board Certification. A voluntarily earned credential that demonstrates the holder's specialized knowledge, skills, and experience within a given specialty; awarded by a third-party, nongovernmental entity or association, such as the Infusion Nurses Certification Corporation (INCC), after the individual has met predetermined and standardized criteria.

Chelator-Based Lock Solution. Solutions such as citrate and ethylenediaminetetraacetic (EDTA) that bind with metallic cations (eg, calcium, magnesium, iron) to produce an antithrombotic effect and/or disrupt biofilm formation.

Chemical Incompatibility. Change in the molecular structure or pharmacological properties of a substance that may or may not be visually observed when a solution or medication contacts an incompatible solution or medication within the vascular access device lumen, administration set, or solution container.

Cleaning. The removal of visible soil (eg, organic and inorganic material) from objects and surfaces. Thorough cleaning is essential before performing disinfection and sterilization procedures because inorganic and organic materials that remain on the surfaces interfere with the effectiveness of these processes.

Clinical Bag. The container carried by home care clinicians when traveling from home to home; contains equipment (eg, blood pressure cuff, stethoscope, pulse oximeter) and necessary supplies (eg, dressings).

Clinician. Refers to the nurse, physician or other appropriately trained and educated health care individual involved with infusion administration or vascular access device insertion and care.

Close Call. Also known as a good catch. Previously referred to as a near miss; implies that an error occurred but it did not reach the patient.

Closed System Transfer. The movement of sterile products from one container to another in which the containers, closure system, and transfer devices remain intact through the entire transfer process, compromised only by the penetration of a sterile, pyrogen-free needle or

cannula through a designated closure or port to effect transfer, withdrawal, or delivery.

Closed System Transfer Device. A transfer device that mechanically prohibits the transfer of environmental contaminants into the system and the escape of hazardous drugs or vapor concentrations outside the system; used in compounding and administering sterile doses of chemotherapy and other hazardous drugs.

Color Coding. System that identifies products and medications by use of a color system.

Compartment. Muscles, nerves, and blood vessels are in compartments which are inflexible spaces bound by skin, fascia, and bone.

Compartment Syndrome. Fluid build-up within a compartment that leads to increased pressure on capillaries, nerves, and muscle. An increase in hydrostatic pressure leads to vascular spasm, pain, and muscle necrosis inside the compartment. Ischemic nerve damage can result in functional loss. Characterized by pain, pallor, paresthesia, pulselessness, and paralysis.

Compatibility. Capable of being mixed and administered without undergoing undesirable chemical and/or physical changes or loss of therapeutic action.

Competency. A required level of effective performance in the work environment defined by adherence to professional standards, including knowledge, skills, abilities, and judgment based on established science.

Competency Assessment. A dynamic process used to verify an individual's performance; designed to empower the individual and support positive behavior in patient care activities.

Compounding. The act of preparing, mixing, assembling, packaging, and labeling a drug, drug delivery device, or device according to a prescription for an individual patient or based on a professional agreement between the practitioner, patient, and pharmacist.

Computerized Prescriber Order Entry (CPOE). A system in which clinicians directly enter medication, test, or procedure orders into an electronic system; medication orders are transmitted directly to the pharmacy.

Contact Precautions. Strategies implemented to prevent the transmission of infectious agents such as wound drainage, which are spread by direct or indirect contact between the patient and environment.

Containment Primary Engineering Control (C-PEC). A ventilated device designed to minimize microbial contamination and worker and environmental exposure by controlling emissions of airborne contaminants by using enclosure, airflow, air pressure, and HEPA filtration. Two main types of C-PECs are biological safety cabinets and compounding aseptic containment isolators.

Contamination. Introduction or transference of pathogens or infectious material from one source to another.

Contrast Media. Iodinated or gadolinium-based pharmaceutical agents given by the intravenous route used to improve medical imaging of internal structures; agents have a wide range of osmolarity and viscosity when compared to normal serum values and may be associated with tissue injury if extravasation occurs.

Crisis Standards of Care. Guidelines designed to help organizations and health care professionals deliver the best possible care in circumstances in which resources are severely limited and health care standards are compromised.

Cross Contamination. The indirect movement of pathogens or other harmful substances from one patient to another patient.

Cultural Competency. Care delivery that is respectful of and responsive to the beliefs, culture, practices, and linguistic needs of patients and their families served by the health care organization.

D

Dead Space. The internal space outside the intended fluid pathway into which fluid can move, as applied to needleless connectors.

Decontamination. The removal of pathogenic microorganisms from objects so they are safe to handle, use, or discard.

Delegation. The process for a clinician (eg, registered nurse) to direct another person (eg, unlicensed assistive personnel) to perform a task or activity not commonly performed by that person however that person has the knowledge and skill to perform the task; the delegating clinician retains accountability for the outcome of the delegated task.

Di(2-ethylhexyl)phthalate (DEHP). A plasticizer that is added to polyvinyl chloride to make solution containers and administration set tubing soft and pliable. It is a known toxin that can seep from the plastic into the bloodstream. Risk of exposure is greatest in infants.

Difficult Intravenous Access (DIVA). Refers to multiple, unsuccessful attempts to cannulate a vein; the need for special interventions to establish venous cannulation based on a known history of difficulty due to diseases, injury, and/or frequent unsuccessful venipuncture attempts; may be acute due to sudden illness (eg, fluid volume deficit) or chronic due to lengthy history of difficult intravenous access.

Dilution. To add a diluent (eg, 0.9% sodium chloride, sterile water) to a solution of medication in order to make it less concentrated, to provide additional solution for ease of administration and titration, or to decrease the risk of tissue damage by bringing the final osmolarity closer to an isotonic solution.

Disclosure. The process of revealing to the patient and family all the facts necessary to ensure understanding of what occurred when a patient experiences a significant complication from a medical error or mistake; information that is necessary for the patient's well-being or relevant to future treatment.

Disinfectant. Agent that eliminates most microorganisms except bacterial spores.

Disinfection. A process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects.

Disinfection Cap. Disinfectant-impregnated protective cap containing an antiseptic solution placed on top of the connection surface of a needleless connector/male luer end of administration set to disinfect the surface and provide protection between intermittent use.

Distal. Farthest from the center, or midline, of the body or trunk, or from the point of attachment; opposite of proximal.

Doppler Flow Study. A form of ultrasound technology that produces audible sounds to determine characteristics of circulating blood.

Dose Error Reduction Systems (DERS). Electronic infusion pumps manufactured with drug libraries containing drug name and soft and hard infusion limits; designed to prevent errors in solution and medication delivery, often called smart pumps.

Droplet Precautions. A type of isolation precaution to reduce the risk of infection from pathogens spread through close respiratory or mucous membrane contact with respiratory secretions.

E

Elastomeric Pump. A portable, single-use device with an elastomeric reservoir (ie, balloon). Used to deliver a variety of infusion therapies.

Electronic Infusion Pump. Device that is powered by electricity or battery to regulate infusion rate.

Electronic Infusion Rate Monitor/Drop Counter. Used as an adjunct to gravity infusions by providing an electronically-monitored infusion; placed around the administration set drip chamber; does not "pump" the fluid rather monitors the drip rate.

Electronic Medical Record (EMR)/Electronic Health Record (EHR). EMR is the same collection of documents as in the health record but manages the documents using electronic clinical information systems (specialized software) that protect and secure patient data. The EMR can track patient data, be used for scheduling visits and reminders, and is a source for quality monitoring and improvement. The EMR is used in a single clinic, hospital, or practice. The EHR often offers more functionality than an EMR and is used across many clinics, hospitals, or practices.

Elliotts B® Solution: A sterile, nonpyrogenic, isotonic solution containing no bacteriostatic preservatives. Elliotts B® Solution is a diluent for intrathecal administration of methotrexate sodium and cytarabine.

Embolus. Mass of undissolved matter present in blood or lymphatic vessel; an embolus may be solid, liquid, or gaseous.

End-Tidal Capnography. The measurement of the partial pressure of carbon dioxide during expiration (end-tidal carbon dioxide); used with general anesthesia, moderate/deep procedural sedation; a more sensitive indicator of respiratory depression than oxygen saturation monitoring with patient-controlled analgesia.

EnFit® Connector. Designed to reduce the risk of inadvertent misconnections by ensuring that feeding tube connectors are incompatible with the connectors for unrelated delivery systems such as intravenous catheters, tracheostomy tubes, and other catheters.

Engineering Controls. Devices that isolate or remove the bloodborne pathogens hazard from the workplace, such as sharps disposal containers, self-sheathing needles, needleless systems, and sharps with engineered protections.

Enhanced Barrier Precautions. A 2019 recommendation from the Centers for Disease Control and Prevention (CDC) for long-term care facilities; enhanced barrier precautions should be used in a location (eg, wing, floor, unit) when a resident of that location is colonized or infected with a novel or targeted multidrug resistance organism (MDRO); the use of personal protective equipment is expanded for high-risk residents in these locations (eg, those with wounds, vascular access devices), including the use of gowns and gloves during high-contact care activities that provide opportunities for transfer of MDROs to staff hands and clothing (eg, during dressing, bathing/showering, transferring, device care or use: central line, urinary catheter, feeding tube, tracheostomy/ventilator, any skin opening requiring a dressing).

Enrolled Nurse (EN). A designation used in Australia; an enrolled nurse works under the direct supervision of a registered nurse.

Entrustable Professional Activities. Key tasks of a discipline that an individual can be trusted to perform in a given health care context once competence has been demonstrated.

Epidural Space. Space surrounding the spinal cord and its meninges; contains fatty tissue, veins, spinal arteries, and nerves; considered a potential space that is not created until medication or air is injected.

Erythema. Redness of skin in a specific area or more generalized.

Evidence-Based Practice. Application of the best available synthesis of research results in conjunction with clinical expertise and with attention to and inclusion of patient preferences.

Expiration Date. The date and time, when applicable, beyond which a product should not be used; the product should be discarded beyond this date and time; assigned on the basis of both stability and risk level, whichever is the shorter period.

Extravasation. Inadvertent infiltration of vesicant solution or medication into surrounding tissue; rated by a standard tool or definition.

Extrinsic Contamination. Contamination that occurs after the manufacturing process of a product.

F

Fat Emulsion. See *Lipid Injectable Emulsion (ILE)*.

Filter. A special porous device used to prevent the passage of air, particulate matter, and microorganisms; product design determines size of substances retained.

Flow-Control Device. Instrument used to regulate infusion flow rate; includes categories of manual devices (eg, slide, roller clamp, screw), non-electronic flow-control devices, and electronic infusion pumps. See *Non-Electronic Flow-Control Device* and *Electronic Infusion Pump*.

Flushing. The act of moving fluids, medications, blood, and blood products out of the vascular access device into the bloodstream; used to assess and maintain patency and prevent precipitation due to solution/medication incompatibility.

G

Guidewire. A long, flexible, metal structure, composed of tightly wound coiled wire in a variety of designs with an atraumatic tip. Only guidewires specifically designed for vascular access should be used for this purpose because they are manufactured with safety mechanisms that allow them to be inserted into the vein or artery. Only the floppy, non-stiff end of the guidewire should be advanced into the vein.

H

Hazardous Drug. Drug exhibiting 1 or more of the following 6 characteristics in humans or animals: carcinogenicity, teratogenicity or other developmental toxicity, reproductive toxicity, organ toxicity at low doses, genotoxicity, and structure and toxicity profiles of new drugs that mimic existing drugs, determined hazardous by the above criteria.

Hazardous Drug Spill. Any fluid containing hazardous drugs escaping from its container in a quantity more than a few drops.

Hazardous Waste. In the context of this document, hazardous waste is differentiated from medical waste and refers to that generated from administration of hazardous drugs (eg, intravenous containers, equipment, and supplies used to administer hazardous drugs).

Health Literacy. The degree to which individuals have the capacity to obtain, process, and understand basic health care information and services needed to make appropriate decisions.

Health Record/Medical Record/Patient Record. A patient-specific chronological and legal collection of health care documents that describe services/care provided, facilitate communication among health care team members, and support payment practices. Documents include, but are not limited to, assessments, observations, problem lists, intervention/procedure descriptions, instructions, orders, progress notes, medications administered, summaries, laboratory and radiologic reports, exams, and/or pictures. This collection may be in paper form, digitized, or stored as an electronic medical record or electronic health record.

Healthcare Failure Mode and Effect Analysis (HFMEA). A systematic, proactive method used to evaluate a process or device for the purposes of identifying where and how a process might fail; results are used to identify and prioritize the most needed process changes.

Hemodynamic Pressure Monitoring. A general term that describes the functional status of the cardiovascular system as it responds to acute stress such as myocardial infarction and cardiogenic or septic shock. A pulmonary artery catheter is used to directly measure intracardiac pressure changes, cardiac output, blood pressure, and heart rate.

Hemolysis. Destruction of the membrane of the red blood cells resulting in the liberation of hemoglobin, which diffuses into the surrounding fluid.

Hemostasis. An arrest of bleeding or of circulation.

Heparin-Induced Thrombocytopenia (HIT). An acute, transient prothrombotic disorder caused by heparin-dependent, platelet-activating antibodies; a hypercoagulable state with a strong association to venous and arterial thrombosis.

High-Alert Medication. Medications that possess a heightened risk of causing significant patient harm when used in error.

Hypertonic. Solution of higher osmotic concentration than that of a reference solution or of an isotonic solution; having a concentration greater than the normal tonicity of plasma.

Hypodermoclysis. The subcutaneous administration of isotonic hydration solutions; used to treat mild to moderate dehydration.

Hypotonic. Solution of lower osmotic concentration than that of a reference solution or of an isotonic solution; having a concentration less than the normal tonicity of plasma.

I

Immunocompromised. Having an immune system with reduced capability to react to pathogens or tissue damage.

Implanted Pump. A catheter inserted into a vessel, body cavity, or organ attached to a subcutaneous reservoir that contains a pumping mechanism for continuous medication administration.

Implanted Vascular Access Port. A catheter inserted into a vein, attached to a reservoir located under the skin.

Incompatible. Incapable of being mixed or used simultaneously without undergoing chemical or physical changes or producing undesirable effects.

Independent Double Check. A process whereby 2 people working separately and apart from each other verify each component of a work process (eg, the prescribed dose, calculated rate of infusion), for select high-risk tasks, vulnerable patients, or high-alert medications.

Infection. The presence and growth of a pathogenic microorganism(s) having a local or systemic effect.

Infiltration. Inadvertent administration of a nonvesicant solution or medication into surrounding tissue; rated by a standard tool or definition.

Informed Consent. A person's voluntary agreement to participate in research or to undergo a diagnostic, therapeutic,

or preventive procedure, based upon adequate knowledge and understanding of relevant information.

Infusate. Parenteral solution administered into the vascular or nonvascular systems; infusion.

Infusion Team/Vascular Access Team (VAT). A group of clinicians centrally structured within the facility charged with the goal of accuracy, efficiency, and consistency for delivery of infusion and vascular access services. Staff mix varies, however this team should be led by a registered nurse specializing in this practice. Scope of service, team name, and roles of team members vary greatly. See *Appendix A*.

Injectable Lipid Emulsion (ILE). Combination of liquid, lipid, and an emulsifying system formulated for intravenous use.

Instill/Instillation. Administration of a solution or medication into a vascular access device (VAD) intended to fill the VAD rather than systemic infusion; examples include locking solutions to maintain catheter patency, thrombolytic medications, and medications/solutions used to dissolve precipitate.

Integrated Securement Device (ISD). A device that combines a dressing with securement functions; includes transparent, semipermeable window and a bordered fabric collar with built-in securement technology.

Interprofessional/Interprofessional Collaboration. A cooperative approach to patient care acknowledging and respecting the unique knowledge, skills, and abilities of each professional health team member.

Intraosseous (IO). The spongy, cancellous bone of the epiphysis and the medullary cavity of the diaphysis, which are connected; the vessels of the IO space connect to the central circulation by a series of longitudinal canals that contain an artery and a vein; the Volkmann's canals connect the IO vasculature with the major arteries and veins of the central circulation.

Intraspinal Access Device. Referring to either an epidural or intrathecal device.

Intrathecal. Within the brain or spinal canal in the space under the arachnoid membrane.

Intraventricular Access Device. An access device consisting of a reservoir (or port) that is attached to a catheter placed in a lateral ventricle of the brain. Used for aspiration of cerebrospinal fluid (CSF) or to deliver medications into the CSF.

Intrinsic Contamination. Contamination that occurs during the manufacturing process of a product.

Irritant. An agent capable of producing discomfort (eg, burning, stinging) or pain as a result of irritation in the internal lumen of the vein with or without immediate external signs of vein inflammation.

Isotonic. Having the same osmotic concentration as the solution with which it is compared (eg, plasma).

J

Joint Stabilization. Use of a device to support and stabilize a joint when veins or arteries in or near that joint must be used for vascular access device placement or maintenance of infusion therapy; is not considered a physical restraint.

Just Culture. A model of shared accountability in health care based on the premise that organizations are accountable for the systems they design and for how they respond to staff behaviors fairly and justly; a just culture understands that individuals should not be held responsible for system failure.

L

Laminar Flow Hood. A contained workstation with filtered air flow; assists in preventing bacterial contamination and collection of hazardous chemical fumes in the work area.

Lean Six Sigma. Refers to the 8 types of waste that organizations strive to eliminate as "DOWNTIME" ("defects, overproduction, waiting, nonutilized talent, transportation, inventory, motion, and extra processing"); resources that do not create value are wasteful and should be eliminated.

Locking. The instillation of a solution into a vascular access device (VAD) used to maintain patency in between VAD use and/or reduce risk of catheter-associated bloodstream infection.

Long Peripheral Intravenous Catheter (Long PIVC). Inserted in either superficial or deep peripheral veins and offer an option when a short PIVC is not long enough to adequately cannulate the available vein. A long PIVC can be inserted via traditional over-the-needle technique or with more advanced procedures such as Seldinger and accelerated Seldinger technique. See *Peripheral Intravenous Catheter (PIVC).*

Long-term. Referring to vascular access devices placed for anticipated need of greater than 1 month.

Luer. A standardized system of small scale fluid fittings used for making leak-free connections between a male-taper fitting and its mating female fitting on all global intravenous (IV) medical devices and laboratory devices; includes, but is not limited to, syringe tips, IV administration sets, extension sets, manifolds, and stopcocks.

Lumen. The interior space of a tubular structure, such as a blood vessel or catheter.

M

Manifold. An accessory to an intravenous administration set that provides multiple stopcocks and regulates the directional flow of fluids for simultaneous/alternate infusion therapy.

Maximal Sterile Barrier Protection. Equipment and clothing used to avoid exposure to pathogens, including sterile coverings for the clinicians and patient: mask, gown, protective eyewear, cap, gloves, large or full body drapes, and towels.

Medical Adhesive-Related Skin Injury (MARSI). Redness, tears, or erosion of the skin, or development of vesicles or bulla in an area exposed to medical adhesive and lasting for 30 minutes or more following adhesive removal.

Medical Waste (Regulated). Includes contaminated sharps; liquid or semiliquid blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious material in a liquid or semiliquid state if compressed; items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling; and microbiological wastes containing blood or other potentially infectious materials.

Medication Reconciliation. The process of collecting and documenting complete and accurate medication information for each patient, including all medications—prescribed, over-the-counter, and herbals/nutritional supplements—that the patient is currently taking.

Microaggregate Blood Filter. Filter that removes microaggregates (includes platelets, leukocytes, and fibrin that are present in stored blood) and reduces the occurrence of nonhemolytic febrile reactions.

Microorganism. Extremely small living body not perceptible to the naked eye.

Midline Catheter. Inserted into a peripheral vein of the upper arm via the basilic, cephalic, or brachial vein with the terminal tip located at the level of the axilla in children and adults; for neonates, in addition to arm veins, midline catheters may be inserted via a scalp vein with the distal tip located in the jugular vein above the clavicle, or in the lower extremity with the distal tip located below the inguinal crease. See *Peripheral Intravenous Catheter (PIVC).*

Milliosmoles (mOsm). One thousandth of an osmole; osmotic pressure equal to 1 thousandth of the molecular weight of a substance divided by the number of ions that the substance forms in a liter of solution.

Minimum Inhibitory Concentration (MIC). The lowest concentration of a drug that will inhibit bacterial growth.

Moderate/Conscious Sedation. Drug-induced depression of consciousness in which a patient is able to persistently respond to verbal commands or light tactile stimulation; interventions are not needed to maintain a patent airway, and the cardiorespiratory functions are sufficient and also usually preserved.

Multidrug-Resistant Organism (MDRO). A microorganism, predominantly bacteria, resistant to 1 or more classes of antimicrobial agents. MDROs include, but are not limited to, methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and certain gram-negative bacilli that have important infection control implications.

N

Near Infrared (nIR) Light Technology. A device using near infrared light, a range of 700 to 1000 nanometers on the electromagnetic spectrum; works by either transilluminating the extremity and projecting the vessel image to a screen or by capturing an image of the superficial veins and reflecting it to the skin surface.

Needleless Connector. A device that allows the connection of the male luer tip of a syringe or administration set directly to the hub of a vascular access device (VAD) or other injection sites on the infusion system without the use of needles; bidirectional fluid flow occurs within the device; includes a variety of mechanisms (eg, mechanical valve, internal blunt cannula, pressure sensitive valve) categorized by how they function, although there are no established criteria for which devices fall into each group. All needleless connectors allow some fluid movement and blood reflux upon connection, disconnection, or both.

- **Anti-Reflux.** Contains a 3-position pressure-activated silicone valve that opens and closes based on infusion pressure; a specific clamping sequence is not required.
- **Negative Displacement.** Allows blood reflux into the VAD lumen upon disconnection due to movement of valve mechanism or withdrawal of the luer tip of a syringe or administration set requiring the specific sequence of flushing, clamping, and then disconnection of the syringe.
- **Neutral.** Contains an internal mechanism designed to reduce blood reflux into the VAD lumen upon connection or disconnection however the sequence of flushing, clamping, and disconnecting the syringe may improve patency.
- **Positive Displacement.** Allows blood reflux on connection and disconnection; a small amount of fluid is held inside the device that displaces intraluminal blood upon disconnection of the set or syringe; requires a specific sequence of flushing, disconnecting syringe, and then clamping.

Needleless System. A device that does not use needles for (1) the collection of bodily fluids or withdrawal of body fluids after initial venous or arterial access is established; (2) the administration of medication or solutions; or (3) any other procedure involving the potential for occupational exposure to bloodborne pathogens due to percutaneous injuries from contaminated sharps.

Neonate. Birth to 28 days of life; pertaining to the first 4 weeks of life.

Noncritical Equipment. Items that come in contact with intact skin but not mucous membranes.

Non-Electronic Flow-Control Device. Refers to both gravity infusions and use of mechanical pumps such as elastomeric/spring-based pumps; gravity infusions control fluid flow rate by manual adjustment of components such as a roller clamp or flow regulator and require reliance on counting drops; is affected by factors such as dislodgement of the components or distance between the solution container and the device; and therefore is the least accurate.

Nonpermeable. Prevents passage of fluid or gases.

Nontunneled Central Vascular Access Device (CVAD). A type of CVAD for short-term use that is inserted directly through the skin, usually via the axillary-subclavian, internal jugular, or femoral vein.

Nonvesicant. Solutions and medications that do not produce tissue damage when inadvertently delivered into subcutaneous tissue; a large volume of a nonvesicant can produce tissue damage through compartment syndrome but would not cause tissue destruction that leads to blistering and necrotic ulcer.

NRFit® Connectors. Designed to reduce the risk of inadvertent misconnections by ensuring that neuraxial (ie, intraspinal) connections are incompatible with the connectors for unrelated delivery systems such as intravenous (IV) catheters, tracheostomy tubes, and catheters; NRFit connectors are 20% smaller in diameter, preventing medical devices meant for neuraxial administration from connecting to devices used for IV, enteral and other therapies.

Nurse-Controlled Analgesia. Used for infants and children when the child is too young, physically unable or cognitively impaired and unable to use a patient-controlled analgesia.

Nurse Practice Act. A law enacted by a jurisdiction (eg, state, province, country) that establishes the board of nursing, defines the qualifications of and scope of practice for registered nurses and licensed practical or vocational nurses.

O

Occlusion: Obstruction of a vascular access device lumen, preventing or limiting the ability to flush and/or administer solutions through a lumen or withdraw blood.

- **Complete occlusion:** Inability to administer solutions or withdraw blood from the central vascular access device (CVAD) lumen.
- **Partial occlusion**: Decreased ability to administer solutions and/or withdraw blood from the CVAD lumen.
- **Withdrawal occlusion**: Ability to infuse solutions with decreased ability or inability to obtain blood return.

Off-Label Use (Extra-Label Use). The use of a marketed drug or device in a manner that is not included in the written directions for use and other written material that accompany the product as approved by the US Food and Drug Administration.

Older Adult. Greater than 65 years of age, as defined by the American Geriatric Society.

Opioid-Induced Respiratory Depression (OIRD). A combination of opioid-induced central respiratory depression (ie, decreased respiratory drive), sedation, and upper airway obstruction due to decreased supraglottic airway tone.

Osmolality. The characteristic of a solution determined by the ionic concentration of the dissolved substances per unit of solvent; measured in milliosmoles per liter.

Osmolarity. The number of osmotically active particles in a solution.

P

Palpable Cord. A vein that is rigid and hard to the touch.

Palpation. Examination by application of the hands or fingers to the surface of the body in order to detect evidence of disease or abnormalities in the various organs; also used to determine location of peripheral superficial veins and their condition.

Parenteral. Administered by any route other than the alimentary canal, such as the intravenous, subcutaneous, intramuscular, or mucosal route.

Parenteral Nutrition (PN). The intravenous provision of total nutritional needs for a patient who is unable to take appropriate amounts of food enterally; typical components include carbohydrates, proteins, and/or fats, as well as additives such as electrolytes, vitamins, and trace elements.

Paresthesia. Pain associated with nerve injury including tingling, prickling, or shock-like sensations.

Particulate Matter. Mobile undissolved particles unintentionally present in solutions, excluding gas bubbles; sources include the environment (eg, dust, fibers), packaging material (eg, rubber, silicone), product-package interactions (eg, rubber, plastic), processes for manufacturing and dilution (eg, metal, glass), and the drug formulations and components (eg, drug precipitate, protein aggregation, undissolved material).

Passive Disinfection. Use of a disinfectant-impregnated protective cap or covering to provide a constant physical barrier against contamination of the needleless connector septum between accesses; may also be used with the male luer end of the administration set when the set is disconnected between intermittent uses.

Passive Safety-Engineered Device. A device (eg, needle, catheter) that does not require additional steps to initiate the safety mechanism since it activates automatically during device use.

Pathogen. A microorganism or substance capable of producing disease.

Patient Care Setting. Where patient care is provided; may include hospital, outpatient, or physician office setting, skilled nursing facility, assisted living facility, and the home.

Patient-Controlled Analgesia (PCA). A drug delivery system that dispenses a preset dose of a narcotic analgesia upon activation by the patient; most often used with intravenous infusion but may also be used with subcutaneous and epidural infusions.

Pediatric. Newborn to 21 years of age. Note: the American Academy of Pediatrics states that pediatrics is actually the fetal period to 21 years of age; upper age limit may vary across countries); neonate refers to the first month of life. See *Neonate*.

Percutaneous. Technique performed through the skin.

Peripheral. Pertaining to or situated at or near the periphery; situated away from a center or central structure.

Peripheral Intravenous Catheter (PIVC). A catheter inserted into and reside in veins of the periphery that includes all extremities, the external jugular vein, and scalp veins in neonates. PIVCs are inserted into superficial veins located just under the skin in the superficial tissue as well as deep veins located under the muscle tissue. See *Short*

Peripheral Intravenous Catheter (Short PIVC), Long Peripheral Intravenous Catheter (Long PIVC), and *Midline Catheter.*

Peripherally Inserted Central Catheter (PICC). A catheter inserted through veins of the upper extremity or neck in adults and children; for infants, may be inserted through veins of the scalp or lower extremity; catheter tip is located in the superior or inferior vena cava, preferably at its junction with the right atrium, regardless of insertion site.

Personal Protective Equipment (PPE). The equipment worn to minimize exposure to a variety of hazards, including bloodborne pathogens; examples of PPE include items such as gloves, eye protection, gown, and face mask.

pH. The degree of acidity or alkalinity of a substance.

Phlebitis. Inflammation of a vein; may be accompanied by pain/tenderness, erythema, edema, purulence, and/or palpable venous cord; rated by a standard scale or definition.

Phlebotomy. Withdrawal of blood from a vein by direct venipuncture or via a vascular access device.

Physical Restraint. Physical, mechanical, or manual device that immobilizes or decreases the ability of the patient to move arms, legs, body, or head freely.

Pinch-off Syndrome. A relatively rare but significant and often unrecognized complication; occurs when the central vascular access device enters the costoclavicular space medial to the subclavian vein and is positioned outside the lumen of the subclavian vein in the narrow area bounded by the clavicle, first rib, and costoclavicular ligament. Catheter compression causes intermittent or permanent catheter occlusion and, because of the "scissoring" effect of catheter compression between the bones, can result in catheter tearing, transection, and catheter embolism.

Policy. Written, nonnegotiable statement(s) that establish rules guiding the organization in the delivery of patient care.

Pounds per Square Inch (psi). A measurement of pressure; 1 psi equals 50 mm Hg or 68 cm H_2O.

Power Injectable. A device (eg, vascular access device, extension set) capable of withstanding injection pressure used for radiology procedures; an upper limit is usually 300 to 325 psi.

Practice Guidelines. Provide direction in clinical care decisions based on the current state of knowledge about a disease state or therapy.

Preanalytic Phase. The period of time before a body fluid specimen reaches the laboratory; includes obtaining, labeling, and transporting the specimen to the laboratory.

Precipitation. The act or process of a substance or drug in solution to settle in solid particles; most commonly caused by a change in pH.

Preservative-Free. Contains no added substance capable of inhibiting bacterial growth. Free of any additive intended to extend the content, stability, or sterility of active ingredients, such as antioxidants, emulsifiers, or bacteriocides.

Priming Volume. Amount of fluid required to fill the fluid pathway of the vascular access device, any add-on devices, and administration set.

Procedure. Written statement of a series of steps required to complete an action.

Product Integrity. The condition of an intact, uncompromised product suitable for intended use.

Provider. A practitioner permitted by law and by the organization to provide care and services within the scope of the practitioner license and consistent with individually assigned clinical responsibilities. These titles may include, but are not exclusive to, physician, nurse practitioner, and physician assistant.

Proximal. Closest to the center or midline of the body or trunk, nearer to the point of attachment; the opposite of distal.

Psychomotor. Characterizing behaviors that place primary emphasis on the various degrees of physical skills and dexterity as they relate to the preceding thought process.

Pulsatile Flushing Technique. Repetitive injection of short (eg, 1 mL) pushes followed by a brief pause for the purpose of creating turbulence within the VAD lumen.

Purulent. Containing or producing pus.

Q

Quality Improvement (QI). An ongoing, systematic approach that uses problem solving to improve quality outcomes or health care processes. This usually involves a cycle of planning, implementation, audit, and evaluation.

R

Radiopaque. Impenetrable to x-rays or other forms of radiation; detectable by radiographic examination.

Reconstitute. The act of adding diluent to a powder to create a solution.

Refractory. When multiple evidence-based therapies have been used appropriately but have failed to reach treatment goals.

Risk Evaluation and Mitigation Strategies (REMS). A US Food and Drug Administration program for monitoring medications with a high potential for serious adverse effects. REMS applies only to specific prescription drugs, but can apply to brand name or generic drugs. REMS focus on preventing, monitoring and/or managing a specific serious risk by informing, educating and/or reinforcing actions to reduce the frequency and/or severity of the event.

Risk Management. Process that centers on identification, analysis, treatment, and evaluation of real and potential hazards.

Root Cause Analysis (RCA). The process for identifying basic or causal factors that underlie variation in performance, including the occurrence or possible occurrence of a sentinel event; focuses primarily on systems and

processes, not individual performance; identifies potential improvements in processes or systems that would tend to decrease the likelihood of such events in the future, or determines, after analysis, that no such improvement opportunities exist.

S

Safety-Engineered Device. Also known as Sharps with Engineered Sharps Injury Protections. A needle-free sharp or a needle device used for withdrawing body fluids, accessing a vein or artery, or administering medications or other solutions, with a built-in safety feature or mechanism that effectively reduces the risk of an exposure incident. Used to prevent percutaneous injuries and blood exposure before, during, or after use.

Scope of Practice. The roles, responsibilities, and functions that a qualified health professional is deemed competent to perform and allowed to undertake, in keeping with the terms of their professional license.

Sentinel Event. See *Serious Adverse Event*.

Sepsis. The systemic response caused by the presence of infectious microorganisms or their toxins in the bloodstream.

Serious Adverse Event. Any unexpected, undesirable event, often resulting in death or serious physical injury that may or may not prolong hospitalization or require intervention to prevent permanent damage. When this is associated with the use of a medical product/medication in a patient, it should be reported to the US Food and Drug Administration.

Sharps. Objects in the health care setting that can be reasonably anticipated to penetrate the skin and to result in an exposure incident; including, but not limited to, needle devices, scalpels, lancets, broken glass, or broken capillary tubes.

Short Peripheral Intravenous Catheter (Short PIVC). An over-the-needle catheter with a hollow metal stylet (needle) positioned inside the catheter; generally inserted in superficial veins. See *Peripheral Intravenous Catheter (PIVC).*

Short-term. When used in reference to a vascular access device, a time frame of less than 1 month.

Simulation. A technique that produces a scenario, environment, or experiment meant to allow a learner to experience a clinical event as close to real as possible for purposes of learning or to acquire or refine a skill.

Site Protection. Method or product used externally to protect the vascular access device, insertion site, and dressing.

Smart Pump. Electronic infusion pump with imbedded computer software aimed at reducing drug dosing errors through the presence and use of a drug library.

Standard. Authoritative statement enunciated and promulgated by the profession by which the quality of practice, service, or education can be judged.

Standard Precautions. Are the minimum infection prevention practices that apply to all patient care, regardless of suspected or confirmed infection status of the patient, in any setting where health care is delivered. These practices are designed to both protect health care providers from infection and prevent the spread of infection from patient to patient; includes hand hygiene; environmental cleaning and disinfection; injection and medication safety; use of appropriate personal protective equipment; minimizing potential exposures (eg, respiratory hygiene and cough etiquette); reprocessing of reusable medical equipment between each patient and when soiled.

Standard-ANTT. A combination of Standard Precautions and an approach of protecting Key-Parts and Key-Sites individually, using non-touch technique and Micro Critical Aseptic Fields within a General Aseptic Field. Used for clinical procedures where achieving asepsis and protecting Key-Parts and Key-Sites is straightforward and short in duration, such as vascular access device flushing and locking, administration set preparation and changes, intravenous medication administration, and simple wound care. In the event of Key-Parts or Key-Sites requiring direct touch, then sterile gloves must be used.

Sterile. Free from living organisms; this is not achievable in a general health care setting, due to the ever presence of microorganisms in the air environment.

Stylet. A sharp rigid metal hollow-bore object within a peripheral catheter designed to facilitate venipuncture and catheter insertion.

Stylet Wire. A long stiffening wire within the catheter lumen that provides assistance advancing a vascular access device along the vein; may be multiple pieces welded together and is not intended for advancement into the vein alone as it does not have an atraumatic tip.

Subcutaneous. Refers to the tissue located beneath the dermal layer of the skin.

Subcutaneous Anchor Securement System (SASS). A securement device that anchors the vascular access device in place via flexible feet/posts that are placed just beneath the skin; these act to stabilize the catheter right at the point of insertion. A separate dressing is placed over the SASS. The SASS does not need to be changed at regular intervals when the dressing is changed; it can remain in place if there are no associated complications.

Subcutaneous Infusion. Administration of medications into the tissues beneath the skin.

Surgical-ANTT. A combination of Standard Precautions, and an approach of protecting Key-Sites and Key-Parts collectively, using a sterile drape(s) and barrier precautions. Used for clinically invasive procedures where achieving asepsis and protecting Key-Parts and Key-Sites are difficult and/or procedures are long in duration, such as surgery or central vascular access device insertion.

Surrogate. Also referred to as legally authorized representative; someone who acts on behalf of the patient when the patient cannot participate in the decision-making process; surrogates may be designated by

the patient and know the patient's preferences or may be court appointed with or without this knowledge; without such knowledge a surrogate is required to make decisions that are in the patient's best interest.

Surveillance. Active, systematic, ongoing observation of the occurrence and distribution of disease within a population and of the events or conditions that increase or decrease the risk of such disease occurrence.

T

Tackifier. A liquid adhesive used to increase the tack or the stickiness of a product.

Therapeutic Phlebotomy. Removal of blood from the circulatory system via venipuncture or vascular access device to reduce a fraction of the patient's whole blood volume.

Thrombolytic Agent. A pharmacological agent capable of lysing blood clots.

Thrombophlebitis. Inflammation of the vein in conjunction with formation of a blood clot (thrombus).

Thrombosis. The formation, development, or existence of a blood clot within the vascular system.

Tissue Adhesive (TA). A medical grade cyanoacrylate glue that can seal the insertion site and temporarily bond the catheter to the skin at the point of insertion and under the catheter hub. TA should be reapplied at each dressing change.

Transducer. A device that converts one form of energy to another.

Transfusion Reaction. Complication of blood transfusion where there is an immune response against the transfused blood cells or other components of the transfusion.

Transillumination. Shining a light at a specific body part (ie, extremity) to identify structures beneath the skin.

Transmission-Based Precautions. The use of Airborne, Droplet, and/or Contact Precautions, which are implemented in addition to Standard Precautions when strategies beyond Standard Precautions are required to reduce the risk for transmission of infectious agents.

Transparent Semipermeable Membrane (TSM). A sterile air-permeable dressing that allows visual inspection of the skin surface beneath it; water resistant.

Tunneled, Cuffed Catheter. A central vascular access device with a segment of the catheter lying in a subcutaneous tunnel with the presence of a cuff into which the subcutaneous tissue grows to offer security for the catheter; indicates that the skin exit site and vein entry site are separated by the subcutaneous tunnel.

U

Ultrasound. A device using sound waves at frequencies greater than the limit of human hearing; sound waves directed into human tissue to identify and display physical structures on a screen.

Umbilical Catheter. A catheter that is inserted into the umbilical artery or vein at the umbilicus.

Unlicensed Assistive Personnel (UAP). A category of health care individuals who work as assistants to and under the direction of licensed health care professionals, including both nursing and medical assistants.

V

Vascular Access Device (VAD). Catheter, tube, or device inserted into the vascular system, including veins, arteries, and bone marrow.

Vascular Visualization Technology. Device that employs the use of sound or light waves to allow for the location and identification of blood vessels and guide device insertion.

Vesicant. An agent capable of causing tissue damage when it escapes from the intended vascular pathway into surrounding tissue.

Visible Light Devices. A device using light from 400 to 700 nanometers, or the middle of the electromagnetic spectrum, to transilluminate an extremity to locate superficial veins.

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