Infusion Therapy

STANDARDS OF PRACTICE

Developed by

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The *Journal of Infusion Nursing*, the official publication of the Infusion Nurses Society (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 selected for publication 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.

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The *Journal of Infusion Nursing* is a member benefit of the Infusion Nurses Society. 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.

Journal of
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The Art and Science of Infusion Nursing

FOREWORD

These are exciting times in the field of infusion practice. Never before has there been as much interest, technology, evidence, or cross-disciplinary collaboration in the field as there is today. Whether it's research that informs the safety of a particular vascular access device, guidance for when a device may be appropriate for use, or in-depth reviews of how best to prevent complications—the knowledge, data, and wisdom in our specialty are brimming. For infusion and vascular clinicians all over the world, there has never been a better moment to be on the front lines of patient care.

Yet, this progress does not come without a price, for with these times also comes great responsibility. For example, our patients have never been more complex in terms of their vascular access needs. Unlike times past, a dizzying array of devices, designs, and technology to meet nuanced needs (eg, power injection-capable midline catheters) or fill key niches (ultrasound-guided devices for patients with difficult access) are now available. The very health care system within which we all operate has transformed—improving in many ways, but also becoming more fractured and misaligned in others. As patients transition through the labyrinth of outpatient, hospital, and post-acute care settings, the imperative to do what's right in their vascular access voyage has perhaps never been more urgent than it is today.

In this whirlwind of change, clinicians are expected to not only master the insertion, care, and management of vascular access devices but to also inform clinical decisions regarding device choice and venous access route. Although such opportunities present a unique step forward for the field, they also introduce many new and unexpected challenges. For example, what should one do when limited evidence exists to guide clinical decision making? When available data do not support current practice, how should one approach the patient or provider so as to prevent harm? How may one learn, master, and implement the evidence to enact change in her or his facility? And relatedly, what practices are associated with improved outcomes, and which are relics of times past? In the endless quest to improve the care and quality of infusion practice, knowing what we don't know has become more important than ever before.

Highlighting how fortunate we have been to have the *Infusion Therapy Standards of Practice* serve as the bedrock of our field for so many years is not hyperbole. Rather, the *Standards* represents the best of our specialty: a tome within which excellence, expectations, and enigmas are not only defined but also primed and supported by available data and strength of the evidence. Whether the purpose lies in informing patient care, legal proceedings, or personal edification and growth, no document is more versatile, time-tested, or valuable in the field of infusion practice. As a reviewer and contributor to this 2016 update, I am pleased to say the exulted tradition of the *Standards* continues. With new and improved sections on special patient populations, the definition and role of infusion teams, vascular visualization technologies, and catheter tip location, the 2016 *Standards* incorporates and assimilates the many advances in our field within a single comprehensive document. Not only have new criteria for practice been added but substantial improvements to the key domains of infection prevention, phlebotomy, and device complications have been included.

These significant enhancements reflect the growth in our field and the ever-changing expectations of the public in infusion care. The new *Standards* is thus not merely recommended, but *required* reading for any clinician interested in infusion or vascular therapy.

As a physician researcher dedicated to improving the safety of patients who require vascular access and infusion-based therapies, the *Standards* has informed the work that I do, the questions I ask, and the clinical care I provide. Quite simply put, there is nothing else like it. This edition continues to provide us with critical answers to the many important questions, conundrums, and challenges we face today. I urge you all to read, evaluate, and adapt the recommendations within this document to your care and decision making. Your patients, practice, and society will thank you for it.

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October 2015

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Ms. Gorski is a former INS president (2007-2008) who served on the INS Standards of Practice Committee in 2006 and chaired the 2011 committee. She is the author of more than 50 journal articles and has authored several books on the topic of infusion therapy. She is a frequent speaker, both nationally and internationally, on standards development, home health care, and infusion therapy.

Lynn Hadaway, MEd, RN-BC, CRNI®
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Ms. Hadaway has more than 40 years of experience as an infusion nurse and is internationally known as a consultant and educator. She is currently serving as the chair for the Infusion Nurses Certification Corporation (INCC) Board of Directors and for the Infusion Team Task Force. She served as a committee member for the revision of the 2006 and 2011 *Standards of Practice*. She has authored more than 75 journal articles and several textbook chapters on infusion therapy. Ms. Hadaway holds board certifications in nursing professional development and infusion nursing.

Mary E. Hagle, PhD, RN-BC, FAAN
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Dr. Hagle joined the Standards of Practice Committee for the 2011 edition and returned for this updated version, refining the "Strength of the Body of Evidence" document after 5 years' use and serving as a reference point for the quality of evidence. With 15 years' experience as a researcher and more than 20 years as a clinical nurse specialist in academic and community medical centers, she has worked with patients and nurses in acute, ambulatory, and long-term care settings. Focusing on vascular access device management and prevention of adverse events, Dr. Hagle is a mentor for research and quality improvement teams, a leader for translating evidence into practice, and a clinical investigator.

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Ms. McGoldrick began her home care career more than 35 years ago, and since that time she has served in a myriad of home care clinical, management, and executive-level positions, including 12 years as a home care and hospice surveyor for The Joint Commission (TJC). She is a frequent speaker on the topic of infection prevention in home care and hospice and has authored several books, articles, chapters, and manuals.

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STANDARDS OF PRACTICE COMMITTEE

CONFLICT OF INTEREST DISCLOSURES

The authors have completed and submitted a form for disclosure of potential conflicts of interest. **Lisa Gorski** reported relationships with ivWatch, BD, 3M, and Covidien; **Lynn Hadaway** reported relationships with 3M, BD, Terumo, Excelsior, Ivera, B Braun, Baxter, Covidien, DEKA, Discrub, SplashCap, Velano Vascular, VATA, West Pharmaceuticals, Elcam, Christie Medical, and Bard Access; **Mary Hagle, Mary McGoldrick,** and **Marsha Orr** reported no relationships; and **Darcy Doellman** reported relationships with Arrow International, Hospira, and Genentech.

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PREFACE

Recognized as the premier organization for the specialty practice of infusion nursing, the Infusion Nurses Society (INS) understands the significance the *Infusion Therapy Standards of Practice (*the *Standards)* holds in relation to the delivery of safe patient care. Developing and disseminating *Standards* is one of the pillars of INS' mission. Infusion therapy is administered to all patient populations in all practice settings, all the more reason to ensure the *Standards* are applied to one's clinical practice. It provides a framework to guide safe practice to ensure the best patient outcomes. There is an expectation that all clinicians are competent in their practice.

With more published research, advances in science, and innovation in technology, it's imperative that the *Standards* is relevant to the clinician's practice. Therefore, INS is committed to revising the document every 5 years. This seventh edition cites 350 more references than the sixth edition of the *Standards* (2011), a testament to the advancing science of infusion therapy. The rankings of the strength of the body of evidence have also shifted in this edition. In 2011, there were 3.8% of Level I rankings, the highest rating. In this revision, that ranking has grown to 5.8%, evidence that there is more robust research with consistent findings in the literature to support the practice. In contrast, the percentage of Level V rankings, the lowest rating, was 67% in 2011 and has decreased to 46% in this document. With more published data and research adding to the science of the practice, the distribution of rankings has changed based on the nature and robustness of the research. As we've seen over time, more strong evidence has provided clinicians with information and data that can justify existing practice or lead to a change in practice.

A major change in this edition of the *Standards* is its title. Infusion therapy does not "belong" to one group of clinicians, but it is the responsibility of any clinician who is involved in the practice. Recognizing infusion care goes beyond nursing, the title has been changed to the *Infusion Therapy Standards of Practice*. This change aligns with the interprofessional approach that is being implemented in health care today.

In this edition, new standards have been added, while other sections have been expanded to offer more guidance to clinicians. The format remains unchanged with practice criteria and relevant references listed after each set of standards.

INS' focus has never changed. We still keep in mind that our patients are the reason we do what we do. We want to ensure we're providing the safe, quality infusion care that our patients deserve. As INS continues to "set the standards for infusion care," the *Infusion Therapy Standards of Practice* is an invaluable guide for *all* clinicians who are responsible for their patients' infusion care.

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A MESSAGE FROM BD MEDICAL

We at BD feel honored to support the *Infusion Therapy Standards of Practice* revision for the fifth time since 1998, as part of our commitment to helping more efficiently deliver health care and improve patient outcomes. With a long history of providing global education and training on best practices, we award grants for education and research to promote innovative solutions in infusion therapy and across the care continuum.

We applaud the Infusion Nurses Society (INS) for striving to keep the *Standards of Practice* current, relevant, and evidence based, helping millions of clinicians provide quality infusion therapy to their patients. We look forward to working with INS in the future while helping improve infusion therapy around the world.

Alicia Mares, BSN, RN, CRNI®
Clinical Marketing Manager
BD Medical

Richard Ji
Vice President, Catheter Solutions
BD Medical

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ACKNOWLEDGMENTS

INS recognizes the significance the *Infusion Therapy Standards of Practice* has to clinical practice and to all clinicians involved in the delivery of safe infusion care. Without the following dedicated individuals and their passion for quality patient care, the seventh edition of the *Standards* would not have been possible.

First, I want to recognize and thank the Standards of Practice Committee: Lisa Gorski, chair; Lynn Hadaway; Mary Hagle; Mary McGoldrick; Marsha Orr; and Darcy Doellman. They spent countless hours researching and critically analyzing the evidence, and writing, reviewing, and revising all the *Standards*. Not only is the depth of their expertise in clinical practice, research, and infusion-related knowledge unsurpassed, but their commitment to this important work is also exceptional.

Thanks go to the reviewers of the *Standards*. From INS members and volunteer leaders, to physicians, pharmacists, legal experts, health care clinicians, and industry partners, their thoughtful reviews and feedback contributed to the global perspective and interprofessional approach of the document.

I want to thank the INS Board of Directors for supporting the efforts of the Standards of Practice Committee during the revision process. I am grateful to the INS staff for the assistance they offered in ensuring that the publication was completed.

I also want to recognize BD Medical for their continuous support over the years of the *Standards of Practice* revisions. INS thanks them for the educational grant that helped fund this project.

Lastly, I want to thank our INS members. It is your passion and commitment to providing quality patient care that motivates us to continue to support the infusion specialty practice.

Mary Alexander, MA, RN, CRNI®, CAE, FAAN
Chief Executive Officer, INS

METHODOLOGY FOR DEVELOPING THE STANDARDS OF PRACTICE

Role of the Standards of Practice Committee

The Standards of Practice Committee brought together a group of professional nurses with a wealth of clinical knowledge and expertise in all the domains of infusion therapy. 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 by phone, 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*. This draft then was sent to over 90 interdisciplinary reviewers who are experts in the field, comprising all aspects of infusion therapy. Sixty reviewers provided in excess of 790 comments, suggestions, references, and questions. The committee addressed each comment and made revisions to the standards, seeking additional evidence as needed. Each standard had a final review by the committee for agreement on the content, evidence, recommendation, and rating.

The standards are written for clinicians of multiple disciplines with various educational backgrounds, training, certification, and licensing, including licensed independent practitioners, because 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

A literature search was conducted for each of the standards of practice using key words and subject headings related to the standard. Searches were limited to English-language, peer-reviewed journals published between 2009 and July 2015. Databases included, but were not limited to, Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE, PubMed, and Web of Science. The references of retrieved articles were reviewed for relevant literature.

Additional sources of evidence included, but were not limited to, the Web sites of professional organizations, manufacturers, pharmaceutical organizations, and the United States Pharmacopeia (USP). US sites included the US Department of Health and Human Services for national centers, such as the Agency for Healthcare Research and Quality (AHRQ), the Centers for Disease Control and Prevention (CDC), and the US Food and Drug Administration (FDA); and the US Department of Labor (eg, Occupational Safety and Health Administration [OSHA]). 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 standards of practice are 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 is evaluated from many perspectives, and the highest, most robust evidence relating to the standards of practice is used. Research evidence is preferred over nonresearch evidence. For research evidence, the study design is 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. Only specific study designs are acceptable for a meta-analysis, and with its statistical analysis, this is 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 project, but because of its lack of research controls, it is ranked at a low level of evidence for clinical practice.

Last, 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.

Rating the Strength of the Body of Evidence

In 2011, the Infusion Nurses Society Standards of Practice Committee developed the rating scale for the strength of the body of evidence to provide guidance for clinicians when implementing standards of practice. This guidance can reflect a range of evidence, from a preponderance of evidence and specific clinician actions highly recommended, to minimal evidence and actions based on organizational preference and/or clinician judgment.

The rating scale for the strength of the body of evidence ranges from the highest rating 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. 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 the strength of the research the guideline uses for a particular recommendation.

There is also a rating for anatomy and physiology, which may be based on anatomy textbooks as well as fully analyzed case studies. This is used for recommendations to stop an unsafe action, such as for preventing 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 and agreed to practice criteria, and as a committee decided on a rating of V, Committee Consensus. This rating was used in less than 2% of the practice criteria.

The last rating is the Regulatory level. The committee was aware that many practices are mandated by regulatory agencies that could penalize clinicians and/or organizations if the regulations are not followed. OSHA is an example of such an agency that has regulations governing certain aspects of infusion therapy.

Practice Criteria 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 criteria 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 the evidence and conclusions are undetermined. In this instance, the practice criteria recommendation is lower, reflected in the use of the term *consider*, and the clinician is advised to use this evidence along with her or his expertise and clinical judgment.

Practice criteria also serve as guidance for aspects of infusion therapy when there is little more than expert opinion. Often, practice questions are raised in publications, at conferences, or through online professional forums. For a few practice criteria, the Standards of Practice Committee provided a consensus recommendation that may guide a novice clinician for safe care without harm. In reviewing the practice criteria and the evidence ratings, the clinician may identify some practices with uncertain or low levels of evidence. This may stimulate areas of needed research in infusion therapy or quality improvement projects to validate practice.

The *Standards of Practice* document 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 for practice recommendations. However, the Infusion Nurses Society and the Standards of Practice Committee are committed to bringing research-based critical changes for practice to clinicians through a variety of dissemination strategies in the time between *Standards of Practice* publication dates.

STRENGTH OF THE BODY OF EVIDENCE

Strength of the Body of Evidence	Evidence Description*
I	Meta-analysis, systematic literature review, guideline based on randomized controlled trials (RCTs), or at least 3 well-designed RCTs.
I A/P	Evidence from anatomy, physiology, and pathophysiology references as understood at the time of writing.
II	Two well-designed RCTs, 2 or more multicenter, well-designed 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, or narrative literature review, 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 directions for use for products or services. Includes standard of practice that is generally accepted but does not have a research basis (eg, patient identification). May also be noted as Committee Consensus, although rarely used.
Regulatory	Regulatory regulations and other criteria set by agencies with the ability to impose consequences, such as the AABB, Centers for Medicare & Medicaid Services (CMS), Occupational Safety and Health Administration (OSHA), and state Boards of Nursing.

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

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 care setting in which vascular access devices (VADs) are placed and/or managed and where infusion therapies are administered.
1.2 Infusion therapy is provided in accordance with laws, rules, and regulations promulgated by federal and state regulatory and accrediting bodies in all patient care settings.
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 provide a basis for clinical decision making.
1.4 Infusion therapy is provided with attention to patient safety and quality. Care is individualized, collaborative, culturally sensitive, and age appropriate.
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 subject to commercial or other conflicts of interest.

2. SPECIAL PATIENT POPULATIONS

Standard

2.1 To ensure patient safety, the clinician providing infusion therapy for special populations (neonatal, pediatric, pregnant, and older adult populations)* is competent in clinical management of such populations, including knowledge of anatomical and physiological differences, safety considerations, implications for vascular access device (VAD) planning and management, and infusion administration.

Practice Criteria

A. Provide care to special populations, which include neonatal, pediatric, pregnant, and older adult patients, that is individualized, collaborative, and age appropriate.[1-5] (V)
B. Provide infusion therapy to special patient populations with attention to:
   1. Anatomic characteristics and their effect on physical assessment, VAD planning, site selection, insertion procedures, and use of specialized infusion-related equipment, including care and maintenance practices during infusion therapy.[3,6-9] (V)
   2. Safety and environmental considerations for infusion therapy in all care settings (eg, acute care, ambulatory, long-term care facility, home care).[3,5,6,8,10] (V)
C. Considerations for neonatal and pediatric patients:
   1. Recognize physiologic characteristics and effect on drug and nutrient selection; administration set selection (eg, free of Di[2-ethylhexyl] phthalate [DEHP]); dosage 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.[2,8-12] (V)
   2. Provide education to the mother regarding the potential impact and risks/benefits of any medication use during lactation.[13] (V)
   3. Provide care with attention to growth and developmental level; include nonpharmacological measures for promoting comfort and reducing pain and fears associated with infusion therapy procedures.[2,14,15] (V)
   4. Assess for psychosocial and socioeconomic considerations that may affect the plan for infusion therapy.[2] (V)
   5. Interact with parents, other family members, or 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*).[2,16] (V)

6. Obtain assent from the school-age or adolescent patient as appropriate (see Standard 9, *Informed Consent*).[2,17,18] (V)

D. Considerations in pregnancy:
   1. Recognize physiologic changes related to pregnancy and their effect on drug dosage and volume limitations and potential impact on the fetus; pharmacologic actions, interactions, side effects, adverse effects; monitoring parameters; and response to infusion therapy.[13] (II)
   2. Recognize that there may be increased risk in central vascular access device (CVAD) complications (eg, infection and thrombosis) during pregnancy.[19-21] (IV)
   3. Consider enteral feedings prior to initiating parenteral nutrition with hyperemesis gravidarum (see Standard 61, *Parenteral Nutrition*).[21] (III)

E. Considerations for the older adult patient population:
   1. Recognize physiologic changes associated with the aging process and their effect on drug dosage and volume limitations, pharmacologic actions, interactions, side effects, monitoring parameters, and response to infusion therapy.[3,6,7,10,22-24] (V)
   2. Assess for any changes in cognitive abilities, dexterity, ability to communicate/learn (eg, changes in vision, hearing, speech), as well as psychosocial and socioeconomic considerations that may affect the plan for infusion therapy.[4,6,7] (V)
   3. Interact with family members, caregivers, or surrogate as members of the patient's health care team, with consent of the patient or as necessary due to mental status.[3,5,16] (V)
   4. Recognize potential for adverse events and drug interactions in older adults who may be prescribed multiple medications.[22-26] (V)

*Special populations identified based on a role delineation study conducted by the Infusion Nurses Certification Corporation reflecting the current infusion practices in these patient populations.

REFERENCES

1. American Nurses Association (ANA). *Neonatal Nursing: Scope and Standards of Practice*. 2nd ed. Silver Spring, MD: ANA; 2013.
2. Frey AM, Pettit J. Infusion therapy in children. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:550-570.
3. American Nurses Association (ANA). *Gerontological Nursing: Scope and Standards of Practice*. 2nd ed. Silver Spring, MD: ANA; 2010.
4. Gray-Miceli D, Wilson LD, Stanley J, et al. Improving the quality of geriatric nursing care: enduring outcomes from the geriatric nursing education consortium. *J Prof Nurs*. 2014;30(6):447-455.
5. Fabian B. Infusion therapy in the older adult. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:571-582.
6. Nygardh A, Ahlstrom G, Wann-Hansson C. Handling a challenging context: experiences of facilitating evidence-based elderly care. *J Nurs Manage*. 2015. doi:10.111/jonm12300.
7. Ijkema R, Langelaan M, van de Steef L, et al. What impedes and what facilitates a quality improvement project for older hospitalized patients? *Int J Quality Health Care*. 2014;26(1):41-48.
8. Cotogni P, Pittiruti M. Focus on peripherally inserted central catheters in critically ill patients. *World J Crit Care Med*. 2014;3(4):80-94.
9. Garner SS, Cox TH, Hill EG, Irving MG, Bissinger RL, Annibale DJ. Prospective controlled study of an intervention to reduce errors in neonatal antibiotic orders. *J Perinatol*. 2015;35(8):631-635. doi:10.1038/jp.2015.20.
10. Winkler M, Guenter P. Long-term home parenteral nutrition: it takes an interdisciplinary approach. *J Infus Nurs*. 2014;37(5):389-395.
11. Loff S, Subotic U, Reinick F, et al. Extraction of di-ethylhexylphthalate by home total parenteral nutrition from polyvinyl chloride infusion lines commonly used in the home. *J Pediatr Gastroenterol Nutr*. 2008;47(1):81-86.
12. Fischer CJ, Bickle Graz M, Muehlethaler V, et al. Phtalates in the NICU: is it safe? *J Paediatr Child Health*. 2013;49(9):E413-E419.
13. Briggs GC, Freeman RK. *Drugs in Pregnancy and Lactation: A Reference Guide to Fetal and Neonatal Risk*. 10th ed. Philadephia, PA: Wolters Kluwer Health; 2015.
14. Gupta HV, Gupta W, Kaur A, et al. Comparison between the analgesic effect of two techniques on the level of pain perception during venipuncture in children up to 7 years of age: a quasi-experimental study. 2014;8(8):PC01-PC04.
15. Vetri Buratti C, Angelino F, Sansoni J, et al. Distraction as a technique to control pain in pediatric patients during venipuncture: a narrative review of literature. *Prof Inferm*. 2015;68(1):52-62.
16. Czaplewski L. Clinician and patient education. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:71-94.
17. Heerman WJ, White RO, Barkin SL. Advancing informed consent for vulnerable populations. *Pediatrics*. 2015;135(3):e562-e564.
18. Blake DR, Lemay CA, Maranda LS, et al. Development and evaluation of a Web-based assent for adolescents considering an HIV vaccine trial. *AIDS Care*. 2015;27(8):1005-1013.
19. Nuthalapaty FS, Beck MM, Mabie WC. Complications of central venous catheters during pregnancy and postpartum: a case series. *Am J Obstet Gynecol*. 2009;201(3):311.e1-e5.
20. Cape AV, Mogensen KM, Robinson MK, et al. Peripherally inserted central catheter (PICC) complications during pregnancy. *J Parenter Enteral Nutr*. 2015;38(5):596-601.
21. Ogura JM, Francois KE, Perlow JH, Elliot JP. Complications associated with peripherally inserted central catheter use during pregnancy. *Am J Obstet Gynecol*. 2003;188(5):1223-1225.
22. Wehling M. Age-associated general pharmacological aspects. In: Wehling M, ed. *Drug Therapy for the Elderly*. New York, NY: Springer-Verlag; 2013.
23. 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.
24. Bozzetti F. Evidence-based nutritional support of the elderly cancer patient. *Nutrition*. 2015;31(4):585-586.

25. Gilden JL, Gupta A. Non-ICU hospital care of diabetes mellitus in the elderly population. *Curr Diabetes Rep*. 2015;15(5):26.
26. Erstad BL. Designing drug regimens for special intensive care unit populations. *World J Crit Care Med*. 2015;4(2):139-151.

3. SCOPE OF PRACTICE

Standard

3.1 The role, responsibilities, and accountability for each type of clinician involved with infusion therapy delivery, according to the applicable regulatory boards, are clearly defined in organizational policy.
3.2 Clinicians involved with infusion therapy practice within the boundaries of their legal scope of practice.
3.3 Clinicians delivering any type of infusion therapy and vascular access device (VAD) insertion, use, maintenance, and removal are qualified and competent to perform the identified functions.
3.4 Members of the health care team collaborate to achieve the universal goals of safe, effective, and appropriate infusion therapy.
3.5 Infusion therapy tasks are delegated by the registered nurse (RN) to unlicensed assistive personnel (UAP) in accordance with rules and regulations promulgated by the state's Board of Nursing and within the policies and procedures of the organization. The RN and the organization are responsible and accountable for the tasks delegated to UAP and licensed practical/vocational nurses (LPN/LVNs).

Practice Criteria

A. Know the scope of practice for one's health care profession or occupation and provide patient care within this legal framework.
   1. Recognize that Nurse Practice Acts differ among jurisdictions (ie, state, province, country).
   2. For other professions, know the designated scope of practice as outlined by the applicable regulatory agency and/or professional organization (eg, American Society of Radiologic Technologists [ASRT], American Association for Respiratory Care [AARC]).
   3. Know the boundaries of practice as established by organizational policies when there is an absence of a legal scope of practice (eg, UAP).[1-3] (V)

B. Recognize the overlap between professional groups and that no single profession can claim exclusive ownership of any skill, activity, or task.[3,4] (V)

C. For nursing personnel, make scope of practice decisions according to the method used by the state Board of Nursing. A standardized decision tree for determining scope of practice is preferred; however, other methods may be used. Frequent application of the decision process may be required due to increasing types of infusion therapies and technologies, expansion of practice into professions other than nursing, and delivery of infusion therapy in acute and alternative health care settings.[5] (Regulatory)

D. Nursing Personnel
   1. Provide infusion therapy based on the components of the nursing process and principles of delegation and supervision using a holistic, patient-centered approach to care.[3,6] (V)
   2. Collaborate with members of the health care team toward the universal goal of safe, effective, and appropriate infusion therapy.[7] (IV)
   3. Execute independent nursing strategies related to infusion therapy using decision-making and critical thinking skills.[2] (V)
   4. Advocate for identification and removal of barriers to allow practice to the full extent of licensure.[8,9] (V)
   5. Registered Nurse (RN)
      a. Complete an organized educational program on infusion therapy due to the lack and/or inconsistency of infusion therapy in basic nursing curricula.[10] (V)
      b. Do *not* accept assignments and tasks when one concludes that she or he is inadequately prepared to perform the assignment or task (refer to Standard 5, *Competency Assessment and Validation*).
      c. Develop the necessary skills for delegation based on rules and regulations articulated by state Boards of Nursing.[3,11,12] (V, Regulatory)
      d. Delegate tasks, activities, and components of care after determination of competency to perform the specific task. Match the staff member's skill to the specific needs of the patient and family.[3,11-14] (V, Regulatory)
      e. Do *not* delegate any aspect of the nursing process, although specific components of care may be delegated.[3,11,12] (V)
      f. Use critical thinking and nursing judgment to apply 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.[3] (V)
      g. Delegate tasks that frequently occur; can be performed with an established order of steps; require little or no modification for each patient; are performed with a predictable outcome; do not require assessment or professional judgment; and do not endanger a patient's life or well-being.[3] (V)
      h. Ensure that delegated tasks are completed in compliance with organizational policies and procedures.[11] (V)

i. In settings without an administrative nursing structure (eg, physician office or clinic), written policies identify which professional can delegate and to whom they can delegate. The delegating individual is accountable for the task performance.[11] (V)
j. Recognize that accepting an assignment to supervise a task (eg, peripheral catheter insertion, accessing an implanted port) delegated by another professional (eg, licensed independent practitioner [LIP]) is outside the guidelines for delegation. Accepting the assignment to supervise such tasks requires that the RN is competent with the task, is able to intervene if needed, and has the opportunity and proximity to monitor performance.[11,12] (V)

6. Licensed Practical/Vocational Nurse (LPN/LVN)
   a. Complete an organized educational program, including supervised clinical practice on infusion therapy, as required for LPN/LVNs in many states. In states without such requirements, completion of an infusion therapy educational program is recommended prior to performing infusion therapy procedures (refer to Standard 5, *Competency Assessment and Validation*).
   b. Practice analysis for LPN/LVNs includes venipuncture for blood sampling and insertion and removal of peripheral catheters, maintenance of central vascular access devices (CVADs), and administration of intravenous (IV) medications by the piggyback method. The majority of states permit LPN/LVNs to administer IV medications through CVADs, while 10 states allowed this activity through delegation, and 5 states prohibited this practice. No regulatory agency includes insertion of midline catheters or CVADs within the scope of practice for LPN/LVNs.[15,16] (V)
   c. Perform infusion-related tasks under the supervision of an RN or LIP with appropriate infusion therapy knowledge and skills.[11] (V)
   d. Adhere to the state Board of Nursing's rules and regulations regarding the authority to delegate by LPN/LVN as this varies greatly between states.[1] (V)
7. Infusion Nurse Specialist (Certified Registered Nurse Infusion [CRNI®])
   a. Enhance professional growth and empowerment by earning board certification to become an infusion nurse specialist (ie, CRNI®).[17,18] (V)
   b. Advocate for expansion of professional practice to the full extent of licensure and board certification including, but not limited to, CVAD insertion and determination of CVAD tip location on imaging modalities.[19-23] (V)
   c. Participate in quality improvement activities and clinical research in infusion therapy.[23,24] (V)
   d. Serve as the primary resource to guide policy and procedure development of infusion therapy derived from best evidence.[18,24] (V)
   e. Serve as educator, leader, manager, and consultant on issues related to infusion therapy.[18,24] (V)
8. Advanced Practice Registered Nurse (APRN)
   a. Know the status of APRNs as LIPs based on legal requirements for physician direction or supervision. APRNs who are LIPs have the legal authority to prescribe infusion therapy. APRNs may perform surgical procedures for insertion and removal of vascular access devices with documented competence.[25] (V, Regulatory)
   b. Provide leadership in education, consulting, and research related to infusion therapy according to the needs of the employing organization and/or patient populations served.[26-29] (V)
   c. Advocate for expansion of professional practice to the full extent of education, certification, and licensure.[30] (V)

E. Unlicensed Assistive Personnel (UAP)
1. Nursing assistive personnel (NAP) is a category of UAP, includes many job titles, has no standardized educational requirements, and does not have a regulated scope of practice. An unofficial UAP scope of practice task list is taken from the 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. No tasks related to VAD insertion, care, or maintenance or to the administration of any IV fluid or medications are included on this list.[31,32] (V, Regulatory)
2. Managing equipment and supplies, gathering data, and assisting licensed clinicians with invasive procedures are infusion-related tasks that may be assigned to NAP.[31] (V)
3. Apply existing rules or regulations, if any, from specific state Boards of Nursing pertaining to delegation of infusion-related tasks to NAP and the supervision of their performance. There is much variation among states regarding what is allowed for UAP dialysis technicians to administer through CVADs.[16] (V)
4. Medical Assistants (MAs) are a different category of UAP, primarily employed in medical offices, although they may be employed in a variety of positions in acute care hospitals. Regulations vary greatly among states, and very few identify any form of scope of practice.[33,34] (V)
5. MAs function in assistive roles to physicians by performing administrative and clinical tasks. The state medical board regulates delegation of tasks from physicians to MAs with tremendous variations among states.[33] (V)

6. A structured nursing department with responsibility and accountability for the action of MAs is not typically found in medical offices. Following delegation from the physician, the licensed nurse may be expected to supervise task performance. The individual licensed nurse is required to obtain clarification from the delegating physician about the role of each professional, especially who will hold accountability for the outcome of the delegated tasks.[11] (V)
7. Infusion therapy-related tasks may be delegated to MAs depending upon the state regulations and after the MA completes education and competency validation.[33] (V)

F. Therapist/Technologist/Technician
1. These groups of clinicians have educational preparation from a variety of schools/colleges (ie, associate's and bachelor's degrees). Individuals hold a state license or certification from a professional organization or both as required by the state board regulating their practice.[35-37] (Regulatory)
2. Each individual practices within the identified scope of practice and has documented competency for each task, skill, or activity performed.[36,38-40] (V)
3. Radiologic Technologist
   a. Holds a state license and/or certification from a national credentialing board (eg, American Registry of Radiologic Technologists [ARRT]).
   b. 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.
   c. There are numerous practice areas for radiologic technologists including, but not limited to, cardiovascular and interventional, computed tomography, magnetic resonance, and nuclear medicine.
   d. Basic techniques of venipuncture, administration of diagnostic contrast agents and/or IV medications, and appropriate delivery of patient care during medication administration are components of the curricula for each practice area as established by ASRT and other radiology organizations.
   e. ASRT-issued advisory opinions that peripheral venipuncture, parenteral injection of contrast media and other medications, and access to existing VADs are within the scope of practice when an LIP is immediately available to ensure proper diagnosis and treatment of adverse events.
   f. Adhere to recommendations, position statements, standards of practice, and other guidance documents from ASRT, American College of Radiology (ACR), and other appropriate regulatory agencies.
   g. Know the proper use of all flow-control devices used in radiology including, but not limited to, power injectors.[38,39,41] (V)

G. Respiratory Care Practitioner
1. Holds a license from the regulatory agency in the jurisdiction (state, province, country) and/or certification from the national certifying board (ie, National Board for Respiratory Care). Two levels of certification are available: Certified Respiratory Therapist (CRT) and Registered Respiratory Therapist (RRT).
2. Adhere to regulations on scope of practice questions as determined by the regulatory agency within each jurisdiction. A few states have addressed the issue of peripherally inserted central catheter and other CVAD insertion by respiratory therapists, either positively or negatively; however, most states have nothing on record regarding this practice question.
3. Arterial puncture and obtaining arterial blood samples are addressed by AARC; there are no national documents addressing any other aspect of infusion therapy or vascular access by respiratory therapists.[40,42-44] (V)

H. Paramedic
1. Holds a license from the regulatory agency in the jurisdiction (state, province, country), and/or certification from the national certifying board, and is credentialed (authorized) by a local emergency services medical director to perform the skills or role.
2. Recognize that emergency medical personnel have historically functioned in a prehospital setting; however, they are now employed in a variety of settings such as hospital emergency departments, hospital units, physician offices, and urgent care settings. Note any alterations in the role when employed in nontraditional settings as there may be prohibitions for certain activities.
3. Two levels of emergency medical services personnel perform infusion therapy:
   a. Advanced Emergency Medical Technicians may insert peripheral venous catheters and intraosseous

devices and administer IV fluids and 50% dextrose for hypoglycemia.

b. Paramedics may insert peripheral venous catheters and intraosseous devices, access indwelling VADs, administer IV medications by infusion, and monitor blood and blood products.[36] (V)

REFERENCES

Note: All electronic references in this section were accessed September 15, 2015.

1. Parnell ER, Kring DL. Practice patterns of licensed practical nurses in North Carolina. *JONAS Healthc Law Ethics Regul*. 2012;14(1):14-18.
2. Russell KA. Nurse practice acts guide and govern nursing practice. *J Nurs Regul*. 2012;3(3):36-42.
3. American Nurses Association and the National Council of State Boards of Nursing. Joint statement on delegation. https://www.ncsbn.org/Joint_statement.pdf. Published 2007.
4. Pfeifer GM. Shifting boundaries in health care. *Am J Nurs*. 2012;112(2):19-20.
5. TriCouncil for Nursing, NCSBN. Interstate practice, education and licensure: changing practice, evolving regulation; 2014. https://www.ncsbn.org/TriCouncil_Framing_Document_FINAL.PDF
6. American Nurses Association. *Nursing Scope and Standards of Practice*. Silver Spring, MD: ANA; 2015:3-6.
7. Boev C, Xia Y. Nurse-physician collaboration and hospital-acquired infections in critical care. *Crit Care Nurse*. 2015;35(2):66-72.
8. D'Amour D, Dubois CA, Dery J, et al. Measuring actual scope of nursing practice: a new tool for nurse leaders. *J Nurs Adm*. 2012;42(5):248-255.
9. Institute of Medicine. Focus on scope of practice. In: *The Future of Nursing: Leading Change, Advancing Health*. Washington, DC: National Academy of Sciences; 2010. http://iom.nationalacademies.org/~/media/Files/Report%20Files/2010/The-Future-of-Nursing/Nursing%20Scope%20of%20Practice%202010%20Brief.pdf.
10. Hadaway L. Development of an infusion alliance. *J Infus Nurs*. 2010;33(5):278-290.
11. National Council of State Boards of Nursing. Working with others: a position paper. https://www.ncsbn.org/Working_with_Others.pdf. Published 2005.
12. Fowler MDM. *Guide to the Code of Ethics for Nurses With Interpretive Statements*. 2nd ed. Silver Spring, MD: American Nurses Association; 2015:68-70.
13. Gravlin G, Bittner NP. Nurses' and nursing assistants' reports of missed care and delegation. *J Nurs Adm*. 2010;40(7/8):329-335.
14. Weydt A. Developing delegation skills. *Online J Issues Nurs*. 2010;15(2). doi:10.3912/OJIN.Vol15No02Man01Found.
15. NCSBN. 2012 LPN/VN practice analysis: linking the NCLEX-PN examination to practice. Chicago, IL: National Council of State Boards of Nursing; 2013. https://www.ncsbn.org/13_LPN_Practice_Analysis_Vol58_updated.pdf. Published 2013.
16. 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.
17. McLaughlin A, Fetzer SJ. The perceived value of certification by Magnet® and non-Magnet nurses. *J Nurs Admin*. 2015;45(4):194-199.
18. Biel M. Infusion nursing certification: identification of stakeholders and demonstration of the value of certification. *J Infus Nurs*. 2007;30(6):332-338.
19. Alexandrou E, Murgo M, Calabria E, et al. Nurse-led central venous catheter insertion: procedural characteristics and outcomes of three intensive care based catheter placement services. *Int J Nurs Stud*. 2012;49(2):162-168.
20. Alexandrou E, Spencer TR, Frost SA, Mifflin N, Davidson PM, Hillman KM. Central venous catheter placement by advanced practice nurses demonstrates low procedural complication and infection rates: a report from 13 years of service. *Crit Care Med*. 2014;42(3):536-543.
21. Yacopetti N, Alexandrou E, Spencer TR, et al. Central venous catheter insertion by a clinical nurse consultant or anaesthetic medical staff: a single-centre observational study. *Crit Care Resusc*. 2010;12(2):90-95.
22. Markovich MB. The expanding role of the infusion nurse in radiographic interpretation for peripherally inserted central catheter tip placement. *J Infus Nurs*. 2008;31(2):96-103.
23. Meyer BM. Broadening infusion specialization as an adjunct to organizational sustainability. *J Infus Nurs*. 2014;37(1):44-54.
24. 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. St Louis, MO: Saunders/Elsevier; 2010:1-9.
25. Kleinpell RM, Hudspeth RS. Advanced practice nursing scope of practice for hospitals, acute care/critical care, and ambulatory care settings: a primer for clinicians, executives, and preceptors. *AACN Adv Crit Care*. 2013;24(1):23-29.
26. Szablewski SG, Zuzelo PR, Morales EM, Thomas L. Describing saline-lock usage patterns on a telemetry unit: a retrospective study. *Clin Nurse Spec*. 2009;23(6):296-304.
27. Morrison T. Qualitative analysis of central and midline care in the medical/surgical setting. *Clin Nurse Spec*. 2012;26(6):323-328.
28. Hooke MC. Clinical nurse specialist and evidence-based practice: managing anthracycline extravasation. *J Pediatr Oncol Nurs*. 2005;22(5):261-264.
29. Bizzarro MJ, Sabo B, Noonan M, et al. A quality improvement initiative to reduce central line-associated bloodstream infections in a neonatal intensive care unit. *Infect Control Hosp Epidemiol*. 2010;31(3):241-248.
30. Clavelle JT. Implementing Institute of Medicine Future of Nursing recommendations: a model for transforming nurse practitioner privileges. *J Nurs Adm*. 2012;42(9):404-407.
31. McMullen TL, Resnick B, Chin-Hansen J, Geiger-Brown JM, Miller N, Rubenstein R. Certified Nurse Aide scope of practice: state-by-state differences in allowable delegated activities. *J Am Med Dir Assoc*. 2015;16(1):20-24.
32. Small A, Okungu LA, Joseph T. Continuing education for patient care technicians: a unit-based, RN-led initiative. *Am J Nurs*. 2012;112(8):51-55.
33. McCarty MN. The lawful scope of practice of medical assistants: 2012 update. *AMT Events*. 2012:110-119.
34. Gent PL, Proulx JR, Seidl K. The forgotten rung: a clinical ladder for UAP. *Nurs Manage*. 2014;45(2):48-52.
35. American Society of Radiologic Technologists (ASRT). State and federal licensure issues. http://www.asrt.org/main/standards-regulations/federal-legislative-affairs/state-and-federal-licensure-issues.
36. National Highway Traffic Safety Administration (NHTSA). National EMS scope of practice model. http://www.ems.gov/education/EMSScope.pdf.

37. American Association for Respiratory Care (AARC). Respiratory therapist state licensure information. http://www.aarc.org/resources/advocacy/state-licensure-information.
38. American Society of Radiologic Technologists (ASRT). Medication injection through existing vascular access. http://www.asrt.org/docs/default-source/practice-standards-published/ps_medication-injectionsthruexvascaccess.pdf?sfvrsn=2.
39. American Society of Radiologic Technologists (ASRT). Medication injection by radiologic technologists. http://www.asrt.org/docs/default-source/practice-standards-published/ps_medicationinjectionsbyrts.pdf?sfvrsn=2.
40. 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.
41. American Society of Radiologic Technologists (ASRT). ASRT position statements: opposition to uncertified or unlicensed individuals. http://www.asrt.org/docs/default-source/governance/hodpositionstatements.pdf?sfvrsn=10. Published June 2015.
42. Quarello F, Bonello F, Boero R, et al. CAPD in a large population: a 7-year experience. *Adv Perit Dial*. 1989;5:56-62.
43. American Association for Respiratory Care (AARC) [position statement]. Respiratory care scope of practice http://c.aarc.org/resources/position_statements/documents/dop.pdf.
44. 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.

4. INFUSION TEAM

Standard

4.1 The infusion team is structured through its scope of service to meet patient and organizational needs for safe, effective, and high-quality infusion therapy.

Practice Criteria

A. Assign vascular access device (VAD) insertion and/or VAD management and surveillance only to individuals and/or teams with infusion therapy education, training, and validated competency.[1-7] (I)
B. Recognize that:
   1. A designated infusion team that is accountable for inserting short peripheral catheters increases the success rate for cannulation on the first attempt and decreases hospital-acquired bloodstream infections, local site infections, occlusions, and accidental removals.[6-12] (V)
   2. A designated infusion team that is accountable for managing VADs, including daily assessment, dressing changes, and/or access, decreases catheter-associated bloodstream infections and related costs, phlebitis and infiltration, and increases patient satisfaction.[7,13-20] (IV)
   3. An infusion team is a resource for infusion therapy product evaluation, education, and standardized evidence-based practices.[7,9-11,13,15-17,21-25] (V)
C. Collect, monitor, and report quality outcome and process data for an infusion team scope of service to evaluate team effectiveness, patient safety, adherence to best practices, and patient satisfaction, including, but not limited to, first-attempt success on cannulation and time-to-VAD insertion once ordered. In collaboration with the infection prevention team, collect, monitor, and report quality outcome data for VAD dwell time, reasons for removal, and complications such as phlebitis, infiltration/extravasation, thrombosis, and catheter-associated bloodstream infection.[8-11,15,17,21,23,24,26-29] (IV)
D. Consider establishing or maintaining an infusion team for central vascular access device (CVAD) insertion, management, and removal.[14,15,17,24,25,27-33] (IV)

REFERENCES

Note: All electronic references in this section were accessed September 15, 2015.

1. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
2. Ramritu P, Halton K, Cook D, Whitby M, Graves N. Catheter-related bloodstream infections in intensive care units: a systematic review with meta-analysis. *J Adv Nurs*. 2008;62(1):3-21.
3. Semelsberger CF. Educational interventions to reduce the rate of central catheter-related bloodstream infections in the NICU: a review of the research literature. *Neonatal Network*. 2009;28(6):391-395.
4. Agnihotri V. *Economic Impact of an Intravenous Team in Reducing Central Line-Associated Bloodstream Infections* [dissertation]. Wayne, NJ: William Paterson University of New Jersey; 2014.
5. 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.
6. Lee WL, Chen HL, Tsai TY, et al. Risk factors for peripheral intravenous catheter infection in hospitalized patients: a prospective study of 3165 patients. *Am J Infect Control*. 2009;37(8):683-686.
7. Ahmed SS, McCaskey MS, Bringman S, Eigen H. Catheter-associated bloodstream infection in the pediatric intensive care unit: a multidisciplinary approach. *Pediatr Crit Care Med*. 2012;13(2):e69-e72.
8. Carr PJ, Glynn RW, Dineen B, Kropmans TJB. A pilot intravenous cannulation team: an Irish perspective. *Br J Nurs*. 2010;19(10):S19-S27.
9. da Silva GA, Priebe S, Dias FN. Benefits of establishing an intravenous team and the standardization of peripheral intravenous catheters. *J Infus Nurs*. 2010;33(3):156-160.
10. Jackson A. Development of a trust-wide vascular access team. *Nurs Times*. 2007;103(44):28-29.
11. O'Connor I, Wilks M, Hennessy E, Millar M. Control of vascular access device associated bloodstream infection in a large London teaching hospital. *J Infect Prev*. 2012;13(3):79-83.

12. 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.
13. Brunelle D. Impact of a dedicated infusion therapy team on the reduction of catheter-related nosocomial infections. *J Infus Nurs*. 2003;26(6):362-366.
14. Guerin K, Wagner J, Rains K, Bessesen M. Reduction in central line-associated bloodstream infections by implementation of a post-insertion care bundle. *Am J Infect Control*. 2010;38(6):430-433.
15. Hawes M. A proactive approach to combating venous depletion in the hospital setting. *J Infus Nurs*. 2007;30(1):33-44.
16. Holzmann-Pazgal G, Kubanda G, Davis K, Khan AM, Brumley K, Denson SE. Utilizing a line maintenance team to reduce central-line-associated bloodstream infections in a neonatal intensive care unit. *J Perinatol*. 2011;32(4):281-286.
17. Pitts S. Retrospective analysis of a pediatric vascular access program and clinical outcomes. *J Assoc Vasc Access*. 2013;18(2):114-120.
18. Secola R, Azen C, Lewis MA, et al. A crossover randomized prospective pilot study evaluating a central venous catheter team in reducing catheter-related bloodstream infections in pediatric oncology patients. *J Pediatr Oncol Nurs*. 2012;29(6):307-315.
19. Wagner J. Impact of a dedicated IV team. *Crit Care Nurs*. 2009;29(2):e12-e13.
20. Rutledge D, Orr M. Effectiveness of intravenous therapy teams. *Online J Clin Innovat*. 2005;8(2):1-24.
21. Bolton D. Writing a business case for the expansion of service: expanding the IV therapy team, from start to finish. *J Infect Prev*. 2009;10:S27-S32.
22. Caguioa J, Pilpil F, Greensitt C, Carnan D. HANDS: standardised intravascular practice based on evidence. *Br J Nurs*. 2012;21(14):S4, S6, S8-S11.
23. Harpel J. Best practices for vascular resource teams. *J Infus Nurs*. 2013;36(1):46-50.
24. Kelly L. Crossing professional boundaries: nurse-led catheter insertion. *Nurs Manage*. 2009;16(6):32-37.
25. Schultz TR, Durning S, Niewinski M, Frey AM. A multidisciplinary approach to vascular access in children. *J Spec Pediatr Nurs*. 2006;11(4):254-256.
26. Hadaway L. Development of an infusion alliance. *J Infus Nurs*. 2010;33(5):278-290.
27. Lisova K, Paulinova V, Zemanova K, Hromadkova J. Experiences of the first PICC team in the Czech Republic. *Br J Nurs*. 2015;24(2):S4, S6, S10.
28. Krein SL, Kuhn L, Ratz D, Chopra V. Use of designated nurse PICC teams and CLASBI prevention practices among US hospitals: a survey based study. *J Patient Safety*. 2015 NOV10. [Epub ahead of print].
29. Alexandrou E, Spencer TR, Frost SA, Parr MJ, Davidson PM, Hillman KM. A review of the nursing role in central venous cannulation: implications for practice policy and research. *J Clin Nurs*. 2010;19(11-12):1485-1494.
30. Swayze SC, James A. The unfamiliar catheter. AHRQ Web site. http://webmm.ahrq.gov/case.aspx?caseID=294.
31. Feil M. Reducing risk of air embolism associated with central venous access devices. *PA Saf Advis*. 2012;9(2):58-64. http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2012/Jun;9(2)/Pages/58.aspx.
32. Hadaway L, Dalton L, Mercanti-Erieg L. Infusion teams in acute care hospitals: call for a business approach—an Infusion Nurses Society white paper. *J Infus Nurs*. 2013;36(5):356-360.
33. Walker G, Todd A. Nurse-led PICC insertion: is it cost effective? *Br J Nurs*. 2013;22(19):S9-S15.

5. COMPETENCY ASSESSMENT AND VALIDATION

Standard

5.1 As a method of public protection to ensure patient safety, the clinician is competent in the safe delivery of infusion therapy and vascular access device (VAD) insertion and/or management within her or his scope of practice.
5.2 The clinician is responsible and accountable for attaining and maintaining competence with infusion therapy administration and VAD insertion and/or management within her or his scope of practice.
5.3 Competency assessment and validation is performed initially and on an ongoing basis.
5.4 Competency validation is documented in accordance with organizational policy.

Practice Criteria

A. Accept individual responsibility for becoming competent and maintaining continued clinical competence.
   1. Competence goes beyond psychomotor skills and includes application of knowledge, critical thinking, and decision-making abilities.
   2. Competency requires a commitment to lifelong learning, self-reflection, and professional ethics.[1,2] (IV)

B. Use a standardized approach to competency assessment and validation across the health care system to accomplish the goal of consistent infusion practices.
   1. Identify and develop competency assessment programs that empower clinicians for educational growth and staff development.
   2. Link continuing competency assessment programs to meet patient needs and improve clinical outcomes.
   3. Establish transparency in the process of assessing competency and the requirements for judging competency.
   4. Collaborate with professional development staff.
   5. Acknowledge the imbalance of power when a manager acts as the competency validator.[1-5] (IV)

C. Validate clinician competency by documenting the knowledge, skills, behaviors, and ability to perform the assigned job.
   1. Validate initial competency before providing patient care (eg, use of simulation, case studies, written tests), when the scope of practice changes, and with the introduction of new procedures, equipment, or technology.

2. Validate continuing competency on an ongoing periodic basis. Frequency of ongoing competency validation is determined by the organization based on the associated risk and known problems, concerns, and outcomes within the organization.[2,6,7] (IV)

D. Identify procedures/skills/tasks for ongoing competency validation by using clinical outcome data; adverse events, serious safety events, and sentinel events; changing patient populations served; and patient satisfaction data.
   1. Prioritize the specific tasks for competency assessment by the frequency of performing those tasks and the risks associated with the tasks. Low-frequency tasks are performed less often (eg, less than weekly). High-risk tasks include invasive procedures with the potential to be harmful or even life threatening to the patient. Problem-prone tasks include those that are documented to produce issues for the patient, staff, or organization.[6,8] (V)

E. Perform a gap analysis to identify educational and/or performance needs for each group of clinicians based on their profession or occupation and their stage of development in their role (ie, novice, advanced beginner, competent, proficient, or expert).[1,7,9-13] (IV)

F. Employ multiple methods to deliver education (eg, lecture, reading materials, simulations, self-study), repeated over time and combined with outcome monitoring and feedback to increase their impact on professional behavior.[9,14] (II)

G. Use evidence and national standards to establish competencies for clinicians providing infusion therapy. Achieving and maintaining board certification (ie, CRNI®) is one method for documenting continuing competence. Include the following aspects of infusion therapy as appropriate:
   1. Technology and clinical application
   2. Fluid and electrolyte balance
   3. Pharmacology
   4. Infection prevention
   5. Special patient populations
   6. Transfusion therapy
   7. Antineoplastics and biologic therapy
   8. Parenteral nutrition[2,15,16] (IV)

H. Expansion of practice to include specialized skills (eg, central vascular access device [CVAD] insertion, antineoplastic administration) requires multiple components of initial competency assessment and validation including:
   1. Evaluation of prior clinical experience related to the specialized skill to determine readiness to learn.
   2. Obtaining the necessary knowledge and critical thinking.
   3. Skill practice in a simulation lab with assistance from a qualified instructor.
   4. Clinical performance with the procedure under supervision until an objective level of competency has been reached (ie, all steps performed successfully). There is no set number of times for performing a procedure that will ensure competency.[17-20] (IV)

I. Enhance the reliability of outcomes of competency assessment by using a combination of different measurement techniques:
   1. Use self-assessment processes to promote self-efficacy and confidence levels.
   2. Use written tests to assess knowledge.
   3. Use clinical scenarios to assess critical thinking skills.
   4. Assess psychomotor skills in a simulation laboratory using multiple methods. Peer evaluation and self-assessment of video-recorded performance reduces stress and anxiety and encourages confidence before observation by the assessor. These methods are beneficial for novice learners, for skills clinically performed on an infrequent basis, or when observation of performance in the work environment is not practical.
   5. Observe performance of knowledge and skills in the work environment as the preferred method for invasive infusion therapy procedures.
   6. Include professional activities, such as presentations at seminars and conferences, maintaining national board certification, publishing in a scholarly journal, conducting clinical research, and portfolio development.
   7. Associate performance appraisals with competency assessment.[2,21-23] (IV)

J. Establish clear performance expectations for contracted clinician competencies (eg, VAD insertion):
   1. Obtain documentation of competency for contracted clinicians.[6,24] (V)
   2. Document compliance of contracted clinicians with the organization's requirements for staff qualifications, personnel practices, and clinical policies and procedures.[6,24] (V)
   3. Ensure supervision of contracted staff learning new procedures within the organization. (V, Committee Consensus)
   4. Use a consistent process to manage contracted staff and monitor outcomes produced by contracted staff.[6,24] (V)

K. Do not perform invasive procedures (eg, venipuncture) on peers due to health risk and the physical and emotional stress created for the volunteer.[25,26] (V)

L. Develop qualifications for the role of competency assessor.
   1. The person assessing the performance of clinicians should be competent with the skill being assessed.

2. Assessors should provide services in an unbiased and objective manner.
3. Equalize the balance of power between the assessor and the clinician being assessed by emphasizing the educational aspects of competency assessment. Managers should *not* serve in the role of competency assessor as this could shift the focus to performance issues.[3,27] (IV)

M. Validate performance using well-designed forms or checklists that focus on objective, measurable assessment of the actual performance. Data on the validity and reliability of specific forms are limited.
1. Include the following in a competency form or checklist: the competency statement, specific performance criteria statements, or critical behaviors; the method of demonstrating performance; the criteria for achieving success; and the signature of the assessor.[5] (V)
2. Formats for the form include a simple met/unmet process, using a global rating scale (ie, Likert scale), or a detailed checklist of major and minor steps in the procedure/skill/task.[28,29] (II)
3. There is no consensus on grading the individual's performance, such as what percentage of performance constitutes competency or when remediation is required.[28,29] (II)

N. Incorporate competency for specific patient populations based on age. Age-based competency will address needs by chronological, functional, or life-stage groups, including physical and psychological development needs and patient educational requirements.[6] (V)

O. Facilitate culturally competent health care by identifying and addressing the needs of ethnically diverse patient populations and validating clinician competency to meet those needs. Cultural competency includes health care-related beliefs and values, prevalent diseases in populations served, religious practices, language and literacy issues, and family-based needs. There is no uniformity in defining cultural competency and no consensus on how to develop, implement, and evaluate cultural competency interventions.[6,30] (IV)

REFERENCES

1. Woody G, Davis BA. Increasing nurse competence in peripheral intravenous therapy. *J Infus Nurs*. 2013;36(6):413-419.
2. Levine J, Johnson J. An organizational competency validation strategy for registered nurses. *J Nurses Prof Dev*. 2014;30(2): 58-65.
3. Cusack L, Smith M. Power inequalities in the assessment of nursing competency within the workplace: implications for nursing management. *J Contin Educ Nurs*. 2010;41(9):408-412.
4. Wilkinson CA. Competency assessment tools for registered nurses: an integrative review. *J Contin Educ Nurs*. 2013;44(1): 31-37.
5. Carreon N, Sugarman C, Beener E, Agan D. Creating and standardizing annual chemotherapy competencies throughout a healthcare system. *J Nurs Prof Dev*. 2015;31(1):35-39.
6. Joint Commission Resources. *Assessing Hospital Staff Competence*. 2nd ed. Oakbrook Terrace, IL: Joint Commission Resources; 2007.
7. Martel D. Infusion therapy in the home care setting: a clinical competency program at work. *Home Healthc Nurse*. 2012;30(9):506-514.
8. McAdams C, Montgomery K. Narrowing the possibilities: using quality improvement tools to decrease competence assessment overload. *J Nurs Staff Dev*. 2003;19(1):40-46.
9. Cherry MG, Brown JM, Neal T, Ben Shaw N. What features of educational interventions lead to competence in aseptic insertion and maintenance of CV catheters in acute care? BEME guide no. 15. *Med Teach*. 2010;32(3):198-218.
10. Berman A, Beazley B, Karshmer J, et al. Competence gaps among unemployed new nursing graduates entering a community-based transition-to-practice program. *Nurse Educ*. 2014;39(2): 56-61.
11. Small A, Okungu LA, Joseph T. Continuing education for patient care technicians: a unit-based, RN-led initiative. *Am J Nurs*. 2012;112(8):51-55.
12. Cicolini G, Simonetti V, Comparcini D, et al. Nurses' knowledge of evidence-based guidelines on the prevention of peripheral venous catheter-related infections: a multicentre survey. *J Clin Nurs*. 2014;23(17-18):2578-2588.
13. Bianco A, Coscarelli P, Nobile CG, Pileggi C, Pavia M. The reduction of risk in central line-associated bloodstream infections: knowledge, attitudes, and evidence-based practices in health care workers. *Am J Infect Control*. 2013;41(2):107-112.
14. 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.
15. 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. St Louis, MO: Saunders/Elsevier; 2010;1-9.
16. Alexander M, Corrigan A, Gorski L, Phillips L, eds. *Core Curriculum for Infusion Nursing*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014.
17. Andam R, Silva M. A journey to pediatric chemotherapy competence. *J Pediatr Nurs*. 2008;23(4):257-268.
18. Huang GC, Newman LR, Schwartzstein RM, et al. Procedural competence in internal medicine residents: validity of a central venous catheter insertion assessment instrument. *Acad Med*. 2009;84(8):1127-1134.
19. 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.
20. Barsuk JH, Cohen ER, Potts S, et al. Dissemination of a simulation-based mastery learning intervention reduces central line-associated bloodstream infections. *BMJ Qual Saf*. 2014;23(9): 749-756.
21. DeBourgh GA. Psychomotor skills acquisition of novice learners: a case for contextual learning. *Nurse Educ*. 2011;36(4): 144-149.

22. Tyler S, Bourbon E, Cox S, et al. Clinical competency, self-efficacy, and job satisfaction: perceptions of the staff nurse. *J Nurses Prof Dev*. 2012;28(1):32-35.
23. Lakanmaa RL, Suominen T, Perttilä J, Ritmala-Castrén M, Vahlberg T, Leino-Kilpi H. Basic competence in intensive and critical care nursing: development and psychometric testing of a competence scale. *J Clin Nurs*. 2014;23(5-6):799-810.
24. Thongkhong-Park P. Second generation contracted services tracer in a hospital. *Joint Commission: The Source*. 2012;9(11):4-10.
25. 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), Article 8.
26. Hilton P, Barrett D. An investigation into students' performance of invasive and non-invasive procedures on each other in classroom settings. *Nurse Educ Pract*. 2009;9(1):45-52.
27. Levett-Jones T, Gersbach J, Arthur C, Roche J. Implementing a clinical competency assessment model that promotes critical reflection and ensures nursing graduates' readiness for professional practice. *Nurse Educ Pract*. 2011;11(1):64-69.
28. Morris MC, Gallagher TK, Ridgway PF. Tools used to assess medical students competence in procedural skills at the end of a primary medical degree: a systematic review. *Med Educ Online*. 2012;17:1-7.
29. Evans LV, Dodge KL. Simulation and patient safety: evaluative checklists for central venous catheter insertion. *Qual Saf Health Care*. 2010;19(suppl 3):i42-i46.
30. Truong M, Paradies Y, Priest N. Interventions to improve cultural competency in healthcare: a systematic review of reviews. *BMC Health Serv Res*. 2014;14(1):99.

6. QUALITY IMPROVEMENT

Standard

6.1 The clinician participates in quality improvement activities advancing safety and excellence in infusion therapy.
6.2 Quality improvement programs include the surveillance, aggregation, analysis, and reporting of infection; infection prevention practices; morbidity and mortality rates associated with infections; and both infusion-related patient quality indicators and adverse events to minimize health care-associated infections related to infusion therapy with clinicians taking action as needed to improve practice, processes, and/or systems.

Practice Criteria

A. Foster a just culture and individual accountability through a focus on improving systems and processes by clinicians and leaders.[1-4](IV)
B. Participate regularly in quality improvement activities such as:
   1. Using 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).
   2. Identifying clinical quality indicators and their benchmarks, such as central line-associated bloodstream infection (CLABSI), catheter-related bloodstream infection (CR-BSI), reasons for removal of a vascular access device (VAD), or number of attempts for VAD insertion.
   3. Collecting data, analyzing, and evaluating outcomes against benchmarks for areas of improvement.
   4. Comparing outcomes to national databases.
   5. Evaluating and reporting quality and safety indicator outcomes, including near misses, errors, and adverse events to identify areas for improvement.
   6. Recommending and implementing changes in structures or processes based on data.
   7. Using cost analysis, cost-effectiveness, and other methods as indicated.
   8. Minimizing and eliminating barriers to change and improvement.
   9. Sharing improvements gained through these processes with other clinicians internally and externally.[5-27] (II)
C. Analyze infusion therapy practice processes and outcomes to determine when remediation, additional education, or other performance improvement action is needed for clinician(s).[28-32] (V)
D. Evaluate the incidence of CLABSI regularly by:
   1. Using surveillance methods and definitions that are consistent and permit comparison to benchmark data as well as reviewing each case for root cause.
   2. Comparing rates to historical internal data and external national rates (eg, National Healthcare Safety Network).
   3. Reporting results regularly to clinicians and leadership.
   4. Reporting as mandated by state and federal requirements to external quality initiatives or state programs.[17,33-41] (II)
   5. Using a standard formula:

$$\frac{\text{Number of BSIs in patients with central lines}}{\text{Total number of central line days}} \times 1000 = \text{CLABSI Rate}$$

E. Evaluate adverse events from peripheral catheters regularly for infiltration, phlebitis, and/or bloodstream infection in identified populations through incidence, point prevalence, reports from electronic medical records, or International Classification of Diseases (ICD) codes by:
   1. Using surveillance methods and definitions that are consistent and permit comparison to benchmark data.[42-49](III)

2. Comparing rates to historical internal data and when possible to external national rates.[42,44,46-48] (III)
3. Reporting results regularly to clinicians and leadership.[42,44,45,47] (IV)
4. Monitor infiltration rates related to peripheral catheters in neonates and children less than 18 years of age considering a standard formula that is clinically feasible.[45,46,49-53] (III)

$$\frac{\text{Number of infiltration incidents}}{\text{Total number of peripheral catheter line days in neonates \&/or children}} \times 1000 = \text{infiltration rate}$$

$$\frac{\text{Number of infiltration incidents}}{\text{Total number of peripheral catheters in neonates \&/or children}} \times 100 = \%\ \text{infiltration}$$

5. Monitor phlebitis rates related to peripheral catheters using a consistent, standard, and clinically feasible calculation, which may be reported as a phlebitis rate based on point prevalence of peripheral short catheters.[8,48,54-56] (III)

$$\frac{\text{Number of phlebitis incidents}}{\text{Total number of peripheral catheters}} \times 100 = \%\ \text{peripheral phlebitis}$$

6. Consider monitoring bloodstream infection rates for peripheral catheters, or vascular catheter-associated infections (peripheral), regularly.[43,57,58] (IV)

F. Analyze technology analytics, such as smart pumps and bar-code medication administration, for errors, overrides, and other alerts so that improvements may be considered.[59,60] (V)

REFERENCES

Note: All electronic references in this section were accessed September 15, 2015.

1. Institute of Medicine. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academies Press; 2001;111-144, 231-308.
2. Wachter RM. Accountability. In: *Understanding Patient Safety*. 2nd ed. New York, NY: McGraw-Hill Medical; 2012: 341-356.
3. Wachter RM. Personal accountability in healthcare: searching for the right balance. *BMJ Qual Saf*. 2013;22(2):176-180.
4. Thompson C, Pulleyblank R, Parrott S, Essex H. The cost-effectiveness of quality improvement projects: a conceptual framework, checklist and online tool for considering the costs and consequences of implementation-based quality improvement [published online July 23, 2015]. *J Eval Clin Pract*. http://onlinelibrary.wiley.com/doi/10.1111/jep.12421/pdf.
5. Agency for Healthcare Research and Quality. National quality measures clearinghouse. http://www.qualitymeasures.ahrq.gov/index.aspx.
6. Cronrath P, Lynch TW, Gilson LJ, et al. PCA oversedation: application of healthcare failure mode effect (HFMEA) analysis. *Nurs Econ*. 2011;29(2):79-87.
7. DesHarnais SI. The outcome model of quality. In: Sollecito WA, Johnson JK, eds. *McLaughlin and Kaluzny's Continuous Quality Improvement in Healthcare*. 4th ed. Burlington, MA: Jones & Bartlett Learning; 2013:155-180.
8. Fakih MG, Jones K, Rey JE, Berriel-Cass D, Kalinicheva T, Saravolatz LD. Sustained improvements in peripheral venous catheter care in non-intensive care units: a quasi-experimental controlled study of education and feedback. *Infect Control Hosp Epidemiol*. 2012;33(5):449-455.
9. Feil M. Reducing risk of air embolism associated with central venous access devices. *PA Patient Saf Advis*. 2012;9(2):58-64. http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2012/Jun;9(2)/Pages/58.aspx.
10. 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.pub7.
11. 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.
12. Institute of Medicine. *Health Professions Education: A Bridge to Quality*. Washington, DC: National Academies Press; 2003.
13. 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.
14. Kelly DL, Johnson SP, Sollecito WA. Measurement, variation, and CQI tools. In: Sollecito WA, Johnson JK, eds. *McLaughlin and Kaluzny's Continuous Quality Improvement in Healthcare*. 4th ed. Burlington, MA: Jones & Bartlett Learning; 2013: 77-116.
15. McLaughlin CP, Kibbe DC. The role of health information technology in quality improvement: from data to decisions. In: Sollecito WA, Johnson JK, eds. *McLaughlin and Kaluzny's Continuous Quality Improvement in Healthcare*. 4th ed. Burlington, MA: Jones & Bartlett Learning; 2013:335-369.
16. Muller R. Bull's eye! Hitting the financial knowledge target. *Nurs Manage*. 2013;44(10):53-55.
17. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
18. Ogrinc GS, Headrick LA, Moore SM, Barton AJ, Dolansky MA, Madigosky WS. *Fundamentals of Health Care Improvement: A Guide to Improving Your Patients' Care*. 2nd ed. Oak Brook, IL: Joint Commission Resources; 2011:1-156.
19. Perucca R. Financial analysis for the infusion alliance. *J Infus Nurs*. 2010;33(5):304-309.
20. Poole S. Infusion alliances: benchmarking and data collection. *J Infus Nurs*. 2010;33(5):310-315.
21. Render ML, Hasselbeck R, Freyberg RW, Hofer TP, Sales AE, Almenoff PL; VA ICU Clinical Advisory Group. Reduction of central line infections in Veterans Administration intensive care units: an observational cohort using a central infrastructure to support learning and improvement. *BMJ Qual Saf*. 2011;20(8):725-732.
22. Smulders CA, van Gestel JP, Bos AP. Are central line bundles and ventilator bundles effective in critically ill neonates and children? *Intensive Care Med*. 2013;39(8):1352-1358.

23. The Joint Commission. Preventing central line-associated bloodstream infections: a global challenge, a global perspective. http://www.jointcommission.org/preventing_clabsi. Published May 2012.
24. van den Bosch CM, Hulscher ME, Natsch S, Gyssens IC, Prins JM, Geerlings SE; Dutch Sepsis QI Expert Panel. Development of quality indicators for antimicrobial treatment in adults with sepsis. *BMC Infect Dis*. 2014;14:345.
25. VA National Center for Patient Safety. Healthcare failure mode and effect analysis (HFMEA). http://www.patientsafety.va.gov/professionals/onthejob/hfmea.asp. Published July 2014.
26. Wachter RM. Safety, quality, and value. In: *Understanding Patient Safety*. 2nd ed. New York, NY: McGraw-Hill Medical; 2012:33-54.
27. Wickman M, Drake D, Heilmann H, Rojas R, Jarvis C. QI: nursing's "evolving responsibility." *Nurs Manage*. 2013;44(10):30-37.
28. American Society of Radiologic Technologists (ASRT). *Medication Injection Through Existing Vascular Access*. Albuquerque, NM: ASRT; 2012.
29. American Society of Radiologic Technologists (ASRT). *Medication Injection by Radiologic Technologists*. Albuquerque, NM: ASRT; 2012.
30. Barnes TA, Kacmarek RM, Kageler WV, Morris MJ, Durbin CG. Transitioning the respiratory therapy workforce for 2015 and beyond. *Respir Care*. 2011;56(5):681-690.
31. Lu MC, Yu S, Chen IJ, Wang KW, Wu HF, Tang FI. Nurses' knowledge of high-alert medications: a randomized controlled trial. *Nurse Educ Today*. 2013;33(1):24-30.
32. National Highway Traffic Safety Administration. National EMS Scope of Practice Model. In: Administration NHTS, ed: US Department of Transportation; 2007. https:www.nremt.org/nremt/downloads/scope%of%practice.pdf.
33. Agency for Healthcare Research and Quality. On the comprehensive unit-based safety program (CUSP): stop BSI. The CLABSI elimination toolkit. Tools for reducing central line-associated blood stream infections. http://www.ahrq.gov/sites/default/files/wysiwyg/professionals/education/curriculum-tools/clabsitools/clabsitools.pdf. Published January 2013.
34. Ceballos K, Waterman K, Hulett T, Makic MB. Nurse-driven quality improvement interventions to reduce hospital-acquired infection in the NICU. *Adv Neonatal Care*. 2013;13(3):154-163.
35. Centers for Disease Control and Prevention. National Healthcare Safety Network. Device-associated module BSI: Bloodstream infection event (central line-associated bloodstream infection and non-central line-associated bloodstream infection). http://www.cdc.gov/nhsn/PDFs/pscManual/4PSC_CLABScurrent.pdf. Published January 2015.
36. Choi SW, Chang L, Hanauer DA, et al. Rapid reduction of central line infections in hospitalized pediatric oncology patients through simple quality improvement methods. *Pediatr Blood Cancer*. 2013;60(2):262-269.
37. Kellie SP, Scott MJ, Cavallazzi R, et al. Procedural and educational interventions to reduce ventilator-associated pneumonia rate and central line-associated blood stream infection rate. *J Intensive Care Med*. 2014;29(3):165-174.
38. 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.
39. 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.
40. Rhee Y, Heung M, Chen B, Chenoweth CE. Central line-associated bloodstream infections in non-ICU inpatient wards: a 2-year analysis. *Infect Control Hosp Epidemiol*. 2015;36(4):424-430.
41. Chopra V, Montoya A, Joshi D, et al. Peripherally inserted central catheter use in skilled nursing facilities: a pilot study. *J Am Geriatr Soc*. 2015;63(9):1894-1899.
42. Wachter RM. Healthcare-associated infections. In: *Understanding Patient Safety*. 2nd ed. New York, NY: McGraw-Hill Medical; 2012:167-170.
43. Centers for Medicare and Medicaid Services. ICD-9-CM diagnosis and procedure codes: abbreviated and full code titles. http://www.cms.gov/Medicare/Coding/ICD9ProviderDiagnosticCodes/codes.html. Published 2014.
44. Förberg U, Johansson E, Ygge BM, Wallin L, Ehrenberg A. Accuracy in documentation of peripheral venous catheters in paediatric care: an intervention study in electronic patient records. *J Clin Nurs*. 2012;21(9-10):1339-1344.
45. Jackson A. Retrospective comparative audit of two peripheral IV securement dressings. *Br J Nurs*. 2012;21(suppl 1):S16-S20.
46. Laudenbach N, Carie BA, Klaverkamp L, Hedman-Dennis S. Peripheral IV stabilization and the rate of complications in children: an exploratory study. *J Pediatr Nurs*. 2014;29(4):348-353.
47. 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.
48. Woody G, Davis BA. Increasing nurse competence in peripheral intravenous therapy. *J Infus Nurs*. 2013;36(6):413-419.
49. Yellen M. Reducing IV infiltration with administration of IV contrast. *Commun Nurs Res*. 2013;46:413.
50. Montalvo I. The National Database of Nursing Quality Indicators® (NDNQI®). *Online J Issues Nurs*. 2007;12(3). http://www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANDPeriodicals/OJIN/TableofContents/volume122007/No3Sept07/NursingQualityIndicators.aspx?%3E.
51. de Lima Jacinto A, Avelar A, Pedreira M. Predisposing factors for infiltration in children submitted to peripheral venous catheterization. *J Infus Nurs*. 2011;34(6):391-398.
52. Hetzler R, Wilson M, Hill EK, Hollenback C. Securing pediatric peripheral IV catheters: application of an evidence-based practice model. *J Pediatr Nurs*. 2011;26(2):143-148.
53. 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.
54. Göransson KE, Johansson E. Prehospital peripheral venous catheters: a prospective study of patient complications. *J Vasc Access*. 2012;13(1):16-21.
55. Mestre G, Berbel C, Tortajada P, et al. Successful multifaceted intervention aimed to reduce short peripheral venous catheter-related adverse events: a quasiexperimental cohort study. *Am J Infect Control*. 2013;41(6):520-526.
56. Trinh TT, Chan PA, Edwards O, et al. Peripheral venous catheter-related *Staphylococcus aureus* bacteremia. *Infect Control Hosp Epidemiol*. 2011;32(6):579-583.
57. Hadaway L. Short peripheral intravenous catheters and infections. *J Infus Nurs*. 2012;35(4):230-240.
58. Runyan D, Stern J, Macri I, Stango C, Vacca M, Riddick S. Peripheral IV securement device implementation to reduce phlebitis and associated infections. *Am J Infect Control*. 2011;39(5):e193-e194.

59. 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.
60. Skledar SJ, Niccolai CS, Schilling D, et al. Quality-improvement analytics for intravenous infusion pumps. *Am J Health Syst Pharm*. 2013;70(8):680-686.

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 infusion therapy.
7.2 Organizational policies, procedures, and/or practice guidelines are based on current research findings and best evidence.
7.3 The clinician uses 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.
7.4 The clinician obtains approval for research and research-related activities in accordance with federal regulations, professional standards, and criteria set forth by accrediting agencies and organizational policies and procedures.

Practice Criteria

A. Use evidence-based knowledge and clinical expertise with patient preferences and values to provide effective and safe infusion therapy practice within the patient's and clinician's current situation.[1-7] (V)
B. Actively participate in critically evaluating, interpreting, synthesizing, and implementing research findings and/or current best evidence into practice, considering the individual'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 quality improvement.[2,6,8-13] (IV)
C. Actively 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 and disseminating research findings to support evidence-based practice initiatives.[5,14-24] (III)
D. Share innovations and knowledge gained through these processes with other clinicians internally and externally.[5,25,26] (I)

REFERENCES

Note: All electronic references in this section were accessed September 15, 2015.

1. Burkhardt MA, Nathaniel AK. Practice issues related to patient self-determination. *Ethics Issues Contemp Nurs*. 4th ed. Stamford, CT: Cengage Learning; 2014:295-328.
2. Hagle M, Taylor B. Evidence-based infusion practice. In: Weinstein S, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2014:245-263.
3. Infusion Nurses Society. Infusion nursing code of ethics. *J Infus Nurs*. 2001;24(4):242-243.
4. Institute of Medicine. *Health Professions Education: A Bridge to Quality*. Washington, DC: National Academies Press; 2003.
5. International Council of Nurses. *Closing the gap: from evidence to action*. Geneva, Switzerland. 2012: 5-7, 20, 39.
6. Melnyk BM, Fineout-Overholt E, Gallagher-Ford L, Kaplan L. The state of evidence-based practice in US nurses: critical implications for nurse leaders and educators. *J Nurs Adm*. 2012;42(9):410-417.
7. Sherwood G, Jones C. Quality improvement in nursing. In: Sollecito WA, Johnson JK, eds. *McLaughlin and Kaluzny's Continuous Quality Improvement in Healthcare*. 4th ed. Burlington, MA: Jones & Bartlett Learning; 2013:485-511.
8. Adams J. Utilizing evidence-based research and practice to support the infusion alliance. *J Infus Nurs*. 2010;33(5):273-277.
9. Green A, Jeffs D, Huett A, et al. Increasing capacity for evidence-based practice through the evidence-based practice academy. *J Contin Educ Nurs*. 2014;45(2):83-90.
10. Hollenbeak C. The cost of catheter-related bloodstream infections: implications for the value of prevention. *J Infus Nurs*. 2011;34(5):309-313.
11. Melnyk BM, Gallagher-Ford L, Long LE, Fineout-Overholt E. The establishment of evidence-based practice competencies for practicing registered nurses and advanced practice nurses in real-world clinical settings: proficiencies to improve healthcare quality, reliability, patient outcomes, and costs. *Worldviews Evid Based Nurs*. 2014;11(1):5-15.
12. Perucca R. Financial analysis for the infusion alliance. *J Infus Nurs*. 2010;33(5):304-309.
13. Toole BM, Stichler JF, Ecoff L, Kath L. Promoting nurses' knowledge in evidence-based practice: do educational methods matter? *J Nurses Prof Dev*. 2013;29(4):173-181.
14. Infusion Nurses Society Web site. Mission. http://www.ins1.org/i4a/pages/index.cfm?pageid=3763.
15. Kelly K, Turner A, Speroni K, McLaughlin M, Guzzetta C. National survey of hospital nursing research, part 2. *J Nurs Adm*. 2013;43(1):18-23.
16. Lyons MG, Phalen AG. A randomized controlled comparison of flushing protocols in home care patients with peripherally inserted central catheters. *J Infus Nurs*. 2014;37(4):270-281.
17. McLaughlin M, Speroni K, Kelly K, Guzzetta C, Desale, S. National survey of hospital nursing research, part 1. *J Nurs Adm*. 2013;43(1):10-17.
18. McLeod MC, Barber N, Franklin BD. Methodological variations and their effects on reported medication administration error rates. *BMJ Qual Saf*. 2013;22(4):278-289.
19. Smith D, Filiatrault P. An assessment of large-volume infusion device use by nurses in preparation for conversion to dose error-reduction software. *J Infus Nurs*. 2013;36(4):280-289.

20. Stevens K, Ovretveit J. Improvement research priorities: USA survey and expert consensus. *Nurs Res Prac*. 2013;2013:article ID 695729.
21. Wilfong D, Falsetti D, McKinnon J, Daniel L, Wan Q. The effects of virtual intravenous and patient simulator training compared to the traditional approach of teaching nurses: a research project on peripheral IV catheter insertion. *J Infus Nurs*. 2011;34(1): 55-62.
22. Wuchner SS. Integrative review of implementation strategies for translation of research-based evidence by nurses. *Clin Nurse Spec*. 2014;28(4):214-223.
23. Zugcic M, Davis JE, Gorski LA, Alexander M. Establishing research priorities for the Infusion Nurses Society. *J Infus Nurs*. 2010;33(3):176-182.
24. Edward KL. A model for increasing appreciation, accessibility and application of research in nursing. *J Prof Nurs*. 2015;31(2): 119-123.
25. Murthy L, Shepperd S, Clarke MJ, et al. Interventions to improve the use of systematic reviews in decision-making by health system managers, policy makers and clinicians. *Cochrane Database Syst Rev*. 2012;(9):CD009401. doi:10.1002/14651858.CD009401.pub2.
26. Wallace J, Byrne C, Clarke M. Making evidence more wanted: a systematic review of facilitators to enhance the uptake of evidence from systematic reviews and meta-analyses. *Int J Evid Based Healthc*. 2012;10(4):338-346.

8. PATIENT EDUCATION

Standard

8.1 The clinician educates the patient, caregiver, and/or surrogate about the prescribed infusion therapy and plan of care including, but not limited to, purpose and expected outcome(s) and/or goals of treatment, infusion therapy administration, infusion device-related care, potential complications, or adverse effects associated with treatment or therapy, and risks and benefits.

8.2 Teaching methods and learning materials are congruent with the skills being taught, incorporate learning theory, and encompass patient and caregiver learning needs.

Practice Criteria

A. Develop an effective 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 and measurable goals.
   2. Engage the patient/caregiver/surrogate in the development of these goals.
   3. Select effective ways to validate appropriate knowledge and skill acquisition for all aspects of infusion delivery that the patient/caregiver/surrogate will be performing.[1-6] (V)

B. Select teaching methods based on an assessment of age, developmental and cognitive level, health literacy, cultural influences, and language preference. Also assess additional factors affecting the patient's, caregiver's and/or surrogate's readiness to learn, such as current stressors, sensory deficits, and functional limitations.[1,2,4] (V)

C. Use educational resources that are understandable and actionable. These elements include consideration of health literacy levels, cultural congruence, primary language, and instructional methods. Avoid medical jargon, and use simple terminology.[1,5,7-11] (IV)
   1. Ensure that Web sites used for patient/caregiver/surrogate education are reputable, usable, and accessible to the learner and incorporate national accessibility standards (ie, meet Federal Section 508 accessibility guidelines and usability guidelines), such as effective use of text, clear navigation, optimizing user experience, and effective page layout and an accessibility statement.[12,13] (III)
   2. 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 and patient engagement; however, there are challenges, including safety, privacy, and misinformation risks.[14] (IV)

D. 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.[1,15,16] (V)

E. Educate patients/caregivers/surrogates about infusion therapy to include, but not limited to:
   1. Proper care of the access device.
   2. Precautions for preventing infection and other complications, including aseptic technique and hand hygiene.
   3. Signs and symptoms to report, 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.
   4. For outpatients and those receiving home infusion therapy, additional education should also include:
      a. Safe storage, maintenance, and disposal of solutions, supplies, and equipment.
      b. Infusion administration as appropriate.
      c. Use and troubleshooting of the electronic infusion device (EID)/infusion system.

d. Signs and symptoms of adverse effects of the therapy prescribed.
e. Prevention of air and catheter embolism and management of the catheter if an embolism is suspected.
f. Prevention of catheter damage, assessment for catheter damage (eg, from scissors), and what immediate actions to take if catheter damage is found.
g. Living with an access device, including activity limitations and protecting the device while performing activities of daily living.[2,3,17-20] (V)

F. Evaluate patient/caregiver/surrogate comprehension and performance at the beginning of infusion therapy and periodically thereafter at established intervals.[1,2,5] (V)

REFERENCES

Note: All electronic references in this section were accessed September 15, 2015.

1. Miller M, Stoeckel P. *Client Education: Theory and Practice*. Sudbury, MA: Jones & Bartlett; 2011.
2. Czaplewski L. Clinician and patient education. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:71-94.
3. McHugh S, Corrigan M, Dimitrov B, et al. Role of patient awareness in prevention of peripheral vascular catheter-related bloodstream infection. *Infect Control Hosp Epidemiol*. 2011;32(1):95-96.
4. Kelo M, Martikainen M, Eriksson E. Patient education of children and their families: nurses' experiences. *Pediatr Nurs*. 2013;39(2):71-79.
5. National Network of Libraries of Medicine. Health literacy. http://nnlm.gov/outreach/consumer/hlthlit.html.
6. Weingart S, Hsieh C, Lane S, Cleary A. Standardizing central venous catheter care by using observations from patients with cancer. *Clin J Oncol Nurs*. 2015;18(3):321-326.
7. Agency for Healthcare Quality and Research. 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). AHRQ publication no. 14-0002-EF. http://www.ahrq.gov/professionals/prevention-chronic-care/improve/self-mgmt/pemat/pemat_guide.pdf. Published November 2013. Updated August 2014.
8. Pilcher J, Flanders S. Who is Billy Ruben? Health literacy and patient education. *Neonatal Network*. 2014;33(3):150-154.
9. 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.
10. Walker J, Gerard PS. Assessing the health literacy levels of patients using selected hospital services. *Clin Nurse Spec*. 2010;24(1):31-37.
11. US Department of Health and Human Services. Healthy People 2020: health communication and information technology. http://www.healthypeople.gov/2020/topics-objectives/topic/health-communication-and-health-information-technology.
12. General Services Administration. Research-based Web design and usability guidelines. http://guidelines.usability.gov.
13. Yadrich D, Fitzgerald S, Werkowitch M, Smith C. Creating patient and family education websites. *Comput Inform Nurs*. 2012;30(1):46-54.
14. Househ M, Borycki E, Kushniruk A. Empowering patients through social media: the benefits and challenges. *Health Inform J*. 2014;20(1):50-58.
15. Peter D, Robinson P, Jordan M, Lawrence S, Casey K, Salas-Lopez D. Reducing readmissions using teach-back. *J Nurs Admin*. 2015;45(1):35-42.
16. Agency for Healthcare Research and Quality. Use the teach-back method: tool #5. http://www.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/literacy-toolkit/healthlit-toolkit2-tool5.html.
17. Anderson M, Ottum A, Zerbel S, Sethi A, Safdar N. Are hospitalized patients aware of the risks and consequences of central-line associated bloodstream infections? *Am J Infect Control*. 2013;41(12):1275-1277.
18. Gorski L, Miller C, Mortlock N. Infusion therapy across the continuum. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:109-126.
19. Perucca R. Peripheral venous access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:456-479.
20. 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.

9. INFORMED CONSENT

Standard

9.1 Obtain informed consent for all invasive procedures and treatments in accordance with local or state laws and organizational policy.
9.2 Informed consent is required for human subject participation in research according to federal rules and regulations.
9.3 The clinician performing the invasive procedure (eg, central vascular access device [CVAD] insertion) facilitates the process and obtains informed consent.
9.4 The clinician confirms that the informed consent process is completed for the defined procedure or treatment.
9.5 The patient or surrogate has the right to accept or refuse treatment.

Practice Criteria

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 licensed independent practitioner (LIP) 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).
3. Continued confirmation of informed consent may be necessary for ongoing treatments (eg, hemodialysis or antineoplastic administration).[1-3] (IV)

B. Follow requirements for obtaining informed consent from the patient/surrogate as regulations vary between jurisdictions (ie, states, provinces, countries). 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. Recognize that there could be condition-based exceptions to requirements for informed consent (eg, emergency/life-threatening situations) and adhere to the organizational policy for managing these situations.[1,2] (IV)

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 understanding 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. The patient/surrogate comprehends the information and can apply it to her or his specific situation.
5. The decision is authorized by the patient/surrogate and documented on the signed form.[2-6] (IV)

D. Facilitate the informed consent process by choosing learning methods most appropriate for the patient's age and level of health literacy.
1. Provide educational materials and the consent document at a reading level between the fourth and sixth grades and in the patient's primary language.
2. Provide information at the most appropriate time considering the effect of anxiety, pain, and other therapeutic interventions on the patient's comprehension.
3. Provide a qualified medical interpreter for non–English-speaking patients and for those who cannot read their primary language.
4. Provide appropriate resources for patients/surrogates who have vision or hearing limitations.
5. Allow sufficient opportunity for the patient/surrogate to ask questions and receive answers.
6. Choose appropriate methods to deliver the information, including verbal and paper-based written information, videos, or computer-based materials.
7. Validate the patient's/surrogate's comprehension of the information by asking the patient/surrogate to recount or "teach-back" the proposed treatment or procedure. Clarify and/or reinforce information as needed.
8. When the patient/surrogate expresses confusion or has further questions, collaborate with the provider about the need for more dialogue.
9. Document the informed consent process by serving as a witness to the patient/surrogate signature on the informed consent document.[2,3,7,8] (IV)

E. For research-informed consent, provide explanations and a consent document that is 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. In addition to the standard components of informed consent, the research 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. Availability of medical treatments if injury occurs.[9-13] (I)

F. Recognize that photographs of patients may or may not require informed consent.
1. 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.
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.[14,15] (IV)

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.[4,6] (IV)

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.[5,16] (V)

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 lack of consensus over the age of assent, this is generally considered 7 years old or school age.[17] (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 medical record.[18,19] (V)

REFERENCES

Note: All electronic references in this section were accessed September 15, 2015.

1. Hall DE, Prochazka AV, Fink AS. Informed consent for clinical treatment. *Can Med Assoc J*. 2012;184(5):533-540.
2. Cook WE. "Sign here": nursing value and the process of informed consent. *Plastic Surg Nurs*. 2014;34(1):29-33.
3. Menendez JB. Informed consent: essential legal and ethical principles for nurses. *JONAS Healthc Law Ethics Regul*. 2013;15(4):140-144.
4. Del Carmen MG, Joffe S. Informed consent for medical treatment and research: a review. *Oncologist*. 2005;10(8):636-641.
5. Brooks CL. Considering elderly competence when consenting to treatment. *Holist Nurse Pract*. 2011;25(3):136-139.
6. Fowler MDM, ed. *Guide to the Code of Ethics for Nurses: Development, Interpretation and Application*. 2nd ed. Silver Spring, MD: American Nurses Association; 2015.
7. Paasche-Orlow MK, Taylor HA, Brancati FL. Readability standards for informed-consent forms as compared with actual readability. *New Engl J Med*. 2003;348(8):721-726.
8. Synnot A, Ryan R, Prictor M, Fetherstonhaugh D, Parker B. Audio-visual presentation of information for informed consent for participation in clinical trials. *Cochrane Database Syst Rev*. 2014;(5):CD003717. doi:10.1002/14651858.CD003717.pub3.
9. Coons S. Informed consent forms growing too complex. *Res Pract*. 2012;13:175-187.
10. Erlen JA. Informed consent: revisiting the issues. *Orthop Nurs*. 2010;29(4):276-280.
11. Nishimura A, Carey J, Erwin PJ, Tilburt JC, Murad MH, McCormick JB. Improving understanding in the research informed consent process: a systematic review of 54 interventions tested in randomized control trials. *BMC Med Ethics*. 2013;14(1):14-28.
12. US Food and Drug Administration. CFR—Code of Federal Regulations Title 21 Part 50 Protection of Human Subjects. http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=50&showFR=1&subpartNode=21:1.0.1.1.20.2.
13. World Health Organization (WHO). *Handbook for Good Clinical Research Practice (GCP): Guidance for Implementation*. Geneva, Switzerland: WHO; 2005:59-71.
14. Harting M, DeWees J, Vela K, Khirallah R. Medical photography: current technology, evolving issues and legal perspectives. *Int J Clin Pract*. 2015;69(4):401-409.
15. Kornhaber R, Betihavas V, Baber RJ. Ethical implications of digital images for teaching and learning purposes: an integrative review. *J Multidisciplinary Healthc*. 2015;8:299-305.
16. Johnson-Greene D. Informed consent issues in traumatic brain injury research: current status of capacity assessment and recommendations for safeguards. *J Head Trauma Rehabil*. 2010;25(2):145-150.
17. Waligora M, Dranseika V, Piasecki J. Child's assent in research: age threshold or personalisation? *BMC Med Ethics*. 2014;15(1):44.
18. Thomas L, Viswanathan A, Cochrane TI, et al. Variability in the perception of informed consent for IV-tPA during telestroke consultation. *Frontiers Neurol*. August 27, 2012. doi:3389/fnevr.2012.00129.
19. The Joint Commission. *Rights and Responsibilities of the Individual: Comprehensive Accreditation Manual for Home Care*. Oakbrook Terrace, IL: The Joint Commission; 2015.

10. DOCUMENTATION IN THE MEDICAL RECORD

Standard

10.1 Clinicians document 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. 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 medical 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, and efficiently retrievable.

10.4 Documentation reflects the continuity, quality, and safety of care.

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 state and federal regulations.

Practice Criteria

A. Documentation includes, but is not limited to, the following:
   1. Patient, caregiver, or legally authorized representative's participation in, understanding of, and responses to therapy, interventions, and education.[1,2] (II)
   2. Specific site preparation, infection prevention, and safety precautions taken, using a standardized tool for documenting adherence to recommended practices.[3-5] (IV)
   3. The type, length, and gauge/size of the vascular access device (VAD) inserted; the lot number for all central vascular access devices (CVADs) and implanted devices.[6-8] (V)
   4. Date and time of insertion, number of attempts, functionality of device, local anesthetic (if used), and the insertion methodology, including visualization and guidance technologies.[9-10] (V)
   5. Identification of the insertion site by anatomical descriptors, laterality, landmarks, or appropriately marked drawings.[6,8] (V)
   6. For midline catheters and peripherally inserted central catheters (PICCs):
      a. External catheter length and length of catheter inserted.[9] (V)
      b. Arm circumference: before insertion of a PICC and when clinically indicated to assess the presence of edema and possible deep vein thrombosis (DVT). Take this measurement 10 cm above the antecubital fossa; assess for the location and other characteristics such as pitting or nonpitting edema.[11,12] (IV)
      c. Confirmation of the anatomic location of the catheter tip for all CVADs prior to initial use and as needed for evaluation of VAD dysfunction.[9] (V)
   7. Condition of the site, dressing, type of catheter stabilization, dressing change, site care, patient report of discomfort or any pain with each regular assessment of the access site, and patient report of changes related to the VAD or access site.[8,13] (V)
   8. A standardized assessment, with photography as needed and in accordance with organizational policy, appropriate for the specific patient population (eg, age), for phlebitis, infiltration, and extravasation that allows for accurate and reliable assessment on initial identification and with each subsequent site assessment (see Standard 9, *Informed Consent*).[8,14,15] (V)
   9. Type of therapy, drug, dose, rate, time, route, and method of administration; condition of the venipuncture or access site prior to and after infusion therapy.[8,16] (V)
   10. Results of VAD functionality assessment including patency, absence of signs and symptoms of complications, lack of resistance when flushing, and presence of a blood return upon aspiration.[8,16] (V)
   11. Type of equipment used for infusion therapy administration; depending on the setting, accountability for maintenance and replacement of tubing/cassettes as well as identification of caregiver or surrogate for patient support.[12,17] (V)
   12. Pertinent problem or diagnosis, initial and ongoing assessment, and vital signs as appropriate; patient's response to VAD insertion and therapy, including symptoms, side effects, or adverse events with related interventions; laboratory test results as appropriate; barriers to patient education or care; and evaluation of expected outcomes.[8,18,19] (V)
   13. Regular assessment of the need for continuation of the VAD:
      a. Daily for acute inpatient settings.[5,20-22] (IV)
      b. During regular assessment visits in other settings, such as in the home or a skilled nursing facility.[23] (V)
   14. Upon removal: condition of site, condition of the catheter and length, reason for device removal, nursing interventions during removal, dressing applied, patient response, patient education, date/time of removal, and any necessary continuing management for complications.[13,17,24] (V)
   15. If cultures are obtained, document source of culture(s).[17] (V)
   16. When multiple VADs or catheter lumens are used, documentation should clearly indicate what solutions and medications are being infused through each device or lumen.[8,17] (V)

B. Documentation of all infusion therapy, clinicians' actions, and patient responses should be completed in an electronic health record or other electronic health information system, if available, using standardized terminologies.[25-29] (IV)
   1. Electronic entries should reflect current patient status, even when an entry is pulled from another location in the medical record.[14,30] (IV)
   2. Standardized templates for documentation of required elements of care should be used but without limiting further description as needed.[14,30,31] (IV)
   3. The electronic medical record should capture data for quality improvement without additional documentation from clinicians.[14] (V)

REFERENCES

Note: All electronic references in this section were accessed September 16, 2015.

1. Jefferies D, Johnson M, Griffiths R. A meta-study of the essentials of quality nursing documentation. *Int J Nurs Pract*. 2010;16(2):112-124.
2. Wang N, Hailey D, Yu P. Quality of nursing documentation and approaches to its evaluation: a mixed-method systematic review. *J Adv Nurs*. 2011;67(9):1858-1875.
3. Aziz AM. Improving peripheral IV cannula care: implementing high-impact interventions. *Br J Nurs*. 2009;18(20):1242-1246.
4. Fakih MG, Jones K, Rey JE, Berriel-Cass D, Kalinicheva T, Saravolatz LD. Sustained improvements in peripheral venous catheter care in non-intensive care units: a quasi-experimental controlled study of education and feedback. *Infect Control Hosp Epidemiol*. 2012;33(5):449-455.
5. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
6. Ahlqvist M, Berglund B, Wiren M, Klang B, Johansson E. Accuracy in documentation: a study of peripheral venous catheters. *J Clin Nurs*. 2009;18(13):1945-1952.
7. Bullock-Corkhill M. Central venous access devices: access and insertion. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:480-494.
8. Dugger B. Documentation. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:540-549.
9. Hagle ME, Cook A. Central venous access. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:335-390.
10. Hagle ME, Mikell M. Peripheral venous access. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:303-334.
11. 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.
12. Gorski L, Perucca R, Hunter MR. Central venous access devices: care, maintenance, and potential complications. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:495-515.
13. American Nurses Association (ANA). *ANA's Principles for Nursing Documentation: Guidance for Registered Nurses*. Silver Spring, MD: ANA; 2010.
14. Kuhn T, Basch P, Barr M, Yackel T; for the 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.
15. Phillips LD, Gorski LA. Professional practice concepts for infusion therapy. In: *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014:540-611.
16. Perucca R. Peripheral venous access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:456-479.
17. Gorski L, Miller C, Mortlock N. Infusion therapy across the continuum. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:109-126.
18. Alfaro-LeFevre R. *Applying Nursing Process: A Tool for Critical Thinking*. New York, NY: Wolters Kluwer/Lippincott Williams & Wilkins; 2010:195-208.
19. French KS. Transforming nursing care through health literacy ACTS. *Nurs Clin North Am*. 2015;50(1):87-98.
20. New KA, Webster J, Marsh NM, Hewer B. Intravascular device use, management, documentation and complications: a point prevalence survey. *Aust Health Rev*. 2014;38(3):345-349.
21. Russell E, Chan RJ, Marsh N, New K. A point prevalence study of cancer nursing practices for managing intravascular devices in an Australian tertiary cancer center. *Eur J Oncol Nurs*. 2014;18(3):231-235.
22. Tiwari MM, Hermsen ED, Charlton ME, Anderson JR, Rupp ME. Inappropriate intravascular device use: a prospective study. *J Hosp Infect*. 2011;78(2):128-132.
23. 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 Nurs*. 2012;35(5):290-292.
24. Guido GW. Documentation and confidentiality. In: *Legal and Ethical Issues in Nursing*. 6th ed. New York, NY: Pearson; 2014:153-187.
25. Englebright J, Aldrich K, Taylor CR. Defining and incorporating basic nursing care actions into the electronic health record. *J Nurs Scholarship*. 2014;46(1):50-57.
26. Kutney-Lee A, Kelly D. The effect of hospital electronic health record adoption on nurse-assessed quality of care and patient safety. *J Nurs Admin*. 2011;41(1):466-472.
27. Nagle LM. Information and knowledge needs of nurses in the 21st century. In: McGonigle D, Mastrian K. *Nursing Informatics and the Foundation of Knowledge*. Burlington, MA: Jones & Bartlett Learning; 2012:147-160.
28. Saranto K, Kinnunen UM, Kivekas E. Impacts of structuring nursing records: a systematic review. *Scand J Caring Sci*. 2014;28(4):629-647.
29. Waneka R, Spetz J. Hospital information technology systems' impact on nurses and nursing care. *J Nurs Admin*. 2010;40(12):509-514.
30. Kelley TF, Brandon DH, Docherty SL. Electronic nursing documentation as a strategy to improve quality of patient care. *J Nurs Scholarship*. 2011;43(2):154-162.
31. Förberg U, Johansson E, Ygge BM, Wallin L, Ehrenberg A. Accuracy in documentation of peripheral venous catheters in paediatric care: an intervention study in electronic patient records. *J Clin Nurs*. 2012;21(9-10):1339-1344.

Section Two: Patient and Clinician Safety

11. ADVERSE AND SERIOUS ADVERSE EVENTS

Standard

11.1 The clinician reports and documents adverse events or serious adverse events (sentinel events) associated with infusion therapy.
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 Criteria

A. Report adverse events or serious adverse events (sentinel events), or the risk thereof (ie, "near misses") associated with vascular access devices (VADs) and/or infusion products/devices and the administration of drugs and biologics, to the licensed independent practitioner (LIP) and appropriate department(s) (eg, risk management [RM], quality improvement) and in accordance with organizational policy.[1-6] (V, Regulatory)
B. Report adverse events associated with drugs, biologics, and infusion devices/products to the US Food and Drug Administration (FDA) through the MedWatch reporting system and/or the Institute for Safe Medication Practices (ISMP). Reports to ISMP are confidentially shared with the FDA and, when applicable, to product vendors to inform them about pharmaceutical labeling, packaging, and nomenclature issues that may cause errors by their design (see Standard 13, *Medication Verification*).[7,8] (V, Regulatory)
C. Use valid and reliable tools to identify and measure adverse events.[2,9,10] (V)
D. Use a standard document developed by legal and risk management personnel to provide objective and specific facts about the adverse event or serious adverse event.[4,5] (V)
E. Immediately investigate serious adverse events 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.[1-6] (V)
    1. Identify cause(s), describe the event, and implement specific strategies and/or actions for improvement that protects patients. An interprofessional approach focuses on systems issues, procedures, human resources, peer and/or clinical review, products/equipment, processes, and training gaps.[1,6] (V)
    2. The clinician actively participates in the development, implementation, and evaluation of the improvement plan.[1,3,6] (V)
    3. Consider using an RCA or other systemic investigation or analysis for complex, recurrent problems and for "near misses."[6] (V)
F. Improve safety within the organization:
    1. Focus on fixing the system(s) and processes, rather than blaming the clinician.
    2. Advocate for teamwork interventions, including training and education (eg, focus on communication, leadership); work redesign (eg, change interactions such as multidisciplinary rounds); and use of structured tools and protocols (eg, handoff communication tools and checklists).
    3. Establish a strong "just culture" that continuously strengthens safety and creates an environment that raises the level of transparency, encourages reporting, empowers the clinician to identify and implement appropriate actions to prevent adverse events and near misses, and promotes quality patient outcomes (see Standard 6, *Quality Improvement*).[1,2,4-6,11-17] (V)
G. Communicate unanticipated outcomes and lessons learned to organizational leadership and clinicians.[1,2,4-6,11-18] (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.[3,19] (V)

REFERENCES

Note: All electronic references in this section were accessed September 16, 2015.

1. The Joint Commission. Sentinel event policy and procedures. http://www.jointcommission.org/sentinel_event_policy_and_procedures/.
2. The Joint Commission. Patient safety systems, 2015. http://www.jointcommission.org/assets/1/8/PSC_for_Web.pdf.
3. National Quality Forum. Patient safety. https://www.qualityforum.org/topics/safety_pages/patient_safety.aspx.
4. American Nurses Association (ANA). *Code of Ethics for Nurses with Interpretive Statements*. Silver Spring, MD: ANA; 2015: 11-12.
5. Sierchio G. Quality management. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:22-48.
6. Alexander M, Corrigan A, Gorski L, Phillips L, eds. *Core Curriculum for Infusion Nursing*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014.
7. Zastrow RL. Root cause analysis in infusion nursing: applying quality improvement tools for adverse events. *J Infus Nurs*. 2015;38(3):225-231.
8. US Food and Drug Administration. MedWatch: the FDA safety information and adverse event reporting program. http://www.fda.gov/Safety/MedWatch/default.htm.
9. Institute for Safe Medication Practices (ISMP). Reporting a medication or vaccine error or hazard to ISMP. https://www.ismp.org/errorReporting/reportErrortoISMP.aspx.
10. Institute for Healthcare Improvement (IHI). Global trigger tool for measuring adverse events. http://www.ihi.org/resources/Pages/Tools/IHIGlobalTriggerToolforMeasuringAEs.aspx.
11. Classen DC, Resar R, Griffith F. Global trigger tool shows that adverse events in hospitals may be ten times greater than previously measured. *Health Aff (Millwood)*. 2011;30(4):581-589.
12. Robert Wood Johnson Foundation. Ten years after keeping patients safe: have nurses' work environments been transformed? *Charting Nursing's Future*. www.rwjf.org/content//dam/farm/reports/issue_briefs/2014/rwjf411417. Published March 2014.
13. Bishop A, Fleming M. Patient safety and engagement at the frontlines of healthcare. *Healthc Qual*. 2014;17:36-40.
14. Tocco S, Blum A. Just culture promotes a partnership for patient safety. *Am Nurse Today*. 2013;8(5). http://www.americannursetoday.com/just-culture-promotes-a-partnership-for-patient-safety.
15. American Nurses Association (ANA). *Nursing Administration: Scope and Standards of Practice*. Silver Spring, MD: ANA; 2009.
16. Hershey K. Culture of safety. *Nurs Clin North Am*. 2015;50(1):139-152.
17. Wu AW, Steckelberg RC. Medical error, incident investigation and the second victim: doing better but feeling worse. *BMJ Qual Saf*. 2012;21(4):267-270.
18. Pham JC, Aswani MS, Rosen M, et al. Reducing medical errors and adverse events. *Annu Rev Med*. 2012;63:447-463.
19. Chamberlain CJ, Koniaris LG, Wu AW, Pawlik TM. Disclosure of "nonharmful" medical errors and other events: duty to disclose. *Arch Surg*. 2012;147(3):282-286.

12. PRODUCT EVALUATION, INTEGRITY, AND DEFECT REPORTING

Standard

12.1 Clinician end users are involved in the evaluation of infusion-related technologies, including clinical application, expected outcomes, performance, infection prevention, safety, efficacy, reliability, and cost.

12.2 Infusion equipment and supplies are inspected for product integrity and functionality before, during, and after use as determined by verification of inspection or expiration date and visual inspection of the product.

12.3 If a product is expired, its integrity compromised, or found defective, the clinician removes it from patient use, labels it as expired or defective, and reports the product expiration or defect according to organizational policies and procedures.

12.4 Product evaluation, integrity, defect reporting, and product recall are in accordance with organizational policies and procedures and with state and federal rules and regulations.

Practice Criteria

A. Include an interprofessional group of direct and indirect clinician end users in product evaluation, and orient and educate clinicians on the new product/device, as well as data collection tools for analysis and ongoing monitoring.[1-5] (V)

B. Obtain reports of internally and externally reported adverse events for the committee/individual managing product evaluation and product procurement.[6-9] (V)

C. Obtain rental or purchased equipment from a properly qualified vendor.[6] (V)

D. Include the following in product defect reporting: suspected and known intrinsic and extrinsic contamination; product damage; product tampering; improper, unclear, or confusing patient or user instructions or labeling; similar or confusing names; packaging problems; and errors related to reliance on color coding (see Standard 13, *Medication Verification*).[7,10-13] (V, Regulatory)

E. Retain the product, product overwrap or packaging, and other identifying information (such as model number, lot number, serial number, expiration date, and unique device identification when available) for further analysis and reporting when a product defect is identified before use.[1,14] (V)

F. Retain serial and lot numbers used in product identification, tracking, and product recall, as well as unique device identification when available, in order to comply with recalls or to file an adverse event report.[7,14] (Regulatory)

G. Include the following information pursuant to US Food and Drug Administration Form 3500A when a product defect results in an adverse event:
   1. Patient information including name, age or date of birth, gender, and weight.
   2. Identification of occurrence, event, or product problem.
   3. Outcomes attributed to the occurrence or event (eg, death or serious injury), defined as disability resulting in permanent impairment of a body function or permanent damage to a body structure, or injury or illness that requires intervention to prevent permanent impairment of a body structure or function.
   4. Date of event.
   5. Date of report by the initial reporter.
   6. Description of event or problem, including a discussion of how the device was involved, nature of the problem, patient follow-up or required treatment, and any environmental conditions that may have influenced the event.
   7. Description of relevant tests and laboratory data, including dates.
   8. Description of other relevant patient history, including preexisting medical conditions.
   9. Device information, including brand name; type of device; manufacturer name and address; expiration date; unique device identifier (UDI) that appears on the label; model number; catalog number; serial number; lot number or other identifying number; date of device implantation; date of device removal; and operator of the device (health professional, patient, lay user, other).
   10. Whether the device was available for evaluation and whether it was returned to the manufacturer.
   11. Concomitant medications and therapy dates.[7] (Regulatory)

H. Use the following prevention strategies in product evaluation to improve safety and reduce preventable adverse events:
   1. Identify patients or conditions associated with higher risk.
   2. Facilitate optimal purchase decisions.
   3. Enable early detection and intervention to address risk factors.[7,15-22] (V)

REFERENCES

Note: All electronic references in this section were accessed September 16, 2015.

1. Miller C. Product selection and evaluation. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:437-446.
2. Kuwabara C, Evora Y, deOliveira M. Risk management in technovigilance: construction and validation of a medical-hospital product evaluation instrument. *Rev Lat Am Enfermagem*. 2010;18(5):943-951.
3. Davis RE, Sevdalis N, Neale G, Massey R, Vincent CA. Hospital patients' reports of medical errors and undesirable events in their health care. *J Eval Clin Pract*. 2013;19(5):875-881.
4. Swayze SC, Rich SE. Promoting safe use of medical devices. *Online J Issues Nurs*. 2011;17(1).
5. Tay S, Spain B, Morandell K, Gilson J, Weinberg L, Story D. Functional evaluation and practice survey to guide purchasing of intravenous cannulae. *BMC Anesthesiol*. 2013;13(1):49.
6. American Society for Health-System Pharmacists. ASHP guidelines on home infusion pharmacy services. *Am J Health Syst Pharm*. 2014;71(4):325-341.
7. US Food and Drug Administration. Medical devices. 3 CFR Title 21. http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=803&showFR=1&subpartNode=21:8.0.1.1.3.3.
8. Stacey S, Coombes I, Wainwright C, Klee B, Miller H, Whitfield K. Characteristics of adverse medication events in a children's hospital. *J Paediatr Child Health*. 2014;50(12):966-971.
9. US Food and Drug Administration. Current postmarket surveillance efforts. http://www.fda.gov/MedicalDevices/Safety/CDRHPostmarketSurveillance/ucm348738.htm. Revised April 1, 2014.
10. US Agency for Healthcare Research and Quality. Patient safety and quality improvement: final rule. 42 CFR part 3. http://www.pso.ahrq.gov/statute/pl109-41.pdf. Published November 21, 2008.
11. US Food and Drug Administration. Medical device safety: recent medical device recalls. http://www.fda.gov/MedicalDevices/Safety/default.htm.
12. ECRI Institute. Alerts tracker. https://www.ecri.org/components/alertstracker/Pages/default.aspx.
13. US Department of Labor. Occupational Safety and Health Administration. Safe medical devices act: medical device reporting for user facilities. 21 USC § 360i (1990).
14. US Food and Drug Administration. Unique device identification (UDI). http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/UniqueDeviceIdentification/default.htm.
15. Brady PW, Varadarajan K, Peterson LE, Lannon C, Gross T. Prevalence and nature of adverse medical device events in hospitalized children. *J Hosp Med*. 2013;8(7):390-393.
16. Emmendorfer T, Glassman PA, Moore V, Leadholm TC, Good CB, Cunningham F. Monitoring adverse drug reactions across a nationwide health care system using information technology. *Am J Health Syst Pharm*. 2012;69(4):321-328.
17. Flewwelling CJ, Easty AC, Vicente KJ, Cafazzo JA. The use of fault reporting of medical equipment to identify latent design flaws. *J Biomed Inform*. 2014;51:80-85.
18. Gibson R. Nursing practice and work environment: designing equipment devices for safety: a role for nursing advocacy. *Am Nurse Today*. 2015;9(11):16.
19. Mattox E. Medical devices and patient safety. *Crit Care Nurse*. 2012;32(4):60-68.
20. 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;15:220-228.
21. Reynolds IS, Rising JP, Coukell AJ, Paulson KH, Redberg RF. Assessing the safety and effectiveness of devices after US Food and Drug Administration approval: FDA-mandated postapproval studies. *JAMA Intern Med*. 2014;174(11):1773-1779.
22. Tsai TT, Box TL, Gethoffer H, et al. Feasibility of proactive medical device surveillance: the VA Clinical Assessment Reporting

and Tracking (CART) program. *Med Care*. 2013;51(3)(suppl 1): S57-S61.

13. MEDICATION VERIFICATION

Standard

13.1 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, expiration date, sterility state, route of administration, frequency, rate of administration, and any other special instructions.
13.2 At least 2 patient identifiers are used to ensure accurate patient identification when administering medications.

Practice Criteria

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 settings) to reduce the risk of medication errors, including omissions, duplications, dosing errors, and drug interactions.[1-6] (IV)
B. Implement special safeguards to reduce the risk of medication errors with high-alert medications such as standardizing storage, preparation, and administration (eg, standard order sets); improving access to drug information; limiting access (stored securely, limited quantities); using supplementary labels and automated alerts; and using automated or independent double checks.[7-11] (IV)
C. Perform an independent double check by 2 clinicians for the organization's selected high-alert medications that pose the greatest risk of harm. Develop a standard process and educate staff in how to perform the double check.[9-13] (IV)
D. Use technology, when available, to verify medications prior to administration. Analyze effectiveness and limitations related to technology through organizational quality improvement processes.
    1. Use of bar-code technology 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 bar-code technology.[14-19] (III)
    2. Use of electronic infusion devices (EIDs) that include dose-error reduction software ("smart pumps") is associated with reduced risk for infusion-related medication errors, including error interceptions (eg, wrong rate) and reduced adverse drug events. Failure to comply with appropriate use, overriding of alerts, and use of the wrong drug library contribute to the risks associated with smart pumps. Regular education and training and assessment of use are recommended for both routine users and new staff members.[20] (II)
E. Use a list of confusing drug names (ie, look-alike, sound-alike) to implement safeguards to reduce the risk for medication errors such as using both generic and brand names; including purpose of medication on label; and changing the appearance of look-alike names by using US Food and Drug Administration (FDA)- and Institute for Safe Medication Practices (ISMP)-approved tall man (mixed case) lettering.[21] (V)
F. Label medications that are prepared and not immediately administered (eg, perioperative, procedural settings) as soon as prepared with the medication name, strength, quantity, diluent/volume, expiration date, and preparer initials. Begin the administration within 1 hour after the start of the preparation or discard (see Standard 17, *Compounding and Preparation of Parenteral Solutions and Medications*).[2,3,22-24] (V, Regulatory)
G. Discard and do not use any medication syringes that are unlabeled unless the medication is prepared at the patient's bedside and immediately administered without a break in the process.[2,3,22,24] (V)
H. Do not use color coding, 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 catheters are connected.[25] (IV)
I. Report adverse events associated with medicines and biologics to the appropriate department within the organization and to the FDA through the MedWatch reporting system and/or ISMP. Reports to ISMP are confidentially shared with the FDA and, when applicable, to product vendors to inform them about pharmaceutical labeling, packaging, and nomenclature issues that may cause errors by their design.[24,26,27] (Regulatory)

REFERENCES

Note: All electronic references in this section were accessed September 16, 2015.

1. Barnsteiner JH. Medication reconciliation. In: Hughes RG, ed. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville, MD: Agency for Healthcare Research and Quality. http://www.ncbi.nlm.nih.gov/books/NBK2648. Published April 2008.
2. The Joint Commission. National patient safety goals: hospital accreditation program. http://www.jointcommission.org/assets/1/6/2015_NPSG_HAP.pdf.

3. The Joint Commission. National patient safety goals: ambulatory health care accreditation program. http://www.jointcommission.org/assets/1/6/2015_NPSG_AHC1.PDF.
4. The Joint Commission. National patient safety goals: home care accreditation program. http://www.jointcommission.org/assets/1/6/2015_NPSG_OME.pdf.
5. The Joint Commission. National patient safety goals: long term care accreditation program. http://www.jointcommission.org/assets/1/6/2015_NPSG_LT2.pdf.
6. Desai R, Williams CE, Greene SB, et al. Medication errors during patient transitions into nursing homes: characteristics and association with patient harm. *Am J Geriatric Pharmacother*. 2011;9(6):413-422.
7. Institute for Safe Medication Practices (ISMP). ISMP list of high alert medications in acute care settings. http://ismp.org/Tools/institutionalhighAlert.asp. Published 2014.
8. Institute for Safe Medication Practices (ISMP). ISMP list of high alert medications in community/ambulatory healthcare. http://ismp.org/communityRx/tools/ambulatoryhighalert.asp. Published 2011.
9. Markert A, Thierry V, Kleber M, et al. Chemotherapy safety and severe adverse events in cancer patients: strategies to efficiently avoid chemotherapy errors in in- and outpatient treatment. *Int J Cancer*. 2008;124(3):722-728.
10. Neuss MN, Polovich M, McNiff K, et al. 2013 updated American Society of Clinical Oncology/Oncology Nursing Society standards including standards for the safe administration and management of oral chemotherapy. *Oncol Nurs Forum*. 2013;40(3):225-233.
11. Ayer P, Adams S, Boullata J, et al. A.S.P.E.N. parenteral nutrition safety consensus recommendations. *J Parenter Enteral Nutr*. 2014;38(3):291-333.
12. Institute for Safe Medication Practices (ISMP). Independent double checks: undervalued and misused. *ISMP Med Saf Alert*. 2102;18(12):1-4. http://www.ismp.org/newsletters/acutecare/showarticle.aspx?id=51.
13. Paparella SF. Taking another look at independent double checks. *J Emerg Nurs*. 2013;39(6):631-632.
14. Young J, Slebodnick M, Sands L. Bar code technology and medication administration error. *J Patient Saf*. 2010;6(2):115-120.
15. Henneman PL, Marquard JL, Fisher DL, et al. Bar-code verification: reducing but not eliminating medication errors. *J Nurs Adm*. 2012;42(12):562-566.
16. Voshall B, Piscotty R, Lawrence J, Targosz M. Barcode medication administration work-arounds: a systematic review and implications for nurse executives. *J Nurs Adm*. 2013;43(10):530-535.
17. Hardmeier A, Tsourounis C, Moore M, et al. Pediatric medication administration errors and workflow following implementation of a bar code medication administration system. *J Healthc Quality*. 2014;36(4):54-62.
18. Thomas M. Evaluation of the personalized bar-code identification card to verify high-risk, high-alert medications. *Comput Inform Nurs*. 2013;3(9):412-421.
19. Raman K, Heelen M, Kerr G, Higgins TL. Addressing challenges in bar-code scanning of large volume infusion bags. *Am J Health Syst Pharm*. 2011;68(15):1450-1453.
20. 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.
21. Institute for Safe Medication Practices (ISMP). FDA and ISMP lists of look-alike drug names with recommendations for tall man letters. http://ismp.org/Tools/tallmanletters.pdf. Published 2011.
22. Institute for Safe Medication Practices (ISMP). Safe practice guidelines for adult IV push medications. http://www.ismp.org/Tools/guidelines/IVSummitPush/IVPushMedGuidelines.pdf. Published 2015.
23. United States Pharmacopeial Convention (USP). USP-NF General Chapter <797>: pharmaceutical compounding—sterile preparations. https://www.ascp.com/sites/default/files/USP-797.pdf. Published 2011.
24. Dolan S, Felizardo G, Barnes S, et al. APIC position paper: safe injection, infusion, and medication vial practices in healthcare. *Am J Infect Control*. 2010;38:167-172.
25. Simmons D, Symes L, Guenter P, Graves K. Tubing misconnections: normalization of deviance. *Nutr Clin Pract*. 2011;26(3):286-293.
26. US Food and Drug Administration. MedWatch: the FDA safety information and adverse event reporting program. http://www.fda.gov/Safety/MedWatch/default.htm.
27. Institute for Safe Medication Practices (ISMP). Reporting a medication or vaccine error or hazard to ISMP. https://www.ismp.org/errorReporting/reportErrortoISMP.aspx.

14. LATEX SENSITIVITY OR ALLERGY

Standard

14.1 Exposure to latex in the health care environment is minimized.
14.2 Latex-free personal protective equipment (PPE), patient care equipment, and supplies are provided to latex-sensitive or latex-allergic clinicians and patients and used during patient care.

Practice Criteria

A. Screen clinicians at the time of hire for a latex allergy.[1-3] (V)
B. Use low-allergen, powder-free gloves, nitrile gloves, glove liners, or other similar alternatives, especially if sensitive or allergic to latex.[1-3] (V)
C. Remove latex-containing products from the patient care setting to reduce the exposure to latex.[1-3] (V)
D. Report the development of latex sensitivities or allergies to the employer. The employer will report allergic reactions to the Occupational Safety and Health Administration (OSHA) as required and report allergic events related to latex medical devices to the US Food and Drug Administration (FDA) MedWatch Program.[4,5] (V, Regulatory)
E. 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.[6] (V)
F. Assess the patient for latex allergies. To prevent the inadvertent exposure of an infant to latex sensitization, assess the mother for known latex allergy. Document the findings in the patient's medical record and communicate a positive screen for latex sensitivity or allergies to others involved in the patient's care and

incorporate into the patient's plan of care. Educate the patient on how to avoid latex exposure.[7] (V)

REFERENCES

Note: All electronic references in this section were accessed September 16, 2015.

1. US Department of Labor. Potential for sensitization and possible allergic reaction to natural rubber latex gloves and other natural rubber products. *Safety and Health Information Bulletin* 01-28-2008. https://www.osha.gov/dts/shib/shib012808.html. Published January 28, 2008.
2. US Department of Health and Human Services. National Institute for Safety and Health (NIOSH). Preventing allergic reactions to natural rubber latex in the workplace. Publication no. 97-135. http://www.cdc.gov/niosh/docs/97-135. Published June 1997.
3. US Department of Health and Human Services. National Institute for Safety and Health (NIOSH). NIOSH fast facts: home health-care workers: how to prevent latex allergies. Publication no. 2012-119. http://www.cdc.gov/niosh/docs/2012-119/pdfs/2012-119.pdf. Published February 2012.
4. US Food and Drug Administration. MedWatch: the FDA safety information and adverse event reporting program. http://www.fda.gov/safety/medwatch/default.htm. Published July 16, 2015.
5. US Department of Labor. Occupational Safety and Health Administration. Update to OSHA's recordkeeping rules. https://www.osha.gov/recordkeeping2014/faqs.html. Published February 19, 2015.
6. US Food and Drug Administration. 21 CFR §801.437.l.8. User labeling for devices that contain natural rubber. http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?FR=801.437. Published April 1, 2014.
7. Gawchik S. Latex allergy. *Mount Sinai J Med*. 2011;78(5):759-772.

15. HAZARDOUS DRUGS AND WASTE

Standard

15.1 Organizational policies and procedures address safe handling of hazardous drugs, appropriate use of personal protective equipment (PPE), exposure risk reduction, and safe handling of waste, including spills, in accordance with local, state, and federal regulations and manufacturers' directions for use.

15.2 All hazardous waste is discarded in appropriate containers and disposed of according to local, state, and federal regulations.

Practice Criteria

A. Identify hazardous drugs used in the health care setting. The National Institute for Occupational Safety and Health (NIOSH) provides a list of antineoplastic and nonantineoplastic drugs that meet the definition of hazardous drugs, including those with safe handling guidance from the manufacturer. This list is periodically updated.
   1. Additional resources used to evaluate the hazard potential of a drug include safety data sheets (SDSs); drug package inserts; Drugbank (http://drugbank.ca); DailyMed (http://dailymed.nlm.nih.gov/dailymed); International Agency for Research on Cancer (IARC) (http://www.iarc.fr); special health warnings from drug manufacturers; the US Food and Drug Administration (FDA) (http://www.fda.gov/drugs/default.htm); and other professional groups' and organizations' evidence-based recommendations.[1,2] (V, Regulatory)

B. Provide education to clinicians who handle hazardous drugs and waste. Education should include toxicities associated with exposure, required precautions, and what types of PPE to wear to prevent exposure.[3-8] (V, Regulatory)
   1. While most hazardous drugs are antineoplastic agents, recognize that there are infusion drugs from other categories classified as hazardous. Furthermore, certain antineoplastic drugs are administered for noncancer indications. Clinicians in all settings who administer hazardous drugs should be provided appropriate PPE and engineering controls to reduce exposure (refer to Standard 58, *Antineoplastic Therapy*).
   2. Allow clinicians who are actively trying to conceive, are pregnant, or are breastfeeding to refrain from exposure to hazardous drugs and waste.[4,9] (Regulatory)

C. Safely dispose of hazardous waste and materials contaminated with hazardous drugs.
   1. Place contaminated materials including needles, empty vials/syringes/solution containers, and administration sets, gloves, and gowns into sealable, leakproof bags or rigid waste containers that are clearly labeled for cytotoxic waste.[2,4] (V, Regulatory)
   2. Do not place drug-contaminated items in medical waste (red) containers because medical waste disposal is handled differently from hazardous waste (see Standard 18, *Medical Waste and Sharps Safety*).[2,4] (V, Regulatory)
   3. In the home setting, store such disposal containers in an area away from children and pets.[4] (V)
   4. Ensure that a spill kit is available, and follow directions for use in the event of a hazardous drug leak or spill. Report such spills as an occurrence according to organizational procedures. Large spills should be handled by health care workers who are trained in hazardous waste handling.[2,4] (V, Regulatory)

D. Handle patient body fluids safely for at least 48 hours after receiving a hazardous drug and instruct the patient/caregiver/surrogate in safe handling:
   1. Wear double chemotherapy gloves and a disposable gown when handling patient emesis or

excretions. Wear a face shield if splashing is anticipated.[4] (V)
2. Use disposable linens whenever possible; in institutions, washable linens should be placed in a leakproof bag and handled as contaminated.[4] (V)
3. Home setting: Place contaminated linens into a washable pillowcase separate from other items and wash twice in hot water. Discard disposable diapers in plastic bags and discard used gloves in cytotoxic waste container if available.[4] (V)

REFERENCES

Note: All electronic references in this section were accessed September 16, 2015.

1. Connor TH, MacKenzie BA, DeBord DG, et al. *NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings, 2014*. Cincinnati, OH: National Institute for Occupational Safety and Health (NIOSH); September 2014. NIOSH publication 2014-138 (supersedes 2012-150).
2. National Institute for Occupational Safety and Health (NIOSH). NIOSH alert: preventing occupational exposures to antineoplastic and other hazardous drugs in health care settings. Publication 2004-165. http://www.cdc.gov/niosh/docs/2004-165/pdfs/2004-165.pdf. Published September 2004.
3. Occupational Safety and Health Administration (OSHA). Hazard communication standard 1910. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10099. Published March 2012.
4. Polovich M, Olsen M, LeFebvre K. *Chemotherapy and Biotherapy Guidelines and Recommendations for Practice*. 4th ed. Pittsburgh, PA: Oncology Nursing Society; 2014.
5. Polovich M, Gieseker KE. Occupational hazardous drug exposure among non-oncology nurses. *Medsurg Nurs*. 2011;20(2):79-85, 97.
6. Menonna-Quinn D. Safe handling of chemotherapeutic agents in the treatment of nonmalignant diseases. *J Infus Nurs*. 2013;36(3):198-204.
7. Friese CR, Himes-Ferris L, Frasier MN, et al. Structures and processes of care in ambulatory oncology settings and nurse-reported exposure to chemotherapy. *BMJ Qual Saf*. 2012;21(9):753-759.
8. Oncology Nursing Society. Oncology Nursing Society position on the education of the nurse who administers chemotherapy and biotherapy, 2014. https://www.ons.org/advocacy-policy/positions/education/rn.
9. American College of Occupational and Environmental Medicine Task Force on Reproductive Toxicology. Reproductive and developmental hazard management guidance. http://www.acoem.org/Reproductive_Developmental_Hazard_Management.aspx. Published April 26, 2011.

Section Three: Infection Prevention and Control

16. HAND HYGIENE

Standard

16.1 Hand hygiene is performed routinely during patient care activities.

Practice Criteria

A. Perform hand hygiene with an alcohol-based hand rub or antimicrobial soap and water during patient care:
   1. Before having direct contact with the patient.
   2. Before donning sterile gloves when inserting a central intravascular catheter.
   3. Before inserting a peripheral vascular catheter.
   4. After contact with the patient's intact or nonintact skin.
   5. After contact with body fluids or excretions, mucous membranes, and wound dressings (if the hands are not visibly soiled).
   6. After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient.
   7. After removing gloves.[1-6] (III)

B. Use an alcohol-based hand rub routinely when performing hand hygiene unless the hands are visibly soiled, or there is an outbreak of a spore-forming pathogen or norovirus gastroenteritis.[1-8] (III)

C. Perform hand hygiene with either a nonantimicrobial soap or an antimicrobial soap and water:
   1. When the hands are visibly contaminated with blood or other body fluids.[1-6] (II)
   2. After providing care or having contact with patients suspected or confirmed of being infected with norovirus gastroenteritis or a spore-forming pathogen during an outbreak (eg, *Clostridium difficile*).[1-8] (II)
   3. Before eating and after using a restroom.[1-8] (II)

D. Do not wear artificial fingernails or extenders when having direct contact with patients at high risk (eg, those in intensive care units or operating rooms, or when inserting a central vascular access device (CVAD).[1] (III)

E. Keep the nail length short.[1-4] (III)

F. Store hand hygiene products in convenient locations at the point of use. Provide hand hygiene products that have a low irritancy potential and compatible hand lotions or creams to prevent irritant contact dermatitis.[1,3] (IV)

G. Involve the clinician with the evaluation of hand hygiene products to assess for product feel, fragrance, and skin irritation. Clinicians who have sensitivity to a particular product should be provided with an alternative. Other products for skin care such as gloves, lotions, and moisturizers should be assessed for compatibility with hand antisepsis products.[1,3] (IV)

H. Do not add soap to a partially empty soap dispenser.[1] (III)

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

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

REFERENCES

Note: All electronic references in this section were accessed September 16, 2015.

1. Boyce JM, Pittet D. 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. Atlanta, GA: Centers for Disease Control and Prevention; October 2002. http://www.cdc.gov/handhygiene/guidelines.html.
2. World Health Organization (WHO). WHO Guidelines on Hand Hygiene in Health Care. Geneva, Switzerland: WHO; 2009. http://www.who.int/gpsc/5may/tools/9789241597906/en.
3. Ellingson K, Haas J, Ailello A, et al; Society for Healthcare Epidemiology of America. Strategies to prevent healthcare-associated infections through hand hygiene. *Infect Control Hosp Epidemiol*. 2014;35(8):937-960. http://www.jstor.org/stable/10.1086/677145.
4. Institute for Healthcare Improvement. Improving hand hygiene: a guide for improving practices among health care workers. http://www.ihi.org/resources/Pages/Tools/HowtoGuideImprovingHandHygiene.aspx. Published 2006.
5. World Health Organization (WHO). Hand hygiene in outpatient and home-based care and long-term care facilities. http://www.who.int/gpsc/5may/EN_GPSC1_PSP_HH_Outpatient_care/en. Published 2012.
6. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. www.cdc.gov/hicpac/pdf/guidelines/bsi-guidelines-2011.pdf. Published April 2011.
7. MacCannell T, Umscheid C, Agarwal R, et al; Healthcare Infection Control Practices Advisory Committee. Guideline for the prevention and control of norovirus gastroenteritis outbreaks in healthcare settings, 2011. http://www.cdc.gov/hicpac/norovirus/001_norovirus.html. Published 2011.
8. Dubberke E, Gerding D. Rationale for hand hygiene recommendations after caring for a patient with *Clostridium difficile* infection. http://www.shea-online.org/Portals/0/CDI%20hand%20hygiene%20Update.pdf.

17. COMPOUNDING AND PREPARATION OF PARENTERAL SOLUTIONS AND MEDICATIONS

Standard

17.1 Compounding of parenteral solutions and medications is in accordance with state and federal regulations, the American Society of Health-System Pharmacists (ASHP), the Drug Quality and Security Act, and the United States Pharmacopeia (USP) National Formulary (NF), including but not limited to General Chapter <797>.

Practice Criteria

A. Use sterile medications that were compounded in a pharmacy environment that meets USP <797>, state pharmacy rules and regulations, and ASHP guidelines. The compounding environment is defined by risk category.[1-4] (V, Regulatory)
   1. Use pharmacy-prepared or commercially available prefilled syringes of appropriate intravenous (IV) solution to flush and lock vascular access devices (refer to Standard 40, *Flushing and Locking*).

B. Begin the administration of an "immediate-use" compounded sterile product (CSP), as defined by USP <797>, within 1 hour after the start of the preparation, or discard.[1-3] (V, Regulatory)

C. Administer IV push medication in a safe manner:
   1. When it is necessary to prepare more than 1 medication in a single syringe for IV push administration, limit preparation to the pharmacy.[5] (V)
   2. In adults, use IV push medications in a ready-to-administer form (to minimize the need for manipulation outside the pharmacy sterile compounding area).[5] (V)
   3. If dilution or reconstitution of an IV push medication becomes necessary outside the pharmacy sterile compounding area, perform these tasks immediately prior to administration in a clean, uncluttered, and functionally separate location using organization-approved, readily available drug information resources and sterile equipment and supplies.[5,6] (V)
   4. If more than 1 syringe of medication or solution to a single patient needs to be prepared at the bedside, prepare each medication or solution separately, and immediately administer it before preparing the next syringe. If preparing several IV push medications at a time for sequential IV push administration, label each syringe as it is being prepared and prior to the preparation of any subsequent syringes. If 1 or more medications or solutions needs to be prepared away from the patient's bedside, immediately label each syringe, 1 at a time, before preparing the next medication or solution.[5] (V)
   5. Do not dilute or reconstitute IV push medications by drawing up the contents into a commercially available, prefilled flush syringe of 0.9% sodium chloride (USP).[5,6] (V)
   6. Do not withdraw IV push medications from commercially available, cartridge-type syringes into another syringe for administration.[5] (V)

D. Do not use IV solutions in containers intended for infusion, including minibags, as common-source containers (multiple-dose product) to dilute or reconstitute medications for 1 or more patients in clinical care areas (see Standard 40, *Flushing and Locking*). (V)[5-7]

E. Use safe injection practices:
   1. Use a new needle and syringe for every injection.[6-8] (III)
   2. Discard a single-dose vial after a single entry.[5-8] (V)
   3. Dedicate a multidose vial for a single patient.[5-8] (V)

a. Use a multidose vial up to a maximum of 28 days of opening or puncture (except for vaccines or when original manufacturer's expiration date is shorter) or when the manufacturer's expiration date is reached if it is not opened in a direct patient care area or a shorter period.[1-3,6-8] (V, Regulatory)
b. 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.[1-3,6] (V, Regulatory)

F. Use a filter needle or filter straw to withdraw medication from an ampoule, and discard any leftover medication.[1-3,5,6] (V, Regulatory)
G. Disinfect the vial septum before each entry and the neck of a glass ampoule prior to breaking the ampoule, and allow the disinfectant to dry prior to entry.[5,6] (V)
H. Do not add medications to infusing containers of IV solutions (refer to Standard 57, *Parenteral Medication and Solution Administration*).

REFERENCES

Note: All electronic references in this section were accessed September 17, 2015.

1. United States Pharmacopeial Convention (USP). USP-NF General Chapter <797>: pharmaceutical compounding—sterile preparations. https://www.ascp.com/sites/default/files/USP-797.pdf. Published 2011.
2. Drug Quality and Security Act. Pub L 113-54. http://www.gpo.gov/fdsys/pkg/PLAW-113publ54/html/PLAW-113publ54.htm.
3. American Society of Health-System Pharmacists (ASHP). ASHP guidelines on compounding sterile preparations. *Am J Health Syst Pharm*. 2014;71(2):145-166.
4. National Association of Boards of Pharmacy (NABP). Compounding and reconstituting drugs for infusion in establishments other than pharmacies (resolution 109-6-13). https://www.nabp.net/news/compounding-and-reconstituting-drugs-for-infusion-in-establishments-other-than-pharmacies-resolution-109-6-13. Published June 5, 2013.
5. Institute for Safe Medication Practices (ISMP). *ISMP Safe Practice Guidelines for Adult IV Push Medications*. http://www.ismp.org/Tools/guidelines/ivsummitpush/ivpushmedguidelines.pdf. Published 2015.
6. Dolan S, Felizardo G, Barnes S, et al. APIC position paper: safe injection, infusion, and medication vial practices in healthcare. *Am J Infect Control*. 2010;38(3):167-172.
7. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. Management of multidrug-resistant organisms in healthcare settings, 2006. http://www.cdc.gov/hicpac/pdf/guidelines/MDROGuideline2006.pdf.
8. Centers for Disease Control and Prevention (CDC); Safe Injection Practices Coalition. Single dose or multi-dose? http://www.cdc.gov/injectionsafety/PDF/SDVMDF_infographic.pdf. Published July 13, 2015.

18. MEDICAL WASTE AND SHARPS SAFETY

Standard

18.1 Each organization has protocols for the safe handling of regulated medical waste that are based on local, state, and federal laws and regulations.
18.2 Each organization has an exposure control plan that is in accordance with the Occupational Safety and Health Administration (OSHA) blood-borne pathogen standard.
18.3 Regulated medical waste is discarded in the appropriate container and disposed of according to local, state, and federal regulations.
18.4 Contaminated sharps are discarded in a nonpermeable, puncture-resistant, tamper-proof biohazard container.
18.5 Safety engineered devices, such as self-sheathing needles, that isolate or remove the blood-borne pathogens hazard are available in the workplace and consistently activated or used.

Practice Criteria

A. Use safety-engineered devices for needlestick injury prevention.[1-4] (Regulatory)
B. Consider the use of passive safety-engineered devices for needlestick injury prevention.[5-7] (V)
C. Do not break or bend sharps. Use a 1-handed technique for recapping if necessary.[1-4,8-10] (V, Regulatory)
D. Activate built-in safety controls during use, and discard as a single unit after use.[1-4] (Regulatory)
E. 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).[1-4,8,9,11] (V, Regulatory)
   1. Place sharps containers in the immediate area where sharps are used and are easily accessible.[1-4] (V, Regulatory)
   2. Replace sharps disposal containers when about three-fourths full to avoid overfilling and disposal-related injuries.[1-3,7,10,12] (V, Regulatory)
F. Educate and train clinicians in the use of safety-engineered devices.[1-4,8-10] (V, Regulatory)
G. Identify, report, and document exposure to potentially infectious materials or injury from sharps; follow organizational protocol for postexposure follow-up. Monitor and analyze data for trends and implement performance improvement as needed.[1-3,8-10] (V, Regulatory)

REFERENCES

Note: All electronic references in this section were accessed September 17, 2015.

1. Occupational exposure to bloodborne pathogens: needlestick and other sharps injuries. 29 CFR Section 1910. *Fed Regist*. 1991; 56(235):64003-64282. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051#1910.1030(d)(2)(vii)(A).
2. Occupational exposure to bloodborne pathogens: needlestick and other sharps injuries; final rule. 29 CFR Section 1910. *Fed Regist*. 2001;66:5317-5325. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=16265&p_table=FEDERAL_REGISTER.
3. Occupational Safety and Health Administration (OSHA). Compliance directive: enforcement procedures for the occupational exposure to bloodborne pathogens. CPL 02-02-069. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=2570. Published November 27, 2001.
4. Occupational Safety and Health Administration (OSHA). Disposal of contaminated needles and blood tube holders used for phlebotomy. http://www.osha.gov/dts/shib/shib101503.html. Published 2004.
5. Black L. Chinks in the armor: percutaneous injuries from hollow bore safety-engineered sharps devices. *Am J Infect Control*. 2013; 41(5):427-432.
6. Grimmond T, Good L. EXPO-S.T.O.P.: A national survey and estimate of sharps injuries and mucocutaneous blood exposures among healthcare workers in USA. *J Assoc Occup Health Prof Healthc*. 2013;33(4):31-36.
7. Tossini 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.
8. National Institute for Occupational Safety and Health. (NIOSH). Preventing needlestick injuries in health care settings. Publication no. 2000-108. http://www.cdc.gov/niosh/docs/2000-108. Published November 1999.
9. National Institute for Occupational Safety and Health (NIOSH). NIOSH hazard review: occupational hazards in home healthcare. Publication 2010-125. http://www.cdc.gov/niosh/docs/2010-125/pdfs/2010-125.pdf. Published January 2010.
10. Centers for Disease Control and Prevention (CDC). Workbook for designing, implementing and evaluating a sharps injury prevention program. http://www.cdc.gov/sharpssafety/pdf/sharpsworkbook_2008.pdf. Published 2008.
11. US Food and Drug Administration. Best way to get rid of used needles and other sharps. http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/HomeHealthandConsumer/ConsumerProducts/Sharps/ucm263240.htm. Published July 22, 2015.
12. Lavoie MC, Verbeek JH, Pahwa M. Devices for preventing percutaneous exposure injuries caused by needles in healthcare personnel. *Cochrane Database Syst Rev*. 2014;(3):CD009740. doi:10.1002/14651858.CD009740.pub2.

19. STANDARD PRECAUTIONS

Standard

19.1 Standard Precautions are used during all infusion procedures 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.

Practice Criteria

A. Select personal protective equipment (PPE) based on the nature of the patient interaction and potential for exposure to blood, body fluids, or infectious agents, and the Centers for Disease Control and Prevention (CDC) isolation precaution guidelines in effect at the time of the patient encounter for specific communicable diseases (eg, Ebola virus disease).[1,2] (III, Regulatory)
B. Ensure that sufficient and appropriate PPE is available and readily accessible at the point of care.[2,3] (V, Regulatory)
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.[1,4] (III)
D. When wearing PPE, keep the hands away from the face, and limit surfaces touched in the patient's environment.[4] (V)
E. 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), body fluids, mucous membranes, nonintact skin, or contaminated equipment.[1,2,5] (III, Regulatory)
    1. Change gloves during patient care when torn or heavily contaminated, or if moving from a contaminated body site to a clean body site.[1,5] (IV)
F. Wear a gown to protect skin and clothing during procedures or activities in which contact with blood or body fluids is anticipated.[1,2] (III, Regulatory)
    1. Do not wear the same gown or gloves when caring for more than 1 patient.[1] (IV)
G. 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.[1,2] (III, Regulatory)
H. 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.[1] (III)
I. 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.[1] (III)
J. In the home setting when caring for a patient with a multidrug-resistant organism (MDRO), following Standard Precautions, limit reusable patient care

equipment and leave in the home until discharged. Clean and disinfect before removing from the home or transport in a container (eg, plastic bag) to an appropriate site for cleaning and disinfection.[6] (IV)

REFERENCES

Note: All electronic references in this section were accessed September 17, 2015.

1. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. http://www.cdc.gov/hicpac/2007ip/2007isolationprecautions.html. Published 2007.
2. Occupational exposure to bloodborne pathogens: needlestick and other sharps injuries. 29 CFR Section 1910. *Fed Regist*. 1991; 56(235):64003-64282. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051#1910.1030(d)(2)(vii)(A).
3. Centers for Disease Control and Prevention (CDC). Guide to infection prevention in outpatient settings: minimum expectations for safe care. http://www.cdc.gov/HAI/pdfs/guidelines/Outpatient-Care-Guide-withChecklist.pdf. Published 2014.
4. Centers for Disease Control and Prevention (CDC). Sequence for donning and removing personal protective equipment. http://www.cdc.gov/hai/prevent/ppe.html. Published October 16, 2014.
5. Centers for Disease Control and Prevention (CDC). Guideline for hand hygiene in healthcare settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. http://www.cdc.gov/handhygiene/guidelines.html. Published 2002.
6. Siegel JD, Rhinehart E, Jackson M; Healthcare Infection Control Practices Advisory Committee. Management of multi-drug-resistant organisms in healthcare settings. http://www.cdc.gov/hicpac/mdro/mdro_0.html. Published 2006.

20. TRANSMISSION-BASED PRECAUTIONS

Standard

20.1 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.

20.2 Airborne Precautions are implemented to prevent the transmission of infectious agents that remain infectious when suspended in the air over long distances or as recommended by the Centers for Disease Control and Prevention (CDC) isolation guidelines in effect at the time of the patient encounter.

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

20.4 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.

20.5 Adapt and apply Transmission-Based Precautions as appropriate for non–acute care settings where infusion therapy is provided, including long-term care facilities, home care, and other settings.

Practice Criteria

A. Select and use personal protective equipment (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 the CDC isolation precaution guidelines in effect at the time of the patient encounter for specific communicable diseases (eg, Ebola virus disease).[1,2] (III, Regulatory)

B. Wear a face mask and observe Droplet Precautions, in addition to Standard Precautions, when there is potential contact with respiratory secretions and sprays of blood or body fluids.[1,2] (III, Regulatory)

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.[1,3,4] (III)

D. Wear a fit-tested N95-or-higher respirator certified by the National Institute for Occupational Safety and Health (NIOSH) and observe Airborne Precautions, in addition to Standard Precautions, if the patient is suspected or confirmed of having an infection spread by airborne route or Ebola virus disease to prevent the potential exposure to infectious agents transmitted via the airborne route (eg, *M. tuberculosis*). Perform fit testing prior to its initial use and at least annually thereafter.[1,3,5] (III, Regulatory)

E. 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 have been met.[1] (III)

F. In the home setting, when caring for a patient with a multidrug-resistant organism (MDRO) or on Contact Precautions, limit reusable patient care equipment, and leave in the home until discharged. Disinfect before removing from the home in a container (eg, plastic bag) or transport to an appropriate site for cleaning and disinfection.[6] (IV)

REFERENCES

Note: All electronic references in this section were accessed September 18, 2015.

1. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. http://www.cdc.gov/hicpac/pdf/isolation/Isolation2007.pdf.
2. Bloodborne Pathogens Standard 1910.1030. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051.
3. Centers for Disease Control and Prevention (CDC). Sequence for donning and removing personal protective equipment. http://www.cdc.gov/hai/pdfs/ppe/PPE-Sequence.pdf. Published October 16, 2014.
4. Centers for Disease Control and Prevention (CDC); Healthcare Infection Control Practices Advisory Committee; HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Guideline for hand hygiene in healthcare settings. http://www.cdc.gov/handhygiene/guidelines.html. Published 2002.
5. Occupational Safety and Health Administration (OSHA). Respiratory Protection Standard 1910.134. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=12716.
6. Siegel JD, Rhinehart E, Jackson M; Healthcare Infection Control Practices Advisory Committee. Management of multi-drug-resistant organisms in healthcare settings. http://www.cdc.gov/hicpac/mdro/mdro_0.html. Published 2006.

21. DISINFECTION OF DURABLE MEDICAL EQUIPMENT

Standard

21.1 Durable medical equipment (DME), such as intravenous (IV) poles; flow-control devices; ultrasound or infrared devices for vascular visualization; and other nondisposable, hard nonporous surface, infusion-related equipment are cleaned and disinfected using an Environmental Protection Agency (EPA)-registered disinfectant.

21.2 Cleaning and disinfectant products are used in accordance with the equipment and manufacturers' directions for use to prevent damage or alteration to the function or performance of the equipment.

Practice Criteria

A. Inspect DME surfaces for breaks in integrity that would impair either cleaning or disinfection. Discard or repair equipment that no longer functions as intended or cannot be properly cleaned and disinfected.[1] (IV)
B. Clean and disinfect DME surfaces when visibly soiled, on a regular basis (eg, at a frequency defined by organizational policies and procedures) and at established intervals during long-term single-patient use.[1] (IV)
C. Clean and disinfect DME surfaces with an EPA-registered hospital disinfectant according to the label's safety precautions and directions for use.[1,2] (V)
D. Implement patient-dedicated use of DME when a patient is placed on Contact Precautions. If common use of medical equipment for multiple patients is unavoidable (eg, ultrasound or infrared devices for vascular visualization), clean and disinfect the equipment before use on another patient (see Standard 20, *Transmission-Based Precautions*).[1,3] (III,V)
E. Handle DME according to Standard Precautions. Wear personal protective equipment (PPE—eg, gloves, gown), according to the level of anticipated contamination, when handling patient care equipment and instruments/devices are visibly soiled or may have been in contact with blood or body fluids.[4] (III)
F. Limit the amount of DME that is brought into the home of patients infected or colonized with multidrug-resistant organisms (MDROs) or on Contact Precautions. When possible, leave DME in the home until the patient is discharged (see Standard 20, *Transmission-Based Precautions*).[3,4] (IV).
G. Place used DME (eg, IV poles, flow-control devices) in a plastic bag or decontaminate prior to transport to another location (ie, soiled utility area or warehouse) for subsequent cleaning and disinfection.[3,4] (IV)

REFERENCES

Note: All electronic references in this section were accessed September 18, 2015.

1. Rutala W, Weber D; Healthcare Infection Control Practice Advisory Committee (HICPAC). Guideline for disinfection and sterilization in healthcare facilities, 2008. http://www.cdc.gov/hicpac/Disinfection_Sterilization/acknowledg.html.
2. Rutala W, Weber D. Disinfection and sterilization: an overview. *Am J Infect Control*. 2013;41(5):S2-S5.
3. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. http://www.cdc.gov/hicpac/2007IP/2007isolationPrecautions.html.
4. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. Management of multidrug-resistant organisms in healthcare settings, 2006. http://www.cdc.gov/hicpac/pdf/MDRO/MDROGuideline2006.pdf. Published 2015.

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 and contraindications and manufacturers' directions for use.
II. The use and maintenance of infusion equipment is established in organizational policies and procedures.

22. VASCULAR VISUALIZATION

Standard

22.1 To ensure patient safety, the clinician is competent in the use of vascular visualization technology for vascular access device (VAD) insertion. This knowledge includes, but is not limited to, appropriate vessels, size, depth, location, and potential complications.
22.2 Vascular visualization technology is used in patients with difficult venous access and/or after failed venipuncture attempts.
22.3 Vascular visualization technology is employed to increase the success with peripheral cannulation and decrease the need for central vascular access device (CVAD) insertion, when other factors do not require a CVAD.

Practice Standard

A. Assess the patient's medical history for conditions that may affect the peripheral vasculature and increase the need for devices to assist in locating 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, 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.
   8. Intravenous drug users.[1-7] (III)

B. Consider the use of visible light devices that provide transillumination of the peripheral veins and arteries in infants and children with difficult venous access.
   1. 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).
   2. Disinfect the device after each patient use due to the potential for blood contamination during the procedure (refer to Standard 21, *Disinfection of Durable Medical Equipment*).
   3. Darken the room to remove ambient light levels when using these devices; ensure adequate light to observe blood return from the cannula or catheter.
   4. Be aware that the light spectrum being used limits the successful location of deep veins due to high amounts of body fat.[1,8-11] (I)

C. Consider the use of near-infrared (nIR) light technology to aid in locating viable superficial peripheral venous sites and decreasing procedure time for short peripheral catheter 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 and transillumination projected to a screen. The clinician may choose to use a static process by imaging and marking the vein location on the skin or a dynamic process of using the image to guide catheter insertion. No studies have compared

these various methods of device use, leaving this decision to the discretion of the clinician.[1,6,12] (III)

2. Consider nIR light technology to identify peripheral venous sites and facilitate more informed decisions about vein selection (ie, bifurcating veins, tortuosity of veins, palpable but nonvisible veins). Two nonrandomized studies have shown improvement in first-attempt success for peripheral catheter insertion using nIR; however, other studies have not shown this same outcome. Additional research is needed to address the reason(s), which could include differences in nIR devices, patient-related factors, and skill level of the inserters before using the nIR devices.[11-19] (I)

D. Consider nIR for cannulation of the radial artery at the wrist in children. It was slightly more successful on first attempt with a lower total number of attempts, although there was no statistical difference or clinical improvement noted.[20] (V)

E. Use ultrasonography (US) for short peripheral catheter placement in adult and pediatric patients with difficult venous access.[2] (II)

1. In pediatrics, US significantly reduces the number of venipuncture attempts and procedure time. In adults, US studies show a trend toward fewer venipuncture attempts and reduced risk of peripheral catheter failure. There is significant variation between studies, including use of 1 versus 2 inserters, use of the static versus dynamic techniques, and experience level of the inserters within and between studies. Failure rates of US-guided peripheral catheters vary between studies, with hematoma being the most common complication.[21] (I)
2. Choose a catheter length that will allow sufficient length residing inside the vein lumen. Vein depth greater than or equal to 1.2 cm and insertion into the deep brachial or basilic veins of the upper arm are associated with shorter survival probability; however, vein diameter had no effect on catheter survival. Longer catheter length (ie, 12 cm) is reported to have longer survival than 5-cm catheter length.[22,23] (III)
3. Dynamic, or "real-time," visualization of the needle position is recommended to prevent vein wall damage.[24] (V)
4. Use of short axis (out of plane view) versus long axis (in plane view) for peripheral catheter insertion depends upon the size and depth of the target vein and the skill of the inserter.[24,25] (V)

F. Use US guidance for insertion of midline catheters in patients with difficult venous access.[26,27](V)

G. Use US guidance for arterial puncture and catheter placement in adults and children.[2,28] (I)

H. Use US guidance when placing CVADs in adults and children to improve insertion success rates, reduce number of needle punctures, and decrease insertion complication rates.[2,24,25,29-33] (I)

1. Scan the anatomy prior to insertion to identify vascular anomalies (eg, occlusion or thrombosis) and to assess vein diameter.[2,25,29] (IV)
2. Use a "real-time" or dynamic technique for CVAD insertion.[2,31] (I)
3. For internal jugular insertion sites, the short-axis view increases insertion success, and the long-axis view is technically more difficult to achieve. Position the probe vertically to the vein and insert the needle as close to the probe as possible to keep the needle within view.[25,34] (III)
4. US-guided saphenous and femoral CVADs placed in critically ill neonates and infants have outcomes equivalent to insertion under fluoroscopy in an interventional radiology suite.[35] (IV)

I. Using a long-axis view, US-guided subclavian catheters are commonly inserted below the clavicle at the midclavicular line or more laterally. The puncture site may allow the catheter to enter the axillary vein first or, depending upon the trajectory of the needle, may enter the subclavian vein directly.[36] (V)

J. Use a large, sterile transparent membrane dressing over the probe (ie, for peripheral catheter insertion) or sterile sheath cover, and sterile gel.[27,37] (V)

REFERENCES

Note: All electronic references in this section were accessed September 18, 2015.

1. Hadaway L. Infusion therapy equipment. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:391-436.
2. Lamperti M, Bodenham AR, Pittiruti M, et al. International evidence-based recommendations on ultrasound-guided vascular access. *Intensive Care Med*. 2012;38(7):1105-1117.
3. Sebbane M, Claret P-G, Lefebvre S, et al. Predicting peripheral venous access difficulty in the emergency department using body mass index and a clinical evaluation of venous accessibility. *J Emerg Med*. 2013;44(2):299-305.
4. 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.
5. Shahzad A, Naufal Mohamad Saad M, Walter N, Saeed Malik A, Meriaudeau F. A review on subcutaneous veins localization using imaging techniques. *Curr Med Imaging Rev*. 2014;10(2):125-133.
6. Peterson KA, Phillips AL, Truemper E, Agrawal S. Does the use of an assistive device by nurses impact peripheral intravenous catheter insertion success in children? *J Pediatr Nurs*. 2012;27(2):134-143.
7. Houston PA. Obtaining vascular access in the obese patient population. *J Infus Nurs*. 2013;36(1):52-56.
8. ECRI Institute. Hazard report: common flashlights can cause burns when used for transillumination. *Health Devices*. 2003;32(7):273-274.

9. Goren A, Laufer J, Yativ N, et al. Transillumination of the palm for venipuncture in infants. *Pediatr Emerg Care*. 2001;17(2):130-131.
10. Yamazaki S, Tomita S, Watanabe M, Kawaai H, Shimamura K. Effects of a transmitted light device for pediatric peripheral venipuncture and intravenous cannulation. *Med Devices (Auckland, NZ)*. 2011;4:189.
11. 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.
12. Graaff J, Cuper N, Mungra R, Vlaardingerbroek K, Numan S, Kalkman C. Near-infrared light to aid peripheral intravenous cannulation in children: a cluster randomised clinical trial of three devices. *Anaesthesia*. 2013;68(8):835-845.
13. Chiao F, Resta-Flarer F, Lesser J, et al. Vein visualization: patient characteristic factors and efficacy of a new infrared vein finder technology. *Br J Anaesth*. 2013;110(6):966-971.
14. Hess H. A biomedical device to improve pediatric vascular access success. *Pediatr Nurs*. 2010;36(5):259-263.
15. Sun CY, Lee KC, Lin IH, et al. Near-infrared light device can improve intravenous cannulation in critically ill children. *Pediatr Neonatol*. 2013;54(3):194-197.
16. van der Woude OC, Cuper NJ, Getrouw C, Kalkman CJ, de Graaff JC. The effectiveness of a near-infrared vascular imaging device to support intravenous cannulation in children with dark skin color: a cluster randomized clinical trial. *Anesth Analg*. 2013;116(6):1266-1271.
17. Szmuk P, Steiner J, Pop RB, Farrow-Gillespie A, Mascha EJ, Sessler DI. The VeinViewer vascular imaging system worsens first-attempt cannulation rate for experienced nurses in infants and children with anticipated difficult intravenous access. *Anesth Analg*. 2013;116(5):1087-1092.
18. Aulagnier J, Hoc C, Mathieu E, Dreyfus JF, Fischler M, Guen M. Efficacy of AccuVein to facilitate peripheral intravenous placement in adults presenting to an emergency department: a randomized clinical trial. *Acad Emerg Med*. 2014;21(8):858-863.
19. Cuper NJ, de Graaff JC, Verdaasdonk RM, Kalkman CJ. Near-infrared imaging in intravenous cannulation in children: a cluster randomized clinical trial. *Pediatrics*. 2013;131(1):e191-e197.
20. Cuper N, De Graaff J, Hartman B, Verdaasdonk R, Kalkman C. Difficult arterial cannulation in children: is a near-infrared vascular imaging system the answer? *Survey Anesthesiol*. 2013;57(2):80-81.
21. 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.e1.
22. Fields JM, Dean AJ, Todman RW, et al. The effect of vessel depth, diameter, and location on ultrasound-guided peripheral intravenous catheter longevity. *Am J Emerg Med*. 2012;30(7):1134-1140.
23. Elia F, Ferrari G, Molino P, et al. Standard-length catheters vs long catheters in ultrasound-guided peripheral vein cannulation. *Am J Emerg Med*. 2012;30(5):712-716.
24. Moore CL. Ultrasound first, second, and last for vascular access. *J Ultrasound Med*. 2014;33(7):1135-1142.
25. Schindler E, Schears GJ, Hall SR, Yamamoto T. Ultrasound for vascular access in pediatric patients. *Pediatr Anesth*. 2012;22(10):1002-1007.
26. 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.
27. Warrington J, William G, Penoyer DA, Kamps TA, Van Hoeck EH. Outcomes of using a modified Seldinger technique for long term intravenous therapy in hospitalized patients with difficult venous access. *J Assoc Vasc Access*. 2012;17(1):24-30.
28. Gao Y-B, Yan J-H, Gao F-Q, Pan L, Wang X-Z, Lv C-J. Effects of ultrasound-guided radial artery catheterization: an updated meta-analysis. *Am J Emerg Med*. 2015;33(1):50-55.
29. Granziera E, Scarpa M, Ciccarese A, et al. Totally implantable venous access devices: retrospective analysis of different insertion techniques and predictors of complications in 796 devices implanted in a single institution. *BMC Surg*. 2014;14:27. doi. 10.1186/1471-2482-14-27.
30. Cotogni P, Pittiruti M. Focus on peripherally inserted central catheters in critically ill patients. *World J Crit Care Med*. 2014;3(4):80-94.
31. Shekelle PG, Dallas P. Use of real-time ultrasound guidance during central line insertion: brief update review. In: Shekelle PG, Wachter RM, Pronovost PJ, et al, eds. *Making Health Care Safer II: An Updated Critical Analysis of the Evidence for Patient Safety Practices*. Rockville, MD: Agency for Healthcare Research and Quality. Published March 2013. http://www.ahrq.gov/sites/default/files/wysiwyg/research/findings/evidence-based-reports/services/quality/ptsafetyII-full.pdf.
32. Lalu MM, Fayad A, Ahmed O, et al. Ultrasound-guided subclavian vein catheterization: a systematic review and metaanalysis. *Crit Care Med*. 2015;43(7):1498-1507.
33. 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.
34. Chittoodan S, Breen D, O'Donnell BD, Iohom G. Long versus short axis ultrasound guided approach for internal jugular vein cannulation: a prospective randomised controlled trial. *Med Ultrason*. 2011;13(1):21-25.
35. Gaballah M, Krishnamurthy G, Keller MS, McIntosh A, Munson DA, Cahill AM. US-guided placement and tip position confirmation for lower-extremity central venous access in neonates and infants with comparison versus conventional insertion. *J Vasc Interv Radiol*. 2014;25(4):548-555.
36. Perbet S, Pereira B, Grimaldi F, Dualé C, Bazin J-E, Constantin J-M. Guidance and examination by ultrasound versus landmark and radiographic method for placement of subclavian central venous catheters: study protocol for a randomized controlled trial. *Trials*. 2014;15(1):175.
37. Dargin J, Rebholz C, Lowenstein R, Mitchell P, Feldman J. Ultrasonography-guided peripheral intravenous catheter survival in ED patients with difficult access. *Am J Emerg Med*. 2010;28(1):338-345.

23. CENTRAL VASCULAR ACCESS DEVICE (CVAD) TIP LOCATION

Standard

23.1 Tip location of a central vascular access device (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 medical 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 Criteria

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 preprocedure chest radiographs.[1-3] (IV)
B. Avoid CVAD tip locations in veins distal to the superior or inferior vena cava (eg, innominate or brachiocephalic, subclavian, external, or common iliac veins), as they are associated with higher rates of complications. These noncentral, suboptimal tip locations are included in data collection for central line-associated bloodstream infection (CLABSI) surveillance according to the National Healthcare Safety Network from the Centers for Disease Control and Prevention (CDC). Although these tip locations may be clinically indicated in rare cases due to anatomical or pathophysiological changes, the goal for tip location should be the CAJ.[4-8] (IV)
C. Position the tip of a CVAD in the lower segment of the superior vena cava at or near the CAJ for adults and children.
    1. For upper body insertion sites, respiratory movement, 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.[9-11] (II)
    2. For lower body insertion sites, the CVAD tip should be located in the inferior vena cava above the level of the diaphragm.[3] (IV)
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.[6,10] (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.
    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.
    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, atrial fibrillation, extreme tachycardia). Follow manufacturers' directions for use in the appropriate patient populations.
    3. Use caution with ultrasound for CVAD tip location, as its use in replacing chest radiographs is controversial in all ages due to small sample sizes in available studies and lack of standardized techniques. Consider use in neonates and in emergency departments when immediate knowledge of the CVAD tip location is beneficial.
    4. Avoid fluoroscopy except in the case of difficult CVAD insertions, as it requires exposure to ionizing radiation.
    5. Postprocedure radiograph imaging is not necessary if alternative tip location technology confirms proper tip placement.[3,12-18] (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. Additionally, a change in the patient position from supine to standing, usually required for the radiograph, results in movement of the catheter tip by as much as 2 cm.[3,11,12,19,20] (II)
G. Recognize that radiographic or ECG tip location technology does not differentiate between venous and arterial placement. When arterial placement is suspected, use other methods to confirm or rule out arterial placement (refer to Standard 53, *Central Vascular Access Device [CVAD] Malposition*).
H. Clinicians with documented competency determine the tip location of a CVAD by using ECG or assessing the postprocedure chest radiograph and initiate infusion therapy based on this assessment. When a postprocedure chest radiograph is used, the radiologist as directed by organizational policies and procedures authors the complete report.[2,21] (V)
I. Document the CVAD tip location by including a copy of the ECG tracing, chest radiograph report, or other appropriate report in the medical record (refer to Standard 10, *Documentation in the Medical Record*).

REFERENCES

Note: All electronic references in this section were accessed September 18, 2015.

1. 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.
2. Bullock-Corkhill M. Central venous access devices: access and insertion. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010: 480-494.
3. Perin G, Scarpa M. Defining central venous line position in children: tips for the tip. *J Vasc Access*. 2015;16(2):77-86.
4. Centers for Disease Control and Prevention (CDC). Bloodstream infection event (central line-associated bloodstream infection and non-central line associated bloodstream infection). http://www.cdc.gov/nhsn/PDFs/pscManual/4PSC_CLABScurrent.pdf. Published January 2015. Updated April 2015.
5. Jumani K, Advani S, Reich NG, Gosey L, Milstone AM. Risk factors for peripherally inserted central venous catheter complications in children. *JAMA Pediatr*. 2013;167(5):429-435.
6. Blackwood BP, Farrow KN, Kim S, Hunter CJ. Peripherally inserted central catheters complicated by vascular erosion in neonates [published online February 19, 2015]. *J Parenter Enteral Nutr*. doi:10.1177/0148607115574000.
7. Jain A, Deshpande P, Shah P. Peripherally inserted central catheter tip position and risk of associated complications in neonates. *J Perinatol*. 2013;33(4):307-312.
8. 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.
9. Shah PN, Kane D, Appukutty J. Depth of central venous catheterization by intracardiac electrocardiogram in adults. *Anesthesiol Pain Med*. 2013;2(3):111-114.
10. 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.
11. 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-S39.
12. Pittiruti M, Bertollo D, Briglia E, et al. The intracavitary ECG method for positioning the tip of central venous catheters: results of an Italian multicenter study. *J Vasc Access*. 2012;13(3): 357-365.
13. Zanobetti M, Coppa A, Bulletti F, et al. Verification of correct central venous catheter placement in the emergency department: comparison between ultrasonography and chest radiography. *Intern Emerg Med*. 2013;8(2):173-180.
14. Katheria A, Fleming S, Kim J. A randomized controlled trial of ultrasound-guided peripherally inserted central catheters compared with standard radiograph in neonates. *J Perinatol*. 2013;33(10):791-794.
15. Gaballah M, Krishnamurthy G, Keller MS, McIntosh A, Munson DA, Cahill AM. US-guided placement and tip position confirmation for lower-extremity central venous access in neonates and infants with comparison versus conventional insertion. *J Vasc Intervent Radiol*. 2014;25(4):548-555.
16. Gekle R, Dubensky L, Haddad S, et al. Saline flush test: can bedside sonography replace conventional radiography for confirmation of above-the-diaphragm central venous catheter placement? *J Ultrasound Med*. 2015;34(7):1295-1299.
17. Saul T, Doctor M, Kaban NL, Avitabile NC, Siadecki SD, Lewiss RE. The ultrasound-only central venous catheter placement and confirmation procedure. *J Ultrasound Med*. 2015;34(7):1301-1306.
18. Alonso-Quintela P, Oulego-Erroz I, Silvia R-B, Manoel M-F, Santiago L, Antonio R. 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):e340-5.
19. Song Y, Byun J, Hwang S, Kim C, Shim S. 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.
20. Vesely T. Central venous catheter tip position: a continuing controversy. *J Vasc Intervent Radiol*. 2003;14:527-534.
21. Infusion Nurses Society (INS). The role of the registered nurse in determining distal tip placement of peripherally inserted central catheters by chest radiograph. *J Infus Nurs*. 2010;33(1):19-20.

24. FLOW-CONTROL DEVICES

Standard

24.1 Factors to be considered in the choice of a flow-control device include patient age and condition, prescribed infusion therapy, and care setting.
24.2 Administration sets with anti–free-flow mechanisms are used with electronic infusion devices (EIDs).
24.3 Dose-error reduction systems are considered in the selection and use of EIDs.

Practice Criteria

A. Choose a flow-control device for a given clinical application taking into account factors such as age, acuity, and mobility of the patient; severity of illness; type of therapy; dosing considerations; health care setting; and the potential for side effects or adverse effects of the therapy.[1-6] (V)
   1. Use manual flow-control devices such as flow regulators and pressure bags or mechanical pumps such as elastomeric balloon pumps, spring-based pumps, and negative-pressure pumps for lower-risk infusions.[1-5] (V)
   2. Use EIDs for the administration of infusion therapies that require precise flow control and for patient safety. Features (eg, anti–free-flow protection, air-in-line, occlusion alarms) should be consistent with recommendations for safe and effective use.[1-7] (V)
   3. Consider use of smart pumps with dose-error reduction software as they are associated with reduced risk for infusion-related medication errors including error interceptions (eg, wrong rate) and reduced adverse drug events (refer to Standard 13, *Medication Verification*).

B. Monitor flow-control devices during the administration of infusion therapy to ensure safe and accurate delivery of the prescribed infusion rate and volume.[1,8-15] (IV)

C. Do not rely on EID alarms to detect intravenous (IV) infiltration or extravasation, as these alarms are not intended to detect disruption of the fluid flow pathway.[13-15] (V)
D. Standardize the types of pumps used in an organization. When feasible, pumps available in the setting should be standardized to promote user familiarity with operation. Involve end users in the evaluation and selection of flow-control devices (see Standard 12, *Product Evaluation, Integrity, and Defect Reporting*).[2-4,16-25] (IV)
E. Recognize the problem of alarm fatigue with multiple electronic monitoring and therapeutic devices. Implement evidence-based recommendations (eg, alarm parameter settings) from professional agencies through an interprofessional team process.[3,25] (III)
F. Educate patients and/or caregivers in the home care setting about safe and effective use of flow-control devices using appropriate teaching materials and methods (see Standard 8, *Patient Education*).[6,26,27] (V)

REFERENCES

Note: All online references in this section were accessed August 25, 2015.

1. Hadaway L. Infusion therapy equipment. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:391-436.
2. Weinstein SM. Infusion delivery systems and safety. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:267-302.
3. Emergency Care Research Institute (ECRI). Top 10 technology hazards 2015. https://www.ecri.org/Pages/2015-Hazards.aspx.
4. Phillips LD, Gorski LA. *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014: 285-299.
5. 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. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:28-33.
6. Broadhurst D. Transition to an elastomeric infusion pump in home care. *J Infus Nurs*. 2012;35(3):143-151.
7. US Food and Drug Administration. Infusion pump risk reduction strategies. http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/GeneralHospitalDevicesandSupplies/InfusionPumps/ucm202498.htm.
8. Hicks R, Becker S. An overview of intravenous-related medication administration errors as reported to MEDMARK®, a national medication error-reporting program. *J Infus Nurs*. 2006;29(1):20-27.
9. Hertzel C, Sousa VD. Use of smart pumps for preventing medication errors. *J Infus Nurs*. 2009;32(5):257-267.
10. Murdoch LJ, Cameron VL. Smart infusion technology: a minimum safety standard for intensive care? *Br J Surg*. 2008;17(10):630-636.
11. Rothschild JM, Keohane CA, Cook EF, et al. A controlled trial of smart infusion pumps to improve medication safety in critically ill patients. *Crit Care Med*. 2005;33(3):679-680.
12. Nuckols T, Bower A, Paddock S, et al. Programmable infusion pumps in ICUs: an analysis of corresponding adverse drug events. *J Gen Intern Med*. 2007;23(suppl 1):41-45.
13. Institute for Healthcare Improvement. Reduce adverse drug events (ADEs) involving intravenous medications. http://www.ihi.org/resources/Pages/Changes/ReduceAdverseDrugEventsInvolvingIntravenousMedications.aspx. Published 2015.
14. Iian R, Fowler FA, Ferguson ND, et al. Prolonged time to alarm in infusion devices operated at low flow rates. *Crit Care Med*. 2008;36(10):2763-2765.
15. Pennsylvania Patient Safety Reporting System. IV infiltration: be alarmed even when your infusion pump isn't. *Patient Saf Advis*. 2007;4(3):1-4.
16. Huber C. IV infusion alarms: don't wait for the beep. *Am J Nurs*. 2009;109(4):32-33.
17. Bowcutt M, Rosenkoetter MM, Chernecky CC, Wall J, Wynn D, Serrano C. Implementation of an intravenous medication infusion pump system: implications for nursing. *J Nurs Manage*. 2008;16(2):188-197.
18. Carayon P, Hundt A, Wetterneck T. Nurses' acceptance of smart IV pump technology. *Int J Med Inform*. 2010(6);79(6):401-411.
19. Nemeth C, Nunnally M, Bitan Y, Nunnally S, Cook RI. Between choice and chance: the role of human factors in acute care equipment decisions. *J Patient Saf*. 2009;5(2):114-121.
20. Breland B. Continuous quality improvement using intelligent infusion pump data analysis. *Am J Health Syst Pharm*. 2010;67(17):1446-1455.
21. Skledar S, Niccolai C, Schilling D, et al. Quality-improvement analytics for intravenous infusion pumps. *Am J Health Syst Pharm*. 2013;70(8):680-686.
22. Adachi W, Lodolce AE. Use of failure mode and effects analysis in improving the safety of IV drug administration. *Am J Health Syst Pharm*. 2005;62(9):917-920.
23. Elias B, Moss J. Smart pump technology: what we have learned. *Comput Inform Nurs*. 2011;29(3):184-190.
24. US Food and Drug Administration. Manufacturer and user facility device experience (MAUDE). http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfMAUDE/search.CFM. Updated August 15, 2015.
25. Cvach M. Monitor alarm fatigue: an integrative review. *Bio Med Instrum Technol*. 2012;46(4):268-277.
26. US Food and Drug Administration. Infusion pump risk reduction strategies for home health nurses. http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/GeneralHospitalDevicesandSupplies/InfusionPumps/ucm205411.htm. Published April 22, 2010.
27. US Food and Drug Administration. Home healthcare medical devices: a checklist. http://www.fda.gov/medicaldevices/productsandmedicalprocedures/homehealthandconsumer/ucm070217.htm. Updated May 5, 2015.

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 Criteria

A. Use blood and fluid warmers only when warranted by patient history, clinical condition, and prescribed therapy including, but not limited to, avoiding or treating hypothermia intraoperatively, 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.[1-11] (II)

B. Use only a US Food and Drug Administration (FDA)-cleared blood warming device when clinically indicated and in accordance with the manufacturer's directions for use, such as with large-volume or rapid transfusions, exchange transfusions, patients with clinically significant conditions, and the neonate/pediatric population. The risk for clinically important hypothermia is increased when blood is transfused through a central vascular access device (CVAD) (see Standard 62, *Transfusion Therapy*).[1,5,11,12] (V)

C. Use blood and fluid warmers equipped with warning systems, including an audible alarm and visual temperature gauges and within the maintenance date.[12] (V)

D. Do not use warming methods not expressly designed for blood and fluid warming including, but not limited to, microwave ovens, hot water baths, and other devices because temperatures and infection risks cannot be controlled.[1,4,12] (V)

E. Do not warm solutions and blood above a set point temperature recommended by the manufacturer of the warming device.[8] (V)

F. Warming of contrast media is sometimes performed in the radiology or surgical environment to reduce the viscosity and may help to reduce extravasation of higher-viscosity contrast media. When contrast media is warmed, use a temperature log for the warmer, and follow the device manufacturer's guidelines for maintenance of the warming device. Consult the manufacturer's package insert for the specific contrast agent regarding whether warming is contraindicated.[13,14] (V)

REFERENCES

Note: All references in this section were accessed August 26, 2015.

1. AABB. *Standards for Blood Banks and Transfusion Services*. 29th ed. Bethesda, MD: AABB; 2014.
2. AABB. *Primer of Blood Administration (Revised September 2010)*. Bethesda, MD: AABB; 2010.
3. Smith C, Wagner K. Principles of fluid and blood warming in trauma. *Int Trauma Care*. 2008;18(1):71-79.
4. ECRI Institute. Suggested guidelines for blood warmer use. http://www.mdsr.ecri.org/summary/detail.aspx?doc_id=8269.
5. Maynard K. Administration of blood components. In: Fung MK, Grossman BJ, Hillyer CD, Westhoff CM, eds. *American Association of Blood Banks Technical Manual*. 18th ed. Bethesda, MD: AABB; 2014:545-559.
6. Hasankhani H, Mohammadi E, Moazzami F, Mokhtari M, Naghgizadh MM. The effects of intravenous fluids temperature on perioperative hemodynamic situation, post-operative shivering, and recovery in orthopaedic surgery. *Can Oper Room Nurs J*. 2007;25(1):20-27.
7. Woolnough M, Allam J, Hemingway M, Cox M, Yentis SM. Intra-operative fluid warming in elective caesarean section: a blinded randomized controlled trial. *Int J Obstet Anesth*. 2009;18(4):346-351.
8. Torossian A. Thermal management during anaesthesia and thermoregulation standards for the prevention of inadvertent perioperative hypothermia. *Best Pract Res Clin Anesth*. 2008;22(4):659-668.
9. Self W, White S, McNaughton C, Storrow A, Slovis C, Collins S. Warming intravenous fluids for improved patient comfort in the emergency department: a pilot crossover randomized controlled trial. *West J Emerg Med*. 2013;14(5):542-546.
10. Jeong S-M, Hahm K-D, Jeong Y-B, Yang H-S, Choi I-C. Warming of intravenous fluids prevents hypothermia during off-pump coronary artery bypass graft surgery. *J Cardiothoracic Vasc Anesth*. 2008;22(1):67-70.
11. Trick N. Blood component therapy. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:242-262.
12. ASTM International. ASTM F2172-02(2011): standard specification for blood/intravenous fluid/irrigation fluid warmers. http://www.astm.org/Standards/F2172.htm. Published 2011.
13. Davenport M, Wang C, Bashir M, Neville A, Paulson E. Rate of contrast material extravasations and allergic-like reactions: effect of extrinsic warming of low-osmolality iodinated CT contrast material to 37°. *Radiology*. 2012;262(2):475-484.
14. American College of Radiology. ACR Manual on Contrast Media. Version 10.1, 2015. http://www.acr.org/~/media/37D84428BF1D4E1B9A3A2918DA9E27A3.pdf.

Section Five: Vascular Access Device (VAD) Selection and Placement

Section Standards

I. To ensure patient safety, the clinician is competent in the use and placement of vascular access devices (VADs), including knowledge of anatomy, physiology, and appropriate infusion therapies for each type of VAD.
II. Indications and protocols for VAD selection and placement are established in organizational policies, procedures, and/or practice guidelines and according to manufacturers' directions for use.

26. VASCULAR ACCESS DEVICE (VAD) PLANNING

Standard

26.1 The appropriate type of vascular access device (VAD), peripheral or central, is selected to accommodate the patient's vascular access needs based on the prescribed therapy or treatment regimen; anticipated duration of therapy; vascular characteristics; and patient's age, comorbidities, history of infusion therapy, preference for VAD location, and ability and resources available to care for the device.
26.2 Selection of the most appropriate VAD occurs as a collaborative process among the interprofessional team, the patient, and the patient's caregiver(s).
26.3 The VAD selected is of the smallest outer diameter with the fewest number of lumens and is the least invasive device needed for the prescribed therapy.
26.4 Peripheral vein preservation is considered when planning for vascular access.
26.5 Safety-engineered devices are selected and consistently activated and/or used.

Practice Criteria

I. Short Peripheral Catheters

A. Choose a short peripheral catheter as follows:
   1. Consider the infusate characteristics (eg, irritant, vesicant, osmolarity) in conjunction with anticipated duration of infusion therapy (eg, less than 6 days) and availability of peripheral vascular access sites.[1-7] (IV)
   2. Use vascular visualization technology (eg, near infrared, ultrasound) to increase success for patients with difficult venous access (refer to Standard 22, *Vascular Visualization*).
   3. Do not use peripheral catheters for continuous vesicant therapy, parenteral nutrition, or infusates with an osmolarity greater than 900 mOsm/L (see Standard 58, *Antineoplastic Therapy*; Standard 61, *Parenteral Nutrition*).[1-3, 6-8] (IV)

B. Select the smallest-gauge peripheral catheter that will accommodate the prescribed therapy and patient need[1,4]: (V)
   1. Consider a 20- to 24-gauge catheter for most infusion therapies. Peripheral catheters larger than 20 gauge are more likely to cause phlebitis.[1-4,9] (IV)
   2. Consider a 22- to 24- gauge catheter for neonates, pediatric patients, and older adults to minimize insertion-related trauma.[1-4] (V)
   3. Consider a larger-gauge catheter (16-20 gauge) when rapid fluid replacement is required, such as with trauma patients, or a fenestrated catheter for a contrast-based radiographic study.[1-4,10] (IV)
   4. Use a 20- to 24- gauge catheter based on vein size for blood transfusion: when rapid transfusion is required, a larger-size catheter gauge is

recommended (refer to Standard 62, *Transfusion Therapy*)

5. Use steel winged devices only for single-dose administration. The device is not left in place.[1-3,5] (IV)

II. Midline Catheters

A. Choose a midline catheter as follows:
   1. Consider infusate characteristics in conjunction with anticipated duration of treatment (eg, 1-4 weeks).[1-3,5] (IV)
   2. Consider a midline catheter for medications and solutions such as antimicrobials, fluid replacement, and analgesics with characteristics that are well tolerated by peripheral veins.[11-14] (V)
   3. Do not use midline catheters for continuous vesicant therapy, parenteral nutrition, or infusates with an osmolarity greater than 900 mOsm/L (see Standard 61, *Parenteral Nutrition*).[1-3, 6,11] (V)
   4. Use caution with intermittent vesicant administration due to risk of undetected extravasation. The administration of vancomycin for less than 6 days through a midline catheter was found to be safe in 1 study.[1-3, 15] (IV)
   5. 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.[1,16-17] (IV)

III. Central Vascular Access Devices (CVADs) (Nontunneled, Tunneled, Implanted Ports)

A. Use CVADs to administer any type of infusion therapy.[3,6,17] (V)

B. To minimize unnecessary CVAD placement, identify an evidence-based list of indications for CVAD use including, but not limited to[18]: (IV)
   1. Clinical instability of the patient and/or complexity of infusion regimen (multiple infusates).
   2. Episodic chemotherapy treatment anticipated for more than 3 months.
   3. Prescribed continuous infusion therapy (eg, parenteral nutrition, fluid and electrolytes, medications, blood or blood products).
   4. Invasive hemodynamic monitoring.
   5. Long-term intermittent infusion therapy (eg, any medication including anti-infectives in patients with a known or suspected infection).
   6. History of failed or difficult peripheral venous access, if use of ultrasound guidance has failed.

C. Recognize risks with peripherally inserted central catheters (PICCs), including venous thrombosis and an increased risk for central line-associated bloodstream infection (CLABSI) in hospitalized patients.
   1. Use a PICC with caution in patients who have cancer or are critically ill due to venous thrombosis and infection risk.[19,20] (III)
   2. Measure the vein diameter using ultrasound before insertion and consider choosing a catheter with a catheter-to-vein ratio of 45% or less (refer to Standard 52, *Central Vascular Access Device [CVAD]-Associated Venous Thrombosis*).
   3. Do not use a PICC as an infection prevention strategy.[18,20] (III)

D. Collaborate with the interprofessional team to consider anti-infective CVADs in the following circumstances, as anti-infective CVADs have shown a decrease in colonization and/or CLABSI in some settings.[5,18] (I)
   1. Expected dwell of more than 5 days.
   2. CLABSI rate remains high even after employing other preventive strategies.
   3. Patients with enhanced risk of infection (ie, neutropenic, transplant, burn, or critically ill patients).
   4. Emergency insertions.
   5. Do not use anti-infective CVADs in patients with allergies to the anti-infective substances, such as chlorhexidine, silver sulfadiazine, rifampin, or minocycline.

E. Consider an implanted vascular access port for patients who are anticipated to require intermittent long-term infusion therapy (eg, antineoplastic therapy). When used intermittently, ports have a lower incidence of catheter-related bloodstream infection (CR-BSI); however, continuous port access has infection rates that are similar to other long-term CVADs.[3,6,21-23] (IV)
   1. Contraindications to vascular access port insertion include severe uncorrectable coagulopathy, uncontrolled sepsis or positive blood culture, and burns, trauma, or neoplasm that preclude chest wall placement.[22-23] (V)
   2. Radiologically guided insertion of implanted vascular access ports in the forearm may be an alternative site for patients in whom chest ports cannot be implanted.[24] (IV)
   3. The implanted vascular access port, when not accessed, has the advantage of allowing for ease of bathing and swimming and is associated with an improved patient self-image.[2,17] (V)

F. Consider a cuffed, tunneled CVAD for patients who are anticipated to require intermittent or continuous long-term infusion therapy (eg, antineoplastic therapy, parenteral nutrition).[6,17,25] (V)

G. Consider the need for a CVAD that is designed for power injection and know the pressure limits and other limitations (eg, maximum number of power injections) of the device and all attached or add-on devices (eg, implanted port access needle, extension

set, needleless connector) to avoid catheter rupture.[26-27] (V)

H. Plan proactively for a fistula or graft for patients with chronic kidney disease (CKD) as a permanent access for dialysis (refer to Standard 29, *Hemodialysis Vascular Access Devices [VADs]*).

IV. Arterial Catheters

A. Place 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.[5] (V)

B. The most commonly used catheter gauge for radial catheters is a 20-gauge catheter; a low rate of complications was documented in one large study.[28] (V)

REFERENCES

Note: All electronic references in this section were accessed August 31, 2015.

1. Perucca, R. Peripheral venous access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:456-479.
2. Hagle ME, Mikell M. Peripheral venous access. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:303-334.
3. Alexander M, Gorski L, Corrigan A, Bullock M, Dickenson A, Earhart A. Technical and clinical application. In: Alexander M, Corrigan M, Gorski L, Phillips L, eds. *Core Curriculum for Infusion Nursing*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:1-85.
4. Fabian B. Infusion therapy in the older adult. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:571-582.
5. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
6. Chopra V, Flanders SA, Saint S, et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from an international panel using the RAND/UCLA Appropriateness Method. *Ann Intern Med*. 2015;163(suppl 6):S1-S39.
7. Gorski L, Hagle M, Bierman S. Intermittently delivered IV medication and pH: reevaluating the evidence. *J Infus Nurs*. 2015;38(1):27-46.
8. Boullata JI, Gilbert K, Sacks G, Labossiere RJ, Crill C, Goday P; American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) A.S.P.E.N. clinical guidelines: parenteral nutrition ordering, order review, compounding, labeling, and dispensing. *J Parenter Enteral Nutr*. 2014. doi:10.1177/0148607114521833.
9. Wallis MC, McGrail M, Webster J. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from an RCT. *Infect Control Hosp Epidemiol*. 2014;35(1):63-68.
10. Johnson P, Christensen G, Fishman E. IV 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. *Am J Roentgenol*. 2014;202(6):1166-1170.
11. Alexandrou E, Ramjan L, Spencer T, et al. The use of midline catheters in the adult acute care setting: clinical implications and recommendations for practice. *J Assoc Vasc Access*. 2011;16(1):35-41.
12. Sharp R, Esterman A, McCutcheon H, Hearse N. The safety and efficacy of midlines compared to peripherally inserted central catheter for adult cystic fibrosis patients: a retrospective, observational study. *Int J Nurs Stud*. 2014;51(5):694-702.
13. 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 Clin Res*. 2013;191(1):1-5.
14. Cummings M, Hearse N, McCutcheon H, Deuter K. Improving antibiotic treatment outcomes through the implementation of a midline: piloting a change in practice for cystic fibrosis patients. *J Vasc Nurs*. 2011;29(1):11-15.
15. Caparas JV, Hu JP. Safe administration of vancomycin through a novel midline catheter: a randomized, prospective clinical trial. *J Assoc Vasc Access*. 2014;15(4):251-256.
16. National Kidney Foundation Vascular Access Work Group; Kidney Disease Outcomes Quality Initiative (KDOQI). Clinical practice guidelines and recommendations for vascular access. *Am J Kidney Dis*. 2006;48(1)(suppl 1):S248-S273.
17. Bullock-Corkhill M. Central vascular access device access and insertion. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:480-494.
18. 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. http://www.jstor.org/stable/10.1086/676533.
19. Chopra V, Anand S, Hickner A, et al. Risk of venous thromboembolism associated with peripherally inserted central catheters: a systemic review and meta-analysis. *Lancet*. 2013;382(9889):311-325.
20. Chopra V, O'Horo J, Rogers M, et al. 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.
21. Loveday H, Wilson J, Pratt M, et al. epic3: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect*. 2013;86(suppl 1):S1-S70.
22. Walser E. Venous access ports: indications, implantation technique, follow-up, and complications. *Cardiovasc Intervent Radiol*. 2012;35(4):751-764.
23. Piran S, Ngo V, McDiarmid S, LeGal G, Petrcich W, Carrier M. Incidence and risk factors of symptomatic venous thromboembolism related to implanted ports in cancer patients. *Thromb Res*. 2014;133:30-33.
24. Wildgruber M, Borgmeyer S, Haller B, et al. Short-term and long-term outcome of radiological-guided insertion of central venous access port devices implanted at the forearm: a retrospective monocenter analysis in 1794 patients. *Eur Radiol*. 2015;25:606-616.

25. Moller T, Adamsen L. Hematologic patients' clinical and psychosocial experiences with implanted long-term central venous catheter. *Cancer Nurs*. 2010;33(6):426-435.
26. Slaby J, Navuluri R. Chest port fracture caused by power injection. *Semin Intervent Radiol*. 2011;28(3):357-358.
27. Smith L. Implanted ports, computed tomography, power injectors, and catheter rupture. *Clin J Oncol Nurs*. 2008;12(5):809-812.
28. Nuttall G, Burckhardt J, Kane HA, et al. Surgical and patient risk factors for severe arterial line complications in adults. *Anesthesiology*. 2015 Dec 4. [Epub ahead of print]

27. SITE SELECTION

Standard

27.1 Select the vein or site that best accommodates the outer diameter and length of the vascular access device (VAD) required for the prescribed therapy.
27.2 Peripheral vein preservation is considered when selecting a site for infusion therapy.
27.3 Assess the patient's condition; age; diagnosis; comorbidities; condition of the vasculature at the insertion site and proximal to the intended insertion site; condition of skin at intended insertion site; history of previous venipunctures and access devices; type and duration of infusion therapy; and patient preference for VAD site selection.
27.4 Placement of central vascular access devices (CVADs) by clinicians competent in the procedure is established in organizational policies, procedures, and/or practice guidelines and in accordance with rules and regulations promulgated by the state's Board of Nursing or other licensing agency.

Practice Criteria

I. Peripheral Venous Access via Short Peripheral Catheters

A. For adult patients:
   1. Use the venous site most likely to last the full length of the prescribed therapy, using the forearm to increase dwell time, decrease pain during dwell time, promote self-care, and prevent accidental removal and occlusions. Consider veins found on the dorsal and ventral surfaces of the upper extremities, including the metacarpal, cephalic, basilic, and median veins.[1-9] (IV)
   2. Do not use veins of the lower extremities unless necessary due to risk of tissue damage, thrombophlebitis, and ulceration.[3,10,11] (IV)

B. For pediatric patients:
   1. Use the venous site most likely to last the full length of the prescribed therapy, considering veins in the hand, forearm, and upper arm below the axilla. Avoid the antecubital area, which has a higher failure rate.
   2. For infants and toddlers, also consider veins of the scalp, and if not walking, the foot.
   3. Avoid the hand or fingers, or the thumb/finger used for sucking.
   4. Avoid veins in the right arm of infants and children after procedures treating congenital cardiac defects that may have decreased blood flow to the subclavian artery.[5,12-15] (V)

C. For all patients:
   1. Discuss with the patient the arm preference for VAD site selection, including a recommendation to use sites in the nondominant arm.[6,7,16,17] (V)
   2. Avoid the ventral surface of the wrist due to pain on insertion and possible nerve damage (refer to Standard 47, *Nerve Injuries)*.
   3. Avoid areas of flexion and areas of pain on palpation; avoid compromised areas and sites distal to these compromised areas, such as areas with open wounds; areas on an extremity with an infection; veins that are compromised (eg, bruised, infiltrated, phlebitic, sclerosed, corded, or engorged); areas of valves; areas of previous infiltration or extravasation; and areas of planned procedures.[3,4,7,11,13,18] (V)
   4. Avoid veins in an upper extremity on the side of breast surgery with axillary node dissection, with lymphedema, or with an arteriovenous fistula/graft; after radiation therapy to that side of the body; or the affected extremity from a cerebrovascular accident. For patients with chronic kidney disease, avoid unnecessary venipuncture of peripheral veins in the upper extremity intended for future vascular access. A collaborative discussion with the patient and the licensed independent practitioner (LIP) is needed to discuss the benefits and risks of using a vein in an affected extremity (see Standard 29, *Hemodialysis Vascular Access Devices [VADs]*).[7,19-25] (V)
   5. Cannulation of hemodialysis fistulas, grafts, and catheters for infusion therapy requires the order of a nephrologist or LIP, unless an emergency situation exists.[7,25] (V)
   6. Use ultrasonography (US) for short peripheral catheter placement in adult and pediatric patients with difficult venous access and/or after failed venipuncture attempts (see Standard 22, *Vascular Visualization*).[26-31] (I)

II. Peripheral Venous Access via Midline Catheters

A. Select sites in the upper arm, preferred, or secondarily the region of the antecubital fossa, using the basilic, cephalic, median cubital, and brachial veins, with the basilic vein preferred. For neonates and pediatric patients, additional site selections include veins in the leg with the tip below the groin and in the scalp with the tip in the neck, above the thorax.[7,12,13,32-34] (V)
B. Avoid cannulation in areas with pain on palpation, areas of open wounds, areas on an extremity with an

infection, veins that are compromised (eg, bruised, infiltrated, phlebitic, sclerosed, corded, or engorged), and areas of planned procedures.[3,7,11,12] (V)

C. Avoid veins in the right arm of infants and children after procedures treating specific congenital cardiac defects that may have decreased blood flow to the subclavian artery.[12] (V)

D. Consider using vascular visualization technologies that aid in vein identification and selection for difficult intravenous access (see Standard 22, *Vascular Visualization*).[27,28,31] (I)

III. Central Venous Access via Peripherally Inserted Central Catheters

A. Select the median cubital, cephalic, basilic, and brachial veins with sufficient size for peripherally inserted central catheters (PICC) cannulation. A venous site in adults where the catheter-to-vein ratio is equal to or less than 45% is recommended. For neonate and pediatric patients, additional site selections include the axillary vein, the 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: upper and lower extremities have similar complication rates, although tip placement at removal was more frequently noncentral for PICCs in upper extremities.[35-40] (IV)

B. Avoid areas of pain on palpation or areas with wounds, and veins that are compromised (eg, bruised, infiltrated, phlebitic, sclerosed, corded, or engorged).[3,41] (IV)

C. Avoid PICCs in patients with chronic kidney disease due to the risks of central vein stenosis and occlusion, as well as resultant venous depletion preventing future fistula construction (see Standard 29, *Hemodialysis Vascular Access Devices [VADs]*).[19,22,42,43] (IV)

D. Use ultrasound (US) to aid in vein identification and selection for decreased adverse events and first-attempt success (see Standard 22, *Vascular Visualization*).[36,39,44-46] (IV)

IV. Central Venous Access via Nontunneled Central Vascular Access Devices

A. To minimize the risk of catheter-related infection with a nontunneled CVAD, the subclavian vein is favored in adult patients, rather than the jugular or femoral veins. However, for patients with chronic kidney disease, consider the risks of central vein stenosis and venous occlusion when the subclavian vein is used; weigh the benefits and risks that accompany each access site. Avoid areas of wounds or infections (see Standard 29, *Hemodialysis Vascular Access Devices [VADs]*; Standard 48, *Central Vascular Access Device [CVAD] Occlusion*).[11,19,41,47-49] (I)

B. To minimize the risk of catheter-related thrombotic complications with a nontunneled CVAD, the subclavian vein is recommended in adult patients, rather than the femoral vein.[47] (I)

1. If the patient has chronic kidney disease, consider the internal jugular vein or, secondarily, the external jugular vein, weighing benefits and risks for each access site.[22] (V)

C. There is no preferred venous insertion site for a nontunneled CVAD in infants and children to minimize the risk of infection.[11] (V)

D. Use ultrasound (US) in adult patients for vein identification and selection to decrease risks of cannulation failure, arterial puncture, hematoma, and hemothorax (see Standard 22, *Vascular Visualization*).[46,50-52] (I)

V. Central Venous Access via Tunneled Central Vascular Access Devices and Implanted Ports

A. Collaborate with the health care team and patient in assessment and site selection for the placement of tunneled catheters and implanted ports. Use the subclavicular or medial inframammary sites in children to reduce complications.[23,53-55] (IV)

VI. Peripheral Arterial Access

A. Include as selection criteria from physical assessment the presence of a pulse and presence of distal circulation.[3,56] (I A/P)

B. For adults, the radial artery is the most appropriate access for percutaneous cannulation, with the brachial artery followed by the dorsalis pedis as alternative sites. For pediatric patients, use the radial, posterior tibial, and dorsalis pedis arteries. For adults and children, these sites are preferred over the femoral or axillary sites to reduce the risk of infection. The brachial artery is not used in pediatric patients due to the absence of collateral blood flow.[27,57,58] (III)

1. Prior to puncture of the radial artery, assess the circulation to the hand. Review the medical history (eg, trauma, previous radial artery cannulation, radial artery harvesting); assess for the use of anticoagulants; and perform a physical examination of hand circulation such as assessing radial and ulnar pulses, and performing the Allen test, pulse oximetry, or Doppler flow study (refer to Standard 43, *Phlebotomy)*.

C. Do not administer infusion therapy in peripheral arteries via peripheral arterial catheters; these catheters are used for hemodynamic monitoring, blood gas analysis, and obtaining blood samples.[3,59] (V)

D. Use US in arterial identification and selection to increase first-attempt success (see Standard 22, *Vascular Visualization*).[60-62] (I)

VII. External Jugular Vein Access

A. Clinicians having validated competency may insert short peripheral catheters, midline catheters, and PICCs using the external jugular vein in patients in acute care settings and in emergency situations when other veins cannot be accessed.[3,63,64] (V)

B. When a short peripheral catheter is inserted into the external jugular vein and infusion therapy is expected to exceed 96 hours, collaborate with the LIP for an alternative vascular access site as soon as possible.[7,21,63] (V)

REFERENCES

Note: All electronic references in this section were accessed September 22, 2015.

1. 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.
2. Fields JM, Dean AJ, Todman RW, et al. The effect of vessel depth, diameter, and location on ultrasound-guided peripheral intravenous catheter longevity. *Am J Emerg Med*. 2012;30(7): 1134-1140.
3. Hadaway L. Anatomy and physiology related to infusion therapy: In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:139-177.
4. Hagle ME, Mikell M. Peripheral venous access. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:303-334.
5. 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.
6. Marsigliese AM. Evaluation of comfort level and complication rates as determined by peripheral intravenous catheter sites. *Can Intraven Nurs Assoc Yearbook*. 2001;17:26-39.
7. Perucca R. Peripheral venous access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:456-479.
8. Salgueiro-Oliveira A, Parreira P, Veiga P. Incidence of phlebitis in patients with peripheral intravenous catheters: the influence of some risk factors. *Aust J Adv Nurs*. 2012;30(2):32-39.
9. 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.
10. 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.
11. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
12. Beauman SS, Swanson A. Neonatal infusion therapy: preventing complications and improving outcomes. *Newborn Infant Nurs Rev*. 2006;6(4):193-201.
13. Frey AM, Pettit J. Infusion therapy in children. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:550-570.
14. Germino K, Gerard J, Flood R. Greater saphenous vein location in a pediatric population. *J Pediatr Nurs*. 2012;27(6):626-631.
15. Malyon L, Ullman AJ, Phillips N, et al. Peripheral intravenous catheter duration and failure in paediatric acute care: a prospective cohort study. *Emerg Med Australas*. 2014;26(6): 602-608.
16. Busch JD, Herrmann J, Heller F, et al. Follow-up of radiologically totally implanted central venous access ports of the upper arm: long-term complications in 127,750 catheter-days. *Am J Roentgenol*. 2012;199(2):447-452.
17. O'Halloran L, El-Masri MM, Fox-Wasylyshyn SM. Home intravenous therapy and the ability to perform self-care activities of daily living. *J Infus Nurs*. 2008;31(6):367-374.
18. Redfern WS, Braby JE. Pediatric infusion therapy. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:687-742.
19. American Nephrology Nurses' Association [position statement]. Vascular access for hemodialysis. https://www.annanurse.org/sites/default/files/download/reference/health/position/vascAccess.pdf. Revised October 2013.
20. Camp-Sorrell D, ed. *Access Device Guidelines: Recommendations for Nursing Practice and Education*. 3rd ed. Pittsburgh, PA: Oncology Nursing Society; 2011.
21. Chopra V, Flanders SA, Saint S, et al. The Michigan appropriateness guide for intravenous catheters (MAGIC): results from an international panel using the RAND/UCLA appropriateness method. *Ann Intern Med*. 2015;163(suppl 6): S1-S39.
22. Hoggard J, Saad T, Schon D, Vesely TM, Royer T; American Society of Diagnostic and Interventional Nephrology, Clinical Practice Committee; Association for Vascular Access [position statement]. Guidelines for venous access in patients with chronic kidney disease. *Semin Dial*. 2008;21(2):186-191.
23. Institute of Medicine. Committee on Quality of Health Care in America. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academies Press; 2001.
24. UK Renal Association. Preservation of sites for native vascular access (guidelines 2.1-2.2). In: Clinical practice guideline: vascular access for haemodialysis. 6th ed. http://www.renal.org/docs/default-source/guidelines-resources/final-version-update-va-guidelines-2015-docx-2.pdf?sfvrsn=2. Published 2015.
25. Smith SF, Duell DJ, Martin BC. Hemodialysis (renal replacement therapy). In: Smith SF. *Clinical Nursing Skills: Basic to Advanced Skills*. 8th ed. New York, NY: Pearson; 2012:804-809.
26. Bauman M, Braude D, Crandall C. Ultrasound-guidance vs. standard technique in difficult vascular access patients by ED technicians. *Am J Emerg Med*. 2009;27(2):135-140.
27. Egan G, Healy D, O'Neill H, Clarke-Moloney M, Grace PA, Walsh SR. Ultrasound guidance for difficult peripheral venous access: systematic review and meta-analysis. *Emerg Med J*. 2013; 30(7):521-526.
28. 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.
29. 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.
30. Moore C. An emergency department nurse-driven ultrasound-guided peripheral intravenous line program. *J Assoc Vasc Access*. 2013;18(1):45-51.
31. 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.
32. Alexandrou E, Ramjan L, Spencer T, et al. The use of midline catheters in the adult acute care setting: clinical implications and recommendations for practice. *J Assoc Vasc Access*. 2011(1);16:35-41.
33. 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.
34. Owen K. The use of 8 cm midlines in community IV therapy. *Br J Nurs*. 2014;23:S18-S20.
35. Bullock-Corkhill M. Central venous access devices: access and insertion. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:480-494.
36. Dawson R. 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.
37. Liem TK, Yanit KE, Moseley SE, et al. Peripherally inserted central catheter usage patterns and associated symptomatic upper extremity venous thrombosis. *J Vasc Surg*. 2012;55(3):761-767.
38. 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.
39. 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.
40. Wrightson DD. Peripherally inserted central catheter complications in neonates with upper versus lower extremity insertion sites. *Adv Neonatal Care*. 2013;13(3):198-204.
41. 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.
42. El Ters M, Schears GJ, Taler SJ, et al. Association between prior peripherally inserted central catheters and lack of functioning arteriovenous fistulas: a case-control study in hemodialysis patients. *Am J Kidney Dis*. 2012;60(4):601-608.
43. 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.
44. Association for Vascular Access Board of Directors [position statement]. The use of ultrasound guidance by registered nurses for central venous catheter insertion. http://www.avainfo.org/website/download.asp?id=279996.
45. de Carvalho Onofre P, da Luz Gonçalves Pedreira M, Peterlini M. Placement of peripherally inserted central catheters in children guided by ultrasound: a prospective randomized, and controlled trial. *Pediatr Crit Care Med*. 2012;13(5):e282-e287.
46. Shekelle PG, Wachter RM, Pronovost PJ, et al. Making health care safer II: an updated critical analysis of the evidence for patient safety practices. *Evid Rep Technol Assess (Full Rep)*. 2013;(211):1-945.
47. 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;(3):CD004084. doi:10.1002/14651858.CD004084.pub3.
48. Parienti JJ, du Cheyron D, Timsit JF, et al. Meta-analysis of subclavian insertion and nontunneled central venous catheter-associated infection risk reduction in critically ill adults. *Crit Care Med*. 2012;40(5):1627-1634.
49. Marik PE, Flemmer M, Harrison W. The risk of catheter-related bloodstream infection with femoral venous catheters as compared to subclavian and internal jugular venous catheters: a systematic review of the literature and meta-analysis. *Crit Care Med*. 2012;40(8):2479-2485.
50. Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for subclavian or femoral vein catheterization. *Cochrane Database Syst Rev*. 2015;(1):CD011447. doi:10.1002/14651858.CD011447.
51. Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization. *Cochrane Database Syst Rev*. 2015;(1):CD006962. doi:10.1002/14651858.CD006962.pub2.
52. Wu SY, Ling Q, Cao LH, Wang J, Xu MX, Zeng WA. Real-time two-dimensional ultrasound guidance for central venous cannulation: a meta-analysis. *Anesthesiology*. 2013;118(2):361-375. doi:10.1097/ALN.0b013e31827bd172.
53. Fallon SC, Larimer EL, Gwilliam NR, et al. Increased complication rates associated with Port-a-Cath placement in pediatric patients: location matters. *J Pediatr Surg*. 2013;48(6):1263-1268.
54. Maurer M, Dardess P, Carman, KL, et al. *Guide to Patient and Family Engagement: Environmental Scan Report*. Rockville, MD: Agency for Healthcare Research and Quality; May 2012. AHRQ publication 12-0042-EF.
55. Plumhans C, Mahnken AH, Ocklenburg C, et al. Jugular versus subclavian totally implantable access ports: catheter position, complications and intrainterventional pain perception. *Eur J Radiol*. 2011;79(3):338-342.
56. Ball JW, Dains JE, Flynn JA, Solomon BS, Stewart RW. Blood vessels. In: *Seidel's Guide to Physical Examination*. 8th ed. New York, NY: Mosby; 2015.
57. O'Horo J, Maki D, Krupp A, Safdar N. Arterial catheters as a source of bloodstream infection: a systematic review and meta-analysis. *Crit Care Med*. 2014;42(6):1334-1339.
58. Lorente L, Santacreu R, Martin M, Jimenez A, Mora M. Arterial catheter-related infection of 2,949 catheters. *Crit Care*. 2006;10(3):1-7. http://ccforum.com/content/10/3/R83.
59. Hadaway L. Infusion therapy equipment. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:391-436.
60. Gao YB, Yan JH, Gao FQ, Pan L, Wang XZ, Lv CJ. Effects of ultrasound-guided radial artery catheterization: an updated meta-analysis. *Am J Emerg Med*. 2015;33(1):50-55.
61. Gu WJ, Tie HT, Liu JC, Zeng XT. Efficacy of ultrasound-guided radial artery catheterization: a systematic review and meta-analysis of randomized controlled trials. *Crit Care*. 2014;18(3):R93.
62. Shiloh AL, Savel RH, Paulin LM, Eisen LA. Ultrasound-guided catheterization of the radial artery: a systematic review and meta-analysis of randomized controlled trials. *Chest*. 2011;139(3):524-529.
63. Infusion Nurses Society [position paper]. The role of the registered nurse in the insertion of external jugular peripherally

inserted central catheters and external jugular peripheral intravenous catheters. *J Infus Nurs*. 2008;31(4):226-227.
64. Tecklenburg F, Cochran J, Webb S, Habib D, Losek J. Central venous access via external jugular vein in children. *Pediatr Emerg Care*. 2010;26(8):554-557.

28. IMPLANTED VASCULAR ACCESS PORTS

Standard

28.1 Placement and removal of an implanted vascular access port are considered surgical procedures and are to be performed by a licensed independent practitioner (LIP) or advanced practice registered nurse (APRN) with validated competency operating within the state's rules and regulations for professional practice and according to organizational policies, procedures, and/or practice guidelines.
28.2 Implanted vascular access ports are accessed using noncoring safety needles.
28.3 Only implanted vascular access ports and noncoring needles designed for power injection are used with power-injection equipment for radiologic imaging in accordance with manufacturers' directions for use.
28.4 A sterile dressing is maintained over the access site if the implanted vascular access port remains accessed.

Practice Criteria

A. Confirm that the implanted port has a labeled indication for power injection before using it for this purpose.[1,2] (V)
   1. Use at least 2 identification methods that may include presence of identification cards, wristbands, or key chains provided by the manufacturer; review operative procedure documentation; and palpate the port.
   2. Do not use palpation of the port as the only identification method as not all power-injection-capable implanted vascular access ports have unique characteristics identifiable by palpation.
   3. During and after power injection be aware of the potential for catheter rupture, which can lead to extravasation, catheter fragment emboli, 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*]).

B. Assess patient needs and preferences related to pain management during port access (refer to Standard 32, *Local Anesthesia for Vascular Access Device [VAD] Placement and Access*).

C. Adhere to aseptic technique during implanted port access, including use of sterile gloves and mask.[3,4] (V, Committee Consensus)
   1. Perform hand hygiene before and after examining the site to assess for swelling, erythema, drainage, venous patterns, or discomfort.[5,6] (V)
   2. Perform skin antisepsis prior to port access.
      a. Use the preferred skin antiseptic agent of >0.5% chlorhexidine in alcohol solution.[4-7] (I)
      b. If there is a contraindication to alcoholic chlorhexidine, tincture of iodine, an iodophor (povidone-iodine), or 70% alcohol may also be used.[5] (I)
      c. Allow skin antiseptic agent to fully dry prior to port access.[5] (V)

D. Access the implanted vascular access port with the smallest-gauge noncoring needle to accommodate the prescribed therapy.
   1. To reduce the risk of needle dislodgment during access, use a noncoring needle of a length that allows the needle to sit flush to the skin and securely within the port.[7] (V)
   2. Consider orienting the bevel of an implanted port access needle in the opposite direction from the outflow channel where the catheter is attached to the port body. In vitro testing demonstrates a greater amount of protein is removed when flushing with this bevel orientation.[8] (IV)
   3. There is insufficient evidence to recommend an optimal time for replacement of the noncoring needle when the implanted vascular access port is used for continuous infusions.[5] (V)

E. Assess vascular access device (VAD) functionality by 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 (refer to Standard 40, *Flushing and Locking*).

F. Flush and lock the implanted vascular access port with preservative-free 0.9% sodium chloride (USP) or heparin lock solution (refer to Standard 40, *Flushing and Locking*).
   1. Flush accessed but noninfusing implanted vascular access ports daily.[9] (IV)
   2. There is insufficient evidence to recommend the optimal frequency for flushing an implanted vascular access port that is not accessed for infusion; refer to manufacturers' directions for use and organizational policy.[10-12] (V)
   3. Anticipate use of antimicrobial locking solutions for patients who have a history of catheter-related bloodstream infections (CR-BSIs) (refer to Standard 40, *Flushing and Locking*).

G. Use a transparent semipermeable membrane (TSM) dressing or gauze dressing that covers the noncoring needle and access site when the port is accessed. Change the TSM dressing every 5-7 days and gauze dressings every 2 days. When gauze is used under the TSM dressing to support the wings of an access needle and does not obscure the access site, change the TSM dressing every 5-7 days.[5-8,13-16] (IV)

H. Provide appropriate patient/caregiver education including placement procedure; type of port placed (eg, power injectable, number of lumens); importance of carrying port identification card (eg, in wallet); routine care, including frequency of flushing; expectations of aseptic technique during access; use of only noncoring needles (including appropriate type for power injection); and identification of potential complications and interventions.[4,16] (V)

I. Provide appropriate patient/caregiver education for patients who are receiving infusions at home via an accessed port, including checking the dressing daily; how to dress and undress to avoid pulling at the noncoring needle; protecting the site during bathing; making sure women's bra straps do not rub over the accessed area; immediately reporting any signs or symptoms of pain, burning, stinging, or soreness at the site; and recognizing the importance of stopping the infusion pump and immediately reporting any wetness, leaking, or swelling noted at the site (see Standard 8, *Patient Education*).[17] (V)

REFERENCES

Note: All electronic references in this section were accessed August 26, 2015.

1. Slaby J, Navuluri R. Chest port fracture caused by power injection. *Semin Intervent Radiol*. 2011;28(3):357-358.
2. Smith L. Implanted ports, computed tomography, power injectors, and catheter rupture. *Clin J Oncol Nurs*. 2008;12(5):809-812.
3. Eisenberg S. Accessing implanted ports: still a source of controversy. *Clin J Oncol Nurs*. 2011;15(3):324-326.
4. Centers for Disease Control and Prevention. Basic infection control and prevention plan for outpatient oncology settings. http://www.cdc.gov/HAI/settings/outpatient/basic-infection-control-prevention-plan-2011/index.html. Published December 2011.
5. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
6. Bustos C, Aguinaga A, Carmona-Torre F, Pozo J. Long-term catheterization: current approaches in the diagnosis and treatment of port-related infections. *Infect Drug Resistance*. 2014;7:25-35.
7. Bullock-Corkhill M. Central venous access devices: access and insertion. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:480-494.
8. Guiffant G, Durussel J, Flaud P, Vigier J, 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 Evidence Res*. 2012;5:31-37.
9. Goossens G, Jerome M, Janssens C, et al. Comparing normal saline versus heparin to lock non-valved totally implantable venous access devices in cancer patients: a randomized, non-inferiority, open trial. *Ann Oncol*. 2013;24(7):1892-1899.
10. Conway M, McCollom C, Bannon C. Central venous catheter flushing recommendations: a systematic evidence-based practice review. *J Pediatr Oncol Nurs*. 2014;31(4):185-190.
11. Baram A, Majeen G, Abdullah H, Subhi A. Heparin versus saline solutions for locking of totally implantable venous access port (TIVAP): cohort study of the first Kurdistan series of TIVAP. *Adv Lung Cancer*. 2014;3(4):67-74.
12. Rosenbluth G, Tsang L, Vittinghoff E, Wilson S, Wilson-Ganz J, Auerbach A. Impact of decreased heparin dose for flush-lock of implanted venous access port in pediatric oncology patients. *Pediatr Blood Cancer*. 2014;61(5):855-858.
13. Gorski L, Perucca R, Hunter M. Central venous access devices: care, maintenance, and potential complications. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:495-515.
14. Lapalu J, Losser MR, Albert O, et al. Totally implantable port management: impact of positive pressure during needle withdrawal on catheter tip occlusion (an experimental study). *J Vasc Access*. 2010;11(1):46-51.
15. Camp-Sorrell D, ed. *Access Device Guidelines: Recommendations for Nursing Practice and Education*. Pittsburgh, PA: Oncology Nursing Society; 2011.
16. Walser E. Venous access ports: indications, implantation technique, follow-up, and complications. *Cardiovasc Intervent Radiol*. 2012;35(4):751-764.
17. Moller T, Adamsen L. Hematologic patients' clinical and psychosocial experiences with implanted long-term central venous catheter. *Cancer Nurs*. 2010;33(6):426-435.

29. HEMODIALYSIS VASCULAR ACCESS DEVICES (VADs)

Standard

29.1 The selection of the most appropriate type of vascular access device (VAD) for hemodialysis occurs in collaboration with the patient/caregiver and the interprofessional team based on the projected treatment plan.

29.2 Placement and removal of a tunneled or implanted hemodialysis VAD, creation of an arteriovenous (AV) fistula, and insertion of an AV graft are considered surgical procedures and will be performed by a licensed independent practitioner (LIP) with validated competency operating within the state's rules and regulations for professional practice.

29.3 Removal of a temporary nontunneled or nonimplanted hemodialysis VAD is performed either by or upon the order of an LIP in accordance with state licensure rules and regulation and organizational policies.

29.4 Hemodynamic monitoring and venipuncture are not performed on the extremity containing an AV fistula or graft.

Practice Criteria

A. Determine the access method in advance of beginning dialysis. The general order for vascular access preference is fistula, AV graft, and long-term VAD.

The patient/caregiver and interprofessional team should collaborate on the decision to place a hemodialysis VAD or create a means of long-term vascular access for the purpose of hemodialysis.[1-7] (III)

B. Use vein preservation techniques for patients who are likely to need vascular access for hemodialysis. Avoid access devices that are associated with thrombosis and central venous stenosis, such as temporary subclavian vein catheters and peripherally inserted central catheters (PICCs).[1,2,7-9] (I)
C. When feasible, use a matured AV fistula. Variables such as clinical, anatomical, functional, and pathological issues are under study to identify predictors of fistula maturation.[1,2,7,10,11] (IV)
D. Monitor all access devices for signs or symptoms of dysfunction, infection, or other complications at each dialysis session.[1,8] (V)
E. Do not routinely replace temporary catheters used for dialysis.[9] (I)
F. Use povidone-iodine ointment or bacitracin/gramicidin/polymixin ointment at the dialysis catheter exit site when there is no interaction with the catheter material, according to the manufacturer's directions for use.[9] (I)
G. Avoid using a hemodialysis catheter for routine blood sampling, blood transfusions, or other infusion medications. In critically ill patients, a noncuffed catheter with a medial infusion port may be placed for short-term vascular access for infusion therapy needs. Administer medications through the medial infusion port and not the dialysis lumens. Because multiple lumens increase the risk of infection, limit the duration that a dialysis catheter with a medial infusion port is used.[8] (V)
H. Aspirate the locking solution and confirm a blood return before use of a tunneled or nontunneled dialysis catheter.[8] (V)
I. Wear sterile gloves and a mask when performing dressing changes for hemodialysis access devices, including AV fistulas and grafts (when dressings are present). Clean gloves can be worn for accessing a tunneled catheter with an established cuff (see Standard 41, *Vascular Access Device [VAD] Assessment, Care, and Dressing Changes*).[2,6,8] (V)
J. Teach patients/caregivers/surrogates how to care for and protect the VAD and to report any signs and symptoms of dysfunction, infection, or other complications pertaining to the access device in use (see Standard 8, *Patient Education*).[1,2,8] (V)

REFERENCES

Note: All electronic references in this section were accessed August 26, 2015.

1. National Kidney Foundation. KDOQI clinical practice guidelines. Selection and placement of hemodialysis access. NKF; 2006. http://www2.kidney.org/professionals/KDOQI/guideline_upHD_VA/va_guide2.htm.
2. American Nephrology Nurses' Association. Vascular access fact sheet. http://www.annanurse.org/download/reference/practice/vascularAccessFactSheet.pdf. Published 2013.
3. National Institute of Diabetes and Digestive and Kidney Diseases. Vascular access for hemodialysis. http://www.kidney.niddk.nih.gov/kudiseases/pubs/vascularaccess. Published May 2014.
4. Mbamalu G, Whiteman K. Vascular access team collaboration to decrease catheter rates in patients on hemodialysis: utilization of Kotter's change process. *Nephrol Nurs J*. 2014;41(3):283-287.
5. United States Renal Data Center. Clinical indicators and preventive care. http://www.usrds.org/2014/view/v2_03.aspx. Published 2014.
6. Lincoln M. Preventing catheter-associated bloodstream infections in hemodialysis centers: the facility perspective. *Nephrol Nurs J*. 2011;38(5):411-415.
7. Santoro D, Benedetto F, Mondello P, et al. Vascular access for hemodialysis: current perspectives. *Int J Nephrol Renovascular Dis*. 2014;4(7):281-294.
8. Robson J. A review of hemodialysis vascular access devices. *J Infus Nurs*. 2013;36(6):404-410.
9. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
10. Dember L, Imrey B, Beck G, et al. Objectives and design of the hemodialysis fistula maturation study. *Am J Kidney Dis*. 2014;63(1):104-112.
11. Schinstock C, Albright R, Williams A, et al. Outcomes of arteriovenous fistula creation after the Fistula First initiative. *Clin J Am Soc Nephrol*. 2011;6(8):1996-2002.

30. UMBILICAL CATHETERS

Standard

30.1 Placement and removal of an umbilical arterial and venous catheter (UAC and UVC) are performed by licensed clinicians with validated competency, operating within the state's rules and regulations for professional practice in accordance with organizational policies and procedures.

30.2 The clinical need for the umbilical catheter is assessed on a daily basis and promptly removed when no longer indicated.

Practice Criteria

A. Establish organizational guidelines for appropriate use of UACs and UVCs based on gestational age, birth weight, and severity of illness in an effort to decrease their unnecessary use and associated complications.[1-3] (IV)
   1. Use UACs for obtaining blood samples and continuous blood pressure monitoring.

2. Maintain patency and reduce risk of thrombosis by continuous infusion of heparin 0.25 to 1 unit per mL (total dose of heparin 25-200 units per kg per day).
3. Use UVCs for the infusion of medications and solutions, parenteral nutrition, and blood products.[2,4,5] (II)

B. Perform skin antisepsis prior to insertion:
1. Use povidone-iodine, >0.5% chlorhexidine in alcohol solution, or aqueous chlorhexidine solution.
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. Studies have not established the safest and most effective chlorhexidine solution in neonates. Use all chlorhexidine antiseptic agents with caution in infants under 2 months of age.
3. Avoid the use of tincture of iodine due to the potential deleterious effect on the neonatal thyroid gland.[4,6-11] (I)

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] (V)

D. Place the catheter tip for:
1. UVCs in the inferior vena cava near the junction with the right atrium.
2. UACs in the thoracic portion of the descending aorta below the aortic arch (ie, high position) or below the renal arteries and above the aortic bifurcation into the common iliac arteries (ie, low position).[12,17-19] (IV)

E. Confirm the catheter tip location by radiography, echocardiography, or ultrasonography before catheter use.
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.[17,18,20] (IV)
2. For difficult bedside UVC placement or patients with congenital cardiac conditions, fluoroscopy guidance is safe.[21] (V)
3. For UAC, obtain AP radiographic view of the chest and abdomen for tip location between the thoracic vertebrae 6 and 10 for high position and between lumbar vertebrae 4 and 5 for low position.[17] (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 identifying the exact tip location. However, ultrasound will not rule out loops or curls in the catheter pathway.[18,22,23] (IV)
5. Neonatal echocardiography may be superior to chest and abdominal radiography for identifying malpositioned catheters or in extremely low-birth-weight neonates.[24,25] (V)

F. Choose a method for securing the UVC and UAC based on promoting skin integrity, decreasing complications, and ease of use. There is a lack of evidence demonstrating the best method.[26] (IV)

G. Do not use topical antibiotic ointment or creams on umbilical sites due to the risk of fungal infections and antimicrobial resistance.[4] (I)

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 ultrasound or echocardiogram for diagnostic purposes.[27-31] (IV)

I. Remove umbilical catheters promptly when no longer needed or if a complication occurs.
1. Consider limiting UVC dwell time to 7 to 14 days; risks of infection are increased with longer dwell times. UVC removal at 7 days followed by insertion of a peripherally inserted central catheter (PICC) for continued infusion therapy is one strategy to reduce central line-associated bloodstream infection.[4,30,32,33] (III)
2. Consider limiting UAC dwell time to no more than 5 days.[4,34,35] (IV)
3. 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 per minute to minimize arterial spasm.[31] (V)

REFERENCES

Note: All electronic references in this section were accessed September 22, 2015.

1. Shahid S, Dutta S, Symington A, Shivananda S. Standardizing umbilical catheter usage in preterm infants. *Pediatrics*. 2014;133(6):e1742-e1752.
2. Imamura T, Momoi N, Go H, et al. Evaluation of arterial catheter management in very preterm neonates: peripheral artery versus umbilical artery. *Fukushima J Med Sci*. 2012;58(1):1-8.

3. Oelberg DG, Baker A, Quast D, Worley L. Impact of umbilical catheterization on morbidity and mortality in extremely premature newborns. *J Neonatal Perinat Med*. 2014;7(1):13-19.
4. O'Grady N, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
5. Monagle P, Chan AK, 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(suppl 2):e737S-e801S.
6. Chapman A, Aucott S, Milstone A. Safety of chlorhexidine gluconate used for skin antisepsis in the preterm infant. *J Perinatol*. 2012;32(1):4-9.
7. Chapman AK, Aucott SW, Gilmore MM, Advani S, Clarke W, Milstone AM. Absorption and tolerability of aqueous chlorhexidine gluconate used for skin antisepsis prior to catheter insertion in preterm neonates. *J Perinatol*. 2013;33(10):768-771.
8. 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.
9. Tamma PD, Aucott SW, Milstone AM. Chlorhexidine use in the neonatal intensive care unit: results from a national survey. *Infect Control Hosp Epidemiol*. 2010;31(8):846-849.
10. Popoola V, Milstone A. Decolonization to prevent *Staphylococcus aureus* transmission and infections in the neonatal intensive care unit. *J Perinatol*. 2014;34(11):805-810.
11. US Food and Drug Administration. Chlorascrub swabsticks. http://www.fda.gov/Safety/MedWatch/SafetyInformation/Safety-RelatedDrugLabelingChanges/ucm307251.htm.
12. Verheij GH, Te Pas AB, Smits-Wintjens VE, Šràmek A, Walther FJ, Lopriore E. Revised formula to determine the insertion length of umbilical vein catheters. *Eur J Pediatr*. 2013;172(8):1011-1015.
13. Gupta A, Peesay M, Ramasethu J. Simple measurements to place umbilical catheters using surface anatomy. *J Perinatol*. 2015;35(7):476-480.
14. Kieran EA, Laffan EE, O'Donnell CP. Estimating umbilical catheter insertion depth in newborns using weight or body measurement: a randomised trial [published online August 11, 2015]. *Arch Dis Child Fetal Neonatal Ed*. 2015;5(7):476-489. doi:10.1136/archdischild-2014-307668.
15. Kumar P, Kumar C, Nayak M, Shaikh F, Dusa S, Venkatalakshmi A. Umbilical arterial catheter insertion length: in quest of a universal formula. *J Perinatol*. 2012;32(8):604-607.
16. Min SR, Lee H-S. Comparison of Wright's formula and the Dunn method for measuring the umbilical arterial catheter insertion length. *Pediatr Neonatol*. 2015;56(2):120-125.
17. Marshall M, Trotter C. Radiographic assessment of umbilical venous and arterial catheter tip location. *Neonatal Network*. 2014;33(4):208-216.
18. 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.
19. 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.
20. Butler G, 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.
21. 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.
22. Michel F, Brevaut-Malaty V, Pasquali R, et al. Comparison of ultrasound and X-ray in determining the position of umbilical venous catheters. *Resuscitation*. 2012;83(6):705-709.
23. 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.
24. Harabor A, Soraisham A. Rates of intracardiac umbilical venous catheter placement in neonates. *J Ultrasound Med*. 2014;33(9):1557-1561.
25. Pulickal A, Charlagorla P, Tume S, Chhabra M, Narula P, Nadroo A. Superiority of targeted neonatal echocardiography for umbilical venous catheter tip localization: accuracy of a clinician performance model. *J Perinatol*. 2013;33(12):950-953.
26. Elser HE. Options for securing umbilical catheters. *Adv Neonatal Care*. 2013;13(6):426-429.
27. Arnts IJJ, Bullens LM, Groenewoud JMM, Liem KD. Comparison of complication rates between umbilical and peripherally inserted central venous catheters in newborns. *J Obstet Gynecol Neonatal Nurs*. 2014;43(2):205-215.
28. Yeh J, Vargas JH, Wozniak LJ, Smith JB, Boechat MI, Touma M. Massive liver mass and parenteral nutrition extravasation secondary to umbilical venous catheter complications. *J Clin Neonatol*. 2014;3(3):158.
29. Weisz DE, Poon WB, James A, McNamara PJ. Low cardiac output secondary to a malpositioned umbilical venous catheter: value of targeted neonatal echocardiography. *AJP Rep*. 2014;4(1):23-28.
30. Keir A, Giesinger R, Dunn M. How long should umbilical venous catheters remain in place in neonates who require long-term (≥5-7 days) central venous access? *J Paediatr Child Health*. 2014;50(8):649-652.
31. Frey A, Pettit J. Infusion therapy in children. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:550-570.
32. Yumani DF, Dungen FA, Weissenbruch MM. Incidence and risk factors for catheter-associated bloodstream infections in neonatal intensive care. *Acta Paediatrica*. 2013;102(7):e293-e298.
33. Butler-O'Hara M, D'Angio CT, Hoey H, Stevens TP. An evidence-based catheter bundle alters central venous catheter strategy in newborn infants. *J Pediatr*. 2012;160(6):972-977.
34. Coleman MM, Spear ML, Finkelstein M, et al. Short-term use of umbilical artery catheters may not be associated with increased risk for thrombosis. *Pediatrics*. 2004;113(4):770-774.
35. 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.

31. APHERESIS CATHETERS

Standard

31.1 The selection of the most appropriate type of vascular access device (VAD) for therapeutic apheresis occurs in collaboration with the patient/caregiver and the interprofessional team based on the projected treatment plan.

Practice Criteria

A. Consider the following when choosing the most appropriate VAD for therapeutic apheresis: the type

of apheresis procedure (centrifugation-based or filter-based systems); the patient's vascular anatomy; acuity; frequency and treatment duration; and underlying disease state.[1-3] (IV)

B. Peripheral or central VADs are recommended for therapeutic apheresis as follows:
   1. Use of 16- to 18-gauge peripheral catheters placed in antecubital veins for adults. Peripheral vein access is not recommended in young children (< 30 kg) due to small veins but may be possible with older children and adolescents. Peripheral veins are not appropriate for filter-based apheresis systems.[1-5] (IV)
   2. Use a nontunneled or tunneled cuffed central VAD with a catheter size of at least 11.5 Fr for adults.[1-3] (IV)
   3. Implanted vascular access ports are used less commonly.[1-4] (IV)
   4. Peripherally inserted central catheters should not be used for therapeutic apheresis due to small internal diameters and inability to accommodate blood flow rates.[3] (IV)
   5. Arteriovenous (AV) fistulae and AV grafts may be placed for long-term treatment.[1-3] (IV)

REFERENCES

1. Kalantari K. The choice of vascular access for therapeutic apheresis. *J Clin Apher*. 2012;27(3):153-159.
2. Okafor C, Kalantarinia K. Vascular access considerations for therapeutic apheresis procedures. *Semin Dial*. 2011;25(2):140-144.
3. Golestaneh L, Mokrzycki MH. Vascular access in therapeutic apheresis: update 2013. *J Clin Apher*. 2013;28(1):64-72.
4. Goldstein SL. Therapeutic apheresis in children: special considerations. *Semin Dial*. 2012;25(2):165-170.
5. Hunt EAK, Jain NG, Somers MJG. Apheresis therapy in children: an overview of key technical aspects and a review of experience in pediatric renal disease. *J Clin Apher*. 2013;28(1):36-47.

32. LOCAL ANESTHESIA FOR VASCULAR ACCESS DEVICE (VAD) PLACEMENT AND ACCESS

Standard

32.1 The clinician considers local anesthesia for vascular access device (VAD) placement and access based upon assessment of patient condition, needs, risks, benefits, and anticipated discomfort of the procedure.

32.2 When local anesthesia is ordered or necessary, use the agent and method that is least invasive and carries the least risk for adverse reactions.

32.3 When administering a local anesthetic, assess the patient and intervene for potential allergic reactions, tissue damage, or inadvertent injection of the drug into the vascular system.

32.4 Protocols for the use of local anesthesia for VAD placement are established in organizational policies, procedures, and/or practice guidelines.

Practice Criteria

A. Consider local anesthetic agents for painful VAD placement or access including, but not limited to, topical vapocoolant sprays, topical transdermal agents, intradermal lidocaine, and pressure-accelerated lidocaine.[1-11] (I)

B. Use the most effective and available local anesthetic method and/or agent, considering time to peak effectiveness, as well as adjunctive and less invasive anxiolytic, cognitive, behavioral, and complementary therapies, to reduce pain and discomfort prior to each painful VAD puncture or procedure in children, some adults, and for large-bore vascular access in the hand (eg, 16 gauge).[1,2,9,12-17] (I)

REFERENCES

1. Crowley M, Brim C, Proehl J, et al; 2011 ENA Emergency Nursing Resources Development Committee. Emergency nursing resource: difficult intravenous access. *J Emerg Nurs*. 2012;38(4):335-343.
2. Bueno M, Yamada J, Harrison D, et al. A systematic review and meta-analyses of nonsucrose sweet solutions for pain relief in neonates. *Pain Res Manag*. 2013;18(3):153-161.
3. Fein JA, Zempsky WT, Cravero JP; Committee on Pediatric Emergency Medicine and Section on Anesthesiology and Pain Medicine; American Academy of Pediatrics. Relief of pain and anxiety in pediatric patients in emergency medical systems. *Pediatrics*. 2012;130(5):e1391-e1405.
4. Hui-Chen F, Hsiu-Lin C, Shun-Line C, et al. The effect of EMLA cream on minimizing pain during venipuncture in premature infants. *J Trop Pediatr*. 2013;59(1):72-73.
5. 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.
6. 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.
7. Pywell A, Xyrichis A. Does topical amethocaine cream increase first-time successful cannulation in children compared with a eutectic mixture of local anaesthetics (EMLA) cream? A systematic review and meta-analysis of randomised controlled trials. *Emerg Med J*. 2014;32(9):733-737.
8. Ruetzler K, Sima B, Mayer L, et al. Lidocaine/tetracaine patch (Rapydan) for topical anaesthesia before arterial access: a double-blind, randomized trial. *Br J Anaesth*. 2012;109(5):790-796.
9. Winfield C, Knicely C, Jensen C, et al. What is the least painful method of anesthetizing a peripheral IV site? *J Perianesth Nurs*. 2013;28(4):217-222.

10. Zempsky WT, Schmitz ML, Meyer JM. Safety and efficacy of needle-free powder lidocaine delivery system in adult patients undergoing venipuncture or peripheral venous cannulation: randomized, double-blind, placebo-controlled trial [published online May 15, 2015]. *Clin J Pain*. doi:10.1097/AJP.0000000000000257.
11. Page DE, Taylor DM. Vapocoolant spray vs subcutaneous lidocaine injection for reducing the pain of intravenous cannulation: a randomized, controlled, clinical trial. *Br J Anaesth*. 2010;105(4):519-525.
12. Evans JG, Taylor DM, Hurren F, Ward P, Yeoh M, Howden BP. Effects of vapocoolant spray on skin sterility prior to intravenous cannulation. *J Hosp Infect*. 2015;90(4):333-337.
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;(5):CD008408. doi:10.1002/14651858.CD008408.pub3.
14. Hunsaker S, Hillis D. Intraosseous vascular access for alert patients. *Am J Nurs*. 2013;113(11):34-40.
15. Kassab M, Foster JP, Foureur M, Fowler C. Sweet-tasting solutions for needle-related procedural pain in infants one month to one year of age. *Cochrane Database Syst Rev*. 2012;(12):CD008411. doi:10.1002/14651858.CD008411.pub2.
16. Uman LS, Birnie KA, Noel M, et al. Psychological interventions for needle-related procedural pain and distress in children and adolescents. *Cochrane Database Syst Rev*. 2013;(10):CD005179. doi:10.1002/14651858.CD005179.pub3.
17. Waterhouse MR, Liu DR, Wang VJ. Cryotherapeutic topical analgesics for pediatric intravenous catheter placement: ice versus vapocoolant spray. *Pediatr Emerg Care*. 2013;29(1):8-12.

33. VASCULAR ACCESS SITE PREPARATION AND DEVICE PLACEMENT

Standard

33.1 A new, sterile vascular access device (VAD) is used for each catheterization attempt.
33.2 Skin antisepsis is performed prior to VAD placement.
33.3 Aseptic technique is adhered to during all aspects of VAD placement.
33.4 The VAD is not altered outside the manufacturer's directions for use.
33.5 Proper tip location for central vascular access devices (CVADs) is verified prior to use.

Practice Criteria

I. General

A. Provide patient education prior to inserting a VAD (refer to Standard 8, *Patient Education*).
B. Obtain informed consent according to organizational policy or procedure (refer to Standard 9, *Informed Consent*).
C. Ensure that the intended VAD site is visibly clean prior to application of an antiseptic solution; when visible soil is present, cleanse the intended VAD insertion site prior to application of antiseptic solution(s).[1-3] (V)
D. 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 (although research is limited).[4] (V)
E. Immediately remove the VAD and promptly notify the licensed independent practitioner (LIP) in the following situations:
   1. If nerve damage is suspected, such as when the patient reports paresthesias (numbness or tingling) related to VAD insertion (refer to Standard 47, *Nerve Injuries*).
   2. If an artery is inadvertently accessed, apply pressure to the peripheral site. Inadvertent arterial puncture during CVAD placement is a life-threatening complication requiring immediate intervention. Treatment options include open operative approach and repair and, more commonly, endovascular management (see Standard 53, *Central Vascular Access Device [CVAD] Malposition*).[5,6] (V)
F. Make no more than 2 attempts at short peripheral intravenous access per clinician, and limit total attempts to no more than 4. Multiple unsuccessful attempts cause patient pain, delay treatment, limit future vascular access, increase cost, and increase the risk for complications. Patients with difficult vascular access require a careful assessment of VAD needs and collaboration with the health care team to discuss appropriate options.[7] (IV)
G. Dedicate a tourniquet to only a single patient.[8-10] (III).

II. Short Peripheral and Midline Catheters

A. Consider implementation of specialized infusion teams to improve success rates with peripheral intravenous (IV) insertion (refer to Standard 4, *Infusion Team*).
B. Consider use of visualization technologies to aid in vein identification and selection in patients with difficult venous access (refer to Standard 22, *Vascular Visualization*).
C. Use an appropriate method to promote vascular distention when placing short peripheral catheters. These include:
   1. Use of a blood pressure cuff or tourniquet applied in a manner to impede venous flow while maintaining arterial circulation. Loosely apply tourniquet or avoid its use in patients who bruise easily, are at risk for bleeding, have compromised circulation, and/or have fragile veins.[1,2,7] (I A/P)

2. Use of gravity (positioning the extremity lower than the heart for several minutes), having the patient open and close her or his fist, and lightly stroking the vein downward.[1,2,7] (I A/P)
3. Use of warmth. The use of dry heat has been found to increase the likelihood of successful peripheral catheter insertion.[11-14] (IV)

D. Perform skin antisepsis using the preferred skin antiseptic agent of >0.5% chlorhexidine in alcohol solution. If there is a contraindication to alcoholic chlorhexidine solution, tincture of iodine, an iodophor (povidone-iodine), or 70% alcohol may also be used. Use chlorhexidine with caution in premature infants and infants under 2 months of age due to risks of skin irritation and chemical burns. Allow the antiseptic agent to fully dry before insertion.[3,15-19] (I)
E. Adhere to and maintain aseptic technique with short peripheral catheter insertion:
1. Use a new pair of disposable, nonsterile gloves in conjunction with a "no-touch" technique for peripheral IV insertion, meaning that the insertion site is not palpated after skin antisepsis.[3,20] (V)
2. Consider increased attention to aseptic technique, including strict attention to skin antisepsis and the use of sterile gloves, when placing short peripheral catheters. While there is a lack of evidence comparing bloodstream infection (BSI) rates with or without use of sterile gloves, longer dwell times have raised concerns regarding risk for BSI. Furthermore, contamination of nonsterile gloves is documented.[21-23] (V, Committee Consensus)

F. Consider the use of maximal sterile barrier precautions with midline catheter insertion.[24-26] (V)
G. Use the safest available insertion technique, including the Seldinger, modified Seldinger technique (MST), or new techniques that eliminate multiple steps (eg, alterations to the Seldinger technique) for midline catheter placement, to reduce the risk for insertion-related complications such as air embolism, guidewire loss, embolism, inadvertent arterial cannulation, and bleeding.[26-31] (V)
H. Ensure appropriate midline catheter tip location:
1. Adults and older children: at the level of the axilla and distal to the shoulder.[24-26,32] (V)
2. Neonate/pediatric scalp vein placement: jugular vein above the clavicle.[32] (V)
3. Neonate/pediatric lower extremity vein placement (before walking age): in the leg with the tip below the inguinal crease.[32] (V)

III. Central Vascular Access Device (CVAD)

A. Implement the central line bundle when placing CVADs, which includes the following interventions: hand hygiene; skin antisepsis using >0.5% chlorhexidine in alcohol solution; maximal sterile barrier precautions; and avoidance of the femoral vein in obese adult patients during placement under planned and controlled conditions.[3,15,16,33] (I)
B. Ensure adherence to proper technique through use of and completion of a standardized checklist completed 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 CVAD inserter.[15,34]
C. Use a standardized supply cart or kit that contains all necessary components for the insertion of a CVAD.[15] (IV)
D. Use ultrasound technology when inserting CVADs to increase success rates and decrease insertion-related complications (refer to Standard 22, *Vascular Visualization*).
E. Measure upper-arm circumference before insertion of a peripherally inserted central catheter (PICC) and when clinically indicated to assess the presence of edema and possible deep vein thrombosis (DVT). Take this measurement 10 cm above the antecubital fossa; assess for the location and other characteristics, such as pitting or nonpitting edema.[35] (V)
F. Use the safest available insertion technique, including the Seldinger, modified Seldinger technique (MST), or new techniques that eliminate multiple steps (eg, alterations to the Seldinger technique) for CVAD placement to reduce the risk for insertion-related complications such as air embolism, guidewire loss, or embolism, inadvertent arterial cannulation, and bleeding.[30,36-39] (V)
G. Ensure proper placement of the CVAD tip, within the lower one-third of the superior vena cava (SVC) or cavoatrial junction or, if placed via the femoral vein, within the inferior vena cava (IVC) above the level of the diaphragm, 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 [CVAD] Tip Location*; Standard 53, *Central Vascular Access Device [CVAD] Malposition*).
H. Carefully evaluate and assess patients who have a pacemaker in place for the most appropriate catheter and insertion site. Pacemakers are usually placed on the left side of the chest or abdomen. The contralateral side is preferred for CVAD placement, but if the ipsilateral side is selected, a peripherally inserted central catheter (PICC) may be the safest choice. It is important to have the pacemaker evaluated before and after CVAD insertion to

determine integrity of the pacemaker unit and leads. There are no published reports of displaced leads noted during CVAD insertion, and there are currently no practice guidelines developed related to pacemakers and CVADs.[40] (V)

IV. Arterial Catheters

A. Consider use of visualization technologies to aid in artery identification and selection (refer to Standard 22, *Vascular Visualization*).

B. Perform skin antisepsis using the preferred skin antiseptic agent of >0.5% chlorhexidine in alcohol solution. If there is a contraindication to alcoholic chlorhexidine solution, tincture of iodine, an iodophor (povidone-iodine), or 70% alcohol may also be used.[3,41-42] (I)

C. Wear a cap, mask, sterile gloves, and eyewear, and use a large, sterile fenestrated drape when placing a peripheral arterial catheter.[3,41-42] (II)

D. Employ maximal sterile barrier precautions when placing pulmonary artery and arterial catheters in the axillary or femoral artery.[3,41-42] (II)

REFERENCES

Note: All electronic references in this section were accessed August 26, 2015.

1. Perucca R. Peripheral venous access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:456-479.
2. Phillips LD, Gorski LA. *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014.
3. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
4. Tanner J, Norrie P, Melen K. Preoperative hair removal to reduce surgical site infection. *Cochrane Database Syst Rev*. 2011;(11):CD004122. doi:10.1002/14651858.CD004122.pub4.
5. Cayne NS, Berland TL, Rockman CB, et al. Experience and technique for the endovascular management of iatrogenic subclavian artery injury. *Ann Vasc Surg*. 2010;24(1):44-47.
6. Abi-Jaoudeh N, Turba UC, Arslan B, et al. Management of subclavian arterial injuries following inadvertent arterial puncture during central venous catheter placement. *J Vasc Interv Radiol*. 2008;20(3):396-402.
7. Hagle ME, Mikell M. Peripheral venous access. In: Weinstein S, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014.
8. Elhassan HA, Dixon T. MRSA contaminated venepuncture tourniquets in clinical practice. *Postgrad Med J*. 2012;88(1038):194-197.
9. Kane L, Krischock L, Lucas C. Phlebotomy tourniquets: vectors for bacterial pathogens. *Arch Dis Child*. 2011;96(suppl 1):A47-A48.
10. Pinto AN, Phan T, Sala G, Cheong EY, Siarakas S, Gottlieb T. Reusable venesection tourniquets: a potential source of hospital transmission of multiresistant organisms. *Med J Aust*. 2001;195(5):276-279.
11. Emergency Nurses Association/Emergency Nursing Resources Development Committee. Emergency nursing resource: difficult intravenous access. http://www.guideline.gov/content.aspx?id=36841. Published 2011.
12. Houston PA. Obtaining vascular access in the obese patient population. *J Infus Nurs* 2013;36(1):52-56.
13. Fink RM, Hjort E, Wenger B, et al. The impact of dry versus moist heat on peripheral IV catheter insertion in a hematology-oncology outpatient population. *Oncol Nurs Forum*. 2009;36(4):E198-E204.
14. Lenhardt R, Seybold T, Kimberger O, Stoiser B, Sessler DI. Local warming and insertion of peripheral venous cannulas. *BMJ*. 2002;325(7361):409-410.
15. 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. http://www.jstor.org/stable/10.1086/676533.
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.
17. Chapman AK, Aucott SW, Gilmore MM, et al. Absorption and tolerability of aqueous chlorhexidine gluconate used for skin antisepsis prior to catheter insertion in preterm neonates. *J Perinatol*. 2013;33(10):768-771.
18. Chapman AK, Aucott SW, Milstone AM. Safety of chlorhexidine gluconate used for skin antisepsis prior to catheter insertion in preterm neonates. *J Perinatol*. 2012;32(1):4-9.
19. US Food and Drug Administration. Chlorascrub swabsticks. Directions for use in infants. http://www.fda.gov/Safety/MedWatch/SafetyInformation/Safety-RelatedDrugLabelingChanges/ucm307251.htm. Published 2012.
20. Rowley S, Clare C, Macqueen S, Molyneux R. ANTT v2: an updated practice framework for aseptic technique. *Br J Nurs*. 2010;19(suppl 5):S5-S11.
21. Hall H, 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. *Southwest Respir Crit Care Chron*. 2014;2(5):3-10.
22. Hughes KA, Cornwall J, Theis J-C, Brooks HJ. Bacterial contamination of unused, disposable non-sterile gloves on a hospital orthopaedic ward. *Australas Med J*. 2013;6(6):331. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3702138/pdf/AMJ-06-331.pdf.
23. Hadaway L. Short peripheral intravenous catheters and infections. *J Infus Nurs*. 2012;35(4):230-240.
24. Alexandrou E, Ramjan LM, Spencer T, et al. The use of midline catheters in the adult acute care setting: clinical implications and recommendations for practice. 2011;16(1):35-41.
25. Caparas JV, Hu JP. Safe administration of vancomycin through a novel midline catheter: a randomized, prospective clinical trial. *J Assoc Vasc Access*. 2014;15(4):251-256.
26. Dumont C, Getz O, Miller, S. Evaluation of midline vascular access: a descriptive study. *Nursing 2014*. 2014;44(10):60-66.
27. 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*. 2013;191(1):1-5.
28. Warrington WG, Penoyer DA, Kamps TA, Van Hoeck EH. Outcomes of using a modified Seldinger technique for long term intravenous therapy in hospitalized patients with difficult venous access. *J Assoc Vasc Access*. 2012;17(1):24-31.
29. Caparas JV, Hu JP, Hung HW. Does a novel method of PICC insertion improve safety? *Nursing 2014*. 2014;44(5):65-67.
30. Association for Vascular Access [position paper]. The use of Seldinger or modified Seldinger technique, in combination with real-time imaging modalities for peripherally inserted central catheter and midline placements by clinicians. http://www.avainfo.org/website/download.asp?id=280292. Published 2011.
31. Cummings M, Hearse N, McCutcheon H, Deuter K. Improving antibiotic treatment outcomes through the implementation of a midline: piloting a change in practice for cystic fibrosis patients. *J Vasc Nurs*. 2011;29(1):11-15.
32. Frey AM, Pettit J. Infusion therapy in children. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:550-570.
33. Shekelle PG, Wachter RM, Pronovost PJ, et al, eds. Executive summary. In: *Making Health Care Safer II: An Updated Critical Analysis of the Evidence for Patient Safety Practices*. Rockville, MD: Agency for Healthcare Research and Quality; March 2013. http://www.ncbi.nlm.nih.gov/books/NBK133363/pdf/TOC.pdf.
34. National Healthcare Safety Network. Adherence for central line insertion practices (CLIP) surveillance, 2015. http://www.cdc.gov/nhsn/acute-care-hospital/clip/index.html.
35. 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.
36. Bullock-Corkhill M. Central venous access devices: access and insertion. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:480-494.
37. Doellman D, Nichols I. Modified Seldinger technique with ultrasound for peripherally inserted central catheter (PICC) in the pediatric patient: a precise advantage. *J Assoc Vasc Access*. 2009;14(2):93-99.
38. Williams TL, Bowdle TA, Winters BD, et al. Guidewires unintentionally retained during central venous catheterization. *J Assoc Vasc Access*. 2014;19(1):29-34.
39. Calvache JA, Rodriguez MV, Trochez A, et al. Incidence of mechanical complications of central venous catheterization using landmark technique: do not try more than 3 times [published online July 2, 2014]. *J Intensive Care Med*. doi:10.1177/0885066614541407.
40. Pacana C, Durand JB. The risk of central venous placement ipsilateral to the permanent pacemaker. *J Assoc Vasc Access*. 2009;14(1):28-30.
41. 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.
42. Safdar N, O'Horo JC, Maki DG. Arterial catheter related bloodstream infection: incidence, pathogenesis, risk factors and prevention. *J Hosp Infect*. 2013;85(3):189-195.

Section Six: Vascular Access Device (VAD) Management

Section Standards

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

34. NEEDLELESS CONNECTORS

Standard

34.1 Use a luer-locking mechanism to ensure a secure junction when attaching needleless connectors to a vascular access device (VAD) hub or access site.
34.2 Disinfect needleless connectors prior to each entry into the device.
34.3 Use aseptic no-touch technique to change the needleless connector.
34.4 Access needleless connectors only with a sterile device.

Practice Criteria

A. The need for a needleless connector placed between the VAD hub and the administration set used for continuous fluid infusion is unknown. The primary purpose of needleless connectors is to protect health care personnel by eliminating needles and subsequent needlestick injuries when attaching administration sets and/or syringes to the VAD hub or injection site for intermittent infusion.[1-3] (Regulatory)
   1. Avoid using a needleless connector for rapid flow rates of crystalloid solutions and red blood cells, as their presence can greatly reduce flow rates.[4] (IV)
B. Consider use of an extension set between the peripheral catheter and needleless connector to reduce catheter manipulation (refer to Standard 36, *Add-on Devices*).
C. Recognize that needleless connectors are potential sites for intraluminal microbial contamination and require careful adherence to infection prevention practices. There is no consensus on the design or type of needleless connector to prevent or reduce VAD-related bloodstream infection.[3,5-8] (IV)
D. Needleless connectors have different internal mechanisms and fluid pathways. The device design that produces the least amount of thrombotic VAD lumen occlusion remains controversial and requires further study.[9-13] (IV)
E. Follow manufacturers' directions for the appropriate sequence of catheter clamping and final syringe disconnection to reduce the amount of blood reflux into the VAD lumen and, thus, the incidence of intraluminal thrombotic occlusion. The sequence for flushing, clamping, and disconnecting the syringe depends upon the internal mechanism for fluid displacement. Standardizing the type of needleless connector within the organization may reduce risk for confusion about these steps and improve outcomes.[14,15] (V)
F. Perform a vigorous mechanical scrub for manual disinfection of the needleless connector prior to each VAD access and allow it to dry.
   1. Acceptable disinfecting agents include 70% isopropyl alcohol, iodophors (ie, povidone-iodine), or >0.5% chlorhexidine in alcohol solution.[7,16] (II)
   2. Length of contact time for scrubbing and drying depends on the design of the needleless connector and the properties of the disinfecting agent. For

70% isopropyl alcohol, reported scrub times range from 5 to 60 seconds with biocide activity occurring when the solution is wet and immediately after drying. More research is needed for other agents or combinations of agents due to conflicting reports regarding the optimal scrub time.[3,17,18] (II)

3. Use vigorous mechanical scrubbing methods even when disinfecting needleless connectors with antimicrobial properties (eg, silver coatings).[19-24] (IV)

G. Use of passive disinfection caps containing disinfecting agents (eg, isopropyl alcohol) has been shown to reduce intraluminal microbial contamination and reduce the rates of central line-associated bloodstream infection (CLABSI). Use of disinfection caps on peripheral catheters has limited evidence but should be considered.
   1. The length of exposure time to be effective depends upon product design; consult manufacturers' directions for use.[18] (V)
   2. Once removed, these used caps are discarded and are never reattached to the needleless connector.[3,18] (II)
   3. After removal, multiple accesses of the VAD may be required to administer a medication (eg, flush syringes and administration sets) and require additional disinfection before each entry. Scrubbing time, technique, and agents for disinfection of the needleless connector between subsequent connections are unknown due to a lack of research. Consider using a vigorous 5- to 15-second scrub time with each subsequent entry into the VAD, depending upon the needleless connector design.[25-30] (Committee Consensus)
   4. Use a stopcock or manifold with an integrated needleless connector rather than a solid cap due to contamination from personnel hands and the environment. Replace the stopcock with a needleless connector as soon as clinically indicated.[31-33] (III)

H. Change the needleless connector no more frequently than 96-hour intervals. Changing on a more frequent time interval adds no benefit and has been shown to increase the risk of CLABSI.
   1. When used within a continuous infusion system, the needleless connector is changed when the primary administration set is changed (eg, 96 hours).
   2. For peripheral catheters with dwell times longer than 96 hours, there are no studies on changing the attached needleless connector/extension set.
   3. 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 manufacturer's directions for use (see Standard 49, *Infection*).[7,34,35] (IV)

I. Ensure that disinfecting supplies are readily available at the bedside to facilitate staff compliance with needleless connector disinfection.[14,36] (V)

REFERENCES

Note: All electronic references in this section were accessed August 27, 2015.

1. Hadaway L, Richardson D. Needleless connectors: a primer on terminology. *J Infus Nurs*. 2010;33(1):22-33.
2. Occupational Safety and Health Administration (OSHA). Occupational safety and health standards: bloodborne pathogens. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051.
3. 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.
4. 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.
5. Btaiche IF, Kovacevich DS, Khalidi N, Papke LF. The effects of needleless connectors on catheter-related bloodstream infections. *Am J Infect Control*. 2011;39(4):277-283.
6. Mermel LA. What is the predominant source of intravascular catheter infections? *Clin Infect Dis*. 2011;52(2):211-212.
7. O'Grady N, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
8. Flynn JM, Keogh SJ, Gavin NC. Sterile v aseptic non-touch technique for needleless connector care on central venous access devices in a bone marrow transplant population: a comparative study [published online June 6, 2015]. *Eur J Oncol Nurs*. doi:10.1016/j.ejon.2015.05.003.
9. Btaiche IF, Kovacevich DS, Khalidi N, Papke LF. The effects of needleless connectors on catheter-related thrombotic occlusions. *J Infus Nurs*. 2010;34(2):89-96.
10. Lynch D. Achieving zero central line-associated bloodstream infections: connector design combined with practice in the long-term acute care setting. *J Assoc Vasc Access*. 2012;17(2):75-77.
11. Logan R. Neutral displacement intravenous connectors: evaluating new technology. *J Assoc Vasc Access*. 2013;18(1):31-36.
12. Caillouet B. Protection of intraluminal pathway with zero fluid displacement connector reduces catheter-related bloodstream infections in a comprehensive cancer center. *J Assoc Vasc Access*. 2012;17(2):86-89.
13. Chernecky CC, Macklin D, Jarvis WR, Joshua TV. Comparison of central line-associated bloodstream infection rates when changing to a zero fluid displacement intravenous needleless connector in acute care settings. *Am J Infect Control*. 2014;42(2):200-202.
14. Hadaway L. Needleless connectors: improving practice, reducing risks. *J Assoc Vasc Access*. 2011;16(1):20-25, 28-30, 32-33.

15. Hadaway L. Needleless connectors for IV catheters. *Am J Nurs*. 2012;112(11):32-44.
16. 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.
17. Pichler J, Soothill J, Hill S. Reduction of blood stream infections in children following a change to chlorhexidine disinfection of parenteral nutrition catheter connectors. *Clin Nutr*. 2013;33(1):85-89.
18. Moureau NL, Flynn J. Disinfection of needleless connector hubs: clinical evidence systematic review. *Nurs Res Pract*. 2015. http://www.hindawi.com/journals/nrp/2015/7967621.
19. Edmiston CE Jr, Markina V. Reducing the risk of infection in vascular access patients: an in vitro evaluation of an antimicrobial silver nanotechnology luer activated device. *Am J Infect Control*. 2010;38(6):421-423.
20. Maki D. In vitro studies of a novel antimicrobial luer activated needleless connector for prevention of catheter related bloodstream infection. *Clin Infect Dis*. 2010;50(12):1580-1587.
21. Chernecky CC, Waller JL, Jarvis WR. In vitro study assessing the antibacterial activity of three silver-impregnated/coated mechanical valve needleless connectors after blood exposure. *Am J Infect Control*. 2012;41(3):278-280.
22. 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.
23. 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.
24. Casey AL, Karpanen TJ, Nightingale P, Cook M, Elliott TS. Microbiological comparison of a silver-coated and a non-coated needleless intravascular connector in clinical use. *J Hosp Infect*. 2012;80(4):299-303.
25. Wright M-O, Tropp J, Dillon-Grant M, et al. Preventing contamination of central venous catheter valves with the use of an alcohol-based disinfecting cap. *Am J Infect Control*. 2012;40(5):e179-e180.
26. Sweet MA, Cumpston A, Briggs F, Craig M, Hamadani M. Impact of alcohol-impregnated port protectors and needleless neutral pressure connectors on central line-associated bloodstream infections and contamination of blood cultures in an inpatient oncology unit. *Am J Infect Control*. 2012;40(10): 931-934.
27. Ramirez C, Lee AM, Welch K. Central venous catheter protective connector caps reduce intraluminal catheter-related infection. *J Assoc Vasc Access*. 2012;17(4):210-213.
28. Merrill KC, Sumner S, Linford L, Taylor C, Macintosh C. Impact of universal disinfectant cap implementation on central line-associated bloodstream infections. *Am J Infect Control*. 2014;42(12):1274-1277.
29. Stango C, Runyan D, Stern J, Macri I, Vacca M. A successful approach to reducing bloodstream infections based on a disinfection device for intravenous needleless connector hubs. *J Infus Nurs*. 2014;37(6):462-465.
30. DeVries M, Mancos PS, Valentine MJ. Reducing bloodstream infection risk in central and peripheral intravenous lines: initial data on passive intravenous connector disinfection. *J Assoc Vasc Access*. 2014;19(2):87-93.
31. Pohl F, Hartmann W, Holzmann T, Gensicke S, Kölbl O, Hautmann M. Risk of infection due to medical interventions via central venous catheters or implantable venous access port systems at the middle port of a three-way cock: luer lock cap vs. luer access split septum system (Q-Syte®). *BMC Infect Dis*. 2014;14(1):41.
32. Mermel L. Intraoperative stopcock and manifold colonization of newly inserted peripheral intravenous catheters. *Infect Control Hosp Epidemiol*. 2014;35(9):1187-1189.
33. Loftus RW, Brown JR, Koff MD, et al. Multiple reservoirs contribute to intraoperative bacterial transmission. *Anesth Analg*. 2012;114(6):1236-1248.
34. 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.
35. 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.
36. Smith JS, Kirksey KM, Becker H, Brown A. Autonomy and self-efficacy as influencing factors in nurses' behavioral intention to disinfect needleless intravenous systems. *J Infus Nurs*. 2011;34(3):193-200.

35. FILTRATION

Standard

35.1 Parenteral nutrition solutions are filtered using an in-line or add-on filter appropriate to the type of solution.
35.2 Blood and blood components are filtered using an in-line or add-on 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 Criteria

A. Use filters adhering to manufacturers' directions for use and filtration requirements of the infusion therapy solution or medication.[1] (V)
   1. Filters are contraindicated for use with certain medications that would be retained on the filter material; consult with pharmacy or published drug resources regarding filtration indications.[1] (V)
   2. Avoid filters when administering very small drug volumes as drug retention may seriously decrease the volume of medication delivered to the patient.[1,2] (V)
   3. Recognize that there is evolving evidence documenting the effect of particulate matter (eg, rubber, glass, latex) on capillary endothelium and

the effect of microbubbles of air that may cause cerebral and pulmonary ischemia; use of particulate-retentive and air-eliminating filters can prevent potential damage from air/particulates (eg, cardiac anomalies with right-to-left shunting).[1,3-5] (V)

4. Use air-eliminating filters during treatment of adults with Eisenmenger's syndrome (heart defect that causes right-to-left shunting) as exclusion of air bubbles in administration sets is recommended as essential.[6] (I A/P)

B. Change add-on filters to coincide with administration set changes; use a primary administration set with a preattached, in-line filter whenever possible to reduce tubing manipulation and risks of contamination, misuse, and accidental disconnection/misconnection.[1] (V)

C. Locate add-on bacteria- and particulate-retentive and air-eliminating membrane filters as close to the vascular access device (VAD) hub as possible.[1] (V)

D. Ensure that electronic infusion device (EID) pressure does not exceed the pounds per square inch (psi) rating of the filter when an EID is used.[1] (V)

E. Filter parenteral nutrition solutions without lipids using a 0.2-micron filter and lipid-containing emulsions (3-in-1) using a 1.2-micron filter, and change filters every 24 hours.

1. When lipids are infused separately from dextrose/amino acids, use a 0.2-micron filter for the dextrose/amino acid solution and infuse the lipid emulsion below the filter (eg, during "piggyback").
2. Separate lipid emulsions may not require filtration; consult manufacturers' directions for use. If required, a 1.2-micron filter is used on the separate lipid emulsion (refer to Standard 61, *Parenteral Nutrition*).

F. 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. Change the transfusion administration set, and filter after each unit or no less often than every 4 hours (refer to Standard 62, *Transfusion Therapy*).

G. Filter intraspinal infusion medications using a surfactant-free 0.2-micron filter (refer to Standard 54, *Intraspinal Access Devices*).

H. 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 17, *Compounding and Preparation of Parenteral Solutions and Medications*).

I. Consider fluid and medication filtration in critically ill patients; filter use was associated with a significant reduction in overall complications for patients in pediatric intensive care units, including a significant reduction in systemic inflammatory response syndrome (SIRS); a 0.2-micron filter was used for crystalline solutions and a 1.2-micron filter was used for lipid-containing admixtures.[7,8] (III)

J. There is insufficient evidence to support the routine use of in-line intravenous particulate filters for nonblood/blood component therapy in peripheral intravenous catheters for the purpose of preventing infusion-related phlebitis.[9] (I)

REFERENCES

Note: All electronic references in this section were accessed August 28, 2015.

1. Hadaway L. Infusion therapy equipment. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:418-421.
2. Gasch J, Leopold CS, Knoth H. Drug retention by inline filters: effect of positively charged polyethersulfone filter membranes on drug solutions with low concentration. *Eur J Pharm Sci*. 2011;44(1-2):49-56.
3. Jack T, Brent BE, Boehne M, et al. Analysis of particulate contaminations of infusion solutions in a pediatric intensive care unit. *Intensive Care Med*. 2010;36(4):707-711.
4. Barak M, Latz Y. Microbubbles: pathophysiology and clinical implications. *Chest*. 2005;128:2918-2932.
5. Wilkins RG, Unverdorben M. Accidental infusion of air: a concise review. *J Infus Nurs*. 2012;35(6):404-408.
6. Warnes CA, Williams RG, Bashore TM, et al. ACC/AHA 2008 guidelines for the management of adults with congenital heart disease. *Circulation*. 2008;118(23):e714-e833.
7. Jack T, Boehne M, Brent BE, et al. In-line filtration reduces severe complications and length of stay on pediatric intensive care unit: a prospective, randomized, controlled trial. *Intensive Care Med*. 2012;38(6):1008-1016.
8. Boehne M, Jack T, Köditz H, et al. In-line filtration minimizes organ dysfunction: new aspects from a prospective, randomized controlled trial. *BMC Pediatr*. 2013;13:21. http://www.biomedcentral.com/1471-2431/13/21.
9. 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.

36. ADD-ON DEVICES

Standard

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

36.2 Add-on devices are of luer-lock or integrated design to ensure a secure junction, reduce manipulation, and minimize the risk of disconnection.

Practice Criteria

A. Consider the use of add-on devices (eg, single- and multilumen extension sets, manifold sets, extension loops, solid cannula caps, needleless connectors, in-line filters, manual flow-control devices and stopcocks) only for clinical indications. When indicated, preferentially use systems that minimize manipulation and reduce multiple components, such as integrated extension sets (see Standard 34, *Needleless Connectors*).[1-4] (IV)
   1. Clinical indications may include adding length, enabling filtration capabilities, or enhancing function of the infusion system (ie, adding an extension to decrease movement/manipulation at the short peripheral catheter hub).[1,2] (V)
   2. Consider that the potential for contamination exists with all add-on devices. Limit the use of add-on devices whenever possible to decrease the number of manipulation episodes, accidental disconnections or misconnections, and costs.[1-9] (IV)

B. Ensure that all add-on devices are compatible with the administration system to prevent the risk of leaks, disconnections, or misconnections.[5-6] (V)

C. Change the add-on device with new vascular access device (VAD) insertion, with each administration set replacement, or as defined by the organization, and whenever the integrity of the product is compromised or suspected of being compromised.[1,2] (V)

D. Avoid the use of stopcocks due to the increased risk of infection.
   1. Propofol anesthesia may increase risk for postoperative infection because of microorganism growth in stopcock dead spaces. Bacterial contamination of the patient's skin, the provider's hands, and the environment contribute to infection risk associated with stopcocks.[10,11] (IV)
   2. Use a stopcock or manifold with an integrated needleless connection rather than a solid cap or replace the stopcock with a needleless connector to reduce stopcock contamination.[12,13] (IV)

REFERENCES

Note: All electronic references in this section were accessed August 28, 2015.

1. Hadaway L. Infusion therapy equipment. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R. eds. *Infusion Nursing*: An Evidence-Based Approach. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:391-436.
2. 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. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:1-85.
3. Gonzalez Lopez J, Arriba Vilela A, Fernandez del Palacio E, Olivares Corral J, Benedicto Marti C, Herrera Portal P. Indwell times, complications and costs of open vs closed safety peripheral intravenous catheters: a randomized study. *J Hosp Infect*. 2014;86(2):117-126.
4. Tamura N, Abe S, Hagimoto K, et al. Unfavorable peripheral intravenous catheter replacements can be reduced using an integrated closed intravenous catheter system. *J Vasc Access*. 2014;15(4):257-263.
5. US Food and Drug Administration. Preventing tubing and luer misconnections. http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/TubingandLuerMisconnections/default.htm.
6. US Food and Drug Administration. Safety considerations to mitigate the risks of misconnections with small-bore connectors intended for enteral applications. http://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM313385.pdf. Published February 11, 2015.
7. Institute for Safe Medication Practices (ISMP). Stay connected program. http://ismp.org/tools/stayconnectedprogram.aspx.
8. American Nurses Association [position paper]. Safety issues related to tubing and catheter misconnections. http://www.nursingworld.org/position/practice/tube.aspx.
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. Cole D, Baslanti T, Gravenstein NL, Gravenstein N. Leaving more than your fingerprint on the intravenous line: a prospective study on propofol anesthesia and implications of stopcock contamination. *Anesth Analg*. 2015;120(4):816-867.
11. Loftus R, Brown J, Koff M, et al. Multiple reservoirs contribute to intraoperative bacterial transmission. *Anesth Analg*. 2012;114(6):1236-1248.
12. Mermel L. Intraoperative stopcock and manifold colonization of newly inserted peripheral intravenous catheters. *Infect Control Hosp Epidemiol*. 2014;35(9):1187-1189.
13. 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.

37. VASCULAR ACCESS DEVICE (VAD) STABILIZATION

Standard

37.1 Stabilize and secure vascular access devices (VADs) to prevent VAD complications and unintentional loss of access.

37.2 Methods used to stabilize the VAD will not interfere with assessment and monitoring of the access site and will not impede vascular circulation or delivery of the prescribed therapy.

Practice Criteria

A. Consider use of an engineered stabilization device (ESD) to stabilize and secure VADs as inadequate

stabilization and securement can cause unintentional dislodgment and complications requiring premature VAD removal. ESDs promote consistent practice among all clinicians, reduce VAD motion that can lead to complications, reduce interruption of needed infusion therapy, and may decrease cost of care.

1. The effect of adhesive ESDs on peripheral catheter complication rates is unclear due to the limited number and quality of randomized trials.
2. Studies on central vascular access devices (CVADs) are limited to small populations or descriptive study design.
3. Many devices merge the interventions of catheter stabilization with the dressing of the VAD, yet there is an absence of data for these combination devices.
4. Decisions about the most appropriate method for VAD stabilization and securement include patient age, skin turgor and integrity, previous adhesive skin injury, and any type of drainage from the insertion site.[1-6] (IV)

B. Avoid use of tape or sutures, as they are not effective alternatives to an ESD. Rolls of nonsterile tape can become contaminated with pathogenic bacteria, although its contribution to VAD infection has not been quantified. Sutures are associated with needlestick injury, in addition to supporting the growth of biofilm and increasing the risk of catheter-related bloodstream infection.[7-10] (II, Regulatory)

C. Do not rely on VAD dressings (ie, standard, nonbordered transparent semipermeable membrane [TSM] dressings, gauze and tape dressings) as a means for VAD stabilization as there is insufficient evidence supporting their benefits as stabilization devices.[11] (I)

D. For peripheral catheters, consider 2 options for catheter stabilization: (1) an integrated stabilization feature on the peripheral catheter hub combined with a bordered polyurethane securement dressing or (2) a standard round hub peripheral catheter in combination with an adhesive ESD. Both have demonstrated equivalent complication rates, although complication rates for both types were not greatly reduced with either type of ESD.[12,13] (III)

1. Use of a bordered polyurethane securement dressing alone on a peripheral catheter with a traditional hub allowed more peripheral catheters to reach 72 hours of dwell time with fewer needing to be restarted; however, more data are needed.[14] (V)
2. Cyanoacrylate tissue adhesives for securement have been studied in vitro, in animals, and in small pilot trials of peripheral venous and arterial catheters. Tissue adhesive plus a standard transparent dressing have shown a slight trend toward reduction in catheter failure with these adhesives in combination with a standard transparent membrane dressing; however, larger trials are needed to confirm these findings and identify patients for whom this might not be suitable.[5,15-17] (III)

E. Use adhesive-based ESDs with peripherally inserted central catheters (PICCs) as they may reduce risk of infection and catheter dislodgment and are considered to be safer than sutures. Sutures were associated with fewer complications when compared to use of tape with PICCs in pediatric patients in a randomized, controlled trial that excluded use of stabilization devices.[3,18-20] (III)

F. Subcutaneous ESDs have been successful in stabilizing PICCs and CVADs inserted through the internal jugular vein of adults. Patient outcomes and patient and inserter satisfaction have been favorable; however, additional studies with other CVADs are needed.[21-23] (V)

G. For CVADs, the use of staples as an alternative to sutures reduces exposure to contaminated sharps and shortens securement time but increases pain on application and removal and does not adequately secure the CVAD. A system using a special catheter clamp designed for staple use demonstrated significantly less time for securing the VAD in a variety of insertion sites, but additional VAD outcome data are needed.[24-26] (IV)

H. Do not use rolled bandages, with or without elastic properties, to secure any type of VAD because they do not adequately secure the VAD, can obscure signs and symptoms of complications, and can impair circulation or the flow of infusion. The presence of skin disorders that contradict the use of medical adhesives (ie, pediatric epidermolysis bullosa, toxic epidermal necrolysis) may necessitate the use of tubular gauze mesh rather than adhesive ESD.[4] (V)

I. Assess the integrity of the ESD with each dressing change and change the ESD according to the manufacturer's directions for use. Remove adhesive ESDs during the dressing change to allow for appropriate skin antisepsis and apply a new ESD. An ESD designed to remain in place for the life of the VAD (eg, sutures, subcutaneous ESD) may need to be removed and replaced if appropriate stabilization is no longer being achieved.[3,22,23,27] (IV)

J. Be aware of the risk of medical adhesive-related skin injury (MARSI) associated with the use of adhesive-based ESDs.

1. Assess skin when the device is changed; anticipate potential risk for skin injury due to age, joint movement, and presence of edema.
2. Apply barrier solutions to skin exposed to the adhesive dressing to reduce the risk of MARSI. Compound tincture of benzoin should not be used due to increased risk of MARSI because it may increase the bonding of adhesives to skin,

causing skin injury when the adhesive-based ESD is removed.[8] (I)

K. Never readvance a dislodged VAD into the vein. After assessment of the tip location, the infusion therapy, and other influencing factors, the VAD could be stabilized at the current location; however, removal, reinsertion at a new site, or exchange could be the most appropriate intervention.[28] (V)

REFERENCES

Note: All electronic references in this section were accessed October 5, 2015.

1. Alekseyev S, Byrne M, Carpenter A, Franker C, Kidd C, Hulton L. Prolonging the life of a patient's IV: an integrative review of intravenous securement devices. *Medsurg Nurs*. 2011;21(5):285-292.
2. 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.
3. 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.
4. Hetzler R, Wilson M, Hill EK, Hollenback C. Securing pediatric peripheral IV catheters: application of an evidence-based practice model. *J Pediatr Nurs*. 2011;26(2):143-148.
5. 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.
6. 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.
7. 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.
8. 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.
9. Occupational Safety and Health Administration (OSHA). *OSHA Fact Sheet: Securing Medical Catheters*. Washington, DC: OSHA; 2004:2.
10. Griswold S, Bonaroti A, Rieder CJ, et al. Investigation of a safety-engineered device to prevent needlestick injury: why has not StatLock stuck? *BMJ*. 2013. doi:10.1136/bmjopen-2012-002327.
11. Webster J, Gillies D, O'Riordan E, Sherriff KL, Rickard CM. Gauze and tape and transparent polyurethane dressings for central venous catheters. *Cochrane Database Syst Rev*. 2011;(11):CD003827. doi:10.1002/14651858.CD003827.pub2.
12. Bausone-Gazda D, Lefaiver C, Walters S. A randomized controlled trial to compare the complications of 2 peripheral intravenous catheter-stabilization systems. *J Infus Nurs*. 2010;33(6):371-384.
13. Delp J, Hadaway L. New product decisions: the process and outcome for a community health system. *J Assoc Vasc Access*. 2011;16(2):74-76, 78-79, 82-84.
14. Jackson A. Retrospective comparative audit of two peripheral IV securement dressings. *Br J Nurs*. 2012;21(suppl 2):10-15.
15. Simonova G, Rickard CM, Dunster KR, Smyth DJ, McMillan D, Fraser JF. Cyanoacrylate tissue adhesives: effective securement technique for intravascular catheters—in vitro testing of safety and feasibility. *Anaesth Intensive Care*. 2012;40(3):460-466.
16. 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.
17. 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.
18. O'Grady N, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
19. Graf J, Newman C, McPherson M. Sutured securement of peripherally inserted central catheters yields fewer complications in pediatric patients. *J Paren Enteral Nutr*. 2006;20(6):S32-S35.
20. Yamamoto A, Solomon J, Soulen M, et al. Sutureless securement device reduces complications of peripherally inserted central venous catheters. *J Vasc Interv Radiol*. 2002;13(1):77-81.
21. Cordovani D, Cooper RM. A prospective trial on a new sutureless securement device for central venous catheters. *Can J Anesth*. 2013;60(5):504-505.
22. Egan GM, Siskin GP, Weinmann R IV, Galloway MM. A prospective postmarket study to evaluate the safety and efficacy of a new peripherally inserted central catheter stabilization system. *J Infus Nurs*. 2013;36(3):181-188.
23. Hughes ME. Reducing PICC migrations and improving patient outcomes. *Br J Nurs*. 2014;23(suppl 2):S12-S18.
24. Vinjirayer A, Jefferson P, Ball D. Securing central venous catheters: a comparison of sutures with staples. *Emerg Med J*. 2004;21(5):582-583.
25. Motonaga GK, Lee KK, Kirsch JR. The efficacy of the arrow staple device for securing central venous catheters to human skin. *Anesth Analg*. 2004;99(5):1436-1439.
26. Silich B, Chrobak P, Siu J, Schlichting A, Patel S, Yang J. Improving safety and efficiency during emergent central venous catheter placement with a needleless securing clamp. *Emerg Med J*. 2013;30(8):683-686.
27. Inwood S. An exploration of the past, present and future of catheter securement. *Br J Nurs*. 2014;23(suppl 8):S26-S27.
28. Gorski L, Perucca R, Hunter M. Central venous access devices: care, maintenance, and potential complications. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:495-515.

38. JOINT STABILIZATION

Standard

38.1 Joint stabilization devices, such as an arm board or splint, are used to facilitate infusion delivery and maintain device patency and are not considered restraints.
38.2 A joint stabilization device is a single-patient-use device.

Practice Criteria

A. Joint stabilization devices may be used to facilitate infusion delivery, maintain device patency, and minimize complications.[1,2] (III)
B. The joint stabilization device is:
   1. Padded as needed and supports the area of flexion (eg, hand, arm, elbow, foot) in order to maintain a functional position.[3-5] (I A/P)
   2. Applied in a manner that permits visual inspection and assessment of the vascular access site and vascular pathway and does not exert such pressure as to cause circulatory constriction, pressure ulcers, skin impairment, or nerve damage in the area of flexion or under the device.[6-12] (IV)
   3. Considered when a short peripheral catheter is placed in the antecubital fossa. This site is not recommended, but if a short peripheral catheter is present, the joint is stabilized.[13] (V)
   4. Removed periodically for assessment of circulatory status, range of motion and function, and skin integrity.[3,6,10,14] (I A/P)
C. Wooden tongue depressors as joint stabilization devices should not be used in preterm infants or immunocompromised individuals.[15-17] (IV)

REFERENCES

1. Dalal S, Chawla D, Singh J, Agarwal R, Deorari A, Paul V. Limb splinting for intravenous cannulae in neonates: a randomised controlled trial. *Arch Dis Child Fetal Neonatal Ed*. 2009;94(6):F394-F396.
2. Tripathi S, Kaushik V, Singh V. Peripheral IVs: factors affecting complications and patency— randomized controlled trial. *J Infus Nurs*. 2008;31(3):182-188.
3. Moore KL, Dalley AF, Agur AMR. Upper limb. In: *Clinically Oriented Anatomy*. 6th ed. New York, NY: Wolters Kluwer/Lippincott Williams & Wilkins; 2010:671-819.
4. Hadaway L. Infusion therapy equipment. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:391-436.
5. Hockenberry M, Wilson D. *Wong's Essentials of Pediatric Nursing*. 9th ed. St Louis, MO: Elsevier; 2013:685.
6. Apold J, Rydrych D. Preventing device-related pressure ulcers: using data to guide statewide change. *J Nurs Care Qual*. 2012;27(1):28-34.
7. Black J, Alves P, Brindle CT, et al. Use of wound dressings to enhance prevention of pressure ulcers caused by medical devices. *Int Wound J*. 2015;12(3):322-327.
8. Black JM, Cuddigan JE, Walko MA, Didier LA, Lander MJ, Kelpe MR. Medical device related pressure ulcers in hospitalized patients. *Int Wound J*. 2010;7(5):358-365.
9. Haesler E, ed; National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. *Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline*. Perth, Australia: Cambridge Media; 2014.
10. 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.
11. Visscher M, Taylor T. Pressure ulcers in the hospitalized neonate: rates and risk factors. *Sci Rep*. 2014;4:7429.
12. Akl KF. Misuse of the wooden tongue depressor. *Indian J Pediatr*. 2010;77(5):579.
13. Phillips LD, Gorski LA. Techniques for initiation and maintenance of peripheral infusion therapy. In: *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014:309-405.
14. Simandl G. Disorders of skin integrity and function. In: Porth CM. *Essentials of Pathophysiology*. 4th ed. New York, NY: Wolters Kluwer/Lippincott Williams & Wilkins; 2015: 1153-1184.
15. Holzel H, Macqueen S, MacDonald A, et al. *Rhizopus microsporus* in wooden tongue depressors: a major threat or minor inconvenience? *J Hosp Infect*. 1998;38(2):113-118.
16. Leeming JG, Moss HA, Elliott TS. Risk of tongue depressors to the immunocompromised. *Lancet*. 1996;348(9031):889.
17. Mitchell SJ, Gray J, Morgan ME, Hocking MD, Durbin GM. Nosocomial infection with *Rhizopus microsporus* in preterm infants: association with wooden tongue depressors. *Lancet*. 1996;348(9025):441-443.

39. SITE PROTECTION

Standard

39.1 The use of site protection and/or physical immobilization devices to protect vascular access devices (VADs) or VAD sites, and their proper application and patient monitoring, are established in organizational policies, procedures, and/or practice guidelines.
39.2 The use of physical immobilization devices (ie, restraints) to protect VAD sites is not routinely implemented and is avoided whenever possible.

Practice Criteria

A. Specific patient populations including pediatric, elderly, or those with cognitive dysfunction are at risk of accidental VAD dislodgment or patient removal of the VAD. Consider VAD site or line protection methods (such as clear plastic domes) for the duration of the VAD, and if all other measures have been tried or have failed, physical immobilization devices (such as soft devices restraining a hand or hands). All patients may need temporary VAD site protection from water, other contaminants, or movement due to activities of daily living.[1-13] (V)
   1. Select a site protection method or immobilization device based on an assessment of the patient's physical, behavioral, cognitive, and psychological status.[1,2,14-18] (V)
   2. Use site protection methods or immobilization devices in a manner that permits visual inspection and assessment of the vascular access site

and vascular pathway and does not exert such pressure as to cause circulatory constriction, pressure ulcers, skin impairment, or nerve damage under the device and in accordance with manufacturers' directions for use. Physical immobilization devices should be distal to the VAD site. The site protection method or selected immobilization device should not interfere with the prescribed infusion rate, delivery method, ability to assess the vascular access site, or catheter stabilization/securement.[2,6,15,19] (I A/P)

3. Rigid site protection devices and all immobilization devices should be removed at established intervals to allow assessment of the extremity's circulatory status and provide an opportunity for supervised range-of-motion activities.[15-19] (I A/P)
4. Regularly assess patient safety without the physical immobilization device as to its need. The physical immobilization device should be removed as soon as the patient's condition allows.[8,16,20-22] (V, Regulatory)

B. Educate the patient, caregiver, or surrogate on the need for and appropriate use of physical immobilization devices (refer to Standard 8, *Patient Education*).

C. Document, at a minimum, the rationale for the physical immobilization device; type and location of the immobilization device; release and reapplication of the device; site and circulatory assessment; any complications caused by the immobilization device; patient's response to the immobilization device; reassessment of the need for the immobilization device; patient education; and removal of the device.[23,24] (V, Regulatory)

REFERENCES

Note: All electronic references in this section were accessed August 31, 2015.

1. Antonelli MT. Restraint management: moving from outcome to process. *J Nurs Care Qual*. 2008;23(3):227-232.
2. Frey AM, Pettit J. Infusion therapy in children. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Therapy: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:550-570.
3. Jumani K, Advani S, Reich NG, Gosey L, Milstone AM. Risk factors for peripherally inserted central venous catheter complications in children. *JAMA Pediatr*. 2013;167(5):429-435.
4. Ludwick R, O'Toole R, Meehan A. Restraints or alternatives: safety work in care of older persons. *Int J Older People Nurs*. 2012;7(1):11-19.
5. Phillips LD, Gorski LA. *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014:271-272.
6. Redfern WS, Brany JE. Pediatric infusion therapy. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2014:687-742.
7. Rickard CM, McCann D, Munnings J, McGrail MR. Routine resite of peripheral intravenous devices every 3 days did not reduce complications compared with clinically indicated resite: a randomised controlled trial. *BMC Med*. 2010;8:53. http://www.biomedcentral.com/1741-7015/8/53. Published September 10, 2010.
8. The Joint Commission (TJC). *Hospital-Provision of Care, Treatment, and Services: PC.03.02.01*. Oakbrook Terrace, IL: TJC; 2015.
9. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
10. Phillips LD, Gorski LA. *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014:462-539.
11. Saibu R, Mitchell P, Salifu M, et al. Dialysis line separation: maximizing patient safety through education and visibility of access site for patients on hemodialysis. *Nephrol Nurs J*. 2011;38(6):515-526.
12. 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.
13. Weingart S, Hsieh C, Lane S, Cleary A. Standardizing central venous catheter care by using observations from patients with cancer. *Clin J Oncol Nurs*. 2014;18(3):321-326.
14. Balas MC, Casey CM, Happ MB. Comprehensive assessment and management of the critically ill. In: Boltz M, Capezuti E, Fulmer TT, Zwicker D, eds. *Evidence-Based Geriatric Nursing Protocols for Best Practice*. 4th ed. New York, NY: Springer; 2012.
15. Bradas CM, Sandhu SK, Mion LC. Physical restraints and side rails in acute and critical care settings. In: Boltz M, Capezuti E, Fulmer TT, Zwicker D, eds. *Evidence-Based Geriatric Nursing Protocols for Best Practice*. 4th ed. New York, NY: Springer; 2012.
16. Hospital conditions of participation: patients' rights, final rule. *Fed Regist*. 2006;71(236):71378-71428. Codified at 42 CFR §482. http://www.cms.hhs.gov/CFCsAndCOPs/downloads/finalpatientrightsrule.pdf. Published December 8, 2006.
17. Mion LC. Physical restraint in critical care settings: will they go away? *Geriatr Nurs*. 2008;29(6):421-423.
18. The Joint Commission (TJC). *Comprehensive Accreditation Manuals. E-dition v.February 1, 2015. Hospital-Provision of Care, Treatment, and Services: PC.03.02.03*. Oakbrook Terrace, IL: TJC; 2015.
19. Smith SF, Duell DJ, Martin BC. Application of immobilizing devices: restraints. *Clinical Nursing Skills: Basic to Advanced Skills*. 8th ed. New York, NY: Pearson; 2012:160-173, 1010-1013.
20. Centers for Medicare & Medicaid Services. State operations provider certification, transmittal 37. https://www.cms.gov/Regulations-and-Guidance/Guidance/Transmittals/downloads/R37SOMA.pdf. Published October 17, 2008.
21. The Joint Commission (TJC). *Hospital—Provision of Care, Treatment, and Services*: *PC.03.02.07*. Oakbrook Terrace, IL: TJC; 2015.
22. The Joint Commission (TJC). *Nursing Care Center—Provision of Care, Treatment, and Services: PC.03.02.13*. Oakbrook Terrace, IL: TJC; 2015.

23. The Joint Commission (TJC). *Hospital—Provision of Care, Treatment, and Services: PC.03.02.05*. Oakbrook Terrace, IL: TJC; 2015.
24. The Joint Commission (TJC). *Hospital—Record of Care, Treatment, and Services: RC.02.01.05*. Oakbrook Terrace, IL: TJC; 2015.

40. FLUSHING AND LOCKING

Standard

40.1 Vascular access devices (VADs) are flushed and aspirated for a blood return prior to each infusion to assess catheter function and prevent complications.
40.2 VADs are flushed after each infusion to clear the infused medication from the catheter lumen, thereby reducing the risk of contact between incompatible medications.
40.3 The VAD is locked after completion of the final flush to decrease the risk of intraluminal occlusion and catheter-related bloodstream infection (CR-BSI), depending on the solution used.

Practice Criteria

A. Use single-dose systems (eg, single-dose vials or prefilled labeled syringes) for all VAD flushing and locking.
   1. Commercially available prefilled syringes may reduce the risk of CR-BSI and save staff time for syringe preparation.[1-3] (IV)
   2. If multiple-dose vials must be used, dedicate a vial to a single patient (see Standard 49, *Infection*).[4] (V)
   3. Do not use intravenous (IV) solution containers (eg, bags or bottles) as a source for obtaining flush solutions.[3-6] (IV)
   4. Inform patients that disturbances in taste and odor may occur with prefilled flush syringes and may be related to several causes including systemic conditions (eg, diabetes, Crohn's disease), medications (eg, antineoplastics), and radiation. Leaching of substances from the plastic syringe into the saline has been reported, although it is not thought to be harmful to health.[7-9] (II)

B. Perform disinfection of connection surfaces (ie, needleless connectors, injection ports) before flushing and locking procedures (refer to Standard 34, *Needleless Connectors*).

C. Flush all VADs with preservative-free 0.9% sodium chloride (USP).
   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 peripheral VAD, 10 mL for central vascular access devices [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, parenteral nutrition, contrast media, and other viscous solutions may require larger flush volumes.[10] (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.[11] (V)
   3. Use only preservative-free solutions for flushing all VADs in neonates to prevent toxicity.[12] (V)
   4. Use 5% dextrose in water followed by preservative-free 0.9% sodium chloride (USP) 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.[13] (V)
   5. Do not use sterile water for flushing VADs.[14] (V)

D. Assess VAD functionality by 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.
   1. During the initial flush, slowly aspirate the VAD for blood return that is the color and consistency of whole blood, which is an important component of assessing catheter function prior to administration of medications and solutions (refer to Standard 48, *Central Vascular Access Device [CVAD] Occlusion*; Standard 53, *Central Vascular Access Device [CVAD] 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, etc.) 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 52, *Central Vascular Access Device [CVAD]-Associated Venous Thrombosis*; Standard 53, *Central Vascular Access Device [CVAD] Malposition*).[10] (IV)
   3. After confirmation of patency by detecting no resistance and the presence of a blood return, use syringes appropriately sized for the medication being injected. Do not transfer the medication to a larger syringe.[3,15] (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.[3,16] (V)

E. Following the administration of an IV push medication, flush the VAD lumen with preservative-free 0.9% sodium chloride (USP) 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.[3] (V)

F. Use positive-pressure techniques to minimize blood reflux into the VAD lumen.
   1. Prevent syringe-induced blood reflux by leaving a small amount (eg, 0.5-1 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.[10,17] (IV)
   2. Prevent disconnection reflux by using the appropriate sequence for flushing, clamping, and disconnection determined by the type of needleless connector being used (refer to Standard 34, *Needleless Connectors*).
   3. Consider using pulsatile flushing technique. In vitro studies have shown that 10 short boluses of 1 mL 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.[10,18] (IV)
   4. When feasible, consider orienting the bevel of an implanted port access needle in the opposite direction from the outflow channel where the catheter is attached to the port body. In vitro testing demonstrates a greater amount of protein is removed when flushing with this bevel orientation.[19] (IV)

G. Lock short peripheral catheters immediately following each use.
   1. In adults, use preservative-free 0.9% sodium chloride (USP) for locking.[10,20-24] (I)
   2. In neonates and pediatrics, use heparin 0.5 units to 10 units per mL or preservative-free 0.9% sodium chloride (USP). Outcome data in these patient populations are controversial.[25,26] (II)
   3. For short peripheral catheters not being used for intermittent infusion, consider locking once every 24 hours.[27] (III)

H. There is insufficient evidence to recommend the solution for locking midline catheters.

I. Lock CVADs with either heparin 10 units per mL or preservative-free 0.9% sodium chloride (USP), according to the directions for use for the VAD and needleless connector.
   1. Establish a standardized lock solution for each patient population, organization-wide.[28,29] (V)
   2. Randomized controlled trials have shown equivalent outcomes with heparin and sodium chloride lock solutions for multiple-lumen nontunneled CVADs, peripherally inserted central catheters (PICCs), and implanted ports while accessed and when the access needle is removed. There is insufficient evidence to recommend one lock solution over the other.[30-33] (I)
   3. Use heparin or preservative-free 0.9% sodium chloride (USP) for locking CVADs in children.[29] (II)
   4. Consider using heparin 10 units per mL for locking PICCs in home care patients.[34] (III)
   5. 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.[10,35-37] (IV)
   6. 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. Heparin-induced thrombocytopenia (HIT) has been reported with the use of heparin lock solutions, although the exact rates are unknown (see Standard 43, *Phlebotomy*).[11,38] (II)
   7. Monitoring platelet counts for HIT is not recommended in postoperative and medical patients receiving only heparin in the form of a catheter lock solution due to a very low incidence of HIT of 1% or less (see Standard 52, *Central Vascular Access Device [CVAD]-Associated Venous Thrombosis*).[38] (II)
   8. Because of conflicts with religious beliefs, inform patients when using heparin derived from animal products (eg, porcine, bovine), and obtain consent. Use preservative-free 0.9% sodium chloride (USP) instead of heparin when possible.[39] (V)

J. Lock hemodialysis CVADs with heparin lock solution 1000 units/mL, 4% citrate, or antimicrobial lock solutions. Use recombinant tissue plasminogen activator to lock hemodialysis catheters once per week as a strategy to reduce CR-BSI.[40-43] (I)

K. Lock apheresis CVADs with heparin 100 units/mL, 4% citrate, acid-citrate-dextrose Formula A, or other antimicrobial lock solutions.[40-42,44,45] (IV)

L. Use solution containing heparin (eg, 1 unit per mL of 0.9% sodium chloride [USP]) or preservative-free 0.9% sodium chloride (USP) as a continuous flow to maintain patency of arterial catheters used for hemodynamic monitoring. The decision to use preservative-free 0.9% sodium chloride (USP) 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.[46-48] (II)

M. Apply the following recommendations for neonates and pediatrics.
   1. Use a continuous infusion of heparin 0.5 units per kg for all CVADs in neonates.
   2. Use continuous infusion of heparin 0.25 to 1 unit per mL (total dose of heparin 25-200 units per kg per day) for umbilical arterial catheters in neonates to prevent arterial thrombosis.
   3. Use heparin 5 units per mL, 1 mL per hour as a continuous infusion for neonates and children with peripheral arterial catheters (see Standard 30, *Umbilical Catheters*).[29] (II)

N. Use antimicrobial locking solutions for therapeutic and prophylactic purposes. Use in patients with long-term CVADs, patients with a history of multiple CR-BSIs, high-risk patient populations, and in facilities with unacceptably high rates of central line-associated bloodstream infection (CLABSI), despite application of other methods of CLABSI reduction.[42,49-52] (I)
   1. Antibiotic lock solutions contain supratherapeutic concentrations of antibiotics and may be combined with heparin. 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 duration of use remains controversial.[53] (II)
   2. Antiseptic locking solutions include ethanol, taurolidine, citrate, 26% sodium chloride, methylene blue, fusidic acid, and ethylenediaminetetra-acetic acid (EDTA) used alone or in numerous combinations.[51] (I)
   3. Follow catheter manufacturers' instructions for intraluminal locking with ethanol. Changes in CVADs made of polyurethane material, but not silicone, have led to catheter rupture and splitting. Monitor for thrombotic lumen occlusion as ethanol has no anticoagulant activity, hemolysis, and hepatic toxicity. Irreversible precipitation of plasma proteins that could add to CVAD lumen occlusion is associated with ethanol concentrations greater than 28%.[37,54-56] (I)
   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%.[36,43] (I)
   5. Monitor taurolidine, an amino acid with antimicrobial effects, for thrombotic lumen occlusion and protein precipitation, which could cause lumen occlusion.[30,51,57] (I)
   6. Use standardized formulations and licensed independent practitioner (LIP)-approved protocols for all antimicrobial lock solutions to enhance patient safety. Consult with pharmacy when combinations of antimicrobial solutions are planned so that correct information about compatibility and stability of the solution are addressed.[53,58] (II)
   7. The length of time that antimicrobial lock solutions should reside inside the CVAD lumen is unclear; up to 12 hours per day may be required. This will limit use in patients receiving continuous or frequent intermittent infusions.[53] (II)
   8. 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 CLABSI rates.[42,58,59] (II)

REFERENCES

Note: All electronic references in this section were accessed September 1, 2015.

1. Bertoglio S, Rezzo R, Merlo FD, et al. Pre-filled normal saline syringes to reduce totally implantable venous access device-associated bloodstream infection: a single institution pilot study [published online March 15, 2013]. *J Hosp Infect*. doi:10.1016/j.jhin.2013.02.008.
2. 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.
3. Institute for Safe Medication Practices (ISMP). *Safe Practice Guidelines for Adult IV Push Medications*. Horsham, PA: ISMP; 2015.
4. Dolan S, Barnes S, Cox T, Felizardo G, Patrick M, Ward K. *APIC Position Paper: Safe Injection, Infusion, and Medication Vial Practices in Healthcare*. Washington, DC: Association for Practitioners in Infection Control; 2009.
5. Perz JF, Thompson ND, Schaefer MK, Patel PR. US outbreak investigations highlight the need for safe injection practices and basic infection control. *Clin Liver Dis*. 2010;14(1):137-151.
6. See I, Nguyen DB, Chatterjee S, et al. Outbreak of *Tsukamurella* species bloodstream infection among patients at an oncology clinic, West Virginia, 2011-2012. *Infect Control*. 2014;35(3):300-306.
7. Celetti SJ, Vaillancourt R, Pascuet E, Sharp D. Taste and/or odour disturbances in pediatric patients undergoing IV flush with

normal saline administered by prefilled syringe. *Can J Hosp Pharm*. 2012;65(5):368-372.
8. Chaveli-López B. Oral toxicity produced by chemotherapy: a systematic review. *J Clin Exp Dent*. 2014;6(1):e81-e90.
9. Maheswaran T, Abikshyeet P, Sitra G, Gokulanathan S, Vaithiyanadane V, Jeelani S. Gustatory dysfunction. *J Pharm Bioallied Sci*. 2014;6(suppl 1):S30.
10. Goossens GA. Flushing and locking of venous catheters: available evidence and evidence deficit [published online May 14, 2015]. *Nurs Res Pract*. doi:10.1155/2015/985686.
11. Gahart BL, Nazareno AR. *Intravenous Medications*. 30th ed. St Louis, MO: Mosby; 2014.
12. Allegaert K. Neonates need tailored drug formulations. *World J Clin Pediatr*. 2013;2(1):1-5.
13. Seneviratne C, Yip J, Chang J, Zhang C, Samaranayake L. 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.
14. Pennsylvania Patient Safety Authority. Sterile water should not be given "freely." *Penn Patient Saf Advis*. 2008;5(2). http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2008/Jun5%282%29/Pages/Home.aspx. Published June 2008.
15. Hadaway L. Misuse of prefilled flush syringes: implications for medication errors and contamination. *Infect Control Resource*. 2008;4(4):2-4.
16. Hadaway L. Infusion therapy equipment. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:391-436.
17. Hadaway L. Flushing vascular access catheters: risk for infection transmission. *Infect Control Resource*. 2007;4(2):1-8.
18. Ferroni A, Gaudin F, Guiffant G, et al. Pulsative flushing as a strategy to prevent bacterial colonization of vascular access devices. *Med Devices (Auckland, NZ)*. 2014;7:379-383.
19. 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 (Auckland, NZ)*. 2012; 5:31.
20. Peterson F, Kirchhoff K. Analysis of the research about heparinized versus nonheparinized intravenous lines. *Heart Lung*. 1991;20(6):631-640.
21. Goode C, Titler M, Rakel B, et al. A meta-analysis of effects of heparin flush and saline flush: quality and cost implications. *Nurs Res*. 1991;40(6):324-330.
22. Mok E, Kwong TK, Chan MF. A randomized controlled trial for maintaining peripheral intravenous lock in children. *Int J Nurs Pract*. 2007;13(1):33-45.
23. 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.
24. Wang R, Luo O, He L, Li JX, Zhang MG. Preservative-free 0.9% sodium chloride for flushing and locking peripheral intravenous access device: a prospective controlled trial. *J Evid Based Med*. 2012;5(4):205-208.
25. Cook L, Bellini S, Cusson RM. Heparinized saline vs normal saline for maintenance of intravenous access in neonates: an evidence-based practice change. *Adv Neonatal Care*. 2011;11(3): 208-215.
26. 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.
27. 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.
28. Peterson K. The development of central venous access device flushing guidelines utilizing an evidence-based practice process. *J Pediatr Nurs*. 2013;28(1):85-88.
29. Monagle P, Chan AK, Goldenberg NA, et al. Antithrombotic therapy in neonates and children—antithrombotic therapy and prevention of thrombosis: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141(suppl 2):e737S-e801S.
30. López-Briz E, Ruiz Garcia V, Cabello JB, Bort-Marti S, Carbonell Sanchis R, Burls A. Heparin versus 0.9% sodium chloride intermittent flushing for prevention of occlusion in central venous catheters in adults. *Cochrane Database Syst. Rev*. 2014;10:CD008462. doi:10.1002/14651858.CD008462.pub2.
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.
32. 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.
33. Rosenbluth G, Tsang L, Vittinghoff E, Wilson S, Wilson-Ganz J, Auerbach A. Impact of decreased heparin dose for flush-lock of implanted venous access ports in pediatric oncology patients. *Pediatr Blood Cancer*. 2014;61(5):855-858.
34. Lyons MG, Phalen AG. A randomized controlled comparison of flushing protocols in home care patients with peripherally inserted central catheters. *J Infus Nurs*. 2014;37(4):270-281.
35. Lee T, Lok C, Vazquez M, Moist L, Maya I, Mokrzycki M. Minimizing hemodialysis catheter dysfunction: an ounce of prevention [published online February 19, 2012]. *Int J Nephrol*. doi:10.1155/2012/170857.
36. Schilcher G, Scharnagl H, Horina JH, et al. Trisodium citrate induced protein precipitation in haemodialysis catheters might cause pulmonary embolism. *Nephrol Dial Transplant*. 2012;27(7):2953-2957.
37. Schilcher G, Schlagenhauf A, Schneditz D, et al. Ethanol causes protein precipitation: new safety issues for catheter locking techniques. *PLoS One*. 2013;8(12):e84869.
38. Linkins LA, Dans AL, Moores LK, et al. Treatment and prevention of heparin-induced thrombocytopenia: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141(suppl 2):e495S-e530S.
39. Eriksson A, Burcharth J, Rosenberg J. Animal derived products may conflict with religious patients' beliefs. *BMC Med Ethics*. 2013;14(1):48.
40. Moran JE, Ash SR. Locking solutions for hemodialysis catheters: heparin and citrate—a position paper by ASDIN. *Semin Dial*. 2008;21(5):490-492.
41. Yon CK, Low CL. Sodium citrate 4% versus heparin as a lock solution in hemodialysis patients with central venous catheters. *Am J Health Syst Pharm*. 2013;70(2):131-136.
42. 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.

43. Grudzinski A, Agarwal A, Bhatnagar N, Nesrallah G. Benefits and harms of citrate locking solutions for hemodialysis catheters: a systematic review and meta-analysis. *Can J Kidney Health Dis*. 2015;2(1):13.
44. 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.
45. 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.
46. Halm MA. Flushing hemodynamic catheters: what does the science tell us? *Am J Crit Care*. 2008;17(1):73-76.
47. Goh LJ, Teo HS, Masagoes M. Heparinized saline versus normal saline in maintaining patency of arterial and central venous catheters. *Proc Singapore Healthc*. 2011;20(3):190-196.
48. Tully RP, McGrath BA, 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.
49. 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):1-45.
50. O'Grady N, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
51. Zacharioudakis IM, Zervou FN, Arvanitis M, Ziakas PD, Mermel LA, Mylonakis E. Antimicrobial lock solutions as a method to prevent central line-associated bloodstream infections: a meta-analysis of randomized controlled trials. *Clin Infect Dis*. 2014;59(12):1741-1749.
52. van de Wetering MD, van Woensel J, Lawrie TA. Prophylactic antibiotics for preventing gram positive infections associated with long-term central venous catheters in oncology patients. *Cochrane Database Syst Rev*. 2013;(11):CD003295. doi:10.1002/14651858.CD003295.pub3.
53. Justo JA, Bookstaver PB. Antibiotic lock therapy: review of technique and logistical challenges. *Infect Drug Resist*. 2014;7:343-363.
54. Mermel LA, Alang N. Adverse effects associated with ethanol catheter lock solutions: a systematic review. *J Antimicrob Chemother*. 2014;69(10):2611-2619.
55. 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.
56. Oliveira C, Nasr A, Brindle M, Wales PW. Ethanol locks to prevent catheter-related bloodstream infections in parenteral nutrition: a meta-analysis. *Pediatrics*. 2012;129(2):318-329.
57. Liu Y, Zhang A-Q, Cao L, Xia H-T, Ma J-J. Taurolidine lock solutions for the prevention of catheter-related bloodstream infections: a systematic review and meta-analysis of randomized controlled trials. *PLoS One*. 2013;8(11):e79417.
58. Bookstaver PB, Rokas K, Norris LB, Edwards JM, Sherertz RJ. Stability and compatibility of antimicrobial lock solutions. *Am J Health Syst Pharm*. 2013;70(24):2185-2198.
59. Landry DL, Braden GL, Gobeille SL, Haessler SD, Vaidya CK, Sweet SJ. Emergence of gentamicin-resistant bacteremia in hemodialysis patients receiving gentamicin lock catheter prophylaxis. *Clin J Am Soc Nephrol*. 2010;5(10):1799-1804.

41. VASCULAR ACCESS DEVICE (VAD) ASSESSMENT, CARE, AND DRESSING CHANGES

Standard

41.1 The entire infusion system, from the solution container to the vascular access device (VAD) insertion site, is regularly checked for system integrity, infusion accuracy, and expiration dates of the infusate, dressing, and administration set.
41.2 Site care, including skin antisepsis and dressing changes, are performed at established intervals and immediately if the dressing integrity becomes damp, loosened, or visibly soiled, or if moisture, drainage, or blood are present under the dressing.
41.3 A sterile dressing is applied and maintained on all peripheral, nontunneled, peripherally inserted central catheters, accessed implanted VADs, and tunneled cuffed catheters, at least until the insertion site is well healed.
41.4 Aseptic technique is followed when providing site care and dressing changes on VADs.
41.5 Label the dressing with the date performed or date to be changed based on organizational policies and procedures.

Practice Criteria

A. Visually inspect the entire infusion system from the solution container, progressing down the administration set to the VAD insertion site with each infusion intervention.
   1. Inspect the infusion system for clarity of the infusate; integrity of the system (ie, leakage, luer connections secure) and of the dressing; correct infusate; accurate flow rate; and for expiration dates of the infusate and administration set.[1,2] (V)
B. Assess VAD function by flushing and aspirating for a blood return prior to each intermittent VAD use (eg, intermittent medication) and as clinically indicated with continuous infusions (eg, occlusion alarms). Recognize the risk of contamination with each manipulation of the infusion system (refer to Standard 36, *Add-on Devices*; Standard 40, *Flushing and Locking*).
C. Assess the VAD catheter-skin junction site and surrounding area for redness, tenderness, swelling, and drainage by visual inspection and palpation through the intact dressing and through patient reports about any discomfort including pain, paresthesias, numbness, or tingling.
   1. Central vascular access devices (CVADs) and midline catheters: assess at least daily.[3-6] (V)

2. Short peripheral catheters: assess minimally 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.[7] (V)
3. Patients receiving outpatient or home care: instruct the patient or caregiver to check the VAD site at least once per day for signs of complications and to report signs/symptoms or dressing dislodgment immediately to their health care provider; for continuous infusions via a short peripheral catheter, instruct to check the site every 4 hours during waking hours.[2,7] (V)

D. Measure the external CVAD length and compare to the external CVAD length documented at insertion when catheter dislodgment is suspected (refer to Standard 10, *Documentation in the Medical Record*; Standard 53, *Central Vascular Access Device [CVAD] Malposition*).

E. Measure upper-arm circumference when clinically indicated to assess the presence of edema and possible deep vein thrombosis (DVT). Take this measurement 10 cm above the antecubital fossa; identify the location and other characteristics, such as pitting or nonpitting. Compare to baseline measurement to detect possible catheter-associated venous thrombosis; a 3-cm increase in arm circumference and edema were associated with upper-arm DVT (see Standard 10, *Documentation in the Medical Record*; Standard 33, *Vascular Access Site Preparation and Device Placement*; Standard 52, *Central Vascular Access Device [CVAD]-Associated Venous Thrombosis*).[8] (IV)

F. Perform skin antisepsis as part of the site care procedure:
1. The preferred skin antiseptic agent is >0.5% chlorhexidine in alcohol solution.[3-5,9,10] (I)
2. If there is a contraindication to alcoholic chlorhexidine solution, tincture of iodine, an iodophor (povidone-iodine), or 70% alcohol may also be used.[3,5] (I)
3. Allow any skin antiseptic agent to fully dry prior to dressing placement; with alcoholic chlorhexidine solutions, for at least 30 seconds; for iodophors, for at least 1.5 to 2 minutes.[3,5,11] (V)
4. Use chlorhexidine with care in premature infants and infants under 2 months of age due to risks of skin irritation and chemical burns.[3-5,12-14] (IV)
5. For pediatric patients with compromised skin integrity, remove dried povidone-iodine with sterile 0.9% sodium chloride (USP) or sterile water.[15] (V)

G. Assess skin underneath dressing. Anticipate potential risk for skin injury due to age, joint movement, and presence of edema. Be aware of the risk of medical adhesive-related skin injury (MARSI) associated with the use of adhesive-based engineered stabilization devices (ESDs). Use a skin barrier solution to reduce the risk of MARSI. Do not use compound tincture of benzoin due to increased risk of MARSI because it may increase the bonding of adhesives to skin, causing skin injury when the adhesive-based ESD is removed (refer to Standard 37, *Vascular Access Device [VAD] Stabilization*).

H. Perform dressing changes on CVADs and midline catheters at a frequency based on the type of dressing.
1. Change transparent semipermeable membrane (TSM) dressings at least every 5 to 7 days and gauze dressings at least every 2 days; research has not supported the superiority of a TSM dressing versus a gauze dressing; note that a gauze dressing underneath a TSM dressing is considered a gauze dressing and changed at least every 2 days.[3-5,16] (II)
2. Select a gauze dressing if there is drainage from the catheter exit site. If gauze is used to support the wings of a noncoring needle in an implanted port and does not obscure the insertion site, it is not considered a gauze dressing.[2-5] (V)
3. Secure dressings to reduce the risk of loosening/dislodgment, as more frequent dressing changes due to dislodgment are associated with increased risk for infection; more than 2 dressing changes for disruption were associated with a greater than 3-fold increase in risk of infection.[17] (III)
4. Change the dressing immediately to closely assess, cleanse, and disinfect the site in the event of drainage, site tenderness, other signs of infection, or if dressing becomes loose/dislodges.[3-5,17] (III)
5. Change the adhesive-based ESD based on manufacturers' directions for use (refer to Standard 37, *Vascular Access Device [VAD] Stabilization*).

I. Perform dressing changes on short peripheral catheters if the dressing becomes damp, loosened, and/or visibly soiled and at least every 5 to 7 days.[3] (V, Committee Consensus)

J. Use chlorhexidine-impregnated dressings over CVADs to reduce infection risk when the extraluminal route is the primary source of infection. Even when organizations show a low baseline central line-associated bloodstream infection (CLABSI) rate, further reduction in CLABSI rate has been demonstrated with use of chlorhexidine-impregnated dressings. The efficacy of chlorhexidine dressings in long-term CVAD use, beyond 14 days when intraluminal sources of infection are the primary source, has not been shown.[18] (I)
1. Do not use if any history of reactions to chlorhexidine.[5] (V)

2. Use chlorhexidine-impregnated dressings with caution in premature neonates and among patients with fragile skin and/or complicated skin pathologies; contact dermatitis and pressure necrosis have occurred.[5,18-20] (V)
3. Monitor for erythema and dermatitis at the dressing site.[5,18-20] (V)

K. Consider bathing patients over 2 months of age with a 2% chlorhexidine preparation on a daily basis if other CLABSI prevention strategies have not been effective.[4,23-29] (I)

L. Consider the use of a hemostatic agent to reduce initial site bleeding if other methods (eg, pressure) fail to reduce the need for unplanned dressing changes after peripherally inserted central catheter (PICC) insertion.[29] (V)

M. Consider use of chlorhexidine-impregnated dressings with peripheral arterial catheters as an infection reduction intervention.[3,17,29] (III)

N. When the subcutaneous tunnel is well healed, consideration may be given to no dressing with a tunneled, cuffed CVAD.[3,5,30,31] (III)

O. Do not use rolled bandages, with or without elastic properties, to secure any type of VAD (refer to Standard 37, *Vascular Access Device [VAD] Stabilization*).

REFERENCES

Note: All electronic references in this section were accessed September 1, 2015.

1. Perucca R. Peripheral venous access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:456-479.
2. Gorski L, Perucca R, Hunter M. Central venous access devices: care, maintenance and potential complications. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R. eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:496-498.
3. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/pubs.html. Published April 2011.
4. 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. http://www.jstor.org/stable/10.1086/676533.
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.
6. Alexandrou E, Ramjan LM, Spencer T, et al. The use of midline catheters in the adult acute care setting: clinical implications and recommendations for practice. *J Assoc Vasc Access*. 2011;16(1):35-41.
7. Gorski LA, Hallock D, Kuehn SC, et al. INS position paper: recommendations for frequency of assessment of the short peripheral catheter. *J Infus Nurs*. 2012;35(5):290-292.
8. 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.
9. Paglianlonga F, Consolo S, Biasuzzi A, et al. Reduction in catheter-related infections after switching from povidone-iodine to chlorhexidine for the exit-site care of tunneled central venous catheters in children on hemodialysis. *Hemodial Int*. 2014;18(suppl 1):S13-S18.
10. Yamamoto N, Kimura H, Misao H, et al. Efficacy of 1.0% chlorhexidine-gluconate ethanol compared with 10% povidone-iodine for long-term central venous catheter care in hematology departments: a prospective study. *Am J Infect Control*. 2014;42(5):574-576.
11. Magalini S, Pepe G, Panunzi S, et al. Observational study on preoperative surgical field disinfection: povidone-iodine and chlorhexidine-alcohol. *Eur Rev Med Pharmacol Sci*. 2013;17(24):3367-3375.
12. US Food and Drug Administration. Chlorascrub swabsticks: directions for use in infants. http://www.fda.gov/Safety/MedWatch/SafetyInformation/Safety-RelatedDrugLabelingChanges/ucm307251.htm. Updated 2012.
13. Chapman AK, Aucott SW, Gilmore MM, et al. Absorption and tolerability of aqueous chlorhexidine gluconate used for skin antisepsis prior to catheter insertion in preterm neonates. *J Perinatol*. 2013;33(10):768-771.
14. Chapman AK, Aucott SW, Milstone AM. Safety of chlorhexidine gluconate used for skin antisepsis prior to catheter insertion in preterm neonates. *J Perinatol*. 2012;32(1):4-9.
15. Doellman D, Pettit J, Catudal P, Buckner J, Burns D, Frey AM; Association for Vascular Access. Best practice guidelines in the care and maintenance of pediatric central venous catheters. 2010; PEDIVAN.
16. Webster J, Gillies D, O'Riordan E, Sherriff KL, Rickard CM. Gauze and tape and transparent polyurethane dressings for central venous catheters. *Cochrane Database Syst Rev*. 2011;(11):CD003827. doi:10.1002/14651858.CD003827.pub2.
17. Timsit JF, Bouadma L, Ruckly S, Schwebel C, Garrouste-Orgeas M, Bronchard R. Dressing disruption is a major risk factor for catheter-related infections. *Crit Care Med*. 2012;40(6): 1707-1714.
18. 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.
19. Ullman AJ, Cooke ML, Mitchell M, et al. Dressings and securement devices for central venous catheters (CVC). *Cochrane Database Syst Rev*. 2015;(9):CD010367. doi: 10.1002/14651858.CD010367.pub2.
20. Weitz NA, Lauren CT, Weiser JA, et al. Chlorhexidine gluconate-impregnated central access catheter dressings as a cause of erosive contact dermatitis: a report of 7 cases. *JAMA Dermatol*. 2013;149(2):195-199.
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-e4.
22. Miller S, Maragakis L. Central line-associated bloodstream infection prevention. *Curr Opinion Infect Dis*. 2012;25(4): 412-422.
23. O'Horo J, Silva G, Munoz-Price S, Safdar N. The efficacy of daily bathing with chlorhexidine for reducing healthcare-associated

bloodstream infections: a meta-analysis. *Infect Control Hosp Epidemiol*. 2012;33(3):257-267.
24. Noto MJ, Domenico HJ, Byrne DW, et al. Chlorhexidine bathing and health care-associated infections: a randomized clinical trial. *JAMA*. 2015;313(4):369-378.
25. Montecalvo M, McKenna D, Yarrish R, et al. Chlorhexidine bathing to reduce central venous catheter-associated bloodstream infection: impact and sustainability. *Am J Med*. 2012;125(5):505-511.
26. Climo M, Yokoe D, Warren D, et al. Effect of daily chlorhexidine bathing on hospital-acquired infection. *N Engl J Med*. 2013;368(6):533-542.
27. Milstone AM, Elward A, Song X, et al. Daily chlorhexidine bathing to reduce bacteraemia in critically ill children: a multicentre, cluster-randomised, crossover trial. *Lancet*. 2013;381(9872):1099-1106.
28. Sievert D, Armola R, Halm M. Chlorhexidine gluconate bathing: does it decrease hospital-acquired infections? *Am J Crit Care*. 2011;20(2);166-170.
29. Blough L, Hinson K, Hen J. The science of a "seal" for PICC line management. *J Assoc Vasc Access*. 2010;15(2):66-73.
30. 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.
31. Camp-Sorrell D, ed. *Access Device Guidelines: Recommendations for Nursing Practice and Education*. Pittsburgh, PA: Oncology Nursing Society; 2011.
32. Olson K, Rennie RP, Hanson J, et al. Evaluation of a no-dressing intervention for tunneled central catheter exit sites. *J Infus Nurs*. 2004;27(1):37-44.

42. ADMINISTRATION SET CHANGE

Standard

42.1 Administration set changes are performed routinely, based on factors such as type of solution administered, frequency of the infusion (continuous versus intermittent), immediately upon suspected contamination, or when the integrity of the product or system has been compromised.
42.2 In addition to routine changes, the administration set is changed whenever the peripheral catheter site is changed or when a new central vascular access device (CVAD) is placed.
42.3 A vented administration set is used for solutions supplied in glass or semirigid containers, and a nonvented administration set is used for plastic solution containers.
42.4 Administration sets are attached to a vascular access device (VAD) hub or access site with a luer-locking mechanism to ensure a secure junction.

Practice Criteria

I. General

A. Minimize the use of add-on devices for administration sets as each device is a potential source of contamination, misuse, and disconnection; when feasible use an administration set with devices as an integral part of the set (refer to Standard 36, *Add-on Devices*).
B. Check the packaging of administration sets for latex and avoid use of a latex-containing set for patients with a latex allergy (refer to Standard 14, *Latex Sensitivity or Allergy*).
C. Attach the administration set and prime just prior to administration.[1,2] (V, Regulatory)
D. Label administration sets for infusion via VADs with the date of initiation or date of change based on organizational policies and procedures. Label administration sets used for medications that are administered via specialized access devices (ie, intraspinal, intraosseous, subcutaneous) to indicate the correct administration route and device, and place the label near the connection to the device.[3,4] (V)
E. Trace all catheters/administration sets/add-on devices between the patient 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.[5-7] (IV)

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. There is strong evidence that changing the administration sets more frequently does not decrease the risk of infection.[8-11] (I)
B. Change a secondary administration set that is detached from the primary administration set every 24 hours as it is now a primary intermittent administration set (see Practice Criteria III, *Primary Intermittent Infusions*).[3] (V)
C. Avoid disconnecting primary continuous administration sets from the VAD hub or access site. (V, Committee Consensus)

III. Primary Intermittent Infusions

A. Change intermittent administration sets every 24 hours. When an intermittent infusion is repeatedly disconnected and reconnected for the infusion, 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 catheter-related bloodstream infection (CR-BSI). There is an absence of studies addressing administration set changes for intermittent infusions.[10] (V, Committee Consensus)
B. Aseptically 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 set ("looping").[3,12] (V)

IV. Parenteral Nutrition

A. Replace administration sets for parenteral nutrition (PN) solutions (total nutrient admixtures [TNA] and amino acid/dextrose formulations) at least every 24 hours; there are also recommendations to change the administration set with each new PN container (see Standard 61, *Parenteral Nutrition*).[9-11] (IV)

B. Replace administration sets used for intravenous fat emulsions (IVFEs) infused separately every 12 hours. Change the administration set with each new container; the characteristics of IVFE (iso-osmotic, near neutral-alkaline pH, and containing glycerol) are conducive to the growth of microorganisms.[11] (V)

C. Use administration sets free of di-ethylhexyl-phthalate (DEHP) to administer lipid-based infusates, such as IVFE or TNA. 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.[11,13] (III)

V. Propofol Infusions

A. Replace administration sets used to administer propofol infusions every 6 or 12 hours per the manufacturers' recommendations or when the container is changed.[14] (I)

VI. Blood and Blood Components

A. Change the transfusion administration set and filter after the completion of each unit or every 4 hours. If more than 1 unit can be infused in 4 hours, the transfusion set can be used for a 4-hour period (refer to Standard 62, *Transfusion Therapy*).

VII. Hemodynamic and Arterial Pressure Monitoring

A. Replace the disposable or reusable transducer and/or dome 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. Minimize the number of manipulations and entries into the system.[15] (II)

REFERENCES

Note: All electronic references in this section were accessed September 30, 2015.

1. US Pharmacopeia (USP). General Chapter <797>: pharmaceutical compounding—sterile preparations. In: *U.S. Pharmacopeia/National Formulary*. 37/32 ed. Rockville, MD: United States Pharmacopeial Convention Inc; 2014.
2. Dolan SA, Felizaredo G, Barnes S, et al. APIC position paper: safe injection, infusion, and medication vial practices in health care. *Am J Infect Control*. 2010;38(3):167-172.
3. Hadaway L. Infusion therapy equipment. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:391-436.
4. Alexander M, Gorski L, Corrigan A, Bullock M, Dickerson A, Earhart A. Technical and clinical application. In: Alexander M, Corrigan A, Gorski L, Phillips L, eds. *Core Curriculum for Infusion Nursing*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:1-85.
5. US Food and Drug Administration. Preventing tubing and luer misconnections. http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/TubingandLuerMisconnections/default.htm.
6. The Joint Commission. Sentinel event alert: managing risk during transition to new ISO tubing connector standards. http://www.jointcommission.org/assets/1/6/SEA_53_Connectors_8_19_14_final.pdf. Published August 20, 2014.
7. US Food and Drug Administration. MedWatch: the FDA safety information and adverse event reporting program. http://www.fda.gov/Safety/MedWatch/default.htm.
8. Ullman AJ, Cooke ML, Gillies D, et al. Optimal timing for intravascular administration set replacement. *Cochrane Database Syst Rev*. 2013;(9):CD003588. doi:10.1002/14651858.CD003588.pub3.
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. http://www.jstor.org/stable/10.1086/676533.
10. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
11. Ayers P, Adams S, Boullata J, et al. A.S.P.E.N. parenteral nutrition safety consensus recommendations. *J Parenter Enteral Nutr*. 2014;38(3):296-333.
12. Institute for Safe Medication Practices. Failure to cap IV tubing and disconnect IV ports place patients at risk for infections. *ISMP Med Saf Alert*. Published July 26, 2007. https://www.ismp.org/newsletters/acutecare/articles/20070726.asp.
13. US Food and Drug Administration. FDA public health notification: PVC devices containing the plasticizer DEHP. http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/PublicHealthNotifications/UCM062182. Published 2002.
14. Diprivan injectable emulsion [package insert]. Wilmington, DE: AstraZeneca; 2008. http://www.accessdata.fda.gov/drugsatfda_docs/label/2008/019627s046lbl.pdf.
15. Daud A, Rickard C, Cooke M, et al. Replacement of administration sets (including transducers) for peripheral arterial catheters: a systemic review. *J Clin Nurs*. 2012;22(3-4):303-317.

43. PHLEBOTOMY

Standard

43.1 Perform patient identification and proper labeling of all blood sample containers at the time of sample collection and in the presence of the patient.

43.2 Use blood conservation techniques for phlebotomy to reduce the risk of hospital-acquired anemia.

Practice Criteria

I. General

A. Control blood sampling procedures to prevent errors in the preanalytic phase before the sample reaches the laboratory. These errors delay treatment decisions due to spurious lab values, enhance the potential for patient harm, and increase costs of care. A centralized phlebotomy service for hospitalized patients has been shown to reduce preanalytic errors, such as hemolysis and specimen labeling. Competent nursing staff should perform sample collections from vascular access devices (VADs).[1-4] (IV)

B. Educate the patient about the purpose and process for blood sampling.[5,6] (V)

C. Assess the patient for fasting prior to collection of blood samples, if appropriate for the requested laboratory values.[5-7] (V)

D. Use the same unique numbers for both patient identification and specimen labeling to reduce preanalytic errors and enhance patient safety. Use multiple process improvement methods such as staff engagement, transparency of data on mislabeled and unlabeled specimens, process changes, root cause analysis, and accountability measures. An electronic system (eg, bar-code or radio-frequency technology) for patient identification and sample container labeling has been shown to reduce these errors.[7-9] (V)

E. Perform all infection prevention practices including hand hygiene, appropriate use of gloves, single-patient tourniquets, single-use venipuncture and sampling devices, use of safety-engineered devices, and appropriate skin antisepsis (see Standard 16, *Hand Hygiene*; Standard 18, *Medical Waste and Sharps Safety*).[5,10] (V, Regulatory)

F. Use vacuum tubes in the correct sequence according to the manufacturer's directions for use (eg, color of the rubber stopper); appropriately mix the tube contents and blood; discard the needle and tube holder as 1 unit; and never remove the rubber stopper from the tubes as methods to decrease blood exposure, accidental needlestick injury, and error in sample analysis.[5,10,11] (V, Regulatory)

G. Do not rely on visual inspection of the blood sample to detect hemolysis. Hemolysis causes spurious values for many tests (eg, electrolytes, glucose, cardiac biomarkers, coagulation times). Contact the clinical laboratory about parameters for the free hemoglobin level that would cause a sample to be rejected.[4,12-14] (III)

H. Employ blood conservation strategies to reduce phlebotomy-associated blood loss, which is a significant cause of hospital-acquired anemia in patients of all ages. This blood loss often results in the need for blood transfusion and its inherent risks. Collaborate with the laboratory about the minimum volume of blood required for each test. Blood conservation strategies include:

1. Eliminating unnecessary laboratory tests.
2. Reducing the frequency of obtaining blood samples.
3. Drawing blood samples based on clinical need rather than a routine schedule.
4. Using small-volume collection tubes (eg, requiring less than 2 mL of blood).
5. Using point-of-care testing methods.
6. Using closed loop systems for venous and arterial VADs as these systems return the blood to the patient.
7. Using the push-pull or mixing method.[5,11,15-23] (III)

I. Place all blood specimens in a closed, leakproof container and dispatch to the laboratory immediately using an appropriate delivery method; or if delivery must be delayed (eg, home-drawn specimens), properly store and control the temperature to reduce the risk for inaccurate laboratory values and the potential for hemolysis.[5-7] (V)

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.[7] (V)

B. Avoid venipuncture on upper extremities with lymphedema, compromised circulation associated with radiation therapy, paralysis, or hemiparesis from a cerebrovascular accident. When possible, restrict venipuncture to the dorsum of the hand in patients with an actual or planned dialysis fistula or graft. Evidence for avoiding all venipuncture on the side of axillary node dissection comes from conflicting studies; however, there remains a recommendation to avoid all venipuncture procedures on these upper extremities (refer to Standard 27, *Site Selection*).

C. Perform venipuncture for phlebotomy with a straight or winged needle on veins in the antecubital fossa (eg, median cubital, cephalic, and basilic veins) due to the lower rates of hemolysis associated with these devices and sites.[13,14,24] (II)

D. Perform skin antisepsis prior to all venipunctures. Appropriate agents include 70% alcohol, >0.5% chlorhexidine in alcohol solution, tincture of iodine, and povidone-iodine. Excessive alcohol on the skin has previously been thought to cause hemolysis; however, 1 study has shown this to not be a cause (see Standard 33, *Vascular Access Site Preparation and Device Placement*).[25-28] (II)

E. Use additional precautions for obtaining blood cultures to avoid false-negative and false-positive results and to reduce incorrect classification as central line-associated bloodstream infection (CLABSI).

1. Use a dedicated phlebotomy team to reduce blood culture contamination.
2. Obtain blood for culturing from a peripheral venipuncture. Use a central vascular access device (CVAD) for drawing blood cultures only when clinically indicated for diagnosis of catheter-related bloodstream infection (CR-BSI).
3. Consider use of a standardized sterile blood culture collection kit to reduce sample contamination.
4. Disinfect the rubber stopper of the blood culture bottles using 70% alcohol. Iodine products are not recommended as they can degrade the stopper material.
5. Draw blood for culture before drawing the sample for other tests.
6. Draw a quantity of blood that is sufficient for isolating organisms (ie, 20-30 mL for adults; no more than 1% of the total blood volume for infants and children).
7. Discard the initial blood sample (eg, 5 mL) when drawing from a direct venipuncture. Do *not* discard the first sample when the sample is obtained from any type of CVAD.[27-29] (II)

F. To improve phlebotomy practice:
1. Avoid tight fist clenching or repetitively opening and closing the fist to prevent pseudohyperkalemia.[30,31] (V)
2. Use a straight or winged needle instead of obtaining the sample during the procedure to insert a short peripheral catheter.[4,11,24,32,33] (II)
3. Avoid use of a tourniquet or blood pressure cuff if possible. If a tourniquet is required, limit tourniquet time to less than 1 minute to reduce the risk of hemolysis and inaccurate chemistry lab values caused by changes in vascular endothelium from increased venous pressure and hypoxia. Immediately release the tourniquet when the blood begins to flow into the collection container.[12,34-36] (IV)
4. For coagulation studies, do not discard the initial sample except when a winged needle with an attached extension set is used. Air in the extension set prevents the correct ratio of blood to anticoagulant additive in the tube.[37-39] (IV)
5. Perform venipuncture in neonates by a skilled phlebotomist instead of heel lance methods due to the increased pain from the heel lance.[40] (II)

III. Blood Sampling via a Vascular Access Device

A. Carefully analyze risks versus benefits before deciding to use a VAD for obtaining blood samples.
1. Risks of venipuncture include anxiety, pain, damage to skin and nearby nerves, and hematoma in patients receiving anticoagulants or with bleeding disorders.
2. Risks associated with use of a VAD include increased hub manipulation and the potential for intraluminal contamination, alterations in VAD patency, and erroneous lab values associated with adsorption of medications infused through the VAD.[41-48] (IV)

B. Consider use of a CVAD phlebotomy bundle checklist combined with periodic direct observations for adherence to the checklist to reduce CR-BSI. There is no consensus on the exact contents of such a checklist.[49,50] (V)

C. Use the discard or push-pull (ie, mixing) methods for obtaining a sample from CVADs. No studies of these specific techniques are found for peripheral or midline catheters. Apply these additional factors based on patient age and type of CVAD.
1. A 3-mL discard volume produces the same measurement outcomes when compared to a 5-mL discard volume in multiple types of CVADs in a pediatric population. The exception to this discard volume is coagulation studies obtained from a CVAD exposed to heparin.[51] (IV)
2. Discard volumes of 6 mL from nontunneled catheters and 9 mL from tunneled cuffed catheters were sufficient to remove infused glucose, although the discard volume for implanted ports could not be established.[50,51] (IV)
3. The push-pull or mixing method produces good outcomes for measuring levels of actinomycin-D and vincristine, obtaining chemistry panels and complete blood counts, and therapeutic drug monitoring for gentamicin and doxorubicin from CVADs. These studies do not provide consensus on the required number of push-pull cycles or the volume of blood to be pulled; however, 5 cycles is the most common.[41,44,52,53] (III)
4. Do not use the reinfusion method (ie, delivery of the discard specimen into the VAD after obtaining the sample) due to risk of contamination and blood clot formation.[50,53,54] (IV)

D. Short peripheral catheters
1. Consider obtaining a blood sample from an indwelling short peripheral catheter for pediatric patients, adults with difficult venous access, presence of bleeding disorders, and the need for serial tests. Infusing solutions should be stopped for at least 2 minutes prior to obtaining the blood sample; waste 1 to 2 mL of blood before obtaining the sample.[55-58] (IV)
2. Sampling of blood from indwelling short peripheral catheters is reliable for many routine blood tests, including coagulation studies. Obtaining blood cultures from short peripheral catheters at insertion or during the dwell is not recommended.[29,59-61] (II)

3. Obtaining a blood sample during the insertion of a short peripheral catheter is associated with higher rates of hemolysis and spurious lab values, regardless of whether the sample was drawn directly from the catheter hub or from an attached extension set. The effect of this process on the outcome of the catheter is unknown.[4,11,14,24] (II)
4. Veins of the antecubital fossa produce the lowest rates of hemolysis. However, short peripheral catheters 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*).[24] (II)
5. Lengthy tourniquet time and difficult catheter insertion can produce inaccurate lab values.[13,62] (IV)

E. For midline catheters, no evidence is available regarding obtaining blood samples.

F. Central vascular access devices
1. For therapeutic drug monitoring, draw the blood sample from a dedicated lumen not used for infusion of the drug being monitored.[63] (IV)
2. When a dedicated CVAD lumen cannot be used, test results may be falsely elevated, requiring careful evaluation if dosage adjustment is dependent upon the accuracy of the test results. Retesting via direct venipuncture may be necessary. Conflicting studies show elevated antibiotic levels with blood sampling from CVADs while others have shown no difference. In vitro and in vivo studies of immunosuppressant medications (eg, cyclosporin and tacrolimus) given through CVADs constructed of silicone, polyurethane, and polyurethane with silver have shown excessively high drug levels.[45,63-65] (III)
3. Ensure that a standardized protocol is used consistently by all staff including thorough flushing of the VAD lumen (eg, 10-20 mL preservative-free 0.9% sodium chloride [USP]) followed by an adequate volume of wasted blood when using the discard method.[44,45,63,65] (IV)
4. Carefully assess coagulation values from a blood sample obtained from a heparinized CVAD. In 1 small study, coagulation values correlated with values drawn from a separate venipuncture, except international normalization ratio (INR), when heparinized peripherally inserted central catheters (PICCs) were flushed with 10 mL of 0.9% sodium chloride and 6 mL of blood was discarded. Retesting via a direct venipuncture is required when questionable results are obtained.[66-68] (IV)
5. Stop all infusions, and flush the lumen with preservative-free 0.9% sodium chloride (USP) prior to blood sampling from a CVAD. Research has not established the length of time for stopping fluid flow or the amount of flush solution. One study suggests a wait time of 10 minutes after stopping the infusion before drawing the sample.[46] (IV)
6. Use the largest lumen for blood sampling from multilumen CVADs. For CVADs with staggered lumen exit sites, the sample should be drawn from the lumen exiting at the point farthest away from the heart. One study suggests larger volumes (10-20 mL) of flush solution provide more accurate peak levels of antibiotics when compared to smaller volumes (3 mL).[46,69] (IV)
7. 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 absence of peripheral venipuncture sites or when there is a need for diagnosis of a CR-BSI. Remove and discard the used needleless connector prior to drawing a blood sample to reduce risk of a false-positive blood culture result.[70-72] (IV)
8. Do not routinely use CVADs infusing parenteral nutrition for blood sampling as this is a significant risk factor for CR-BSI.[47,48] (V)

G. Arterial catheters
1. Prior to puncture of the radial artery, assess circulation to the hand. Review medical history (eg, trauma, previous radial artery cannulation, radial artery harvesting); assess presence of anticoagulants; and perform a physical examination of hand circulation such as assessing radial and ulnar pulses, Allen test, pulse oximetry, or Doppler flow study.[73,74] (I A/P)
2. Use a 20-gauge catheter or smaller to reduce damage to the radial artery.[73] (IV)
3. Because palpation is needed to feel the arterial pulsation, use sterile gloves for puncture and catheter insertion into any artery (refer to Standard 33, *Vascular Access Site Preparation and Device Placement*).
4. For arterial blood gases, expel air from the syringe immediately after obtaining the sample, and place the syringe on ice for immediate transport to the lab.[5] (V)
5. Maintain patency of arterial catheters with 0.9% sodium chloride (USP) with or without added heparin. Do not use solutions containing glucose in adults as this results in falsely elevated glucose levels, possible overtreatment with insulin, and dangerously low serum levels of glucose. Store solutions intended for arterial infusion in a location different from solutions intended for venous infusion. Ensure that the label on the solution container is visible and not obscured by the presence of a pressurized device.[75,76] (IV)

6. Use a closed loop system to reduce hospital-acquired anemia and subsequent need for transfusion.[21] (II)

REFERENCES

Note: All electronic references in this section were accessed September 30, 2015.

1. Gorski L, Perucca R, Hunter M. Central venous access devices: care, maintenance, and potential complications. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:495-515.
2. 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.
3. Dunn EJ, Moga PJ. Patient misidentification in laboratory medicine: a qualitative analysis of 227 root cause analysis reports in the Veterans Health Administration. *Arch Pathol Lab Med*. 2010;134(2):244-255.
4. Lippi G, Plebani M, Di Somma S, Cervellin G. Hemolyzed specimens: a major challenge for emergency departments and clinical laboratories. *Crit Rev Clin Lab Sci*. 2011;48(3):143-153.
5. World Health Organization (WHO). WHO guidelines on drawing blood: best practices in phlebotomy. http://www.ncbi.nlm.nih.gov/books/NBK138665. Published 2010.
6. Phillips LD, Gorski L. Phlebotomy techniques. In: Phillips LD, Gorski L. *Manual of IV Therapeutics*. 6th ed. Philadelphia, PA: FA Davis; 2014:406-461.
7. Ranum A, Hagle M. Diagnostic testing and values. In: Weinstein S, Hagle ME, eds. *Plumer's Principles and Practices of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:108-141.
8. Morrison AP, Tanasijevic MJ, Goonan EM, et al. Reduction in specimen labeling errors after implementation of a positive patient identification system in phlebotomy. *Am J Clin Pathol*. 2010;133(6):870-877.
9. 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.
10. Occupational Safety and Health Administration. Disposal of contaminated needles and blood tube holders used for phlebotomy. http://www.osha.gov/dts/shib/shib101503.html.
11. Berg J, Ahee P, Berg J. Variation in phlebotomy techniques in emergency medicine and the incidence of haemolysed samples. *Ann Clin Biochem*. 2011;48(6):562-565.
12. Saleem S, Mani V, Chadwick MA, Creanor S, Ayling RM. A prospective study of causes of haemolysis during venepuncture: tourniquet time should be kept to a minimum. *Ann Clin Biochem*. 2009;46(pt 3):244-246.
13. Wollowitz A, Bijur PE, Esses D, John Gallagher E. Use of butterfly needles to draw blood is independently associated with marked reduction in hemolysis compared to intravenous catheter. *Acad Emerg Med*. 2013;20(11):1151-1155.
14. Stauss M, Sherman B, Pugh L, et al. Hemolysis of coagulation specimens: a comparative study of intravenous draw methods. *J Emerg Nurs*. 2012;38(1):15-21.
15. McEvoy MT, Shander A. Anemia, bleeding, and blood transfusion in the intensive care unit: causes, risks, costs, and new strategies. *Am J Crit Care*. 2013;22(6):eS1-eS13.
16. Carroll PD, Widness JA. Nonpharmacological, blood conservation techniques for preventing neonatal anemia: effective and promising strategies for reducing transfusion. *Semin Perinatol*. 2012;36(4):232-243.
17. Sztefko K, Beba J, Mamica K, Tomasik P. Blood loss from laboratory diagnostic tests in children. *Clin Chem Lab Med*. 2013; 51(8):1623-1626.
18. Branco BC, Inaba K, Doughty R, et al. The increasing burden of phlebotomy in the development of anaemia and need for blood transfusion amongst trauma patients. *Injury*. 2012;43(1):78-83.
19. Clark SL, Cunningham JL, Rabinstein AA, Wijdicks EF. Electrolyte orders in the neuroscience intensive care unit: worth the value or waste? *Neurocrit Care*. 2011;14(2):216-221.
20. Salisbury AC, Reid KJ, Alexander KP, et al. Diagnostic blood loss from phlebotomy and hospital-acquired anemia during acute myocardial infarction. *Arch Intern Med*. 2011;171(18):1646-1653.
21. Page C, Retter A, Wyncoll D. Blood conservation devices in critical care: a narrative review. *Ann Intensive Care*. 2013;3(1):1-6.
22. Tiwari D, Rance C. Hospital-acquired anaemia secondary to phlebotomy in elderly patients. *Adv Aging Res*. 2014;3(2):70-71. doi:10.4236/aar.2014.32012.
23. Parco S, Visconti P, Vascotto F. Hematology point of care testing and laboratory errors: an example of multidisciplinary management at a children's hospital in northeast Italy. *J Multidiscip Healthc*. 2014;7:45-50.
24. Heyer NJ, Derzon JH, Winges L, et al. Effectiveness of practices to reduce blood sample hemolysis in EDs: a laboratory medicine best practices systematic review and meta-analysis. *Clin Biochem*. 2012;45(13-14):1012-1032.
25. O'Grady N, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
26. Salvagno GL, Danese E, Lima-Oliveira G, Guidi GC, Lippi G. Avoidance to wipe alcohol before venipuncture is not a source of spurious hemolysis. *Biochem Medica (Zagreb)*. 2013;23(2):201-205.
27. 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.
28. 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-position central line-associated bloodstream infections. *Am J Infect Control*. 2015;43(11):1222-1237.
29. Proehl JA, Leviner S, Bradford JY, et al. Clinical practice guideline: prevention of blood culture contamination: Emergency Nurses Association. https://www.ena.org/practice-research/research/CPG/Documents/BCCCPG.pdf.
30. Bailey IR, Thurlow VR. Is suboptimal phlebotomy technique impacting on potassium results for primary care? *Ann Clin Biochem*. 2008;45(3):266-269.
31. Seimiya M, Yoshida T, Sawabe Y, et al. Reducing the incidence of pseudohyperkalemia by avoiding making a fist during phlebotomy: a quality improvement report. *Am J Kidney Dis*. 2010;56(4): 686-692.
32. Straszewski SM, Sanchez L, McGillicuddy D, et al. Use of separate venipunctures for IV access and laboratory studies decreases hemolysis rates. *Intern Emerg Med*. 2011;6(4):357-359.

33. Dietrich H. One poke or two: can intravenous catheters provide an acceptable blood sample? A data set presentation, review of previous data sets, and discussion. *J Emerg Nurs*. 2014;40(6): 575-578.
34. Cengiz M, Ulker P, Meiselman HJ, Baskurt OK. Influence of tourniquet application on venous blood sampling for serum chemistry, hematological parameters, leukocyte activation and erythrocyte mechanical properties. *Clin Chem Lab Med*. 2009;47(6):769-776.
35. Serdar MA, Kenar L, Hasimi A, et al. Tourniquet application time during phlebotomy and the influence on clinical chemistry testing: is it negligible? *Turk J Biochem*. 2008;33:85-88.
36. Elhassan HA, Dixon T. MRSA contaminated venepuncture tourniquets in clinical practice. *Postgrad Med J*. 2012;88(1038):194-197.
37. Raijmakers MT, Menting CH, Vader HL, van der Graaf F. Collection of blood specimens by venipuncture for plasma-based coagulation assays: necessity of a discard tube. *Am J Clin Pathol*. 2010;133(2):331-335.
38. Favaloro EJ, Lippi G. Discard tubes are sometimes necessary when drawing samples for hemostasis. *Am J Clin Pathol*. 2010;134(5):851.
39. Smock KJ, Crist RA, Hansen SJ, Rodgers GM, Lehman CM. Discard tubes are not necessary when drawing samples for specialized coagulation testing. *Blood Coagul Fibrinolysis*. 2010;21(3):279-282.
40. Shah VS, Ohlsson A. Venepuncture versus heel lance for blood sampling in term neonates. *Cochrane Database Syst Rev*. 2011;(10):CD001452. doi:10.1002/14651858.CD001452.pub4.
41. Skolnik JM, Zhang AY, Barrett JS, Adamson PC. Approaches to clear residual chemotherapeutics from indwelling catheters in children with cancer. *Ther Drug Monit*. 2010;32(6):741-748.
42. Asheghan M, Khatibi A, Holisaz MT. Paresthesia and forearm pain after phlebotomy due to medial antebrachial cutaneous nerve injury. *J Brachial Plexus Peripheral Nerve Inj*. 2011;6(1): 1-2.
43. Ohnishi H, Watanabe M, Watanabe T. Butterfly needles reduce the incidence of nerve injury during phlebotomy. *Arch Pathol Lab Med*. 2012;136(4):352.
44. Kontny NE, Hempel G, Boos J, Boddy AV, Krischke M. Minimization of the preanalytical error in plasma samples for pharmacokinetic analyses and therapeutic drug monitoring using doxorubicin as an example. *Ther Drug Monit*. 2011;33(6): 766-771.
45. 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.
46. Fairholm L, Saqui O, Baun M, Yeung M, Fernandes G, Allard JP. Monitoring parenteral nutrition in hospitalized patients: issues related to spurious bloodwork. *Nutr Clin Pract*. 2011;26(6): 700-707.
47. 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.
48. 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. *J Parenter Enteral Nutr*. 2014;38(6):744-749.
49. Secola R, Lewis MA, Pike N, Needleman J, Doering L. Feasibility of the use of a reliable and valid central venous catheter blood draw bundle checklist. *J Nurs Care Qual*. 2012;27(3):218-225.
50. Wyant S, Crickman R. Determining the minimum discard volume for central venous catheter blood draws. *Clin J Nurs*. 2012;16(5):454-458.
51. Cole M, Price L, Parry A, et al. A study to determine the minimum volume of blood necessary to be discarded from a central venous catheter before a valid sample is obtained in children with cancer. *Pediatr Blood Cancer*. 2007;48(7):687-695.
52. 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.
53. Adlard K. Examining the push-pull method of blood sampling from central venous access devices. *J Pediatr Oncol Nurs*. 2008;25(4):200-207.
54. Cosca P, Smith S, Chatfield S, et al. Reinfusion of discard blood from venous access devices. *Oncol Nurs Forum*. 1998;25(6): 1073-1076.
55. Berger-Achituv S, Budde-Schwartzman B, Ellis MH, Shenkman Z, Erez I. Blood sampling through peripheral venous catheters is reliable for selected basic analytes in children. *Pediatrics*. 2010;126(1):e179-e186.
56. Corbo J, Fu L, Silver M, Atallah H, Bijur P. Comparison of laboratory values obtained by phlebotomy versus saline lock devices. *Acad Emerg Med*. 2007;14(1):23-27.
57. Baker RB, Summer SS, Lawrence M, Shova A, McGraw CA, Khoury J. Determining optimal waste volume from an intravenous catheter. *J Infus Nurs*. 2013;36(2):92-96.
58. Hambleton VL, Gómez IA, Andreu FAB. Venipuncture versus peripheral catheter: do infusions alter laboratory results? *J Emerg Nurs*. 2014;40(1):20-26.
59. Prue-Owens LKK. Use of peripheral venous access devices for obtaining blood samples for measurement of activated partial thromboplastin times. *Crit Care Nurse*. 2006;26(1):30-38.
60. Zengin N, Enc N. Comparison of two blood sampling methods in anticoagulation therapy: venipuncture and peripheral venous catheter. *J Clin Nurs*. 2008;17(3):386-393.
61. Ortells-Abuye N, Busquets-Puigdevall T, Díaz-Bergara M, Paguina-Marcos M, Sánchez-Pérez I. A cross-sectional study to compare two blood collection methods: direct venous puncture and peripheral venous catheter. *BMJ Open*. 2014;4(2):e004250.
62. Halm MA, Gleaves M. Obtaining blood samples from peripheral intravenous catheters: best practice? *Am J Crit Care*. 2009;18(5):474-478.
63. 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.
64. Ritzmo C, Albertioni F, Cosic K, Soderhall S, Eksborg S. Therapeutic drug monitoring of methotrexate on the pediatric oncology ward: can blood sampling from central venous accesses substitute for capillary finger punctures? *Ther Drug Monit*. 2007;29(4):447-451.
65. 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.
66. Humphries L, Baldwin KM, Clark KL, Tenuta V, Brumley K. A comparison of coagulation study results between heparinized peripherally inserted central catheters and venipunctures. *Clin Nurse Spec*. 2012;26(6):310-316.
67. Boyd A, Dunne A, Townsend K, Pai AB. Sampling for international normalized ratios in patients on hemodialysis with central venous catheters. *Nephrol Nurs J*. 2006;33(4):408-411.

68. Rioux J-P, De Bortoli B, Quérin S, Déziel C, Troyanov S, Madore F. Measurement of the international normalized ratio (INR) in hemodialysis patients with heparin-locked central venous catheters: evaluation of a novel blood sampling method. *J Vasc Access*. 2008;10(3):180-182.
69. Mogayzel PJ Jr, Pierce E, Mills J, et al. Accuracy of tobramycin levels obtained from central venous access devices in patients with cystic fibrosis is technique dependent. *Pediatr Nurs*. 2008;34(6):464-468.
70. Halm M, Hickson T, Stein D, Tanner M, VandeGraaf S. Blood cultures and central catheters: is the "easiest way" best practice? *Am J Crit Care*. 2011;20(4):335-338.
71. Mathew A, Gaslin T, Dunning K, Ying J. Central catheter blood sampling: the impact of changing the needleless caps prior to collection. *J Infus Nurs*. 2009;32(4):212-218.
72. 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.
73. Wallach SG. Cannulation injury of the radial artery: diagnosis and treatment algorithm. *Am J Crit Care*. 2004;13(4):315-319.
74. Hadaway L. Anatomy and physiology related to infusion therapy. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:139-177.
75. Sprint WP, Woodcock T, Cook T, Gupta K, Hartle A. Arterial line blood sampling: preventing hypoglycaemic brain injury 2014: the Association of Anaesthetists of Great Britain and Ireland. *Anaesthesia*. 2014;69(4):380-385.
76. Gupta K, Cook T. Accidental hypoglycaemia caused by an arterial flush drug error: a case report and contributory causes analysis. *Anaesthesia*. 2013;68(11):1179-1187.

44. VASCULAR ACCESS DEVICE (VAD) REMOVAL

Standard

44.1 The clinical need for each peripheral and nontunneled central vascular access device (CVAD) is assessed on a daily basis.
44.2 Vascular access devices (VADs) are removed upon an unresolved complication, discontinuation of infusion therapy, or when deemed no longer necessary for the plan of care.
44.3 VADs are not removed based solely on length of dwell time because there is no known optimum dwell time.

Practice Criteria

I. Short Peripheral and Midline Catheters

A. Remove the short peripheral catheter if it is no longer included in the plan of care or has not been used for 24 hours or more.[1] (IV)
B. Remove short peripheral 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 (eg, bloodstream infection). Signs and symptoms of complications with or without infusion through the catheter include, but are not limited to, the presence of:
   1. Any level of pain and/or tenderness with or without palpation.
   2. Changes in color (erythema or blanching).
   3. Changes in skin temperature (hot or cold).
   4. Edema.
   5. Induration.
   6. Leakage of fluid or purulent drainage from the puncture site.
   7. Other types of dysfunction (eg, resistance when flushing, absence of a blood return).[2-4] (I)
C. Consider labeling catheters inserted under suboptimal aseptic conditions in any health care setting (eg, "emergent"). Remove and insert a new catheter as soon as possible, preferably within 24 to 48 hours.[5-7] (IV)
D. If unable to insert a new catheter in patients with difficult venous access and continuation of infusion therapy is required, immediately contact the licensed independent practitioner (LIP) about delays in administering the prescribed therapy (refer to Standard 26, *Vascular Access Device [VAD] Planning*).
E. Notify the LIP about signs and symptoms of suspected catheter-related infection and discuss the need for obtaining cultures (eg, drainage, blood culture) before removing a peripheral catheter (refer to Standard 49, *Infection*).
F. In the event of extravasation, detach all administration sets and aspirate from the catheter hub prior to catheter removal to remove the vesicant medication from the catheter lumen and as much as possible from the subcutaneous tissue (refer to Standard 46, *Infiltration and Extravasation*).

II. Nontunneled Central Vascular Access Devices (CVADs)

A. Assess and discuss with the patient's health care team the continuing need for the nontunneled 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, parenteral nutrition, 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.[8-13] (V)

B. Employ strategies to facilitate timely CVAD removal including, but not limited to:
   1. Daily patient rounds by an interprofessional 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 nursing staff.
   4. Assessment by designated unit-based nurse without other patient care responsibilities when other strategies are unsuccessful.[11,14-19] (IV)

C. Assess and report signs and symptoms of CVAD complications to the LIP including, but not limited to, the presence of:
   1. Pain and/or tenderness in unusual locations of neck, chest, or upper abdomen.
   2. Changes in color (erythema or blanching) at or surrounding the insertion site.
   3. Changes in skin temperature at or surrounding the insertion site.
   4. Edema.
   5. Unusual respiratory and neurological changes.
   6. Leakage of fluid or purulent drainage from the puncture site.
   7. Catheter dysfunction (eg, resistance when flushing, alteration in gravity infusion, absence of blood return).
   8. Changes in catheter function associated with arm position changes (refer to Standard 47, *Nerve Injuries*; Standard 49, *Infection*; Standard 52, *Central Vascular Access Device [CVAD]-Associated Venous Thrombosis*; Standard 53, *Central Vascular Access Device [CVAD] Malposition*).

D. Collaborate with the health care team members to plan removal and insertion of a new catheter to meet vascular access needs in the presence of unresolved complication(s) and a continued need for infusion therapy.
   1. Insertion of a peripherally inserted central catheter (PICC) or midline catheter has been suggested as a viable alternative upon removal of other types of CVADs (see Standard 26, *Vascular Access Device [VAD] Planning*).[19,20] (IV)
   2. The decision to remove or salvage a CVAD due to suspected or confirmed catheter-related bloodstream infection (CR-BSI) should be based on blood culture results; specific cultured organism(s); patient's current condition; available vascular access sites; effectiveness of antimicrobial therapy; and LIP direction (refer to Standard 49, *Infection*).
   3. Do not remove a CVAD in the presence of CVAD-associated vein thrombosis when the catheter is correctly positioned at the cavoatrial junction, is functioning correctly 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 52, *Central Vascular Access Device [CVAD]-Associated Venous Thrombosis*).[4,21,22] (I)
   4. Remove a CVAD with a primary or secondary malpositioned catheter tip location that cannot be repositioned to the cavoatrial junction (refer to Standard 53, *Central Vascular Access Device [CVAD] Malposition*).
   5. In the event of infiltration or extravasation from a CVAD, consult with the health care team regarding diagnostic imaging studies and the appropriate medical management prior to removal (refer to Standard 46, *Infiltration and Extravasation*).

E. For CVAD removal:
   1. Place the patient in a supine flat or Trendelenburg position, unless contraindicated, when removing any type of CVAD.
   2. While documentation of air embolism during PICC removal has not been found, 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.
   3. Documentation of air embolism from removal of a femorally inserted CVAD has not been found, although there is evidence of air entering the catheter during insertion and during other procedures through the femoral vein. The exit site will most likely be at or below the level of the heart, possibly decreasing but not eliminating the risk of air embolism on removal (see Standard 50, *Air Embolism*).[23-26] (V)

F. Never forcibly remove a CVAD if resistance is encountered. Contact the LIP to discuss appropriate interventions for successful removal. Forcible removal can result in catheter fracture and embolization. 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.[27,28] (V)

III. Surgically Placed CVADs: Tunneled Cuffed/Implanted Ports

A. Assess the clinical need for a tunneled cuffed catheter and implanted port on a regular basis.[29] (II)

B. Arrange for removal with the LIP when infusion therapy is completed, in the presence of an unresolved complication, and 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).[29] (II)

C. Consult with the health care team regarding the decision to remove or salvage a CVAD due to suspected or confirmed CR-BSI (refer to Standard 49, *Infection*).

D. Immediately report cuff or port body exposure to the health care team and anticipate appropriate interventions (eg, resuture of incision), including CVAD removal.[30,31] (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.[32,33]

IV. Arterial Catheters

A. Assess the clinical need for the arterial catheter on a daily basis and remove when it is no longer needed for the plan of care.[34] (V)

B. Apply digital pressure to the insertion site using a sterile gauze pad until hemostasis is achieved by using manual compression. Hemostatic pads designed to potentiate clot formation used in combination with manual pressure have shown effectiveness equal to or better than manual pressure in small randomized trials. A sterile dressing should be applied to the access site.[35,36] (III)

C. Assess and document the circulatory status distal to the area of cannulation after removal of the arterial catheter.[34] (V)

REFERENCES

Note: All electronic references in this section were accessed September 30, 2015.

1. Mestre G, Berbel C, Tortajada P, et al. Successful multifaceted intervention aimed to reduce short peripheral venous catheter-related adverse events: a quasiexperimental cohort study. *Am J Infect Control*. 2012;41(6):520-526.
2. 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*. 2014;35(1):63-68.
3. Webster J, Osborne S, Rickard CM, New K. Clinically-indicated replacement versus routine replacement of peripheral venous catheters. *Cochrane Database Syst Rev*. 2013;(4):CD007798. doi:10.1002/14651858.CD007798.pub3.
4. Chopra V, Flanders SA, Saint S, et al. The Michigan appropriateness guide for intravenous catheers (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Ann Intern Med*. 2015;163(suppl 6):S1-S39.
5. Fakih MG, Jones K, Rey JE, et al. Peripheral venous catheter care in the emergency department: education and feedback lead to marked improvements. *Am J Infect Control*. 2012;41(6):531-536.
6. O'Grady N, Alexander M, Burns L, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
7. Stuart RL, Cameron DR, Scott C, et al. Peripheral intravenous catheter-associated *Staphylococcus aureus* bacteraemia: more than 5 years of prospective data from two tertiary health services. *Med J Aust*. 2013;198(10):551-553.
8. Tejedor S, Tong D, Stein J, et al. Temporary central venous catheter utilization patterns in a large tertiary care center: tracking the "idle central venous catheter." *Infect Control Hosp Epidemiol*. 2012;33(1):50-57.
9. 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.
10. Weeks KR, Hsu Y-J, 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):S197-S202.
11. Burdeu G, Currey J, Pilcher D. Idle central venous catheter-days pose infection risk for patients after discharge from intensive care. *Am J Infect Control*. 2014;42(4):453-455.
12. Zingg W, Sandoz L, Inan C, et al. Hospital-wide survey of the use of central venous catheters. *J Hosp Infect*. 2011;77(4):304-308.
13. Milstone AM, Reich NG, Advani S, et al. Catheter dwell time and CLABSIs in neonates with PICCs: a multicenter cohort study. *Pediatrics*. 2013;132(6):e1609-e1615.
14. Ilan R, Doan J, Cload B, Squires M, Day A. Removing nonessential central venous catheters: evaluation of a quality improvement intervention. *Can J Anesth*. 2012;59(12):1102-1110.
15. Faruqi A, Medefindt J, Dutta G, Philip SA, Tompkins D, Carey J. Effect of a multidisciplinary intervention on central line utilization in an acute care hospital. *Am J Infect Control*. 2012;40(6):e211-e215.
16. Arora N, Patel K, Engell CA, LaRosa JA. The effect of interdisciplinary team rounds on urinary catheter and central venous catheter days and rates of infection. *Am J Med Qual*. 2014;29(4):329-334.
17. Thom KA, Li S, Custer M, et al. Successful implementation of a unit-based quality nurse to reduce central line-associated bloodstream infections. *Am J Infect Control*. 2014;42(2):139-143.
18. Hammarskjöld F, Berg S, Hanberger H, Taxbro K, Malmvall B-E. 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.
19. Al Raiy B, Fakih MG, Bryan-Nomides N, et al. Peripherally inserted central venous catheters in the acute care setting: a safe alternative to high-risk short-term central venous catheters. *Am J Infect Control*. 2010;38(2):149-153.
20. 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.
21. 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(suppl 2):e419S-e494S.
22. 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.
23. Clark DK, Plaizier E. Devastating cerebral air embolism after central line removal. *J Neurosci Nurs*. 2011;43(4):193-196.
24. Feil M. Reducing risk of air embolism associated with central venous access devices. *Penn Patient Saf Advis*. 2012;9(2):58-62.
25. 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.
26. Jalota L, Aryal MR, Jain S. Iatrogenic venous air embolism from central femoral vein catheterisation. *BMJ Case Rep*. March 13, 2013. doi:10.1136/bcr-2013-008965.
27. Quaretti P, Galli F, Fiorina I, et al. A refinement of Hong's technique for the removal of stuck dialysis catheters: an easy solution to a complex problem. *J Vasc Access*. 2013;15(3):183-188.
28. Ryan SE, Hadziomerovic A, Aquino J, Cunningham I, O'Kelly K, Rasuli P. Endoluminal dilation technique to remove "stuck" tunneled hemodialysis catheters. *J Vasc Interv Radiol*. 2012;23(8):1089-1093.
29. 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.
30. Zawacki WJ, Walker TG, DeVasher E, et al. Wound dehiscence or failure to heal following venous access port placement in patients receiving bevacizumab therapy. *J Vasc Intervent Radiol*. 2009;20(5):624-627.
31. 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.
32. 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.
33. Barnacle AM, Mitchell AW. Technical report: use of ultrasound guidance in the removal of tunnelled venous access catheter cuffs. *Br J Radiol*. 2005;78(926):147-149.
34. Greene MT. Expanded approaches to access and monitoring. In: Weinstein SM, Hagle ME, eds. *Plumer's Priniciples and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:391-426.
35. 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*. 2014;30(3):192-196.
36. Oozawa S, Akagi T, Sano S. A new hemostasis tool after percutaneous angioplasty: the hemcon pad hemostasis device. *J Vasc Med Surg*. 2014;2(125):2.

Section Seven: Vascular Access Device (VAD)-Related Complications

Section Standards

I. To ensure patient safety, the clinician is competent to recognize signs and symptoms of vascular access device (VAD)-related complications during insertion, management, and removal, and appropriately intervene.
II. Prevention, assessment, and management of complications are established in organizational policies, procedures, and/or practice guidelines.

45. PHLEBITIS

Standard

45.1 The clinician assesses the vascular access site for 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.

Practice Criteria

A. Assess regularly, based on patient population, type of therapy, and risk factors, the vascular access sites of short peripheral catheters, midline catheters, and peripherally inserted central catheters (PICCs) for signs and symptoms of phlebitis using a standardized tool or definition. Instruct the patient to report pain or discomfort at the vascular access site. Signs and symptoms of phlebitis include pain/tenderness, erythema, warmth, swelling, induration, purulence, or palpable venous cord. The number or severity of signs and symptoms that indicate phlebitis differs among published clinicians and researchers (see Standard 41, *Vascular Access Device [VAD] Assessment, Care, and Dressing Changes*).[1-18] (III)

B. Recognize risk factors that can be addressed:
   1. Chemical phlebitis may be related to infusates with dextrose >10% or high osmolarity (>900 mOsm/L); certain medications (depending on dosage and length of infusion), such as potassium chloride, amiodarone, and some antibiotics; particulates in the infusate; too large a catheter for the vasculature with inadequate hemodilution; and skin antiseptic solution that is not fully dried and pulled into the vein during catheter insertion. Consider using a midline catheter or PICC for infusates listed above or identified as causing phlebitis, depending on length of infusion time and anticipated duration of therapy. Allow skin to thoroughly dry after application of antiseptic solution.[7,11,19-25] (IV)
   2. Mechanical phlebitis may be related to vein wall irritation, which can come from too large a catheter for the vasculature, catheter movement, insertion trauma, or catheter material and stiffness. Choose the smallest catheter for therapy, 20 or 22 gauge if possible; secure catheter with stabilizing device; avoid areas of flexion, and stabilize joint as needed.[11,16,20,21,23,26,27] (IV)
   3. Bacterial phlebitis may be related to emergent vascular access device (VAD) insertions and poor aseptic technique. Label a catheter inserted during emergent conditions so it can be removed and resited as needed. Move catheter in a lower extremity to an upper extremity in adults; move to a new proximal site or opposite side for pediatrics if possible. Consider a central vascular access device (CVAD) and/or consider alternative route for medication.[9-11,20,21] (IV)
   4. Patient-related factors include current infection, immunodeficiency, and diabetes; insertion in a lower extremity except for infants; and age ≥ 60 years.[16,20,24,27] (IV)

5. Postinfusion phlebitis, although rare, occurs post catheter removal through 48 hours due to any of the factors above.[11,28] (IV)

C. If phlebitis is present with short peripheral catheters, midline catheters, and PICCs, determine the possible etiology of the phlebitis, such as chemical, mechanical, bacterial, or postinfusion; apply warm compress; elevate limb; provide analgesics as needed; consider other pharmacologic interventions such as anti-inflammatory agents; and consider removal as necessary. Topical gels or ointments to treat phlebitis require further study for efficacy (see Standard 44, *Vascular Access Device [VAD] Removal*).[11,20,23,29-34] (III)
   1. Chemical phlebitis: evaluate infusion therapy and need for different vascular access, different medication, or slower rate of infusion; determine if catheter removal is needed. Provide interventions as above.[7,20] (IV)
   2. Mechanical phlebitis: stabilize catheter, apply heat, elevate limb, and monitor for 24 to 48 hours; if signs and symptoms persist past 48 hours, consider removing catheter.[23,33] (V)
   3. Bacterial phlebitis: if suspected, remove catheter. Consider the need to collaborate with the licensed independent practitioner regarding the need for continued or alternative vascular access when the VAD is removed.[10,11,35] (IV)
   4. Postinfusion phlebitis: if bacterial source, monitor for signs of systemic infection; if nonbacterial, apply warm compress; elevate limb; provide analgesics as needed; and consider other pharmacologic interventions such as anti-inflammatory agents or corticosteroids as necessary.[28,33] (V)

D. When the short peripheral catheter, midline catheter, or PICC is removed, monitor the vascular access site 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.[11] (V)

E. Use a standardized phlebitis scale or definition, which is valid, reliable, and clinically feasible. The population for which the scale is appropriate should be identified as adult or pediatric.
   1. Two phlebitis scales have demonstrated validity and reliability in some studies and have been used for adult patients. Recent evidence recommends further study for valid and reliable assessment tools.[6,12,36-39] (I)
   2. The Phlebitis Scale (Table 1) has concurrent validity, interrater reliability, and is clinically feasible.[8] (IV)
   3. Visual Infusion Phlebitis (VIP) Scale (Table 2) has content validity, interrater reliability, and is clinically feasible.[6,40] (IV)

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

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.
Jackson A. A battle in vein infusion: phlebitis. Nursing Times. *1998;28(94).*
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F. Review phlebitis incidents causing harm or injury, using incident or occurrence reports or medical record reviews, for quality improvement opportunities (see Standard 6, *Quality Improvement*).[41-43] (V)

REFERENCES

Note: All electronic references in this section were accessed September 30, 2015.

1. Anson L, Edmundson E, Teasley S. Implications of evidence-based venipuncture practice in a pediatric health care Magnet facility. *J Contin Educ Nurs*. 2010;41(4):179-185.
2. Barría R, Lorca P, Muñoz S. Randomized controlled trial of vascular access in newborns in the neonatal intensive care unit. *J Obstet Gynecol Neonatal Nurs*. 2007;36(5):450-456.
3. Dugan S, Le J, Jew R. Maximum tolerated osmolarity for peripheral administration of parenteral nutrition in pediatric patients. *J Parenteral Enteral Nutr*. 2014;38(7):847-851.
4. Dumont C, Getz O, Miller S. Evaluation of midline vascular access: a descriptive study. *Nursing*. 2014;44(10):60-66.
5. Foster L, Wallis M, Paterson B, James H. A descriptive study of peripheral intravenous catheters in patients admitted to a pediatric unit in one Australian hospital. *J Infus Nurs*. 2002;25(3):159-167.
6. Gallant P, Schultz A. Evaluation of a visual infusion phlebitis scale for determining appropriate discontinuation of peripheral intravenous catheters. *J Infus Nurs*. 2006;29(6):338-345.
7. Gorski LA, Hagle ME, Bierman S. Intermittently delivered IV medication and pH: reevaluating the evidence. *J Infus Nurs*. 2015;38(1):27-46.
8. 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.
9. Maki DG, Ringer M. Risk factors for infusion-related phlebitis with small peripheral venous catheters. *Ann Intern Med*. 1991;114(10):845-854.
10. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
11. Perucca R. Peripheral venous access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. Philadelphia, PA: Saunders/Elsevier; 2010:456-479.
12. Ray-Barruel G, Polit D, Murfield J, Rickard C. Infusion phlebitis assessment measures: a systematic review. *J Eval Clin Pract*. 2014;20(2):191-202.
13. Salgueiro-Oliveira A, Parreira P. Incidence of phlebitis in patients with peripheral intravenous catheters: the influence of some risk factors. *Aus J Adv Nurs*. 2012;30(2):32-39.
14. Tagalakis V, Kahn SR, Libman M, Blostein M. The epidemiology of peripheral vein infusion thrombophlebitis: a critical review. *Am J Med*. 2002;113(2):146-151.
15. Vanhatalo T, Tammela O. Glucose infusions into peripheral veins in the management of neonatal hypoglycemia—20% instead of 15%? *Acta Paediatr*. 2010;99(3):350-353.
16. Wallis M, McGrail M, Rickard C, 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.
17. Washington G, Barrett R. Peripheral phlebitis: a point-prevalence study. *J Infus Nurs*. 2012;35(4):252-258.
18. Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. *Int J Antimicrob Agents*. 2009;34(suppl 4):S38-S42.
19. Biggar C. Comparison of postinfusion phlebitis in intravenous push versus intravenous piggyback cefazolin. *J Infus Nurs*. 2012;35(6):384-388.
20. Dychter S, Gold D, Carson D, Haller M. Intravenous therapy: a review of complications and economic considerations of peripheral access. *J Infus Nurs*. 2012;35(2):84-91.
21. 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.
22. Mowry JL, Hartman LS. Intravascular thrombophlebitis related to the peripheral infusion of amiodarone and vancomycin. *West J Nurs Res*. 2011;33(3):457-471.
23. Phillips LD, Gorski L. Complications of infusion therapy: peripheral and central vascular access devices. In: Phillips LD, Gorski L. *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014:540-611.
24. Salgueiro-Oliveira A, Parreira P. Incidence of phlebitis in patients with peripheral intravenous catheters: the influence of some risk factors. *Aust J Adv Nurs*. 2012;30(2):32-39.
25. Spiering M. Peripheral amiodarone-related phlebitis: an institutional nursing guideline to reduce patient harm. *J Infus Nurs*. 2014;37(6):453-460.
26. Cicolini G, Bonghi AP, Di Labio L, Di Mascio R. Position of peripheral venous cannulae and the incidence of thrombophlebitis: an observational study. *J Adv Nurs*. 2009;65(6):1268-1273.
27. Rego Furtado LC. Incidence and predisposing factors of phlebitis in a surgery department. *Br J Nurs*. 2011;20(14):S16-S18, S20, S22-S25.
28. Webster J, McGrail M, Marsh N, Wallis MC, Ray-Barruel G, Rickard CM. Postinfusion phlebitis: incidence and risk factors [published online May 14, 2015]. *Nurs Res Pract*. doi:10.1155/2015/691934.
29. Di Giacomo M. Comparison of three peripherally-inserted central catheters: pilot study. *Br J Nurs*. 2009;18(1):8-16.
30. dos Reis P, Silveira R, Vasques C, de Carvalho E. Pharmacological interventions to treat phlebitis: systematic review. *J Infus Nurs*. 2009;32(2):74-79.
31. Eppert H, Goddard K. Administration of amiodarone during resuscitation of ventricular arrhythmias. *J Emerg Nurs*. 2010;36(1):26-28.
32. Leal A, Kadakia K, Loprinzi C, et al. Fosaprepitant-induced phlebitis: a focus on patients receiving doxorubicin/cyclophosphamide therapy. *Support Care Cancer*. 2014;22(5):1313-1317.
33. 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.
34. Zheng G, Yang L, Chen H, Chu J, Mei L. Aloe vera for prevention and treatment of infusion phlebitis. *Cochrane Database Syst Rev*. 2014;(6):CD009162. doi://10.1002/14651858.CD009162.pub2.
35. Joanna Briggs Institute. Management of peripheral intravascular devices. *Aust Nurs J*. 2008;16(3):25-28.
36. Powell J, Tarnow KG, Perucca R. The relationship between peripheral intravenous catheter indwell time and the incidence of phlebitis. *J Infus Nurs*. 2008;3(1):39-45.
37. Schultz AA, Gallant P. Evidence-based quality improvement project for determining appropriate discontinuation of peripheral intravenous cannulas. *Evid Based Nurs*. 2005;8(1):8.
38. Uslusoy E, Mete S. Predisposing factors to phlebitis in patients with peripheral intravenous catheters: a descriptive study. *J Am Acad Nurse Pract*. 2008;20(4):172-180.

39. Marsh N, Mihala G, Ray-Barruel G, Webster J, Wallis MC, Rickard CM. Inter-rater agreement on PIVC-associated phlebitis signs, symptoms and scales [published online July 17, 2015]. *J Eval Clin Pract*. doi:10.1111/jep.12396.
40. Bravery K, Dougherty L, Gabriel J, Kayley J, Malster M, Scales K. Audit of peripheral venous cannulae by members of an IV therapy forum. *Br J Nurs*. 2006;15(22):1244-1249.
41. Mestre G, Berbel C, Tortajada P, et al. Successful multifaceted intervention aimed to reduce short peripheral venous catheter-related adverse events: a quasiexperimental cohort study. *Am J Infect Control*. 2013;41(6):520-526.
42. 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.
43. Woody G, Davis BA. Increasing nurse competence in peripheral intravenous therapy. *J Infus Nurs*. 2013;36(6):413-419.

46. INFILTRATION AND EXTRAVASATION

Standard

46.1 The clinician assesses the peripheral and central vascular access device site for signs and/or symptoms of infiltration and extravasation before each infusion and on a regular basis and educates the patient and/or caregiver about infiltration/extravasation, any interventions, and any required follow-up.
46.2 Appropriate intervention(s) are implemented as determined by the characteristics of the solution or medication escaping from the vein.

Practice Criteria

A. Select the most appropriate vascular access device (VAD) and insertion site to reduce the risk for infiltration/extravasation. Do not use winged metal needles for infusion as they are associated with an increased risk of infiltration (refer to Standard 26, *Vascular Access Device [VAD] Planning*; Standard 27, *Site Selection*).
B. Assess all VADs for patency and the absence of signs and symptoms of infiltration and extravasation prior to each intermittent infusion and on a regular basis for continuous infusions. Assessment includes observation, palpation, flushing to identify resistance, aspiration for a blood return, and listening to the patient's report of pain. Frequency of VAD site assessment depends upon the specific patient population and characteristics of the infusion therapy (refer to Standard 40, *Flushing and Locking*; Standard 41, *Vascular Access Device [VAD] Assessment, Care, and Dressing Changes*).
C. Recognize risk factors associated with infiltration and extravasation including:
    1. Insertion sites in the hand, antecubital fossa, and upper arm when compared to sites in the forearm.
    2. Infusion of antibiotics and corticosteroids through a peripheral catheter.
    3. Current infection.
    4. Subsequent peripheral catheters after the first insertion.
    5. Inability or difficulty with communicating pain, tightness, or other discomfort.
    6. Altered mental status or cognition (eg, agitation, confusion, sedation).
    7. Age-related changes to vasculature, skin, and subcutaneous tissue.
    8. Diseases that produce changes in vasculature or impaired circulation (eg, diabetes, lymphedema, systemic lupus, Raynaud's disease, peripheral neuropathy, peripheral vascular disease).
    9. Medications that alter pain sensation (eg, narcotics) or suppress the inflammatory response (eg, steroids).
    10. Difficulty with peripheral venous access related to obesity, history of multiple venipunctures, and infusion therapy.
    11. Peripheral catheters indwelling longer than 24 hours.
    12. Use of deep veins with insufficient catheter length.
    13. Length of the injection or infusion time for vesicant medications.[1-9] (IV)
D. Recognize the differences between vesicant, nonvesicant, and irritant solutions and medications. There is no accepted scoring system for classification of medications as a vesicant or irritant, leaving clinicians to rely upon specific drug information, case reports, and other published literature. Each facility should reach a consensus on what medication is considered to be a vesicant and irritant based on their internal formularies.
    1. Identify the vesicant nature of antineoplastic and noncytotoxic medications prior to administration and be prepared to use the correct antidote treatment for each medication.
    2. Vesicant medications can produce varying degrees of tissue damage, including blistering and necrosis. Surgical washout procedure, debridement, and skin grafting may be indicated.
    3. Nonvesicant solutions and medications may produce tissue damage in neonates and infants.
    4. Vesicant and nonvesicant solutions and medications can produce compartment syndrome with the possibility of arterial and nerve damage that could lead to complex regional pain syndrome or amputation of the extremity if not quickly recognized.
    5. Tissue damage from irritant medications is associated with a large volume of concentrated medication escaping into the tissue.[2,3,10-15] (IV)
E. Identify causes of infiltration/extravasation that may indicate the need for more frequent monitoring or

removal and insertion of a new VAD, including but not limited to:

1. Mechanical issues associated with VAD site selection, catheter size, insertion techniques, central vascular access device (CVAD) tip location, securement, and normal body movement (eg, respiratory and cardiac function).
   a. Peripheral sites most often associated with infiltration/extravasation are the hand and wrist, foot and ankle, and antecubital fossa.
   b. Ultrasound-guided peripheral catheter insertion of deep veins of the upper arm is associated with higher rates of infiltration/extravasation when compared to other peripheral catheter insertion sites. Short catheter length and vessel depth are associated with higher rates of infiltration/extravasation (refer to Standard 22, *Vascular Visualization*).
   c. Extravascular CVAD tip location can occur in many anatomical locations and at any point in the dwell time (refer to Standard 53, *Central Vascular Access Device [CVAD] Malposition*).
2. Pharmacologic or physiochemical properties associated with drug concentration and volume escaping into the tissue; hyperosmolarity and nonphysiological pH; the medication's ability to bind DNA, kill replicating cells, and/or cause vascular dilatation; and excipients, such as alcohol or polyethylene glycol, used in the formulation of some medications.
3. Obstructive issues, such as vein thrombosis or stenosis proximal to (located above) the insertion site and tip location, limiting blood flow and causing overflow of infusing solutions from the puncture site.[3,5,16] (IV)

F. Limit the amount of solution that enters the tissue through early recognition of signs and symptoms of infiltration/extravasation. Signs and symptoms progress from simple to complex, and the clinical presentation can be confused with phlebitis or flare reactions.
   1. 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; may appear with passive stretching of the muscles in the extremity; pain intensity may increase over time.
   2. 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. Compare circumference of both extremities. Edema from a CVAD may appear as a raised area on the neck or chest.
   3. Changes in color may include blanching from nonvesicant solutions; vesicants can produce redness; however, extravasation into deep tissue may not produce visible color changes.
   4. Fluid leakage from the puncture site, subcutaneous tunnel, or port pocket.
   5. Blister formation may appear within hours (eg, contrast media) or may be delayed for days with antineoplastic agents. Progression to ulceration may vary from a few days to 1 to 2 weeks, depending upon the medication that extravasated.[1,4,6,13,16] (IV)

G. Immediately stop the infusion when the patient reports pain, burning, stinging, and/or tightness, at or around the insertion site, catheter tip, or entire venous pathway, as this should not be considered "normal" with any infusion. These symptoms require further assessment to determine the appropriate intervention(s).
   1. Assess the area distal (located below) to the VAD site for capillary refill, sensation, and motor function.
   2. Aspirate for a blood return, although the peripheral catheter tip could be inside the vein lumen, yet an additional puncture of the vein wall has occurred.
   3. Do *not* flush the VAD, as this would inject additional medication into the tissue.
   4. Disconnect the administration set from the catheter hub, and aspirate from the catheter or implanted port access needle with a small syringe, although a very small amount of fluid may be retrieved.
   5. Remove the peripheral catheter or implanted port access needle.
   6. Never apply pressure to the area.
   7. Using a skin marker, outline the area with visible signs of infiltration/extravasation to allow for assessing changes.
   8. Photograph the area to identify progression or exacerbation of the tissue injury.
   9. Notify the licensed independent practitioner (LIP) about the event, and activate the established treatment protocol or the prescribed treatment.
   10. Anticipate use of radiographic tests to identify the catheter tip location. Timing of CVAD removal depends on the plan of care, which is based on the identified extravascular location of the catheter tip. Surgical intervention may be needed as determined by the LIP.
   11. 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 of injection or infusion. The need for surgical consultation is based on the clinical signs and symptoms and their progression.

12. Elevate the extremity to encourage lymphatic reabsorption of the solution/medication.[2,3,6,17] (IV)

H. Follow the established treatment protocol or LIP prescription as appropriate for the solution and medication in the tissue with the goal of limiting the exposure of subcutaneous tissue to the solution or medication. 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.[14,17-19] (IV)

I. Use the appropriate method for clinical management of the infiltration/extravasation site.
   1. Apply dry, cold compresses when the goal is to localize the medication in the tissue and reduce inflammation.
      a. Do not use cold compresses with extravasation of vinca alkaloids 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.
      c. Neutralize the medication with the appropriate antidote.
   2. Apply dry, warm compresses when the goal is to increase local blood flow, and disperse the medication through the tissue.
      a. Do not exceed 42°C (107.6°F) in pediatrics.
      b. Dilute the medication further with the appropriate antidote.
   3. Use dry, cold compresses for nonirritant and hyperosmolar fluids and medications.
   4. Administer the appropriate antidote for the solutions or medication in the tissue.
      a. Daily intravenous (IV) infusion of dexrazoxane over 3 days is the recommended antidote for anthracycline extravasation. Infusion should begin within 6 hours of the extravasation and be infused into the opposite extremity.
      b. Inject other antidotes 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 manufacturer's directions for dose and administration.
         i Sodium thiosulfate is recommended for mechlorethamine and has been suggested for large extravasates of cisplatin.
         ii. Phentolamine is preferred for vasopressor extravasation. Normal perfusion of the area is seen within 10 minutes. Repeated injection may be necessary if hypoperfusion is still present or if vasoconstriction is extending to a greater area.
         iii. Terbutaline injection has been used for vasopressor extravasation due to the intermittent shortages of phentolamine.
         iv. Hyaluronidase is not considered to be an antidote to the specific extravasated drug. Instead, it is an enzyme that increases absorption and dispersion of the drug in the tissue and its use is reported with antineoplastic and noncytotoxic drugs; hyperosmolar solutions (eg, parenteral nutrition and calcium salts); and radiographic contrast media. Recombinant hyaluronidase is not derived from animals and may have a lower risk of allergic response. Do *not* inject by the IV route. Subcutaneous injection within 1 hour of the extravasation event produces the best response. Follow the manufacturer's directions for dose and administration. Use of dry heat in conjunction with hyaluronidase works synergistically to increase blood flow and disperse the extravasated drug.
         v. Apply topical nitroglycerin 2% as a 1-inch strip to the site of vasopressor extravasation; repeat every 8 hours as clinically indicated.
   5. Use nonpharmacologic methods (eg, elevation, heat application, surgical washout) for extravasation of acidic and alkaline medications as subcutaneous injections could cause gas formation and exacerbate the tissue injury.[2,3,17,20,21] (IV)

J. 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.
   1. Electronic infusion pumps do not cause infiltration/extravasation; however, they will exacerbate the problem until the infusion is stopped.
   2. Automated power or pressure injectors produce a jet of fluid exiting the catheter tip. It has been postulated that this jet could induce vessel perforation and extravasation.
   3. Medication 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*).[22-24] (IV)

K. Educate the patient and caregivers about:
   1. The risks of receiving a vesicant medication prior to administration, emphasizing the specific signs and symptoms to immediately report.
   2. The possible progression of the signs and symptoms of infiltration/extravasation.
   3. Changes that should be reported to the LIP (eg, changes in extremity mobility and sensation, elevated temperature, and other signs of infection).

4. Protecting the site from sunlight.
5. The frequency of follow-up visits to the LIP and/or other medical consultants as needed (see Standard 8, *Patient Education*).[2,6] (IV)

L. Use a standardized tool or definition for assessing and documenting infiltration/extravasation from all types of VADs that is valid, reliable, and clinically feasible. This assessment should occur initially and regularly based on organizational policies and procedures; continue until resolution; and be oriented to the patient's size and age. 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.[3,17,25] (IV)

M. 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.[6,17] (IV)

N. 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.[6] (IV)

O. Review infiltration/extravasation incidents causing harm or injury, using incident or occurrence reports or medical record reviews for quality improvement opportunities (refer to Standard 6, *Quality Improvement*).

REFERENCES

Note: All electronic references in this section were accessed October 1, 2015.

1. Warren D. Implementation of a protocol for the prevention and management of extravasation injuries in the neonatal intensive care patient. *Int J Evid Based Healthc*. 2011;9(2):165-171.
2. Boulanger J, Ducharme A, Dufour A, Fortier S, Almanric K. Management of the extravasation of anti-neoplastic agents. *Support Care Cancer*. 2015;23(5):1459-1471.
3. Reynolds PM, Maclaren R, Mueller SW, Fish DN, Kiser TH. Management of extravasation injuries: a focused evaluation of noncytotoxic medications. *Pharmacotherapy*. 2014;34(6):617-632.
4. American College of Radiology. ACR Manual on Contrast Media. Version 10.1, 2015. http://www.acr.org/~/media/37D84428BF1D4E1B9A3A2918DA9E27A3.pdf.
5. Dykes TM, Bhargavan-Chatfield M, Dyer RB. Intravenous contrast extravasation during CT: a national data registry and practice quality improvement initiative. *J Am Coll Radiol*. 2015;12(2):183-191.
6. Polovich M, Olsen M, LeFebvre K, eds. *Chemotherapy and Biotherapy Guidelines and Recommendations for Practice*. 4th ed. Pittsburgh, PA: Oncology Nursing Society; 2014.
7. 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 Nurs*. 2012;35(5):290-292.
8. Kadom N, Hashim HD, Olsen C, Cefaratti M, Bulas D, Shalaby-Rana E. Nursing role model for computed tomography: contrast injection decreases extravasation rates. *J Pediatr Nurs*. 2010;27(2):113-118.
9. 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*. 2014;35(1):63-68.
10. Barbee MS, Owonikoko TK, Harvey RD. Taxanes: vesicants, irritants, or just irritating? *Ther Adv Med Oncol*. 2014;6(1):16-20.
11. Haslik W, Hacker S, Felberbauer F, et al. Port-a-Cath® extravasation of vesicant cytotoxics: surgical options for a rare complication of cancer chemotherapy. *Eur J Surg Oncol*. 2015;41(3):378-385.
12. Kalyani BS, Fisher BE, Roberts CS, Giannoudis PV. Compartment syndrome of the forearm: a systematic review. *J Hand Surg Am*. 2011;36(3):535-543.
13. Prasarn ML, Ouellette EA. Acute compartment syndrome of the upper extremity. *J Am Acad Orthop Surg*. 2011;19(1):49-58.
14. Paquette V, McGloin R, Northway T, DeZorzi P, Singh A, Carr R. Describing intravenous extravasation in children (DIVE study). *Can J Hosp Pharm*. 2011;64(5):340-345.
15. 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.e9-17. doi:10.1016/jcrc.2015.01.014.
16. Al-Benna S, O'Boyle C, Holley J. Extravasation injuries in adults. *ISRN Dermatol*. 2013. doi:10.1155/2013/856541.
17. Hanrahan KM, ed. *Hyaluronidase for Treatment of Intravenous Extravasations: Evidence-Based Practice Guideline*. Iowa City, IA: University of Iowa College of Nursing, Office for Nursing Research; 2012.
18. Pérez Fidalgo JA, García Fabregat L, Cervantes A, Margulies A, Vidall C, Roila F. Management of chemotherapy extravasation: ESMO-EONS clinical practice guidelines. *Eur J Oncol Nurs*. 2012;16(5):528-534.
19. 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 Pediatrics*. 2013. doi:10.1186/1471-2431-13-34.
20. Ebbinghaus S, Kobayashi H. Safe heat application for pediatric patients: a hot item. *J Nurs Care Qual*. 2010;25(2):168-175.
21. Saleem S, Rice L. Limb amputation in hemoglobin SC disease after application of ice and elevation. *Am J Hematol*. 2007;82(1):53-54.
22. Huber C, Augustine A. IV infusion alarms: don't wait for the beep. *Am J Nurs*. 2009;109(4):32-33.
23. Weber P, Coursey C, Howle L, Nelson R, Nichols E, Schindera S. Modifying peripheral IV catheters with side holes and side slits results in favorable changes in fluid dynamic properties during the injection of iodinated contrast material. *Am J Roentgenol*. 2009;193(4):970-979.
24. Davenport MS, Wang CL, Bashir MR, Neville AM, Paulson EK. Rate of contrast material extravasations and allergic-like reactions: effect of extrinsic warming of low-osmolality iodinated CT contrast material to 37°C. *Radiology*. 2012;262(2):475-484.
25. Pop RS. A pediatric peripheral intravenous infiltration assessment tool. *J Infus Nurs*. 2012;35(4):243-248.

47. NERVE INJURIES

Standard

47.1 During peripheral venipuncture and catheter dwell time, reports of paresthesia-type pain require immediate removal of the vascular access device (VAD).
47.2 During the insertion or dwell of central vascular access devices (CVADs), clinicians will maintain a high index of suspicion for nerve injuries when the patient complains of respiratory difficulty or unusual presentations of pain or discomfort.

Practice Criteria

A. Recognize normal and potential anatomical variations of veins, arteries, and nerves used for peripheral or CVAD insertion. Recognize that anatomical variations in these structures are common and can be complex, thus increasing the risk of temporary or permanent nerve injury during VAD insertion and dwell.[1-10] (I A/P)
B. Selecting specific peripheral venous and arterial puncture sites for the purpose of avoiding nerves is not possible; however, common sites have a greater risk of nerve injury. Venipuncture sites with the greatest risk include:
   1. Distal sensory branches of the radial and ulnar nerves for sites in the dorsal hand.
   2. Superficial radial nerve at the cephalic vein of the radial wrist.
   3. Median nerve on the volar aspects of the wrist.
   4. Median and anterior interosseous nerve at or above the antecubital fossa.
   5. Lateral and medial antebrachial nerves for the antecubital fossa.
   6. Brachial plexus nerve for subclavian and jugular sites.

   Arterial sites with the greatest risk include:
   1. Brachial (median nerve).
   2. Radial (median and radial nerve).
   3. Axillary (brachial plexus).

   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 autonomic nerve injury is possible due to direct nerve puncture or nerve compression.[8,9,11-17] (I A/P)
C. 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.[7,9,18-20] (V)
D. Immediately stop the VAD insertion procedure 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. Inform the licensed independent practitioner (LIP) of the patient's report of symptoms as early recognition of nerve damage produces a better prognosis. Consultation with an appropriate surgeon (ie, hand specialist) may be required. Details of the patient's report of symptoms should be documented in the medical record.[9,14,21-25] (V)
E. Do not use subcutaneous probing techniques or multiple passes of the needle or catheter when performing any puncture procedure as this increases the risk of nerve damage.[21,22] (V)
F. 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 intravenous solutions, hematoma, and edema associated with the inflammatory process of phlebitis and thrombophlebitis.[9,19,20,23] (V)
G. Perform neurovascular assessment, 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.[22,26] (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.[14,27,28] (IV)
   3. Complex regional pain syndrome, a chronic, debilitating condition that can result from venipuncture. It 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. It requires lifelong management with medications; nerve blocks; and chemical, thermal, or surgical sympathectomy.[29,30] (IV)
H. In the presence of any CVAD, observe for respiratory difficulties or dyspnea and changes in the eye, such as pupil constriction and upper eyelid drooping.
   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 fluids. CVAD removal is indicated.[31-38] (V)

2. Peripherally inserted central catheters (PICCs) and jugular inserted catheters 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.[39,40] (V)

REFERENCES

1. 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 Plexus Peripheral Nerve Inj*. 2014;9(1):2.
2. 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.
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.
4. Damwan A, Agthong S, Amarase C, Yotnuengnit P. Medial antebrachial cutaneous nerve: anatomical relationship with the medial epicondyle, basilic vein and brachial artery. *Int J Morphol*. 2014;32(2):481-487.
5. Beldner S, Zlotolow D, Melone C, Agnes A, Jones M. Anatomy of the lateral antebrachial cutaneous and superficial radial nerves in the forearm: a cadaveric and clinical study. *J Hand Surg*. 2005;30(6):1226-1230.
6. Paraskevas G, Raikos A, Chouliaras K, Papaziogas B. Variable anatomical relationship of phrenic nerve and subclavian vein: clinical implication for subclavian vein catheterization. *Br J Anaesth*. 2011;106(3):348-351.
7. Kim KH, Byun EJ, Oh EH. Ultrasonographic findings of superficial radial nerve and cephalic vein. *Ann Rehabil Med*. 2014;38(1):52-56.
8. 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.
9. Horowitz S. Venipuncture-induced nerve injury. *J Neuropathic Pain Symptom Palliation*. 2005;1(1):109-114.
10. 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.
11. Zhang J, Moore AE, Stringer MD. Iatrogenic upper limb nerve injuries: a systematic review. *ANZ J Surg*. 2011;81(4):227-236.
12. Stevens R, Mahadevan V, Moss A. Injury to the lateral cutaneous nerve of forearm after venous cannulation: a case report and literature review. *Clin Anat*. 2012;25(5):659-662.
13. Cousins TR, O'Donnell JM. Arterial cannulation: a critical review. *AANA J*. 2004;72(4):267-271.
14. Mackinnon S. Pathophysiology of nerve compression. *Hand Clin*. 2002;18(2):231-241.
15. Alomari A, Falk A. Median nerve bisection: a morbid complication of a peripherally inserted central catheter. *J Assoc Vasc Access*. 2006;7(3):129-131.
16. Puhaindran ME, Wong HP. A case of anterior interosseous nerve syndrome after peripherally inserted central catheter (PICC) line insertion. *Singapore Med J*. 2003;44(12):653-655.
17. Kim HJ, Park SH, Shin HY, Choi YS. Brachial plexus injury as a complication after nerve block or vessel puncture. *Korean J Pain*. 2014;27(3):210-218.
18. Ho K, Lim H. Femoral nerve palsy: an unusual complication after femoral vein puncture in a patient with severe coagulopathy. *Anesth Analg*. 1999;89(3):672-673.
19. Dawson J, Christie M. "Just a sharp scratch": permanent radial, median and ulnar neuropathy following diagnostic venepuncture. *Br J Hosp Med*. 2007;68(3):160-161.
20. 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.
21. Newman B. Arm complications after manual whole blood donation and their impact. *Transfus Med Rev*. 2013;27(1):44-49.
22. Boeson MB, Hranchook A, Stoller J. Peripheral nerve injury from intravenous cannulation: a case report. *AANA J*. 2000;68(1):53-57.
23. Di Fabio R, Casali C, Pierelli F. Iatrogenic selective lesion of the median nerve at the elbow. *Acta Neurol Belg*. 2010;110(1):97.
24. Masoorli S. Nerve injuries related to vascular access insertion and assessment. *J Infus Nurs*. 2007;30(6):346-350.
25. 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.
26. Robson A, See M, Ellis H. Applied anatomy of the superficial branch of the radial nerve. *Clin Anat*. 2008;21(1):38-45.
27. 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.
28. Gourgiotis S, Villias C, Germanos S, Foukas A, Ridolfini MP. Acute limb compartment syndrome: a review. *J Surg Educ*. 2007;64(3):178-186.
29. Elahi F, Reddy CG. Venipuncture-induced complex regional pain syndrome: a case report and review of the literature. *Case Rep Med*. 2014. doi:10.1155/2014/613921.
30. Horowitz S. Venipuncture-induced neuropathic pain: the clinical syndrome, with comparisons to experimental nerve injury models. *Pain*. 2001;94(3):225-229.
31. Rigg A, Hughes P, Lopez A, Filshie J, Cunningham D, Green M. Right phrenic nerve palsy as a complication of indwelling central venous catheters. *Thorax*. 1997;52(9):831-833.
32. Aggarwal S, Hari P, Bagga A, Mehta S. Phrenic nerve palsy: a rare complication of indwelling subclavian vein catheter. *Pediatr Nephrol*. 2000;14(3):203-204.
33. Takasaki Y, Arai T. Transient right phrenic nerve palsy associated with central venous catheterization. *Br J Anaesth*. 2001;87(3):510-511.
34. Sav T. Hiccups, a rare complication arising from use of a central venous catheter. *Hemodialysis Int*. 2010;14(3):337-338.
35. Tosello B, Michel F, Merrot T, et al. Hemidiaphragmatic paralysis in preterm neonates: a rare complication of peripherally inserted

central catheter extravasation. *J Pediatr Surg*. 2011;46(7): E17-E21.
36. 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 Anesth*. 2013;65(6):559-561.
37. 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.
38. Ahn EJ, Baek CW, Shin HY, Kang H, Jung YH. Phrenic nerve palsy after internal jugular venous catheter placement. *Korean J Anesth*. 2012;63(2):183-184.
39. Links DJR, Crowe PJ. Horner's syndrome after placement of a peripherally inserted central catheter. *J Parenter Enteral Nutr*. 2006;30(5):451-452.
40. Suominen PK, Korhonen A-M, Vaida SJ, Hiller AS. Horner's syndrome secondary to internal jugular venous cannulation. *J Clin Anesth*. 2008;20(4):304-306.

48. CENTRAL VASCULAR ACCESS DEVICE (CVAD) OCCLUSION

Standard

48.1 Central vascular access devices (CVADs) are regularly assessed for patency and proper function as defined by the ability to flush the catheter without resistance and the ability to yield a blood return.
48.2 Thrombolytic agents and clearing agents used to clear occluding substances from a CVAD are administered based on an evaluation of potential causes of occlusion and on the order of a licensed independent practitioner (LIP) or an LIP-approved protocol.
48.3 The LIP is notified if catheter patency is not restored and appropriate alternative actions are implemented, such as radiographic studies to identify catheter tip location or dye studies to evaluate catheter flow. Catheter salvage is preferred over catheter removal for management of CVAD occlusions.

Practice Criteria

A. Reduce the risk for CVAD occlusion by:
   1. Using proper flushing and locking procedures (refer to Standard 40, *Flushing and Locking*).
   2. Using the appropriate sequence of catheter clamping and final syringe disconnection based on the type of needleless connector (ie, negative, positive, neutral displacement) to reduce the amount of blood reflux into the CVAD lumen (refer to Standard 34, *Needleless Connectors*).
   3. Checking for incompatibility when 2 or more drugs are infused together; consult with pharmacist when unsure of compatibility.[1,2] (V)
   4. Identifying medications/solutions at high risk for precipitation if they come into contact with each other. These include alkaline drugs such as phenytoin, diazepam, ganciclovir, acyclovir, ampicillin, imipenem, and heparin; acidic drugs such as vancomycin and parenteral nutrition solutions; ceftriaxone and calcium gluconate; and mineral precipitate in parenteral nutrition solutions with increased levels of calcium and phosphate. Reduce risk through adequate flushing with preservative-free 0.9% sodium chloride (USP) between infusions or use separate catheter lumens if available.[1-7] (IV)
   5. Recognizing risk of lipid residue occlusion when administering 3-in-1 parenteral nutrition solutions.[1,2,4-6] (IV)

B. Identify signs of CVAD occlusion:
   1. Inability to withdraw blood or sluggish blood return.
   2. Sluggish flow.
   3. Inability to flush or infuse through the CVAD.
   4. Frequent occlusion alarms on electronic infusion device.
   5. Infiltration/extravasation or swelling/leaking at infusion site.[1-6] (IV)

C. Investigate and evaluate potential causes for a CVAD occlusion:
   1. Check for external mechanical causes such as a tight suture at catheter site, kinked/clamped catheter, clogged filter or needleless connector.[1,2,5,6] (IV)
   2. Suspect precipitation based on the type(s) of administered medications or solutions, observation of the catheter or infusion set for any visible precipitate, history of infusion rate, and flushing frequency.[1,2,7] (IV)
   3. Suspect thrombotic occlusions based on visible blood in catheter or add-on devices, inability to aspirate blood, sluggish flow.[1,3-5] (IV)
   4. Internal mechanical causes may also cause CVAD occlusion including pinch-off syndrome, secondary CVAD malposition, and catheter-associated venous thrombosis (refer to Standard 51, *Catheter Damage [Embolism, Repair, Exchange]*); Standard 52, *Central Vascular Access Device [CVAD]-Associated Venous Thrombosis*; Standard 53, *Central Vascular Access Device [CVAD] Malposition*).

D. Do not leave a CVAD with an occlusion untreated; do not leave an occluded CVAD lumen untreated because another lumen is patent.[1] (V)

E. Resolve external mechanical causes after checking the infusion system, from the administration set down to the dressing (eg, clamped or kinked catheter).[1,2,6] (V)

F Review the patient's medication record and collaborate with the pharmacist and the LIP regarding an appropriate intervention when the suspected cause

of occlusion is medication precipitate or lipid residue. Treatment of these occlusions includes instilling an amount of a catheter-clearance agent based on the catheter lumen priming volume and allowing it to dwell for 20 to 60 minutes:

1. Acidic drug precipitate (low pH, less than 6): 0.1N hydrochloric acid.
2. Alkaline drug precipitate (pH greater than 7): sodium bicarbonate 8.4% or sodium hydroxide 0.1 mmol/L.
3. Lipid residue: 70% ethanol in a sufficient volume to fill the catheter lumen; for pediatric patients, a dose of 0.55 mL/kg has been used with no more than 3 mL maximum. Use ethanol with caution with polyurethane CVADs as ethanol may damage the catheter material; refer to vascular access device (VAD) manufacturers' directions for use regarding exposure to any form of alcohol.[1,2,4,6] (IV)

G. Review the patient's medication record and collaborate with the pharmacist and the LIP regarding an appropriate intervention when the suspected cause of occlusion is thrombosis. Use a thrombolytic agent for suspected thrombotic occlusion:
   1. Instillation of tissue plasminogen activator (tPA, alteplase) 2 mg/2 mL, which is allowed to remain in CVAD lumen for 30 minutes to 2 hours and repeated 1 time if necessary, is recommended as safe and effective in restoring catheter patency in neonatal, pediatric, and adult patients. For pediatric patients weighing 30 kg or less, use the same concentration; however, the volume of tPA should be equal to 110% of the catheter priming volume.[1,3-6,8] (III)
   2. Instillation of tPA based on manufacturers' directions for use, as above, is recommended in current guidelines. While lower tPA doses, use of cryopreserved aliquots of alteplase, and alteplase aliquoting to increase volume (eg, greater than 2 mL) for hemodialysis catheters have been reported in the literature and may be part of organizational protocols, there is limited research available to support the efficacy of thrombolytic drugs for alternative dosing.[1,9-11] (I)
   3. Consider use of tPA in community and long-term care settings.[1] (IV)
   4. Stop all infusions, when possible, if treating a multilumen CVAD to optimize thrombolysis during the dwell time, and facilitate maximum contact between the thrombolytic agent and the thrombus on the internal catheter lumen and external catheter surface at or near the tip.[1] (IV)
   5. Infusion of low doses of alteplase to manage occlusions in hemodialysis catheters (eg, 1-4 mg) over 30 minutes and up to 3 to 4 hours has been reported in both adult and pediatric populations when there is recurrent occlusion after multiple direct alteplase instillations. Alteplase infusion has also been reported as safe and efficacious in critically ill pediatric patients.[1,12] (IV)
   6. Other additional thrombolytic agents under investigation for treatment of CVAD occlusions include recombinant urokinase, retaplase, tenectaplase, and alfimeprase.[1,2] (V)

H. Recognize that thrombi in and around the CVAD facilitate adhesion of bacteria, leading to colonization and potentially infection. Studies suggest that tPA use should heighten the awareness of risk for infection in these patients.[13,14] (V)

I. Avoid applying excessive force to an occluded CVAD when a thrombolytic or clearing agent is instilled to reduce the risk of causing an intraluminal level of pressure that could cause catheter damage. A negative-pressure technique should be used to reduce the risk of catheter damage and to remove intraluminal fluid so that the clearing agent has a better opportunity to reach the occluding substance.[1-4] (V)

J. Use a syringe no smaller than 10 mL for administration of a thrombolytic or catheter clearance agent.[1] (IV)

K. Aspirate degradation products and discard prior to flushing the lumen.[1] (V)

L. Consider alternative actions such as a referral to interventional radiology if the CVAD clearance procedure does not result in catheter patency; catheter removal should be considered if catheter patency is not restored.[1,3] (V)

M. Collaborate with LIP to obtain orders and diagnostic tests to verify suspected CVAD malposition or pinch-off syndrome. Intermittent or positional occlusion may be symptoms of pinch-off syndrome, the compression of the catheter between the clavicle and first rib alongside the subclavian vein (refer to Standard 51, *Catheter Damage [Embolism, Repair, Exchange]*); Standard 53, *Central Vascular Access Device [CVAD] Malposition*).

N. Monitor outcomes, including causes of occlusions in types of 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 (see Standard 6, *Quality Improvement*).[1] (V)

REFERENCES

Note: All electronic references in this section were accessed October 2, 2015.

1. Hill J, Broadhurst D, Miller K, et al. Occlusion management guideline for central vascular access devices (CVADs). *J Can Vasc Access Assoc.* 2013;(suppl 1):3-34. http://cvaa.info/PUBLICATIONS/OcclusionManagementGuideline/tabid/229/Default.aspx.

2. Ast D, Ast T. Nonthrombotic complications related to central vascular access devices. *J Infus Nurs*. 2014;37(5):349-358.
3. Baskin JL, Reiss R, Willmas JA, et al. Thrombolytic therapy for central venous catheter occlusion. *Haematologica*. 2012;97(5):641-649.
4. 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—on behalf of the coagulation defects working group of the Italian Association of Pediatric Hematology and Oncology (AIEOP). *Ann Hematol*. 2015;94(11):1765-1776.
5. Bolton D. Preventing occlusion and restoring patency to central venous catheters. *Br J Comm Nurs*. 2013;18(11):539-540.
6. Doellman D. Prevention, assessment, and treatment of central venous catheter occlusions in neonatal and young pediatric patients. *J Infus Nurs*. 2011;34(4):251-258.
7. Steadman E, Raisch DW, Bennett CL, et al. Evaluation of a potential clinical interaction between ceftriaxone and calcium. *Antimicrob Agents Chemother*. 2010;54(4):1534-1540.
8. Anderson DM, Pesaturo KA, Casavant J, Ramsey EZ. Alteplase for the treatment of occlusion in pediatric patients. *Ann Pharmacother*. 2013;47(3):405-409.
9. van Miert C, Jill R, Jones L. Interventions for restoring patency of occluded central venous catheter lumens. *Cochrane Database Syst Rev*. 2012;(4):CD007119. doi:10.1002/14651858.CD007119.pub2.
10. Ponce D, Mendes M, Silva T, et al. Occluded tunneled venous catheter in hemodialysis patients: risk factors and efficacy of alteplase. *Artif Organs*. 2015;39(9):741-747.
11. 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.
12. 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):253-260.
13. 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 bloodstream infections. *Am J Infect Control*. 2014;42(4):417-420.
14. 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.

49. INFECTION

Standard

49.1 The clinician implements infection prevention measures with the goal of preventing infusion- and vascular access device (VAD)-related infections.
49.2 The clinician assesses the patient with a VAD for signs and/or symptoms of infection and educates the patient and/or caregiver about infection, risks, any interventions, and any required follow-up.

Practice Criteria

A. Assess for signs and symptoms of a VAD-related infection which may include, but is not limited to, erythema; edema; any pain or tenderness or drainage; fluid in the subcutaneous pocket of a totally implanted intravascular device or subcutaneous tunnel for any tunneled catheter; induration at the exit site or over the pocket; spontaneous rupture and drainage; necrosis of the overlying skin at the VAD insertion site; and/or body temperature elevation. Immediately notify the licensed independent practitioner (LIP) when signs and symptoms of a VAD-related infection are present, and implement planned interventions.[1] (IV)
B. Consider site selection for VAD placement as a strategy to prevent infection. To minimize the risk of catheter-related infection with a nontunneled central vascular access device (CVAD), the subclavian vein is recommended in adult patients, rather than the jugular or femoral (refer to Standard 27, *Site Selection*).
C. Remove a peripheral venous catheter if the patient develops symptoms of 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.[1-3] (IV)
D. Do not remove a functioning CVAD based solely on temperature elevation and the absence of confirmatory evidence of catheter-related infection. Use clinical judgment regarding the appropriateness of removing the catheter if an infection is evidenced elsewhere or if a noninfectious cause of fever is suspected.[2,4] (IV)
E. Collaborate with the LIP and patient to collectively determine if the CVAD can be salvaged. For hemodynamically stable outpatients with catheter-related bloodstream infection (CR-BSI), catheter salvage may be a safe and appropriate strategy. Removal of the CVAD is required if there is clinical deterioration or persisting or relapsing bacteremia. The insertion of a new CVAD at a new site should be a collaborative decision based on the specific risks and benefits for each patient. Factors to consider in the decision to salvage a catheter include:
   1. The type of VAD (eg, percutaneous versus surgically inserted long-term catheter).
   2. Difficulty with inserting a new CVAD.
   3. Presence of bleeding disorders.
   4. The infecting organism(s) as confirmed by paired blood cultures.
   5. The presence of other complicating conditions including, but not limited to, severe sepsis, suppurative thrombophlebitis, endocarditis, or the presence of vascular or other hardware (eg, a pacemaker).[1,5-8] (IV)

F. Anticipate the removal of a short-term CVAD (in situ less than or equal to 14 days) in a pediatric patient with an uncomplicated CR-BSI and treat with systemic antibiotics for at least 7 to 14 days based on the pathogen. Infections with *Staphylococcus aureus*, gram-negative bacilli, or *Candida* require immediate removal of the infected CVAD and a defined course of systemic antibiotic therapy, except in rare circumstances when no alternative venous access is available. Patients with a long-term CVAD and an uncomplicated CR-BSI because of coagulase-negative *Staphylococcus* or *Enterococcus* may retain the CVAD and complete a course of systemic antibiotics with the use of antibiotic lock therapy. Closely monitor and clinically evaluate pediatric patients treated without catheter removal, including additional blood cultures and the use of antibiotic lock therapy with systemic therapy for catheter salvage.[8] (V)

G. Consider the use a prophylactic antimicrobial lock solution in a patient with a long-term CVAD who has a history of multiple CR-BSIs despite optimal maximal adherence to aseptic technique. Aspirate all antimicrobial locking solutions from the CVAD lumen at the end of the locking period (refer to Standard 40, *Flushing and Locking*).

H. Remove a CVAD from a patient with CR-BSI associated with any of the following conditions: severe sepsis; suppurative thrombophlebitis; endocarditis; bloodstream infection that continues despite greater than 72 hours of antimicrobial therapy to which the infecting microbes are susceptible; or infections due to *S. aureus*, *P. aeruginosa*, fungi, or mycobacteria following collaboration with the LIP.[1,4] (IV)

I. Do not use a guidewire exchange to replace a nontunneled catheter suspected of infection.[2] (V)

J. Consider a catheter exchange procedure when other vascular access sites are limited and/or bleeding disorders are present. Consider an antimicrobial-impregnated catheter with an anti-infective intraluminal surface for catheter exchange.[1] (IV)

K. Collect a specimen of purulent exudates from a peripheral or CVAD exit site for culture and gram staining to determine the presence of gram-negative or gram-positive bacteria as ordered by an LIP.[1] (IV)

L. Do not routinely culture the CVAD tip upon removal unless the patient has a suspected CR-BSI. Catheter colonization may be detected but does not indicate the presence of a bloodstream infection. This practice results in inappropriate use of anti-infective medications, thus increasing the risk of emergence of antimicrobial resistance. Recognize that the catheter tip culture will identify microorganisms on the external catheter and not microorganisms located on the intraluminal surface.[1] (IV)

M. Culture the tip of short-term central vascular and arterial catheters suspected of being the cause of a CR-BSI using a semiquantitative (roll-plate) method or quantitative (sonication) method upon removal. Culture the introducer/sheath tip from a pulmonary artery catheter when a CR-BSI is suspected.[1] (IV)

N Culture the reservoir contents of a port body of an implanted port and the catheter tip when it is removed for suspected CR-BSI.[1] (IV)

O. Consider contamination of the infusate (such as parenteral solution, intravenous 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 in the patient care setting (extrinsic contamination). An infusate-related bloodstream infection is the isolation of the same organism from the infusate and from separate percutaneous blood cultures, with no other identifiable source of infection.[2,7-9] (IV) (see Standard 43, *Phlebotomy*).

P. For a suspected CR-BSI, obtain paired blood samples for culture, drawn from the catheter and a peripheral vein, before the initiation of antimicrobial therapy. Blood cultures from both the catheter and venipuncture must be positive for the same organism with clinical signs and symptoms and no other recognized source. Consider quantitative blood cultures or the differential period of central line culture versus peripheral blood culture positivity >2 hours for the diagnosis of CR-BSI (see Standard 43, *Phlebotomy*).[1,6,10,11] (IV)

REFERENCES

Note: All electronic references in this section were accessed October 5, 2015.

1. 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):1-45. Erratum in: *Clin Infect Dis*. 2010;50(3):457; *Clin Infect Dis*. 2010;50(7):1079.
2. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
3. 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.
4. Chopra V, Flanders SA, Saint S, et al. The Michigan appropriateness guide for intravenous catheters (MAGIC): results from an international panel using the RAND/UCLA appropriateness method. *Ann Intern Med*. 2015;163(suppl 6):S1-S39.
5. Caroff D, Norris A, Keller S, et al. Catheter salvage in home infusion patients with central line-associated bloodstream infection. *Am J Infect Control*. 2014;42(12):1331-1333.

6. Chopra V, Anand S, Krein SL, Chenoweth C, Saint S. Bloodstream infection, venous thrombosis, and peripherally inserted central catheters: reappraising the evidence. *Am J Med*. 2012;125(8): 733-741.
7. Kumar A, Kethireddy S, Darovic GO. Catheter-related and infusion-related sepsis. *Crit Care Clin*. 2013;29(4):989-1015.
8. 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. http://anestesinorr.se/filer/november/Strategies%20for%20the%20prevention%20of%20central%20venous%20catheter.pdf.
9. The Joint Commission. Preventing central line-associated bloodstream infections: a global challenge, a global perspective. http://www.jointcommission.org/preventing_clabsi. Published May 2012.
10. Septimus E. Clinician guide for collecting cultures. http://www.cdc.gov/getsmart/healthcare/implementation/clinicianguide.html. Published April 7, 2015.
11. Garcia RA, Spitzer DE, 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.

50. AIR EMBOLISM

Standard

50.1 All add-on devices, needleless connectors, and administration sets are of a luer-lock design to ensure a secure junction.
50.2 Air is always purged from syringes, administration sets, needleless connectors, and any other add-on devices.
50.3 Patients and/or caregivers managing infusion therapy in non–acute care settings are instructed in how to prevent an air embolism and implement critical actions if an air embolism is suspected.

Practice Criteria

A. Instruct the patient and/or caregivers not to disconnect or reconnect any intravenous (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.[1-5] (IV)
B. Never use scissors or razors near the catheter.[1,6,7] (IV)
C. For all vascular access devices (VADs), use the following techniques to prevent air embolism:
   1. Priming and air purging of all administration sets.
   2. Patient positioning and catheter-occluding procedures during removal.
   3. Using luer-locking connections, equipment with safety features designed to detect or prevent air embolism such as administration sets with air-eliminating filters and electronic infusion devices with air sensors.
   4. Not leaving unprimed administration sets attached to solution containers.
   5. Ensuring the VAD is clamped before changing administration sets or needleless connectors.[1,2,8,10] (IV)
D. Implement special precautions to prevent air embolism during placement and removal of central vascular access devices (CVADs), including but not limited to the following points[1,8-11]: (IV)
   1. Place patient in a supine position during CVAD removal, or Trendelenburg position if tolerated, so the CVAD insertion site is at or below the level of the heart.[8] (IV)
   2. Instruct the patient to perform a Valsalva's maneuver at the appropriate point during catheter withdrawal. The Valsalva's 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.[12-15] (I A/P)
      a. When the Valsalva's maneuver is contraindicated, use a Trendelenburg or left lateral decubitus position, or have the patient hold her or his breath as applicable.[8,16] (IV)
   3. After removal of a CVAD, apply digital pressure until hemostasis is achieved by using manual compression with a sterile dry gauze pad.[1,8] (IV)
   4. Apply a sterile petroleum-based ointment with a sterile dressing to the access site for at least 24 hours to seal the skin-to-vein tract, and decrease the risk of air embolus.[1,8] (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 peripherally inserted central catheter (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.[2] (V)
E. Suspect air embolism with the sudden onset of dyspnea, 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.[8,11,16,17] (IV)
   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.[8,17] (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.[1,8,16] (IV)
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 licensed independent practitioner (LIP).
   c. Provide 100% oxygen if available and further support actions as needed.[1,2,8] (V)

REFERENCES

Note: All references in this section were accessed September 3, 2015.

1. Broadhurst D. Death by air: how much is too much? *Vasc Access*. 2013;7(1):16-26.
2. Feil M. Reducing risk of air embolism associated with central venous access devices. *Penn Patient Saf Advis*. 2012;9(2):58-64. http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2012/Jun;9(2)/Pages/58.aspx.
3. Makino Y, Shimofusa R, Iwase H, et al. Massive gas embolism revealed by two consecutive postmortem computed-tomography examinations. *Forensic Sci Int*. 2013;231(1-3):e4-e10.
4. Nussinovitch U, Ronen B, Farber E, Yanir Y. Devastating air embolism. *Transfusion*. 2012;52(12):2516.
5. Gorski L, Miller C, Mortlock N. Infusion therapy across the continuum. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:109-126.
6. Menon R, Allford M. To shave or not to shave: air embolism following central venous catheter laceration. *Anaesth Intensive Care*. 2010;38(2):395.
7. Pearson F, Browell C, Duggan J. Air embolism caused by a laceration to central venous catheter during shaving. *Anaesthesia*. 2011;66(3):229.
8. Cook LS. Infusion-related air embolism. *J Infus Nurs*. 2013;36(1):26-36.
9. Davies I, Griffin J. A novel risk of air embolism with intravenous paracetamol. *BMJ Case Rep*. March 2012. doi:10.1136/bcr.01.2012.548.
10. Swayze SC, James A. The unfamiliar catheter. *AHRQ Web MM*. https://psnet.ahrq.gov/webmm/case/294/the-unfamiliar-catheter.
11. Campbell J. Recognising air embolism as a complication of vascular access. *Br J Nurs*. 2014;23(suppl 14):S4-S8.
12. Dada T, Gupta V, Deepak KK, Pandey RM. Narrowing of the anterior chamber angle during Valsalva maneuver: a possible mechanism for angle closure. *Eur J Ophthalmol*. 2006;16(1):81-91.
13. Duszak RS, Pakalnis VA, Talavera F, Charles S, Brown LL, Roy H. Valsalva retinopathy. *Medscape*. http://emedicine.medscape.com/article/1228106-overview. Published October 13, 2014.
14. Hackett DA, Chow CM. The Valsalva maneuver: its effect on intra-abdominal pressure and safety issues during resistance exercise. *J Strength Cond Res*. 2013;27(8):2338-2345.
15. Zhang XY, Cao TS, Yuan LJ. The mechanics of left ventricular filling during the strain phase of the Valsalva maneuver in healthy subjects. *Am J Med Sci*. 2013;346(3):187-189.
16. Hsu M, Trerotola SO. 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 Intervent Radiol*. 2015;26(3):366-371.
17. Ziewacz JE, Arriaga AF, Bader AM, et al. Crisis checklists for the operating room: development and pilot testing. *J Am Coll Surg*. 2011;213(2):212-217.e10.

51. CATHETER DAMAGE (EMBOLISM, REPAIR, EXCHANGE)

Standard

51.1 Assessment of the patient's risk-to-benefit ratio is performed prior to repair or exchange of the vascular access catheter.
51.2 Catheter repair is initiated upon the order of a licensed independent practitioner (LIP).
51.3 Central vascular access device (CVAD) exchange is initiated upon the order of an LIP.
51.4 The clinician implements maximal sterile barrier (MSB) precautions for the CVAD exchange procedure.
51.5 After completion of the exchange procedure, appropriate CVAD tip location is determined and documented prior to resumption of the prescribed therapy.

Practice Criteria

I. General

A. Assess vascular access device (VAD) function using a 10-mL syringe:
   1. Do not forcefully push against resistance, preventing catheter damage or rupture.
   2. If VAD has blood return, no resistance to flushing, and no other signs/symptoms of complications, use syringes appropriately sized for the medication being injected (refer to Standard 40, *Flushing and Locking*).
B. Recognize that catheter dysfunction, such as the inability to aspirate blood with localized pain and/or subcutaneous swelling, may be an indication of catheter embolism; additionally, leaking at the site can indicate catheter rupture. In the presence of these signs and symptoms, evaluate catheter integrity before using the VAD for infusions or blood sampling.[1-4] (IV)
C. Catheter damage increases the risk for catheter fracture and embolization, air emboli, bleeding, catheter-lumen occlusion, and bloodstream infection. Intervention in a timely manner is recommended to

reduce the risk of these complications. Options to consider for managing a damaged or ruptured catheter include use of a repair procedure, an exchange procedure, or insertion of a new catheter at a different site. Factors to consider in making this decision include, but are not limited to, the patient's age, immune status, length of time remaining on infusion therapy, characteristics of infusion therapy (eg, osmolarity), external catheter length, and resulting changes in proper tip location with repair.[5-12] (V)

D. Recognize the early signs and symptoms of pinch-off syndrome in subclavian vein insertion sites, including difficulty aspirating, resistance to flushing, patient report of pain, possible swelling at the insertion site, and a change in the clinical picture with arm or shoulder movement.[2-4,8] (IV)

II. Catheter Embolism

A. Prevent catheter embolism through the following actions:
   1. Do not withdraw the catheter or wire from the needle during insertion.
   2. Do not use power injection with VADs that are not labeled for this purpose.[4,8,13] (IV)

B. The most frequent mechanisms of catheter fragmentation are catheter pinch-off syndrome, catheter damage during catheter exchange, separation of the catheter from an implanted port, and fracture of a portion of an implanted port catheter.
   1. Suspect catheter embolism when the 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.[2-4,6,8,14-17] (IV)
   2. Catheter separation may occur at the lumen-hub junction or other external connections, with resultant bleeding or exsanguination. Gently tug on all connections after insertion to verify a secure hold; all connections must be visible during hemodialysis.[18,19] (V)
   3. For totally implanted CVADs via the subclavian vein with increased risk for catheter embolism due to pinch-off syndrome, consider regular chest radiograph assessments for this syndrome and for catheter embolism.[3,4,8,14,17] (IV)

C. Examine VAD 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.[3,4,8,15] (IV)

D. The clinician should carefully assess the patient for signs or symptoms of catheter embolism and for catheter damage when VAD removal is difficult.[4,15] (V)

III. Catheter Repair

A. Clamp or seal 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 patient 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.[8,20] (V)

B. Use a repair kit designed for the device being repaired and according to the manufacturer's directions for use. If no device-specific repair kit is available, consider other alternatives, such as catheter exchange or insertion of a new catheter.[9,10,21,22] (V)

C. Perform regular assessments after repair to confirm the integrity of the repair, and identify any continuing problems, as the repaired catheter may not have the same strength as the original catheter. Remove the VAD if the repair was unsuccessful or the device is unable to be repaired.[8,9,21] (V)

IV. Catheter Exchange

A. Prior to performing a CVAD exchange, the clinician assesses the risk-benefit of the procedure for all patients, with particular attention to high-risk populations such as:
   1. Patients with burns or transplants.[23,24] (IV)
   2. Neonates and infants.[25-27] (IV)
   3. Patients with an infection or suspected infection.[28-30] (IV)

B. A catheter exchange with or without a guidewire may be considered if there is a need for a different type of catheter, a catheter is malpositioned or malfunctioning and venous access is limited, or other sites are unavailable.
   1. Nontunneled catheters may be exchanged if there is no evidence of infection.[31] (I)
   2. Tunneled cuffed catheters may be exchanged while avoiding infected tunnel or local site infection.[25,27,32] (IV)
   3. If there is limited vascular access or unavailable sites in the presence of an actual or suspected infected catheter or catheter-related bloodstream infection (CR-BSI), consider an antimicrobial impregnated, coated, or bonded catheter for catheter exchange.[23,28,33] (IV)

C. During a CVAD exchange procedure:
   1. Use maximal sterile barrier (MSB) precautions.
   2. Use techniques to reduce the risk of air embolism.
   3. Obtain a radiograph or use other approved technologies to confirm correct CVAD tip location prior to initiating or resuming prescribed therapies.[31,34] (I)

D. Routine exchanges are not necessary for CVADs that are functioning and without evidence of local or systemic complications.[31,34] (I)

REFERENCES

Note: All electronic references in this section were accessed September 3, 2015.

1. Harrison E, Lal S. Central venous catheter embolisation. *BMJ Case Rep*. November 21, 2012. doi:10.1136/bcr-2012-007249.
2. Kim JT, Oh TY, Chang WH, Jeong YK. Clinical review and analysis of complications of totally implantable venous access devices for chemotherapy. *Med Oncol*. 2012;29(2):1361-1364.
3. Surov A, Buerke M, Endres J, Kosling S, Spielman R-P, Behrmann C. Intravenous port catheter embolization: mechanisms, clinical features, and management. *Angiology*. 2008;59(1):90-97.
4. Surov A, Wienke A, Carter JM, et al. Intravascular embolization of venous catheter: causes, clinical signs, and management: a systematic review. *J Parenter Enteral Nutr*. 2009;23(6):677-685.
5. Cohen AB, Dagli M, Stavropoulos SW Jr, et al. Silicone and polyurethane tunneled infusion catheters: a comparison of durability and breakage rates. *J Vasc Intervent Radiol*. 2011;22(5):638-641.
6. Earhart A. Recognizing, preventing, and troubleshooting central-line complications. *Am Nurse Today*. 2013;8(11):18-22.
7. Faraj W, Zaghal A, El-Beyrouthy O, Kutoubi A. Complete catheter disconnection and migration of an implantable venous access device: the disconnected cap sign. *Ann Vasc Surg*. 2010;24(5):692.e11-5.
8. Gorski L, Perucca R, Hunter M. Central venous access devices: care, maintenance, and potential complications. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:495-515.
9. Letachowicz K, Letachowicz W, Klinger M, et al. Repair of damaged connectors of tunneled cuffed catheters with a two-piece adaptor for peritoneal dialysis. *J Assoc Vasc Access*. 2012;13(2):203-207.
10. Lundgren I, Zhou C, Malone F, McAfee N, Gantt S, Zerr D. Central venous catheter repair is associated with an increased risk of bacteremia and central line-associated bloodstream infection in pediatric patients. *Pediatr Infect Dis J*. 2012;31(4):337-340.
11. 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.
12. Schulmeister L. Management of non-infectious central venous access device complications. *Semin Oncol Nurs*. 2010;26(2):132-141.
13. Weinstein SM, Hagle ME. Complications and nursing interventions. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:203-244.
14. Ababou A, Ztot S, Ismaili M, Elhassani A. Spontaneous rupture of subclavian intraport catheter with cardiac and pulmonary embolism. *J Cardiothorac Vasc Anesth*. 2013;27(2):e10-e11.
15. Hudman L, Bodenham A. Practical aspects of long-term venous access. *Contin Educ Anaesth Crit Care Pain*. 2013;13(1):6-11.
16. Lin CH, Wu HS, Chan DC, Hsieh CB, Huang MH, Yu JC. The mechanisms of failure of totally implantable central venous access system: analysis of 73 cases with fracture of catheter. *Eur J Surg Oncol*. 2010;36(1):100-103.
17. Mirza B, Vanek VW, Kupensky DT. Pinch-off syndrome: case report and collective review of the literature. *Am Surg*. 2004;70(7):635-644.
18. Patterson C, Wake A. Central venous catheter failure. *Anaesthesia*. 2013;68(6):645.
19. Saibu R, Mitchell P, Salifu M, et al. Dialysis line separation: maximizing patient safety through education and visibility of access site for patients on hemodialysis. *Nephrol Nurs J*. 2011;38(6):515-526.
20. Hagle ME, Cook AM. Central venous access. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:335-390.
21. Hwang FR, Stavropoulos SW, Shlansky-Goldberg RD, et al. Tunneled infusion catheter breakage: frequency and repair kit outcomes: part 1. *J Vasc Interv Radiol*. 2008;19(2):201-206.
22. Stanelle E, Idowu O, Kim S. A durable repair of a broken silastic catheter using a topical skin adhesive. *J Pediatr Surg*. 2011;46(4):784-785.
23. Kagan R, Neely A, Yakuboff K, et al. A performance improvement initiative to determine the impact of increasing the time interval between changing centrally placed intravascular catheters. *J Burn Care Res*. 2014;35(2):143-147.
24. O'Mara MS, Reed NL, Palmieri TL, Greenhalgh DG. Central venous catheter infections in burn patients with scheduled catheter exchange and replacement. *J Surg Res*. 2007;142(2):341-350.
25. Masumoto K, Esumi G, Teshiba R, Nagata K, Taguchi T. Usefulness of exchanging a tunneled central venous catheter using a subcutaneous fibrous sheath. *Nutrition*. 2011;27(5):526-529.
26. 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.
27. Sharpe E, Pettit J, Ellsbury D. A national survey of neonatal peripherally inserted central catheter (PICC) practices. *Adv Neonatal Care*. 2013;13(1):55-74.
28. Chaftari A, El Zakhem A, Jamal M, Ying J, 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. doi:10.1186/1471-2334-14-518.
29. Guttmann D, Trerotola S, Stavropoulos S, et al. Malfunctioning and infected tunneled infusion catheters: over-the-wire catheter exchange versus catheter removal and replacement. *J Vasc Intervent Radiol*. 2011;22(5):642-646.
30. Raad I, Kassar R, Ghannam D, Chaftari A, Hachem R, Jiang Y. Management of the catheter in documented catheter-related coagulase-negative staphylococcal bacteremia: remove or retain? *Clin Infect Dis*. 2009;49(8):1187-1194.
31. O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html. Published April 2011.
32. Shanaah A, Brier M, Dwyer A. Fibrin sheath and its relation to subsequent events after tunneled dialysis catheter exchange. *Semin Dial*. 2013;26(6):733-737.
33. 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):1-45.

34. 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. http://www.jstor.org/stable/10.1086/676533.

52. CENTRAL VASCULAR ACCESS DEVICE (CVAD)-ASSOCIATED VENOUS THROMBOSIS

Standard

52.1 The clinician assesses the patient for suspected central vascular access device (CVAD)-associated venous thrombosis; provides timely and appropriate information to the licensed independent practitioner (LIP); and assesses patient response to treatment.

Practice Criteria

A. Assess the patient for risk factors for venous thrombosis before CVAD insertion. Risk factors include, but are not limited to:
   1. History of deep vein thrombosis.
   2. Presence of chronic diseases associated with a hypercoagulable state such as cancer, diabetes, irritable bowel syndrome, congenital heart disease, or end-stage renal failure.
   3. Surgical and trauma patients.
   4. Critical care patients; hyperglycemia in nondiabetic children in critical care may be a predictor of venous thromboembolism.
   5. Known presence of genetic coagulation abnormalities (eg, Factor V Leiden, prothrombin mutation).
   6. Pregnancy or the use of oral contraceptives.
   7. Age extremes in young children and older adults.
   8. History of multiple CVADs, especially with difficult or traumatic insertion and the presence of other intravascular devices (eg, pacemakers).[1-5] (II)

B. Choose the type of CVAD with the least risk of thrombosis.
   1. Peripherally inserted central catheters (PICCs) are associated with higher rates of deep vein thrombosis (DVT) than other CVADs due to insertion into veins with smaller diameter and greater movement in the upper extremity. Critical care patients and those with cancer are at a greater risk of DVT with PICCs when compared to other CVADs. PICC insertion sites in the antecubital fossa have higher rates of DVT than mid-upper arm insertion sites. PICC insertion through the internal jugular vein rather than veins of the upper extremity is associated with lower rates of DVT than arm veins.[6,7] (I)
   2. Thrombosis rates for subclavian and internal jugular CVAD are comparable for long-term use in patients with cancer.[8] (II)
   3. For short-term use, subclavian sites have lower DVT rates than femoral sites, but there is no significant difference between jugular and femoral sites.[8] (II)

C. For PICCs, measure the vein diameter using ultrasound before insertion. Choose a catheter with a catheter-to-vein ratio of 45% or less.
   1. A study of 6Fr triple-lumen PICCs was stopped before completion due to an unacceptably high rate of DVT.
   2. 5Fr and 6Fr PICCs develop DVT more rapidly in patients with cancer when compared to smaller-diameter PICCs (eg, 4Fr).
   3. Reverse taper on the hub end of the catheter, resulting in the largest outer diameter being inserted into the smallest vein diameter, is thought to be a contributing factor. However, 1 comparison study between tapered and nontapered PICCs could not find a difference between the catheter design, although the rate for both catheters was high. Trimming a PICC to a patient-specific length can result in the largest diameter of a reverse-tapered PICC inserted into the vein and has been suggested as a factor in DVT.[1,7,9-13] (I)

D. Ensure that all CVAD tips are located in the lower third of the superior vena cava or cavoatrial junction as tips located in the mid-to-upper portion of the superior vena cava are associated with greater rates of DVT. Adjustment of PICCs to achieve correct tip location is not reported to be associated with an increased rate of DVT (see Standard 23, *Central Vascular Access Device [CVAD] Tip Location*).[6,14-16] (II)

E. Recognize that the majority of CVAD-associated DVT is clinically silent and does not produce overt signs and symptoms. Clinical signs and symptoms are related to obstruction of venous blood flow and include, but are not limited to:
   1. Pain in the extremity, shoulder, neck, or chest.
   2. Edema in the extremity, shoulder, neck, or chest.
   3. Erythema in the extremity.
   4. Engorged peripheral veins on the extremity, shoulder, neck or chest wall.
   5. Difficulty with neck or extremity motion.[8,14] (II)

F. Measure upper-arm circumference before insertion of a PICC and when clinically indicated to assess the presence of edema and possible DVT. Take this measurement 10 cm above the antecubital fossa; assess for the location and other characteristics such as pitting or nonpitting edema (refer to Standard 33, *Vascular Access Site Preparation and Device Placement*).

G. Anticipate diagnosis of CVAD-associated DVT with color-flow Doppler ultrasound in veins of the upper

extremity because it is noninvasive and avoids exposure to radiation. Venography with contrast injection, computed tomography venography, or magnetic resonance venography may also be used to assess veins that are obscured by the clavicle or ribs.[1,17] (II)

H. Anticipate prescription of therapeutic doses of anticoagulant medication in the presence of upper extremity DVT 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.[18] (II)

I. CVAD flushing and locking procedures have no effect on catheter-associated venous thrombosis, as the technique and solutions used are directed to the internal CVAD lumen rather than the vein lumen.[19] (V)

J. Do not remove a CVAD in the presence of DVT when the catheter is correctly positioned at the cavoatrial junction, the catheter is functioning correctly with a blood return, and there is no evidence of any infection (refer to Standard 44, *Vascular Access Device [VAD] Removal*).

K. Encourage the patient to use nonpharmacologic strategies for thrombosis prevention whenever possible, including early mobilization of the catheterized extremity, performance of normal activities of daily living, gentle limb exercise, and adequate hydration.[14] (II)

L. Prophylaxis with anticoagulant therapy is not recommended, although a meta-analysis in cancer patients with tunneled cuffed catheters and implanted ports found that symptomatic DVT is reduced with heparin and asymptomatic DVT is reduced with warfarin. Another retrospective analysis in cancer patients suggests that antiplatelet agents may protect against DVT in patients with PICCs; however, additional study is needed.[20-22] (I)

M. Recognize that catheter-related bloodstream infection and symptomatic catheter-associated DVT may develop simultaneously and is probably caused by the fibrin sheath supporting the development of thrombosis and allowing for adherence of organisms. This may be a greater problem in critically ill patients as opposed to home care patients as no correlation between infection, lumen occlusion, and thrombosis was reported in a study of cancer patients receiving home parenteral nutrition. A more recent study showed an increased risk of catheter-associated bloodstream infection in CVADs that had been treated with alteplase for malfunctioning.[23-26] (IV)

N. Recognize that pulmonary emboli and postthrombotic syndrome are associated with upper extremity DVT.[1] (IV)

REFERENCES

Note: All electronic references in this section were accessed September 3, 2015.

1. Grant JD, Stevens SM, Woller SC, et al. Diagnosis and management of upper extremity deep-vein thrombosis in adults. *J Thromb Haemost*. 2012;108(6):1097-1108.
2. Costello JM, Clapper TC, Wypij D. Minimizing complications associated with percutaneous central venous catheter placement in children: recent advances. *Pediatr Crit Care Med*. 2013;14(3):273-283.
3. Gentile A, Petit L, Masson F, et al. Subclavian central venous catheter-related thrombosis in trauma patients: incidence, risk factors and influence of polyurethane type. *Crit Care*. 2013;17(3):R103.
4. 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.
5. Mino JS, Gutnick JR, Monteiro R, Anzlovar N, Siperstein AE. Line-associated thrombosis as the major cause of hospital-acquired deep vein thromboses: an analysis from National Surgical Quality Improvement Program data and a call to reassess prophylaxis strategies. *Am J Surg*. 2014;208(1):45-49.
6. Saber W, Moua T, Williams EC, et al. Risk factors for catheter-related thrombosis (CRT) in cancer patients: a patient-level data (IPD) meta-analysis of clinical trials and prospective studies. *J Thromb Haemost*. 2011;9(2):312-319.
7. 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.
8. 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;(3):CD004084. doi:10.1002/14651858.CD004084.pub3.
9. Trerotola SO, Stavropoulos SW, Mondschein JI, et al. Triple-lumen peripherally inserted central catheter in patients in the critical care unit: prospective evaluation. *Radiology*. 2010;256(1):312-320.
10. Itkin M, Mondshein JI, Stavropoulos SW, Shlansky-Goldberg RD, Soulen MC, Trerotola SO. Peripherally inserted central catheter thrombosis—reverse tapered versus nontapered catheters: a randomized controlled study. *J Vasc Interv Radiol*. 2014;25(1):85-91.e1.
11. 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.
12. Steele D, Norris CM. Cutting peripherally inserted central catheters may lead to increased rates of catheter-related deep vein thrombosis. *J Infus Nurs*. 2014;37(6):466-472.
13. 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.
14. Yacopetti N. Central venous catheter-related thrombosis: a systematic review. *J Infus Nurs*. 2008;31(4):241-248.
15. Jumani K, Advani S, Reich NG, Gosey L, Milstone AM. Risk factors for peripherally inserted central venous catheter complications in children. *JAMA Pediatr*. 2013;167(5):429-435.
16. Baxi SM, Shuman EK, Scipione CA, et al. Impact of postplacement adjustment of peripherally inserted central catheters on the risk of bloodstream infection and venous thrombus formation. *Infect Control Hosp Epidemiol*. 2013;34(8):785-792.

17. Bates SM, Jaeschke R, Stevens SM, et al. Diagnosis of DVT: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141(suppl 2):e351S-e418S.
18. Kearon C, Akl EA, Comerota AJ, et al. Antithrombotic therapy for VTE disease: antithrombotic therapy and prevention of thrombosis—American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141(suppl 2):e419S-e494S.
19. Gorski L, Perucca R, Hunter M. Central venous access devices: care, maintenance, and potential complications. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:495-515.
20. Kahn SR, Lim W, Dunn AS, et al. Prevention of VTE in nonsurgical patients: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141(suppl 2): e195S-e226S.
21. Ahn DH, Illum HB, Wang DH, Sharma A, Dowell JE. Upper extremity venous thrombosis in patients with cancer with peripherally inserted central venous catheters: a retrospective analysis of risk factors. *J Oncol Pract*. 2013;9(1):e8-e12.
22. Akl EA, Ramly EP, Kahale LA, et al. Anticoagulation for people with cancer and central venous catheters. *Cochrane Database Syst Rev*. 2014;(10):CD006468. doi:10.1002/14651858.CD006468.pub5.
23. Nakazawa N. Infectious and thrombotic complications of central venous catheters. *Semin Oncol Nurs*. 2010;26(2):121-131.
24. Chittick P, Sherertz RJ. Recognition and prevention of nosocomial vascular device and related bloodstream infections in the intensive care unit. *Crit Care Med*. 2010;38(suppl 8):S363-S372.
25. Chopra V, Anand S, Krein SL, Chenoweth C, Saint S. Bloodstream infection, venous thrombosis, and peripherally inserted central catheters: reappraising the evidence. *Am J Med*. 2012;125(8): 733-741.
26. 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.

53. CENTRAL VASCULAR ACCESS DEVICE (CVAD) MALPOSITION

Standard

53.1 The clinician verifies the documented anatomic location of the central vascular access device (CVAD) tip upon insertion prior to initial infusion through the catheter.

Practice Criteria

A. Recognize normal vascular, intrathoracic, intraperitoneal, and neck anatomy and its relationship to acceptable CVAD tip location. CVAD tips move due to patient position, respiration, and arm movement. Descent of diaphragm and abdominal contents with position change from lying to standing, obesity, and breast tissue are associated with a change in CVAD tip position.[1,2] (I A/P)

B. Recognize that primary CVAD malposition may occur during the insertion procedure, resulting in intravascular or extravascular tip location.
   1. Intravascular malposition includes the aorta; contralateral innominate and subclavian veins; ipsilateral or contralateral internal jugular veins and tributaries; azygos vein; right or left internal thoracic vein; pericardiophrenic vein; internal mammary vein; deep in the right atrium (more than 2 cm below cavoatrial junction); the right ventricle; and a number of small tributary veins of the innominate and superior vena cava (SVC). Femoral insertion sites may produce malposition of the catheter tip in the lumbar, iliolumbar, and common iliac veins. Malpositions are reported with and without difficult guidewire and/or catheter advancement. Critical care patients may have a tendency for a higher rate of malposition on peripherally inserted central catheter (PICC) insertion because of difficulty in patient positioning, use of mechanical ventilation, and different venous blood flow characteristics. Primary malposition with PICCs is reported to be approximately 3 times more common than with other CVADs.[1,3-9] (I A/P)
   2. Extravascular malposition includes tip location in the mediastinum producing infiltration/extravasation; in the pleura producing hemothorax or pleural effusion; in the pericardium producing pericardial effusion and cardiac tamponade; and in the peritoneum producing intra-abdominal bleeding.[2,4,10-12] (I A/P)

C. Recognize that acquired and congenital anatomical variations cause CVAD malposition during insertion.
   1. Acquired abnormalities include stenosis, thrombosis, and malignant or benign lesions compressing the vein.
   2. Congenital abnormalities include persistent left superior vena cava (PLSVC) and variations of the inferior vena cava, azygous vein, and pulmonary veins. PLSVC is the most common form of congenital anomaly and will probably be undiagnosed until placement of a CVAD is required. PLSVC may be present with or without other congenital cardiac anomalies. Before using a CVAD in a PLSVC, cardiac imaging studies are needed to determine blood flow characteristics. Blood flow into the left atrium and the presence of right-to-left cardiac shunting pose a significant risk for air or thrombotic emboli to a variety of anatomic locations (eg, brain, kidney) and may require repositioning the CVAD.[2,13,14] (I A/P)

D. Use dynamic 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. Use tip location technology to enhance awareness of primary CVAD malposition during the insertion procedure (refer to Standard 23, *Central Vascular Access Device [CVAD] Tip Location*).

F. If arterial placement of a CVAD is suspected, assess waveforms using a pressure transducer, blood gas values for a sample taken from the CVAD, or computed tomography (CT) angiogram with contrast. Pulsatile flow and color of the blood are not always reliable indicators for arterial location.[2,6,15] (I A/P)

G. Recognize that secondary CVAD malposition may occur at any time during the catheter dwell time.
   1. Secondary intravascular malposition is also known as tip migration and is related to sporadic changes in intrathoracic pressure (eg, coughing, vomiting); original tip located high in the SVC; deep vein thrombosis; congestive heart failure; neck or arm movement; and positive pressure ventilation. The most common locations for secondary CVAD malposition include internal jugular; innominate (brachiocephalic); subclavian, axillary, and azygos veins; and deep in the right atrium. Risk factors for implanted port tip migration are reported to be an original tip positioned high in the SVC and presence of lung cancer.[1,16-18] (I A/P)
   2. Secondary extravascular CVAD malposition is associated with erosion of the catheter tip through the vessel wall, usually into a low-pressure space with the risk of bleeding into that space. Fistula formation between veins and arteries or veins and other structures (eg, trachea) is possible. Cardiac tamponade from a CVAD is associated with fluid infusion and may be diagnosed with echocardiogram.[2,17,19,20] (I A/P)

H. Recognize that the growth of infants and children results in suboptimal intravascular tip location when a CVAD is indwelling for extended periods of time. Correlate growth to tip location, and plan for CVAD changes as needed.[21] (V)

I. Before and after using a power-injectable PICC for CT contrast agent injection, a scout scan, or topogram, is recommended to determine the current PICC tip location. Power injection is reported to cause PICC tip migration. Tip migration may be related to a sudden change in viscosity between the contrast agent in the catheter lumen and the postprocedure flush of sodium chloride. No evidence for other types of CVAD malposition related to power injection is available.[22-24] (IV)

J. 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 a problem:
   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 versus 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.
   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.[2,10,14-17,25] (IV)

K. Anticipate diagnostic tests including chest radiograph with or without contrast injection, fluoroscopy, echocardiogram, CT scan, and/or magnetic resonance imaging (MRI) to diagnose secondary malposition based on clinical signs and symptoms and problems with functionality of the catheter. Provide the radiology department with clinical information to enhance their ability to identify the problem. Routine chest radiograph at specific intervals may not identify tip migration because of the sporadic and unpredictable nature of this type of malposition. Chest radiographs for diagnostic purposes should include catheter tip location.[2,6,7,13,16,18,26] (IV)

L. Manage malposition depending upon the location of the CVAD, the continued need for infusion therapy, and the patient's acuity. Collaboration with the licensed independent practitioner (LIP) may be required.
   1. For PICCs with intracardiac location that is more than 2 cm below the cavoatrial junction, retract catheter based on electrocardiogram (ECG) results, or from measurement of the specific distance on the chest radiograph.
   2. For PICCs with jugular vein location, noninvasive techniques are preferred. Reported effective methods include elevating the patient's head, flushing the catheter, walking, or a combination of these techniques. Invasive techniques include partial PICC retraction with guidewire techniques, catheter flushing while advancing, and retraction and advancement under fluoroscopy.
   3. 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. Consult with the LIP

before removal from arteries to determine if surgical removal or use of a percutaneous closure device is most appropriate.
4. Fluid aspiration through the CVAD before removal may be indicated if cardiac tamponade is suspected. Consult with the LIP.
5. Removal from other extravascular tip locations may cause hematoma or pleural or peritoneal effusions.
6. Removal when an infiltration or extravasation has occurred will require a treatment plan for the specific medication involved.[2,6,26-28] (IV)

M. Withhold infusion through a malpositioned catheter until proper tip position has been established. Assess the infusion therapy being administered and, if possible, insert a short peripheral catheter to continue therapy. If the infusion therapy is not possible through a peripheral vein, the nurse should assess the potential risk for discontinuing therapy and consult with the LIP regarding changing the infusion therapy until the proper CVAD tip location can be reestablished.[14,29] (V)

N. Arm movement, body habitus, patient manipulation (eg, Twiddler's syndrome), and inadequate catheter stabilization cause CVAD dislodgment (movement of the CVAD into or out of the insertion site), resulting in changes of the external catheter length and alteration of CVAD tip location.
1. 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.
2. Measure the external CVAD length and compare to the external CVAD length documented at insertion. Dislodgment could indicate the tip location is suboptimal, increasing the risk for catheter-related thrombosis.
3. Management may require catheter exchange or removal and insertion at a new site.[29,30] (V)

REFERENCES

1. Johnston A, Bishop S, Martin L, See T, Streater C. Defining peripherally inserted central catheter tip position and an evaluation of insertions in one unit. *Anaesthesia*. 2013;68(5):484-491.
2. Gibson F, Bodenham A. Misplaced central venous catheters: applied anatomy and practical management. *Br J Anaesth*. 2013;110(3):333-346.
3. Shinoda K, Taki H, Hounoki H, Tsuda R, Tobe K. Accidental cannulation of a femoral central venous catheter into the iliolumbar vein: incidental detection by bone scintigraphy. *Clin Nucl Med*. 2015;40(2):182-183.
4. Takahara S, Aizaki T, Hatakeyama Y, Matsushima S, Kawamura K. Complication of femoral vein CV port catheter malposition. *Kitasato Med J*. 2013;43(1):74-78.
5. Mai CL, Leissner KB. Acute back pain and paresthesia after femoral venous catheter placement. *J Cardiothorac Vasc Anesth*. 2007;21(2):317-318.
6. Curtis O, Metcalfe M, Thompson M. Managing complications of the misplaced central venous catheter. *EJVES Extra*. 2011;22(1):e6-e8.
7. Ibrahim GM. Central venous catheter placement: where is the tip? *Am J Crit Care*. 2012;21(5):370-371.
8. Pikwer A, Baath L, Davidson B, Perstoft I, Akeson J. The incidence and risk of central venous catheter malpositioning: a prospective cohort study in 1619 patients. *Anaesth Intensive Care*. 2008;36(1):30-37.
9. 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.
10. Turi G, Tordiglione P, Araimo F. Anterior mediastinal central line malposition. *Anesth Analg*. 2013;117(1):123-125.
11. Nazir O, Wani M, Jain A, Misra R. Central venous catheter malposition into intrapleural space. *J Sci Soc*. 2014;41(3):197.
12. Weil BR, Ladd AP, Yoder K. Pericardial effusion and cardiac tamponade associated with central venous catheters in children: an uncommon but serious and treatable condition. *J Pediatr Surg*. 2010;45(8):1687-1692.
13. Povoski SP, Khabiri H. Persistent left superior vena cava: review of the literature, clinical implications, and relevance of alterations in thoracic central venous anatomy as pertaining to the general principles of central venous access device placement and venography in cancer patients. *World J Surg Oncol*. 2011;9(1):173.
14. Chen C-Y, Chu Y-C, Chang W-K, Chan K-H, Chen P-T. Diagnosis and insertion of Hickman catheter for a patient with persistent left superior vena cava. *Acta Anaesthesiol Taiwan*. 2013;51(1):44-48.
15. Chirinos JC, Neyra JA, Patel J, Rodan AR. Hemodialysis catheter insertion: is increased PO2 a sign of arterial cannulation? A case report. *BMC Nephrol*. 2014;15(1):127.
16. Wu C-Y, Fu J-Y, Feng P-H, et al. Risk factors and possible mechanisms of intravenous port catheter migration. *Eur J Vasc Endovasc Surg*. 2012;44(1):82-87.
17. Askegard-Giesmann JR, Caniano DA, Kenney BD. Rare but serious complications of central line insertion. *Semin Pediatr Surg*. 2009;18(2):73-83.
18. Alwassia A, Chaubey VK, Patibandla B, Bartley A, Chhabra L. Wandering peripherally inserted central catheter tip: an underrecognised intensivist challenge. *BMJ Case Rep*. 2013. doi:10.1136/bcr-2013-200313.
19. Choi H, Kang B. An uncommon arteriovenous fistula resulting from haemodialysis catheterization despite applying ultrasound guidance: malposition of catheter into right subclavian artery. *Hong Kong J Emerg Med*. 2011;18(3):166.
20. Andrews MH, Chisholm BD. Spontaneous migration of a portacath into the azygos vein with subsequent development of a tracheoazygos fistula. *J Med Imaging Radiat Oncol*. 2015;59(2):200-203.
21. Redfern W, Braby J. Pediatric infusion therapy. In: Weinstein S, Hagle M, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:687-742.
22. Lozano LAS, 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.

23. 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. *Am J Roentgenol*. 2014;202(1):W13-W18.
24. Lambeth L, Goyal A, Tadros A, Asadoorian M, Roberts AC, Karimi A. Peripherally inserted central catheter tip malposition caused by power contrast medium injection. *J Vasc Intervent Radiol*. 2012;23(7):981-983.
25. 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 Anesth* (English ed). 2014. doi: 10.1016/j-bjane.2014.02.007.
26. Bechara CF, Barshes NR, Pisimisis G, Kougias P, Lin PH. Management of inadvertent carotid artery sheath insertion during central venous catheter placement. *JAMA Surg*. 2013;148(11):1063-1066.
27. Redmond C, O'Donohoe R, Breslin D, Brophy D. Inadvertent subclavian artery cannulation with a central venous catheter; successful retrieval using a minimally invasive technique. *Ir Med J*. 2014;107(9):292-293.
28. 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-S39.
29. Gorski L, Perucca R, Hunter M. Central venous access devices: care, maintenance, and potential complications. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:495-515.
30. McGoldrick M. Infection prevention and control. In: Alexander M, Corrigan A, Goski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:204-228.

Section Eight: Other Infusion Devices

Section Standards

I. To ensure patient safety, 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. Intraspinal, IO, and subcutaneous access and medication/solution infusion are initiated upon the order of a licensed independent practitioner (LIP).
III. Insertion, care and management, and complication management for intraspinal, IO, and subcutaneous access are established in organizational policies, procedures, and/or practice guidelines.

54. INTRASPINAL ACCESS DEVICES

Standard

54.1 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.
54.2 Only preservative-free medications are administered via the intraspinal route.
54.3 Removal of a temporary intraspinal access device (intrathecal and epidural) is performed either by or upon the order of a licensed independent practitioner (LIP) in accordance with rules and regulations promulgated by the state's Board of Nursing and in accordance with organizational policy. Removal of long-term implanted ports/reservoirs/pumps or tunneled intraspinal devices are considered surgical procedures.

Practice Criteria

A. Anticipate intraspinal (epidural/intrathecal) infusion administration for patients in practice settings from acute care to outpatient and home care who require pain management (eg, during/after a surgical procedure, women in labor, chronic malignant and nonmalignant pain) and for spasticity control. Infusions may include opioids alone, opioids in combination with dilute local anesthetics, and opioids in combination with local anesthetics and clonidine. Antineoplastic agents and pain medications may be administered via an intraventricular access device.[1-9] (IV)
B. Provide comprehensive education to clinicians who care for patients receiving intraspinal infusions to include the following content: related anatomy and physiology; pharmacology; patient assessment and monitoring; use and troubleshooting of access devices; side effect management; recognition and management of complications and emergency situations; device removal; patient and caregiver education; and review of organizational policies and procedures (see Standard 5, *Competency Assessment and Validation*).[5] (V)
C. Administer only preservative-free medications via an intraspinal route; these include, but are not limited to, morphine, fentanyl, hydromorphone, ziconotide, clonidine, bupivacaine, baclofen, and 0.9% sodium chloride (USP).[1,4,6] (V)
D. Titrate medications carefully during medication initiation when converting from one route to another (eg, intravenous to epidural to intrathecal), when converting from one medication to another, and when adding adjuvant medications. Dosing and opioid conversion guidelines should be used, and dosing should start extremely low when converting from one medication to another.[1,2] (V)

E. Perform a medication reconciliation with every patient encounter; ask patients to report every medication that they take including prescription, over-the-counter, and complementary/herbal medications, as concomitant medication use may increase the risk of complications of intraspinal therapy (see Standard 13, *Medication Verification*).[8] (V)

F. Maintain strict aseptic technique while wearing a mask and sterile gloves during any intraspinal access or maintenance procedure.[4,6,10,11] (V)

G. Confirm proper placement of the intraspinal access device before any infusion or medication administration.[4,6,11] (V)
   1. Aspirate epidural access devices prior to medication administration to ascertain the absence of spinal fluid and blood; if greater than 0.5 mL serous fluid is aspirated, notify the LIP, and do not administer the medication.
   2. Aspirate intrathecal and ventricular access devices prior to medication administration to ascertain the presence of spinal fluid and the absence of blood.

H. Filter infusion medications using a surfactant-free 0.2-micron filter.[6,11] (V)

I. Administer continuous infusions using an electronic infusion device with anti–free-flow protection. Patient-controlled analgesia may be used with epidural infusions.[4,7,8] (V)

J. Perform the access procedure and medication filling of an implanted intraspinal delivery system with a medication reservoir at regular intervals in accordance with the manufacturer's directions for use.[4,8] (V)
   1. Ensure strict attention to needle placement to avoid accidental injection into surrounding tissue.
   2. Observe patients for at least 30 minutes after a pump refill.
   3. Ensure availability of naloxone to treat inadvertent overdoses.

K. Apply a sterile dressing, and stabilize the intraspinal access site:
   1. Routine dressing changes for short-term epidural and intrathecal access devices are not recommended due to risk for dislodgment.[4] (V)
   2. 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. (V, Committee Consensus)
   3. If site care is performed, allow any skin antiseptic agent to fully dry as all antiseptic agents have the potential to be neurotoxic.[4,6] (V)
   4. Use a transparent semipermeable membrane (TSM) dressing to allow for site visualization.[6] (V)
   5. After the first 24 hours postplacement of a ventricular reservoir, leave the site open to air.[4] (V)
   6. 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.[12,13] (III)
   7. Reduce the risk of accidental dislodgment by taping a tension loop of tubing to the patient's body.[6] (V)
   8. Subcutaneous tunneling and sutures resulted in fewer incidents of premature dislodgment of thoracic epidural catheters when compared to taping.[14] (III)

L. Identify catheter tip dislodgment by routinely assessing for changes in external catheter length; clinical evidence of catheter tip dislodgment may include decrease in pain control (eg, intrathecal placement dislodges to epidural space) or an increase in side effects (eg, epidural placement dislodges to intrathecal space).[4,7] (V)

M. Assess and monitor patients after initiating or restarting an intraspinal infusion in a fully equipped and staffed environment (eg, hospital setting) for at least the first 24 hours. Be especially vigilant when monitoring higher-risk patients, such as those with sleep apnea, psychiatric conditions, or patients taking concomitant medications.[2,8] (V)

N. Maintain peripheral intravenous access for at least 24 hours due to the potential need for naloxone administration for evidence of respiratory depression.[6] (V)

O. Assess the patient's response to therapy at established intervals. Recommendations include assessing at the following time intervals: hourly for the first 24 hours and then every 4 hours; assessment of outpatients and patients receiving home care should occur with every patient encounter.[5,7,8] (V)
   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 effects: pruritis, nausea, urinary retention, orthostatic hypotension, motor block.
   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. Dressing for intactness and absence of moisture/leakage.
9. Catheter and administration set connections.
10. 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.
11. Oxygen saturation levels via pulse oximeter and carbon dioxide levels as prescribed.
12. Electronic infusion device for history of analgesic use and correct administration parameters.

P. Address the following patient education topics[1,4,8]: (V)
1. The importance of reporting alcohol use and all medications used including prescription, over-the-counter, and complementary medications.
2. Signs and symptoms to report, including changes in pain perception, new or worsening side effects, and fever.
3. Clinical signs of overdose including dizziness, sedation, euphoria, anxiety, seizures, and respiratory depression.
4. Patients with implanted infusion pump systems: caution with active repetitive bending or twisting of spine as these may increase the risk for catheter damage or dislodgment; increased pain and withdrawal symptoms may be indicative of problems.

REFERENCES

Note: All electronic references in this section were accessed September 8, 2015.

1. American Pain Society (APS). *Principles of Analgesic Use in the Treatment of Acute Pain and Cancer Pain*. 6th ed. Glenview, IL: APS; 2008:47-51.
2. Deer T, Prager J, Levy R, et al. Polyanalgesic consensus conference 2012: recommendations for the management of pain by intrathecal (intraspinal) drug delivery—reports of an interdisciplinary expert panel. *Neuromodulation*. 2012;15(5):467-482.
3. Raffaeli W, Magnani F, Andruccioli J, Sarti D. Intrathecal drug administration for the treatment of cancer and non-cancer chronic pain. In: Carrillo-Ruiz J, ed. *Topics in Neuromodulation Treatment*. doi:10.5772/1255.
4. Stearns CK, Brant JM. Intraspinal access and medication administration. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:525-539.
5. Pasero C, Eksterowicz N, Primeau M, Cowley C. Registered nurse management and monitoring of analgesia by catheter techniques: position statement. *Pain Manage Nurs*. 2007;8(2):48-54.
6. Camp-Sorrell D (ed), Cope DG, Ezzone SA, et al. *Access Device Guidelines: Recommendations for Nursing Practice and Education*. 3rd ed. Pittsburgh, PA: Oncology Nursing Society; 2011:75-80.
7. Gordon D, Schroeder M; Center to Advance Palliative Care. Fast fact #85: epidural analgesia. http://www.capc.org/fast-facts/85-epidural-analgesia. Published 2007.
8. Prager J, Deer T, Levy R, et al. Best practices for intrathecal drug delivery for pain. *Neuromodulation*. 2014;17(4):354-372.
9. Reisfield GM, Wilson GR; Center to Advance Palliative Care. Fast fact #98: intrathecal drug therapy for pain. http://www.capc.org/fast-facts/98-intrathecal-drug-therapy-pain. Published 2007.
10. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Healthcare Infection Control Practices Advisory Committee. Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. http://www.cdc.gov/hicpac/2007ip/2007isolationprecautions.html. Published 2007.
11. Smith S, Duell DJ, Martin B. *Clinical Nursing Skills*. 8th ed. Upper Saddle River, NJ: Prentice Hall; 2011.
12. Ho KM, Litten 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.
13. 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. doi:10.1155/2015/1149785.
14. 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.

55. INTRAOSSEOUS (IO) ACCESS DEVICES

Standard

55.1 The clinician evaluates the patient and anticipates appropriate use of the intraosseous (IO) route in the event of difficult vascular access for emergent, urgent, and medically necessary situations.

Practice Criteria

A. In the event of adult or pediatric cardiac arrest, anticipate use of the IO route if intravenous access is not available or cannot be obtained quickly. Pediatric advanced life support guidelines suggest the use of the IO route as the initial vascular access route.[1-7] (II)

B. The IO route may also be considered 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, or severe dehydration; and/or when delay of care is compromised without rapid vascular access. Use of IO infusion is also reported in anesthesia.[8-18] (IV)

C. Increase and improve appropriate IO use through education and competency programs as underuse of the IO route in emergency departments is reported.[19] (II)
1. Include the following in competency programs: initial and ongoing validation of safe insertion knowledge and skills through demonstration;

demonstration of appropriate maintenance; ability to recognize complications related to IO access (see Standard 5, *Competency Assessment and Validation*).[20,21] (V)

D. Use an appropriate IO device; 3 categories of devices are available, including manual needles, impact driven, and drill powered. Performance (success rates, time of placement, ease of use, user preference) of different IO devices was evaluated with few comparative studies and weak evidence supporting superiority of the battery-powered IO drill over manual needles and other semiautomatic devices.[11,12,22-26] (IV)

E. Select an appropriate IO site based on the clinical situation and device specifics. Refer to manufacturers' directions for use as each IO device has approval for particular sites.
   1. Insertion sites most commonly reported in the literature for use in both adults and children include the proximal and distal tibia and the proximal humerus, the distal femur for children, and the sternum in adults.
   2. Other sites less commonly reported in the literature and that may be off-label for IO access include the radius, ulna, pelvis, and clavicle.[10,11,15,18,23,24,27] (IV)

F. Avoid 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.
   2. Presence of bone diseases such as osteogenesis imperfecta, osteopetrosis, and osteoporosis.[11,12,15,18,23,27,28] (IV)

G. Consider the use of lidocaine as a local anesthetic during insertion (subcutaneously 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.[12,13,15,18,23,26-28] (V)

H. Adhere to aseptic technique during IO access. Perform skin antisepsis using an appropriate solution (eg, >0.5% chlorhexidine in alcohol solution, povidone-iodine, 70% alcohol) based on organizational policies and procedures. There is no evidence addressing the optimal antiseptic solution.[12,18,23,26,27,29] (V)

I. Confirm proper placement of the IO device by assessment of the needle position, sensation of loss of resistance upon bone penetration, absence of any signs of infiltration upon flushing with 5- to 10-mL (adults) or 2- to 5-mL (pediatric) preservative-free 0.9% sodium chloride (USP). 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.[10,24,27] (V)

J. Apply a sterile dressing over the IO access site, and stabilize device.[18,29] (V)

K. Limit dwell time of the IO device to no longer than 24 hours. Assess for an appropriate replacement vascular access device (VAD) (see Standard 26, *Vascular Access Device [VAD] Planning*).[11,18,20] (V)

L. Monitor for complications associated with IO access. While relatively uncommon, the most common reported complication is infiltration/extravasation from dislodgment and compartment syndrome. Infants and young children may be at greater risk for extravasation and subsequent compartment syndrome due to small bone size and too long needle length.[10-12,14,15,18,24,26,27,30,31] (IV)
   1. Reduce risk for infiltration/extravasation through avoiding multiple attempts at IO access at the same site; ensuring proper needle placement; securing IO device; rechecking IO placement, especially before infusing highly irritating solutions/known vesicants and large volume infusions; ongoing and frequent assessment of the IO site and extremity; and limiting infusion time to less than 24 hours.[27,30-32] (IV)
   2. Rarely reported complications include iatrogenic fracture, infection, fat emboli, and osteomyelitis. Infectious complications were more likely to occur with prolonged infusion or if bacteremia was present during the time of insertion.[10-12,14,15,18,24,26,27,30-32] (IV)

REFERENCES

Note: All electronic references in this section were accessed September 8, 2015.

1. Neumar RW, Otto CW, Link MS, et al. Part 8: adult advanced cardiovascular life support: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2010;122(suppl 3):S729-S767.
2. Kleinman NE, Chameides L, Schexnayder SM, et al. Part 14: pediatric advanced life support: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2010;122(suppl 3):S876-S908.
3. Deakin CD, Nolan JP, Soar J, et al. Section 4: European Resuscitation Council guidelines for resuscitation, 2010: adult advanced life support. *Resuscitation*. 2010;81:1305-1352.
4. Biarent D, Bingham R, Eich C, et al. Section 6: European Resuscitation Council guidelines for resuscitation, 2010: pediatric life support. *Resuscitation*. 2010;81:1364-1388.
5. Leidel BA, Kirchoff C, Bogner V, et al. Comparison of intraosseous versus central venous access in adults under resuscitation in the emergency department with inaccessible peripheral veins. *Resuscitation*. 2012;83:40-45.

6. 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.
7. Hoskins SL, do Nascimento P Jr, Lima RM, Espana-Tenorio JM, Kramer GC. Pharmacokinetics of intraosseous and central venous drug delivery during cardiopulmonary resuscitation. *Resuscitation*. 2012;83:107-112.
8. Rouhani S, Meloney L, Ahn R, Nelson B, Burke TF. Alternative rehydration methods: a systematic review and lessons for resource-limited care. *Pediatrics*. 2011;127(3):e748-e757.
9. Neuhaus D, Weiss M, Engelhardt T, et al. Semi-elective intraosseous infusion after failed intravenous access in pediatric anesthesia. *Pediatr Anesth*. 2010;20(2):168-171.
10. Tobias JD, Ross AK. Intraosseous infusions: a review for the anesthesiologist with a focus on pediatric use. *Anesth Analg*. 2010;110(2):391-401.
11. Luck RP, Haines C, Mull CC. Intraosseous access. *J Emerg Med*. 2010;39(4):468-475.
12. The Consortium on Intraosseous Vascular Access for Emergent and Nonemergent Situations in Various Healthcare Settings [position paper]. Recommendations for the use of intraosseous access for emergent and nonemergent situations in various healthcare settings: a consensus paper. *J Infus Nurs*. 2010;33(6):346-351.
13. Emergency Nurses Association/Emergency Nursing Resources Development Committee. Emergency nursing resource: difficult intravenous access. http://www.guideline.gov/content.aspx?id=36841. Published 2011.
14. Hansen M, Meckler G, Spiro D, Newgard C. Intraosseous line use, complications, and outcomes among a population-based cohort of children presenting to California hospitals. *Pediatr Emerg Care*. 2011;27(10):928-932.
15. Anson JA. Vascular access in resuscitation: is there a role for the intraosseous route? *Anesthesiology*. 2014;120(4):1015-1031.
16. Anson JA, Sinz EH, Swick JT. The versatility of intraosseous vascular access in perioperative medicine: a case series. *J Clin Anesth*. 2014;27(1):63-67.
17. Neuhaus D. Intraosseous infusion in elective and emergency anesthesia: when should we use it? *Curr Opin Anesthesiol*. 2014;27(3):282-287.
18. Vizcarra C, Clum S. Intraosseous route as alternative access for infusion therapy. *J Infus Nurs*. 2010;33(3):162-174.
19. 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.
20. Infusion Nurses Society [position paper]. The role of the registered nurse in the insertion of intraosseous devices. *J Infus Nurs*. 2009;32(4):187-188.
21. National Association of EMS Physicians [position paper]. Intraosseous vascular access in the out-of-the hospital setting. http://www.naemsp.org/Documents/Position%20Papers/POSITION%20IntraosseousVascularAccessintheoutofhospitalsetting.pdf. Published 2006.
22. Weiser G, Hoffmann, Galbraith R, Shavit I. Current advances in intraosseous infusion: a systematic review. *Resuscitation*. 2012;83:20-26.
23. Fowler R, Gallagher JV, Isaacs SM, et al. The role of intraosseous vascular access in the out-of-hospital environment [resource document to NAEMSP position statement]. *Prehospital Emerg Care*. 2007;11(1):63-66.
24. Hunsaker S, Hillis D. Intraosseous vascular success for alert patients. *Am J Nurs*. 2013;113(11):34-39.
25. Olaussen A, Williams B. Intraosseous access in the prehospital setting: literature review. *Prehosp Disaster Med*. 2012;27(5):468-472.
26. Garside J, Prescott S, Shaw S. Intraosseous vascular access in critically ill adults: a review of the literature. *Nurs Crit Care*. Feb 2015. doi:10.1111/nicc.12163.
27. Dev SP, Stefan RA, Saun T, Lee S. Insertion of an intraosseous needle in adults. *N Engl J Med*. 2014;24:e35.
28. Paxton JH. Intraosseous vascular access: a review. *Trauma*. 2012;14(3):195-232.
29. Parker M, Henderson K. Alternative infusion access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:516-524.
30. Dolister M, Miller S, Borron S. Intraosseous vascular access is safe, effective and costs less than central venous catheters for patients in the hospital setting. *J Assoc Vasc Access*. 2013;14(3):216-224.
31. Taylor CC, Clarke NMP. Amputation and intraosseous access in infants. *BMJ*. 2011;342:d2778.
32. Atanda A Jr, Statter MB. Compartment syndrome of the leg after intraosseous infusion: guidelines for prevention, early detection, and treatment. *Am J Orthop*. 2008;37(12):e198-e200.

56. CONTINUOUS SUBCUTANEOUS INFUSION AND ACCESS DEVICES

Standard

56.1 The clinician assesses the patient 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 Criteria

A. Consider administration of isotonic solutions (5% dextrose in water or 0.9% sodium chloride) via a subcutaneous access device (hypodermoclysis) for treatment of mild to moderate dehydration.[1-8] (V)
B. Consider the subcutaneous route for continuous opioid (eg, morphine, hydromorphone, fentanyl) and other infusion therapies/medications (eg, immunoglobulin therapy, terbutaline). In addition, administer other medication on an intermittent basis via a subcutaneous access device.[2,5,9-11] (V)
C. Use hyaluronidase to facilitate the dispersion and absorption of 1,000 mL or more of subcutaneously administered hydration solutions in adults and pediatric patients. The dosage of subcutaneous solutions administered is dependent upon the patient's age, weight, clinical condition, and laboratory values. The rate and volume of subcutaneous fluid administration should not exceed those employed for intravenous infusion.[2,3,5-7,12-20] (V)

D. Consider the use of hyaluronidase to increase the dispersion and absorption of other injected drugs.[19,20] (V)
   1. In patients taking salicylates (eg, aspirin), steroids (eg, cortisone or estrogens), or antihistamines, a larger dose of hyaluronidase for equivalent dispersing effect may be required.[19] (V)
   2. Do not use hyaluronidase to enhance the dispersion and absorption of dopamine and/or alpha-agonist drugs, as the drugs are incompatible. Consult the drug manufacturers' references prior to administering any drug with hyaluronidase.[19] (V)
   3. When hyaluronidase is added to a local anesthetic agent, it hastens the onset of analgesia and tends to reduce the swelling caused by local infiltration, but the wider spread of the local anesthetic solution increases its absorption; this shortens its duration of action and tends to increase the incidence of systemic reaction.[19] (V)
   4. Use with caution in a nursing mother as it is not known if hyaluronidase is excreted in breast milk.[19] (V)
   5. Assess for adverse reactions of hyaluronidase of mild local access site reactions such as redness, pain, anaphylactic-like reactions, and allergic reactions.[19] (V)

E. Select a site for subcutaneous access to include areas with intact skin that are not near a joint and have adequate subcutaneous tissue, such as the upper arm, subclavicular chest wall, abdomen (at least 2 inches away from the umbilicus), upper back, and thighs and/or as recommended by the drug manufacturer. Avoid areas that are scarred, infected, or acutely inflamed.[1,2,5-7,21] (V)

F. Rotate the subcutaneous access site used for medication administration every 7 days and as clinically indicated based on the access site assessment findings.[5,6] (V)

G. Rotate the subcutaneous access site used for hydration solutions every 24 to 48 hours or after 1.5 to 2 liters of solution has infused and as clinically indicated based on the access site assessment findings.[2,7] (V)

H. Assess the subcutaneous access site and rotate the site when there is erythema, swelling, leaking, local bleeding, bruising, burning, abscess, or pain.[1,5-7] (V)
   1. For patients receiving subcutaneous immunoglobulin infusions, some swelling and site erythema, pain, and pruritis are common and tend to decrease over time. Persistent reactions may require a slower infusion rate or decreased volume per site, longer needle, or site change.[10,22] (V)

I. Use a small-gauge (ie, 24- to 27-gauge) infusion device to establish subcutaneous access, and insert the subcutaneous infusion device according to the manufacturer's guidelines. Use a subcutaneous needle labeled for high flow rates when indicated by the drug manufacturer.[5-7,21] (V)
   1. A stainless steel winged needle is not recommended.[5] (IV)

J. Perform skin antisepsis prior to inserting the subcutaneous access device using 70% isopropyl alcohol, povidone-iodine, or >0.5% chlorhexidine in alcohol solution.[6,23] (V)

K. Aspirate the subcutaneous infusion access device to confirm the absence of a blood return prior to medication and fluid administration.[5,6,10] (V)

L. Apply a transparent semipermeable membrane (TSM) dressing over the subcutaneous access site to allow for continuous observation and assessment. Change the TSM dressing with each subcutaneous site rotation but immediately if the integrity of the dressing is compromised.[2,5,7] (V)

M. The optimal subcutaneous infusion rate is unknown. Medication infusion rates of 3 to 5 mL per hour are reported, and hydration infusion rates of up to 1500 mL over 24 hours are reported. More than 1 subcutaneous infusion site may be used to accomplish a larger infusion volume. Follow the manufacturer's recommended subcutaneous administration rate/infusion method for immunoglobulin infusions.[2,6,7,9] (V)

N. Regulate the infusion of medications administered as a continuous infusion via a subcutaneous access device using an electronic infusion device that has the ability to titrate the rate up or down if required to improve tolerability.[5,21] (V)

O. Infuse isotonic fluids for hydration via a subcutaneous access device using a manual flow regulator.[4,6,7] (V)

REFERENCES

Note: All electronic references in this section were accessed September 8, 2015.

1. Smith L. Hypodermoclysis with older adults. *Nursing*. 2014;44(12):66.
2. Humphrey P. Hypodermoclysis: an alternative to IV infusion therapy. *Nursing*. 2011;41(11):16-17.
3. Mei A, Auerhahn C. Hypodermoclysis: maintaining hydration in the frail older adult. *Ann Long Term Care*. 2009;17(5):28-30. http://www.annalsoflongtermcare.com/content/hypodermoclysis-maintaining-hydration-frail-older-adult.
4. Scales K. Use of hypodermoclysis to manage dehydration. *Nurs Older People*. 2011;23(5):16-22.
5. Parker M, Henderson K. Alternative infusion access devices. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:516-524.
6. Lybarger E. Hypodermoclysis in the home and long-term care settings. *J Infus Nurs*. 2009;32(1):40-44.
7. Walsh G. Hypodermoclysis: an alternative method for rehydration in long-term care. *J Infus Nurs*. 2005;28(2):123-129.
8. Emergency Nurses Association/Emergency Nursing Resources Development Committee. Emergency nursing resource: difficult intravenous access. http://www.guideline.gov/content.aspx?id=36841. Published December 15, 2011.

9. Justad M. Continuous subcutaneous infusion: an efficacious, cost-effective analgesia alternative at the end of life. *Home Healthc Nurse*. 2009;27(3):140-147.
10. Younger MEM, Blouin W, Duff C, Epland KB, Murphy E, Sedlak D. Subcutaneous immunoglobulin replacement therapy: ensuring success. *J Infus Nurs*. 2015;38(1):70-79.
11. Lednik L, Baker M, Sullivan K, Poynter M, O'Quinn L, Smith C. Is self-administration of subcutaneous immunoglobulin therapy safe in a home care setting? An evidence-based practice journey. *Home Healthc Nurse*. 2013;31(3):134-141.
12. Gabriel J. The use of subcutaneous infusion in medication administration. *Br J Nurs*. 2013;22(suppl 3):S6-S12.
13. Bartz B, Klein C, Seifert A, Herget I, Ostgathe C, Stiel S. Subcutaneous administration of drugs in palliative care: results of a systematic observational study. *J Pain Symptom Manage*. 2014;46(4):540-547.
14. Arthur A. Innovations in subcutaneous infusions. *J Infus Nurs*. 2015;38(3):179-187.
15. Kuensting L. Comparing subcutaneous fluid infusion with intravenous fluid infusion in children. *J Emerg Nurs*. 2013;39(1):86-91.
16. Mace S, Harb H, Friend K, Turpin R, Armstrong E, Lebel F. *Am J Emerg Med*. 2013;31(6):928-934.
17. Spandorfer P. Subcutaneous rehydration updating a traditional technique. *Pediatr Emerg Care*. 2011;27(3):230-236.
18. Spandorfer P, Mace S, Okada P, 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.
19. Hylenex [package insert]. San Diego, CA: Halozyme Therapeutics, Inc; 2015. http://www.hylenex.com/files/doc_downloads/June2015/Hylenex-Package-Insert-LBL301-02-Rev-January-2015.pdf.
20. Rosengren S, Dychter S, Printz MA, et al. Clinical immunogenicity of rHuPH20, a hyaluronidase enabling subcutaneous drug administration. *AAPS J*. 2015;17(5):1144-1156.
21. HyQvia [package insert]. Westlake Village, CA: Baxter Healthcare Corporation; 2014. http://www.fda.gov/downloads/BiologicsBloodVaccines/BloodBloodProducts/ApprovedProducts/LicensedProductsBLAs/FractionatedPlasmaProducts/UCM414440.pdf.
22. Younger ME, Aro L, Blouin W, et al. Nursing guidelines for administration of immunoglobulin replacement therapy. *J Infus Nurs*. 2013;36(1):58-68.
23. McGoldrick M. Infection prevention and control. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:212.

Section Nine: Infusion Therapies

Section Standards

I. Infusion therapy administration is initiated upon the orders of a licensed independent practitioner (LIP) in accordance with organizational policies and procedures.
II. References and resources that include current information about parenteral medications and solutions, including indications, dosing, acceptable infusion routes/rates, compatibility data, and adverse/side effects, are readily available to the clinician at the point of care.
III. At least 2 patient identifiers are used to ensure accurate patient identification when administering infusion medications and solutions.
IV. Aseptic technique is adhered to during all aspects of parenteral medication and solution administration.

57. PARENTERAL MEDICATION AND SOLUTION ADMINISTRATION

Standard

57.1 The clinician reviews information regarding the prescribed medication/solution including indications, dosing, acceptable infusion routes/rates, compatibility data, and adverse/side effects for appropriateness prior to administration.
57.2 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, expiration date, sterility state, route, rate, and frequency of administration, and any other special instructions.

Practice Criteria

A. Review the order for appropriateness of prescribed infusion solution or medication for the patient's age and condition, access device, dose, rate and route of administration; follow the rights of medication administration; address concerns about the appropriateness of orders with the pharmacist, prescribing licensed independent practioner (LIP), supervisor, and/or risk management, or as defined in organizational policy.[1-4] (V)
B. 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 (eg, neonatal, pediatric, pregnant, older adults) (refer to Standard 2, *Special Patient Populations*).
C. Administer solutions and medications prepared and dispensed from the pharmacy or as commercially prepared solutions and medications in accordance with USP <797>; if compounded outside of the pharmacy ("immediate-use" compounded sterile product), initiate administration within 1 hour after the start of the preparation (refer to Standard 17, *Compounding and Preparation of Parenteral Solutions and Medications*).
D. Identify and verify medications and infusion solutions and medications:
    1. Review the label for accuracy against the order (name, dosage, concentration, administration route, frequency, infusion rate); integrity of solution (eg, no leakage/discoloration/precipitate/gas formation); integrity of packaging (eg, open or damaged packaging); sterility (within beyond-use or expiration date); and in the alternative care settings, verify appropriate storage/refrigeration.
    2. Perform a medication reconciliation at each care transition and when a new medication(s) is ordered to reduce the risk of medication error, including omissions, duplications, dosing errors, and drug interactions.
    3. Use technology according to organizational policies and procedures (eg, bar code, smart pump with dose-error reduction software), when

available, to verify medications prior to administration.
4. Discard and do not use any medication syringes that are unlabeled unless the medication is prepared at the patient's bedside and immediately administered without a break in the process.
5. Perform an independent double check by 2 clinicians according to organizational procedures for high-alert medications (refer to Standard 13, *Medication Verification*).

E. Limit the use of add-on devices (eg, extension sets) to only those clinically indicated due to increased risk for contamination from manipulation and to the risk for accidental disconnections and misconnections (refer to Standard 36, *Add-on Devices*).

F. Prepare solutions and medications for administration (eg, spiking infusion container, priming) just prior to administration.[5,6] (V)

G. Administer intravenous (IV) push medications and any subsequent flush at the rate recommended by the manufacturer or in accordance with organizational procedures or guidelines, and use an appropriate volume of flush solution to ensure administration of the entire dose.
1. Administer IV push medications through the needleless connector port closest to the patient in an existing IV infusion to allow the medication to reach the circulatory system as soon as possible.[6] (V)

H. Do not add medications to infusing containers of IV solutions.[7] (V)

I. Assess vascular access device (VAD) function and patency prior to administration of parenteral solutions and medications (refer to Standard 40, *Flushing and Locking*).

J. Perform disinfection of connection surfaces (ie, needleless connectors, injection ports) before medication administration, flushing, and locking procedures (refer to Standard 34, *Needleless Connectors*).

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. Label administration sets with the infusing solution/medication near the patient connection and near the solution container.
3. Instruct the patient, caregivers, and unlicensed assistive personnel (UAP) to obtain assistance from licensed staff 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.
4. Route tubing having different purposes in different directions (eg, IV catheters routed toward the head; feeding tubes routed toward the feet).[8,9] (IV)

L. Anticipate the implementation of new connector standards from the International Organization for Standardization (ISO). New connectors that will make it nearly impossible to connect from one delivery system to another (eg, enteral to IV) are being engineered and introduced into the health care system. This requires awareness, organizational preparation, and clinician education and training.[10] (V)

M. There is insufficient evidence to recommend the frequency of routine replacement of IV solution containers (without postmanufacturer additives) with the exception of parenteral nutrition solutions, which are replaced every 24 hours. Replacing other IV solution containers less often than every 24 hours is considered in times of product shortages, but such decisions are weighed against the risk of infection. 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 recommended (see Standard 61, *Parenteral Nutrition*).[11,12] (III)

N. Provide patient/caregiver education including, but not limited to, infusion administration 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*).

O. 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.[1,13] (V)

P. Discontinue infusion medications/solutions:
1. Upon LIP order.
2. In the event of a severe reaction (eg, anaphylactic/anaphylactoid reaction, speed shock, circulatory overload); notify rapid response team as available and LIP immediately.[13] (V)

Q. Document as follows:
1. Type of therapy, drug, dose, rate, time, route, and method of administration.
2. When multiple vascular access devices (VADs) or catheter lumens are used, document which solutions and medications are being infused through each device or lumen.
3. Condition and patency of VAD site prior to and after infusion therapy.
4. Discontinuation of therapy and reason for discontinuation.
5. Patient's response to infusion therapy including symptoms, side effects, or adverse events and laboratory tests as appropriate.
6. Patient/caregiver participation in, and understanding of, therapy, interventions, and patient

education (refer to Standard 10, *Documentation in the Medical Record*).

REFERENCES

Note: All electronic references in this section were accessed September 9, 2015.

1. Turner M, Hankins J. Pharmacology. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:263-298.
2. CNA/NSO. CNA HealthPro nurse claims study: an analysis of claims with risk management recommendations, 1997-2007. http://www.hpso.com/Documents/Risk%20Education/individuals/rnclaimstudy.pdf. Published 2009.
3. Reising DL. Make your nursing care malpractice-proof. *Am Nurse Today*. 2012;7(1):24-28.
4. Austin S. Seven legal tips for safe nursing practice. *Nursing*. 2008;38(3):34-39.
5. Dolan S, Felizardo G, Barnes S [position paper]. Safe injection, infusion, and medication vial practices in healthcare. *Am J Infect Control*. 2010;38(3):167-172.
6. Institute for Safe Medication Practices (ISMP). Safe practice guidelines for adult IV push medications. http://www.ismp.org/Tools/guidelines/ivsummitpush/ivpushmedguidelines.pdf. Published 2015.
7. Potter PA, Perry AG, Stockert P, Hall A. *Fundamentals of Nursing*. 8th ed. St Louis, MO: Mosby/Elsevier; 2013:609.
8. Simmons D, Symes L, Guenter P, Graves K. Tubing misconnections: normalization of deviance. *Nutr Clin Pract*. 2011;26(3):286-293.
9. US Food and Drug Administration. Tubing and luer misconnections: preventing dangerous medical errors. http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/TubingandLuerMisconnection s/default.htm.
10. The Joint Commission. Sentinel event alert: managing risk during transition to new ISO tubing connector standards. http://www.jointcommission.org/assets/1/6/SEA_53_Connectors_8_19_14_final.pdf. Published August 20, 2014.
11. American Society of Health-System Pharmacists; University of Utah Drug Information Service. Intravenous solution conservation strategies. http://www.ashp.org/DocLibrary/Policy/Conservation-Strategies-for-IV-Fluids.pdf. Published March 20, 2014.
12. Rickard CM, Vannapraseuth B, McGrail MR, et al. A cross-sectional study investigating the relationship between intravenous infusate colonization and fluid container hang time. *J Clin Nurs*. 2009;18(2):3022-3028.
13. Phillips LD, Gorski LA. *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014.

58. ANTINEOPLASTIC THERAPY

Standard

58.1 Antineoplastic agents are administered only upon written orders, including new orders or changes to existing orders. Verbal orders are acceptable only if antineoplastic agents are to be placed on hold or discontinued.

58.2 Compounding of antineoplastic agents is in accordance with state and federal regulations; the American Society of Health-System Pharmacists (ASHP); the Drug Quality and Security Act; and the United States Pharmacopoeia (USP)-National Formulary (NF), including but not limited to General Chapter <797>.

58.3 Clinical management of potential adverse events, including treatment and management of anaphylactic reactions and extravasation injuries, is addressed in organizational policies, procedures, and/or practice guidelines.

Practice Criteria

A. Ensure that personal protective equipment (PPE) and engineering controls are in place for clinicians working with antineoplastic drugs in the health care setting. Antineoplastic drugs are considered hazardous drugs, and organizational policies and procedures to reduce risk for drug exposure should be in place (see Standard 15, *Hazardous Drugs and Waste*).
   1. Provide access to PPE; safety data sheets (SDSs; formerly material safety data sheets); spill kits; containment bags; and designated waste disposal containers in all areas where hazardous drugs are handled.[1-6] (V)
   2. During compounding, employ the following: double chemotherapy gloves; protective gown; eye/respiratory protection; ventilated engineering controls such as a class II biological safety cabinet (BSC) or compounding aseptic containment isolator (CACI); closed system drug transfer device.[1,6] (V, Regulatory)
   3. During drug administration, employ the following: double gloves; protective gown; eye protection if liquid could splash; respiratory protection if inhalation potential; and a closed system drug transfer device.[1,2] (V)
   4. Drug administration sets should be attached and primed prior to the addition of the antineoplastic agent within the BSC or CACI.[7] (V)

B. Ensure that only qualified clinicians administer antineoplastic therapy based on completion of a specialized education and competency program; annual assessment of competency is recommended.[4,5,8] (V)

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*).[4,5] (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.[4,5,7,9] (V)

E. Assess patient prior to each treatment cycle, including a review of current laboratory data and diagnostic tests, current medication list (including over-the-counter and complementary and alternative therapies), pretreatment vital signs and weight, expected side effects of therapy, and presence of new signs or symptoms of toxicity.[10] (V)

F. Implement safeguards to reduce the risk of medication errors with antineoplastic drugs. Antineoplastic drugs are high-alert medications.
   1. Use standardized orders, standardized dosage calculation, established dosage limits, computerized prescriber order entry (CPOE), bar-code technology, and smart pumps (see Standard 13, *Medication Verification*).[11] (V)
   2. Consult with pharmacist to review drug interactions with each change in the patient's medication list.[4] (V)
   3. At the time of the order, independently verify the antineoplastic order by 2 clinicians who are qualified in antineoplastic administration to include confirmation of 2 patient identifiers, drug names, dose, volume, route, rate, calculation for dosing, treatment cycle, and day.[4,10-13] (V)
   4. Prior to administration, independently verify the antineoplastic order by 2 clinicians who are qualified in antineoplastic administration to include drug name, dose, volume, rate of administration, expiration date, infusion pump rate, and appearance/physical integrity of the drugs.[4,10,11,13] (V)
   5. Consider involving 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.[9] (IV)
   6. Monitor cumulative chemotherapy dose, as appropriate, to ensure that the drug is discontinued if the maximum lifetime dose is reached.[10,11] (V)

G. Administer vesicant medications safely via a short peripheral catheter[5,10,14]: (V)
   1. Limit to intravenous (IV) push or infusions lasting less than 30 to 60 minutes.
   2. Do not use an infusion pump for peripheral vesicant administration.
   3. Do not use scalp veins in the neonate and pediatric patient.
   4. Avoid the following sites: dorsal hand, wrist, antecubital fossa, near a joint, and in the limb where there is impaired circulation or lymphatic drainage and/or history of lymph node dissection.
   5. Do not use an established IV site that is greater than 24 hours old. If a new IV site is initiated, use the smallest catheter possible. If the IV attempt is unsuccessful, additional attempts should be proximal to the previous attempt or on the opposite arm.
   6. Instruct patient in the importance of immediately reporting any pain, burning, sensation changes, or feeling of fluid on skin during the infusion.
   7. Confirm and document a positive blood return prior to vesicant administration. Do not administer in the absence of a blood return (see Standard 46, *Infiltration and Extravasation*).
   8. Provide dilution by administering through a free-flowing infusion of a compatible solution.
   9. Assess and verify blood return every 2 to 5 mL for IV push and every 5 to 10 minutes during an infusion, remaining with the patient during the entire infusion.
   10. Discontinue infusion at first sign of extravasation (see Standard 46, *Infiltration and Extravasation*).

H. Administer vesicant medications safely via central vascular access devices (CVADs).[5,10,14] (V)
   1. Confirm and document a positive blood return prior to vesicant administration. Do not administer in the absence of a blood return (see Standard 46, *Infiltration and Extravasation*).
   2. Do not administer if signs of inflammation, swelling, or signs of venous thrombosis present (refer to Standard 52, *Central Vascular Access Device [CVAD]-Associated Venous 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 and every 5 to 10 minutes during an infusion.
   6. Discontinue infusion at first sign of extravasation (see Standard 46, *Infiltration and Extravasation*).
   7. Safely dispose of hazardous waste and materials contaminated with hazardous drugs (refer to Standard 15, *Hazardous Drugs and Waste*).

REFERENCES

Note: All electronic references in this section were accessed September 9, 2015.

1. Connor TH, MacKenzie BA, DeBord DG, et al; National Institute for Occupational Safety and Health (NIOSH). *NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings*. Cincinnati, OH: US Department of Health and Human Services; 2014. Publication no. 2014-138.

2. National Institute for Occupational Safety and Health (NIOSH). NIOSH alert: preventing occupational exposures to antineoplastic and other hazardous drugs in health care settings. Publication no. 2004-165. http://www.cdc.gov/niosh/docs/2004-165/pdfs/2004-165.pdf. Published 2004.
3. Rizalar S, Tural E, Altay B. Nurses' protective measures during chemotherapy preparation and administration in Turkey. *Int J Nurs Pract*. 2012;18(1):91-98.
4. Neuss MN, Polovich M, McNiff K, et al. 2013 updated American Society of Clinical Oncology/Oncology Nursing Society chemotherapy administration safety standards including standards for the safe administration and management of oral chemotherapy. *Oncol Nurs Forum*. 2013;40(3):225-233.
5. Polovich M, Olsen M, LeFebvre K. *Chemotherapy and Biotherapy Guidelines and Recommendations for Practice*. 4th ed. Pittsburgh, PA: Oncology Nursing Society; 2014.
6. United States Pharmacopeial (USP) Convention. USP-NF General Chapter <797>: pharmaceutical compounding—sterile preparations. http://www.usp.org/usp-healthcare-professionals/compounding/compounding-general-chapters. Published 2015.
7. Schulmeister L. Antineoplastic therapy. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:351-371.
8. Oncology Nursing Society. Oncology Nursing Society position on the education of the nurse who administers chemotherapy and biotherapy. https://www.ons.org/advocacy-policy/positions/education/rn. Published 2015.
9. Schwappach DLB, Wernli M. Medication errors in chemotherapy: incidence, types, and involvement of patients in prevention—a review of the literature. *Eur J Cancer Care*. 2010;19(3):285-292.
10. Dahlin C, Lynch M, Polovich M, et al. Vesicant administration and extravasation management. In: Esparza DM, ed. *Oncology Policies and Procedures*. Pittsburgh, PA: Oncology Nursing Society; 2014.
11. Goldspiel B, Hoffman JM, Griffith NL, et al. ASHP guidelines on preventing medication errors with chemotherapy and biotherapy. *Am J Health Syst Pharm*. 2014;72(8):e6-e35.
12. Markert A, Thierry V, Kleber M, et al. Chemotherapy safety and severe adverse events in cancer patients: strategies to efficiently avoid chemotherapy errors in in- and outpatient treatment. *Int J Cancer*. 2008;124(3):722-728.
13. Bruce S. Before you press that button: a look at chemotherapy errors. *Clin J Oncol Nurs*. 2013;17(1):31-32.
14. Camp-Sorrell D, ed. *Access Device Guidelines: Recommendations for Nursing Practice and Education*. Pittsburgh, PA: Oncology Nursing Society; 2011.

59. BIOLOGIC THERAPY

Standard

59.1. Biologic infusion therapies include, but are not limited to, colony-stimulating factors, gene therapy, monoclonal antibodies, fusion proteins, interleukin inhibitors, and immunoglobulins; are ordered in accordance with state laws and regulations, and administered in a setting in which the clinician is prepared to recognize and manage severe adverse reactions.

59.2 Patients who receive biologic therapies are screened for absence of contraindications to administration prior to the beginning of therapy and prior to each administration.

Practice Criteria

A. Implement safeguards to reduce the risk of medication adverse reactions and errors with biologic therapies; immunosuppressant therapies are high-alert medications.[1] (V)
   1. Standardize prescribing, storage, dispensing, and drug administration through strategies such as computerized prescriber order entry (CPOE), bar-code technology, and smart pumps using dose-error reduction systems (refer to Standard 13, *Medication Verification*).
   2. Ensure clinician access to drug information.[1] (V)
   3. Collaborate with the licensed independent practitioner (LIP) and pharmacy regarding special safeguards; due to serious risks associated with some biologic agents, risk evaluation and mitigation strategies (REMS) may be required by the US Food and Drug Administration (FDA).[2] (Regulatory)
   4. Anticipate potential orders for premedications, such as acetaminophen 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.[3-8] (V)
   5. Ensure availability of drugs for treatment of adverse reactions in the treatment setting, including drugs to treat anaphylaxis; consider patient safety as a primary factor when selecting the treatment setting.[3,5-9] (V)

B. Store, prepare, and administer biologic infusion products according to the manufacturers' package inserts and in accordance with USP <797>, and dispose of biologic waste per state guidelines.[5,10] (V)
   1. Do not use immunoglobulin products that have been frozen.
   2. Reconstitute or prepare liquid products in a clean environment consistent with USP <797> (refer to Standard 17, *Compounding and Preparation of Parenteral Solutions and Medications*).
   3. Check expiration dates, and never use expired product.
   4. Examine solution for particulates, turbidity, or clumping, and do not use if present.
   5. Ensure that biologic products are at room temperature before infusing.

6. Avoid switching immunoglobulin products as this puts the patient at greater risk for adverse reactions.[5] (V).

C. Ensure competency in the administration of biologic infusion therapies to include knowledge of the clinical implications, safe preparation of the agents, infection prevention, ability to establish venous access, knowledge of appropriate subcutaneous infusion sites, provision of patient/family education, and management of therapy-related adverse events.[3,5-7,9] (V)

D. Assess patients[3-8,11-16]: (IV)
   1. For risk factors before initiation of therapy, 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; TB testing; history of malignancies; weight changes; and hepatitis B and C screening.
   2. For any significant changes in health status prior to each infusion, such as changes in weight, presence of any acute illness, infection, or presence of diarrhea.
   3. Check vital signs prior to infusion and as indicated during infusion.
   4. Review laboratory data specific to the biological therapy prior to initiation and during subsequent infusions as indicated.

E. Inform the patient and caregiver about all aspects of biologic therapy, including physical and psychological effects, side and adverse effects, and management of adverse events, such as infusion reactions, risks and benefits, and delayed reactions (see Standard 8, *Patient Education*).[5-7] (V)

F. Select the most appropriate flow-control method for the biologic therapy, taking into account factors such as manufacturers' recommendations for infusion rates; dosing considerations; volume; duration and use of filters; age, acuity, and mobility of the patient; health care setting; and the potential for side effects or adverse effects of the therapy (see Standard 24, *Flow-Control Devices*).[5-7] (V)

G. Consider the option of self-administered subcutaneous immunoglobulin (SCIg) when feasible. Studies have shown higher immunoglobulin gamma (IgG) trough levels, lower cost, and enhanced compliance and quality of life.[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 56, *Continuous Subcutaneous Infusion and Access Devices*).[16] (V)
   3. Identify the best method for infusion delivery. Most often, a syringe pump is used; manually pushing the SCIg is also an option for some patients.[16] (V)
   4. Educate the patient/caregiver about drug preparation, subcutaneous administration, the importance of site rotation, what to do with missed doses, and what to monitor or report during or after the injection.[16,17] (V)

H. Consider nurse-administered home administration of intravenous immunoglobulin in long-term, stable patients who require extended therapy for primary immune deficiency diseases.
   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] (IV)

REFERENCES

Note: All electronic references in this section were accessed September 10, 2015.

1. Institute for Safe Medication Practices (ISMP). ISMP list of high alert medications in community/ambulatory healthcare. http://ismp.org/communityRx/tools/ambulatoryhighalert.asp. Published 2011.
2. US Food and Drug Administration. Approved risk and mitigation strategies. http://www.accessdata.fda.gov/scripts/cder/rems/index.cfm.
3. Eisenberg S. Biologic therapy. *J Infus Nurs*. 2012;35(5):301-313.
4. 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.
5. Younger M, Blouin W, Duff C, Epland K, Murphy E, Sedlak D. Nursing guidelines for administration of immunoglobulin replacement therapy. *J Infus Nurs*. 2013;36(1):58-68.
6. Czaplewski L, Vizcarra C. Antineoplastic and biologic therapy. In: Alexander M, Corrigan A, Gorski L, Phillips L, eds. *Core Curriculum for Infusion Nursing*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:258-308.
7. Vizcarra C. Biologic therapy. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010: 299-315.
8. Vogel W. Infusion reactions: diagnosis, assessment, and management. *Clin J Oncol Nurs*. 2010;14(2):E10-E21.
9. Rheumatology Nurses Society [position statement]. Administration of biologic infusions. http://www.prweb.com/releases/rheumatology/nursing/prweb12558929.htm. Published March 3, 2015.
10. United States Pharmacopeial (USP) Convention. USP-NF General Chapter <797>: pharmaceutical compounding—sterile preparations. http://www.usp.org/usp-healthcare-professionals/compounding/compounding-general-chapters. Published2015.
11. Tehrani R, Ostrowski R, Hariman R, Jay W. Review of biologic therapies. *Neuro-opthalmology*. 2009;33(6):286-299.
12. Rosman Z, Shoenfeld Y, Zandman-Goddard G. Biologic therapy for autoimmune diseases: an update. *BMC Med*. 2013;11:88. http://www.biomedcentral.com/1741-7015/11/88.

13. Goh L, Ash S. Update on biologic therapies in ankylosing spondylitis: a literature review. *Int J Rheum Dis*. 2012;15(5):445-454.
14. Page E, Dar W, Knechtle S. Biologics in organ transplantation. *Transplant Int*. 2012;25(7):707-719.
15. Namey M, Halper J, O'Leary S, Beavin J, Bishop C. Best practices in multiple sclerosis. *J Infus Nurs*. 2010;33(2):98-111.
16. Younger M, Blouin W, Duff C, Epland K, Murphy E, Sedlak D. Subcutaneous immunoglobulin replacement therapy: ensuring success. *J Infus Nurs*. 2015;38(1):70-79.
17. Lingman-Framme J, Fasth A. Subcutaneous immunoglobulin for primary and secondary immunodeficiencies: an evidence-based review. *Drugs*. 2013;73(12):1307-1319.
18. Abolhassani H, Sadaghiani M, Aghamohammadi A, Ochs H, Rezaei N. Home-based subcutaneous immunoglobulin versus hospital-based intravenous immunoglobulin in treatment of primary antibody deficiency: systematic review and meta analysis. *J Clin Immunol*. 2012;32(6):1180-1192.
19. Luthra R, Quimbo R, Iyer R, Luo M. An analysis of intravenous immunoglobulin site of care: home versus hospital. *Am J Pharm Benefits*. 2014;6:e41-e49.

60. PATIENT-CONTROLLED ANALGESIA

Standard

60.1 The clinician is competent in the care of patients receiving patient-controlled analgesia (PCA), with knowledge of the appropriate drugs used with PCA, including pharmacokinetics and equianalgesic dosing, contraindications, side effects and their management, appropriate administration modalities, and anticipated outcomes.
60.2 The patient and caregiver are educated in the use of PCA. The patient's and caregiver's comprehension and ability to comply with procedures are evaluated and documented prior to and on initiation of therapy.
60.3 The use of infusion devices for PCA adheres to manufacturers' directions for use.

Practice Criteria

A. Assess the patient for the appropriateness of PCA therapy and the patient's comprehension of, and ability to participate in, the intended therapy.[1-7] (I)
B. Assess the patient for appropriateness of using authorized agent-controlled analgesia (AACA) if the patient is unable to actively participate in PCA or parent/nurse-controlled analgesia (PNCA) for infants.[8-11] (V)
C. Use standardized medication concentrations and standardized or preprinted order sets for PCA and AACA.[12-16] (V)
D. Identify patient risk factors which include, but are not limited to, older age, morbid obesity, obstructive sleep apnea, chronic obstructive pulmonary disease, renal insufficiency, and continuous basal infusions for patients who have obstructive sleep apnea or are opioid naïve.[17-21] (II)
E. Consider a double check by another clinician using independent verification prior to initiation of the PCA and when the syringe, solution container, drug, or rate is changed. Give special attention to drug, concentration, dose, and rate of infusion according to the order and as programmed into the electronic infusion device (EID) in order to reduce the risk of adverse outcomes and medication errors (see Standard 13, *Medication Verification*).[14,20] (V)
F. Provide patient and caregiver education appropriate to duration of therapy and care setting and include the purpose of PCA therapy, operating instructions for the EID, expected outcomes, precautions, potential side effects, and contact information for support services.[8,14,17,20-24] (II)
G. Evaluate the effectiveness of PCA/AACA/PNCA and absence of adverse events using valid and reliable monitoring and assessment methods or scales and documentation tools through:
    1. Regular assessment and reassessment of patient self-report of pain or objective measure of pain, using a consistent pain-assessment scale appropriate to the patient.
    2. Monitoring for potential adverse effects including, but not limited to, sedation and respiratory depression. If risk factors are present, monitoring more frequently and using capnography, pulse oximetry, and/or other clinically effective methods.
    3. Regular evaluation of PCA injections and attempts.
    4. Considering the need for change in treatment methods as necessary.[8,11,14,17,20,21,25-35] (II)
H. Participate in selection and evaluation of PCA EIDs and quality processes to promote patient safety, which includes dose-error reduction systems (DERSs), bar-coding technology, and Healthcare Failure Mode and Effect Analysis (HFMEA).[14,20,21,27,29,36-44] (V)

REFERENCES

Note: All electronic references in this section were accessed September 11, 2015.

1. American Pain Society. *Principles of Analgesic Use in the Treatment of Acute Pain and Cancer Pain*. 6th ed. Glenview, IL: American Pain Society; 2009.
2. Anghelescu DL, Faughnan LG, Oakes LL, Windsor KB, Pei D, Burgoyne LL. Parent-controlled PCA for pain management in pediatric oncology: is it safe? *J Pediatr Hematol Oncol*. 2012;34(6):416-420.
3. Bainbridge D, Martin J, Cheng DC. Patient-controlled versus nurse-controlled analgesia after cardiac surgery: a meta-analysis. *Can J Anesth*. 2006;53(5):492-499.

4. Crisp CC, Bandi S, Kleeman SD, et al. Patient-controlled versus scheduled, nurse-administered analgesia following vaginal reconstructive surgery: a randomized trial. *Am J Obstet Gynecol*. 2012;207(5):433.e1-433.e6.
5. Horgas AL, Yoon SL, Grall M. Pain management. In: Boltz M, Capezuti E, Fulmer T, Zwicker D. *Evidence-Based Geriatric Nursing Protocols for Best Practice*. 4th ed. New York, NY: Springer; 2012:246-267.
6. Hudcova J, McNicol ED, Quah CS, Lau J, Carr DB. Patient controlled opioid analgesia versus conventional opioid analgesia for postoperative pain. *Cochrane Database Syst Rev*. 2006(4):CD003348. doi:10.1002/14651858.CD003348.pub2.
7. Myers M, Eckes E. A novel approach to pain management in persons with sickle cell disease. *Medsurg Nurs*. 2012;21(5): 293-298.
8. 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 Manage Nurs*. 2013;14(3):176-181.
9. D'Arcy Y. PCA by proxy: taking the patient out of patient-controlled analgesia. *Dimens Crit Care Nurs*. 2013;32(4): 200-203.
10. 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.
11. 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.
12. Ehringer G, Duffy B. Promoting best practice and safety through preprinted physician orders. In: Henriksen K, Battles JB, Keyes MA, Grady ML, eds. *Advances in Patient Safety: New Directions and Alternative Approaches*. Rockville, MD: Agency for Healthcare Research and Quality; 2008. Publication 08-0034-2. http://www.ahrq.gov/downloads/pub/advances2/vol2/Advances-Ehringer_17.pdf.
13. Institute for Safe Medication Practices. Guidelines for standard order sets. http://www.ismp.org/Tools/guidelines/StandardOrder Sets.pdf. Published 2010.
14. San Diego Patient Safety Council. Tool kit: patient controlled analgesia (PCA) guidelines of care for the opioid naïve patient. http://www.carefusion.com/pdf/The_Center/2008-PCA-toolkit-disclaimer-updated-may-30-2014.pdf. Published 2009. Updated 2014.
15. Schein JR, Hicks RW, Nelson WW, Sikirica V, Doyle DJ. Patient controlled analgesia-related medication errors in the postoperative period: causes and prevention. *Drug Saf*. 2009;32(7): 549-559.
16. Weber LM, Ghafoor VL, Phelps P. Implementation of standard order sets for patient-controlled analgesia. *Am J Health Syst Pharm*. 2008;65(12):1184-1191.
17. 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 Manage Nurs*. 2011;12(3):118-145.e10.
18. Smetzer J, Cohen MR, Jenkins R. APSF offers recommendations for safe post-op opioid administration and monitoring. *ISMP Med Saf Alert*. 2009;14(19):3.
19. Smetzer J, Cohen MR, Jenkins R. Beware of basal opioid infusions with PCA therapy. *ISMP Med Saf Alert*. 2009;14(5):1-3.
20. The Joint Commission. Sentinel event alert: safe use of opioids in hospitals. http://www.jointcommission.org/assets/1/18/SEA_49_opioids_8_2_12_final.pdf. Published 2012.
21. Surprise JK, Simpson MH. One hospital's initiatives to encourage safe opioid use. *J Infus Nurs*. 2015;38(4):278-283.
22. Moyano J, Zambrano S. The influence of information leaflets on morphine consumption in postoperative patients using patient-controlled analgesia. *J Pain Palliat Care Pharmacother*. 2011; 25(4):335-339.
23. Patak L, Tait A, Mirafzali L, Morris M, Dasgupta S, Brummett C. Patient perspectives of patient-controlled analgesia (PCA) and methods for improving pain control and patient satisfaction. *Reg Anesth Pain Med*. 2013;38(4):326-333.
24. Yankova Z. Patients' knowledge of patient-controlled analgesia (PCA) and their experience of postoperative pain relief: a review of the impact of structured preoperative education. *J Adv Perioper Care*. 2008;3(3):91-99.
25. 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.
26. Herr K, Coyne PJ, McCaffery M, Manworren R, Merkel S. Pain assessment in the patient unable to self-report: position statement with clinical practice recommendations. *Pain Manage Nurs*. 2011;12(4):230-250.
27. Institute for Safe Medication Practices. Fatal PCA adverse events continue to happen… better patient monitoring is essential to prevent harm. *Acute Care ISMP Med Saf Alert*. May 30, 2013. https://www.ismp.org/newsletters/acutecare/showarticle.aspx?id=50.
28. Institute for Safe Medication Practices. Proceedings from the ISMP summit on the use of smart infusion pumps: guidelines for safe implementation and use. http://www.ismp.org/Tools/guidelines/smartpumps/comments/printerVersion.pdf. Published 2009.
29. Maddox RR, Danello S, Williams CK, Fields M. Intravenous infusion safety initiative: collaboration, evidence-based best practices, and "smart" technology help avert high-risk adverse drug events and improve patient outcomes. In: Henriksen K, Battles JB, Keyes MA, Grady ML, eds. *Advances in Patient Safety: New Directions and Alternative Approaches*. Rockville, MD: Agency for Healthcare Research and Quality; 2008. Publication no. 08-0034-4.
30. Maddox RR, Williams CK. Clinical experience with capnography monitoring for PCA patients. *APSF Newsletter*. 2012;26(3):47-50. http://www.apsf.org/newsletters/pdf/winter_2012.pdf.
31. McCarter T, Shaik Z, Scarfo K, Thompson LJ. Capnography monitoring enhances safety of postoperative patient-controlled analgesia. *Am Health Drug Benefits*. 2008;1(5):28-35.
32. Nisbet AT, Mooney-Cotter F. Comparison of selected sedation scales for reporting opioid-induced sedation assessment. *Pain Manage Nurs*. 2009;10(3):154-164.
33. Overdyk FJ, Carter R, Maddox RR, Callura J, Herrin AE, Henriquez C. Continuous oximetry/capnometry monitoring reveals frequent desaturation and bradypnea during patient-controlled analgesia. *Anesth Analg*. 2007;105(2):412-418.
34. Voepel-Lewis T, Marinkovic A, Kostrzewa A, Tait AR, Malviya S. The prevalence of and risk factors for adverse events in children receiving patient-controlled analgesia by proxy or patient-controlled analgesia after surgery. *Anesth Analg*. 2008;107(1):70-75.
35. Patino M, Redford DT, Quigley TW, Mahmoud M, Kurth CD, Szmuk P. Accuracy of acoustic respiration rate monitoring in pediatric patients. *Paediatr Anaesth*. 2013;23(12):1166-1173.

36. Cronrath P, Lynch T, West D, et al. PCA oversedation: application of healthcare failure mode effect analysis (HFMEA™). *Nurs Econ*. 2011;29(2):79-87.
37. Drummond G, Bates A, Mann J, Arvind D. Characterization of breathing patterns during patient-controlled opioid analgesia. *Br J Anaesth*. 2013;111(6):971-978.
38. 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.
39. Gentile DL, St Marie B. Pain management. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. New York, NY: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:651-683.
40. Jahansouz F, Rafie S, Chu F, Lamott J, Atayee R. Impact of smart infusion pump implementation on intravenous patient-controlled analgesia medication errors. *Calif J Health Syst Pharm*. 2013;25(5):145-150.
41. Moss J. Reducing errors during patient-controlled analgesia therapy through failure mode and effects analysis. *Jt Comm J Qual Patient Saf*. 2010;36(8):359-364.
42. Prewitt J, Schneider S, Horvath M, Hammond J, Jackson J, Ginsberg B. PCA safety data review after clinical decision support and smart pump technology implementation. *J Patient Saf*. 2013;9(2):103-109.
43. Reston J. Smart pumps and other protocols for infusion pumps: brief review. In: Shekelle PG, Wachter RM, Pronovost PJ, et al, eds. *Making Health Care Safer II: An Updated Critical Analysis of the Evidence for Patient Safety Practices*. Rockville, MD: Agency for Healthcare Research and Quality; March 2013: 48-54.
44. Tran M, Ciarkowski S, Wagner D, Stevenson JG. A case study on the safety impact of implementing smart patient-controlled analgesic pumps at a tertiary care academic medical center. *Jt Comm J Qual Patient Saf*. 2012;38(3):112-119.

61. PARENTERAL NUTRITION

Standard

61.1 The decision to implement parenteral nutrition (PN) occurs in collaboration with the patient/caregiver and the interprofessional team based on the projected treatment plan.
61.2 PN is administered using filtration appropriate to the type of solution/emulsion.
61.3 PN is administered using an electronic infusion device (EID) with anti–free-flow control and appropriate alarms.
61.4 Compounding of PN is in accordance with state and federal regulations, the American Society of Health-System Pharmacists (ASHP), the Drug Quality and Security Act, and the United States Pharmacopoeia (USP) National Formulary (NF) including, but not limited to, General Chapter <797>.
61.5 Medications are not added to or coinfused with the PN solutions/emulsions before or during infusion without consultation with a pharmacist regarding compatibility and stability.

Practice Criteria

A. Prescribe PN safely and appropriately.
   1. Use the enteral route in preference to the parenteral route for nutrition support whenever feasible.[1-6] (I)
   2. For patients who will transition from an acute care to the home setting, include the following factors in the discharge planning process: insurance coverage, home safety, and a physical, nutritional, and psychological needs assessment.[7] (V)
   3. Use standardized order forms or templates and computerized prescriber order entry (CPOE) whenever feasible, as they have been found to prevent errors related to prescriptions for PN.[8,9] (IV)
   4. Develop licensed independent practitioner (LIP)-approved written protocols for PN component substitution or conservation methods in the event of drug/component shortages.[9] (V)

B. Prepare and compound PN properly.
   1. Compound PN solutions/emulsions in the pharmacy using a primary engineering control in accordance with USP <797> standards.[10] (Regulatory)
   2. Attach administration tubing to the PN container and prime the tubing just prior to use.[10] (Regulatory)
   3. Assess for compatibility and stability before adding medications and other substances to PN solutions/emulsions in compliance with USP <797> standards. In acute care settings, no additions should be made to the PN solutions outside of the compounding pharmacy; in home settings, additions to the PN solution should be limited in number and made as close as possible to infusion initiation.[4,10] (V, Regulatory)
   4. Label PN solutions/emulsions in accordance with USP <797> standards. Medications and other substances added to PN solutions/emulsions are also documented on the label.[10] (Regulatory)

C. PN administration.
   1. Filter PN solutions without lipids using a 0.2-micron filter and lipid-containing emulsions (3-in-1) using a 1.2-micron filter to reduce the risk of microbial, precipitate, or particulate contamination. When lipids are infused separately from dextrose/amino acids, a 0.2-micron filter is used for the dextrose/amino acid solution, and the lipid emulsion must be infused below the 0.2-micron filter (eg, during "piggyback"). Separate lipid emulsions may not require filtration; consult manufacturers' directions for use. If required, a 1.2-micron filter is used on the separate lipid emulsion.[1-9] (II)
   2. Do not exceed a hang time of 24 hours for PN containing dextrose and amino acids alone or with fat emulsion added as a 3-in-1 formulation.

Do not exceed a hang time of 12 hours for fat emulsions alone.[4] (IV)

3. Replace administration sets for PN solutions (total nutrient admixtures [TNA] and amino acid/dextrose formulations) at least every 24 hours. There are also recommendations to change the administration set with each new PN container. Containers and administration sets should be di-(2-ethylhexyl)phthalate (DEHP)-free (refer to Standard 42, *Administration Set Change*).
4. Administer PN solutions/emulsions containing final concentrations exceeding 10% dextrose or other additives that result in an osmolarity of greater than 900 mOsm/L through a central vascular access device (CVAD) (see Standard 23, *Central Vascular Access Device [CVAD] Tip Location*; Standard 26, *Vascular Access Device [VAD] Planning*).[11-16] (III)
5. Reserve the administration of PN solutions/emulsions with a final concentration of 10% dextrose or lower administered via a short peripheral or midline catheter 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. Clinical trials demonstrate that peripheral PN causes phlebitis. The risk/benefit decision to use peripheral PN should include as many phlebitis-mitigating techniques as possible (see Standard 26, *Vascular Access Device [VAD] Planning*).[11-16] (IV).
6. Use EIDs with anti–free-flow protection and alarms for occlusion. Consider the use of smart pumps with dose-error reduction software as they are associated with reduced risk for infusion-related medication errors, including error interceptions (eg, wrong rate) and reduced adverse drug events (refer to Standard 13, *Medication Verification*; Standard 24, *Flow-Control Devices*).
7. Reduce the risk of catheter-related bloodstream infection (CR-BSI) when administering PN.
   a. Avoid blood sampling via the CVAD used for PN when feasible (refer to Standard 43, *Phlebotomy*).
   b. Consider use of a designated single-lumen catheter to administer lipid-containing PN solutions.[17] (IV)
8. Avoid unplanned interruptions in the administration of PN. Tapering the rate of administration is not required for adult patients but is recommended for children < 3 years of age.[4] (V)
9. Keep PN solutions refrigerated and protected from light until shortly before the time of administration to avoid oxidation of vitamins.[1,4] (IV)
10. Do not attach administration sets until the time of infusion.[4] (V)

D. Monitor and provide patient education.
   1. Include physiological, sociological, and psychological aspects of response to therapy for patients who are on long-term PN.[18-20] (II)
   2. Monitoring of the patient receiving PN includes 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.[5-7,18-20] (V)
   3. Monitor blood glucose on and off PN during initial cycling in the acute care or home setting.[5-7] (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, EID use and troubleshooting, signs and symptoms to report, and assist patients to fit PN into their lifestyle (see Standard 8, *Patient Education*).[1,7,18-22] (V)

REFERENCES

Note: All electronic references in this section were accessed September 14, 2015.

1. Durfee S, Adams S, Arthur E, et al; Home and Alternate Site Care Standards Task Force, American Society for Parenteral and Enteral Nutrition. A.S.P.E.N. standards for nutrition support: home and alternate site care. *Nutr Clin Pract*. 2014;29(4):542-555.
2. Corkins M, Griggs K, Groh-Wargo S, et al; Task Force on Standards for Nutrition Support: Pediatric Hospitalized Patients, American Society for Parenteral and Enteral Nutrition. A.S.P.E.N. standards for nutrition support: pediatric hospitalized patients. *Nutr Clin Pract*. 2013;28(2):262-276.
3. Ukleja A, Freeman K, Gilbert K, et al; Task Force on Standards for Nutrition Support: Adult Hospitalized Patients, American Society for Parenteral and Enteral Nutrition. A.S.P.E.N. standards for nutrition support: adult hospitalized patients. *Nutr Clin Pract*. 2010;25(4):403-414.
4. Ayers P, Adams S, Boullata J, et al. A.S.P.E.N. parenteral nutrition safety consensus recommendations. *J Parenter Enteral Nutr*. 2014;38(3):296-333.
5. Krzywda E, Meyer D. Parenteral nutrition. In: Alexander M, Corrigan A, Gorski L, Hankins J, Perucca R, eds. *Infusion Nursing: An Evidence-Based Approach*. 3rd ed. St Louis, MO: Saunders/Elsevier; 2010:316-350.
6. American Society for Parenteral and Enteral Nutrition. Standards of practice for nutrition support nurses. *Nutr Clin Pract*. 2007;22(5):558-586.
7. Winkler M, Guenter P. Long-term home parenteral nutrition: it takes an interdisciplinary approach. *J Infus Nurs*. 2014;37(5):389-395.

8. Boullata J, Glibert K, Sacks G, et al. A.S.P.E.N. clinical standards: parenteral nutrition ordering, order review, compounding, labelling, and dispensing. *J Parenter Enteral Nutr*. 2014;38(3):334-377.
9. Gahart B, Nazareno A. *Intravenous Medications: A Handbook for Nurses and Health Professionals*. 31st ed. St Louis, MO: Elsevier/Mosby/Sanders; 2015.
10. US Pharmacopeia (USP). General Chapter <797>: pharmaceutical compounding—sterile preparations. In: *U.S. Pharmacopeia/National Formulary*. 37/32 ed. Rockville, MD: United States Pharmacopeial Convention Inc; 2014.
11. Dugan S, Le J, Jew RK. Maximum tolerated osmolarity for peripheral administration of parenteral nutrition in pediatric patients. *J Parenter Enteral Nutr*. 2014;38(7):847-851.
12. Gazitua R, Wilson K, Bistrian BR, Blackburn GL. Factors determining peripheral vein tolerance to amino acid infusions. *Arch Surg*. 1979;114(8):897-900.
13. Stranz M, Kastango E. A review of pH and osmolarity. *Int J Pharm Compd*. 2002;6(3):216-220.
14. Hoheim DF, O'Callaghan TA, Joswiak BJ, et al. Clinical experience with three-in-one admixtures administered peripherally. *Nutr Clin Pract*. 1990;5(3):118-122.
15. Isaacs JW, Millikan WJ, Stackhouse J, Hersh T, Rudman D. Parenteral nutrition of adults with 900-milliosmolar solution via peripheral vein. *Am J Clin Nutr*. 1977;30(4):552-559.
16. Hoffmann E. A randomized study of central venous versus peripheral intravenous nutrition in the postoperative period. *Clin Nutr*. 1989;8(4):179-180.
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.
18. Kirby D, Corrigan M, Speerhas R, Emery D. Home parenteral nutrition tutorial. *J Parenter Enteral Nutr*. 2012;36(6):632-644.
19. Baxter JP, Fayers PM, McKinley AW. A review of the quality of life of adult patients treated with long-term parenteral nutrition. *Clin Nutr*. 2006;25(4):543-553.
20. Stern JM, Jacyna N, Lloyd DAJ. Review article: psychological aspects of home parenteral nutrition, abnormal illness behavior and risk of self-harm in patients with central venous catheters. *Alimentary Pharmacol Ther*. 2008;27(10):910-918.
21. Winkler MF, Smith CE. The impact of long-term home parenteral nutrition on the patient and family. *J Infus Nurs*. 2015;38(4):290-300.
22. The Oley Foundation Web site. www.oley.org.

62. TRANSFUSION THERAPY

Standard

62.1 Verification of the correct patient and blood product is performed in the presence of the patient prior to transfusion.

62.2 Blood and blood components are filtered using an in-line or add-on filter appropriate to the prescribed therapy.

Practice Criteria

A. Administer human blood and blood components (whole blood, red blood cells, plasma and plasma components, platelets, granulocytes, cryoprecipitate) only after alternative therapy has been considered. Transfuse blood and blood components in accordance with evidence-based indications to ensure patient safety, optimal patient outcomes, and eliminate unnecessary transfusions.[1-6] (V)

B. Ensure that informed consent was obtained. Consent should include a description of risks, benefits, and treatment alternatives, an opportunity to ask questions, and the right to accept or refuse the transfusion.[7,8] (V)

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 vascular access device (VAD), and current laboratory values.[8,9] (V)

D. Choose an appropriate VAD based on patient condition and transfusion needs:
   1. Short peripheral catheters: use 20 to 24 gauge based on vein size and patient preference. When rapid transfusion is required, a larger-size catheter gauge is recommended (14-18 gauge).[8,10] (IV)
   2. Central vascular access devices (CVADs): acceptable for transfusions; recognize that with peripherally inserted central catheters, infusion may be slower based on catheter length and lumen size.[8,11] (V)
   3. Neonatal/pediatric patients: umbilical venous catheters or small saphenous vein catheters (24 gauge) are commonly used in infants and/or pediatric patients.[8,10,12] (V)

E. Perform patient and blood product identification:
   1. At the time that the blood component is released from the transfusion service to include: recipient's 2 independent identifiers; ABO group and Rh type; donation identification number; ABO group and Rh type if required; crossmatch test interpretation if performed; special transfusion requirements; expiration date/time; and date/time of issue.[7,8,13] (V)
   2. During 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: registered nurse and responsible adult):
      a. Verify the blood component: review the licensed independent practitioner's (LIP's) order for transfusion; type of blood component (red blood cell, plasma, platelet); patient blood type compatibility with the unit to be transfused; crossmatch test interpretation if performed; donor identification number; unit

expiration date/time; and any product modification such as irradiation or cytomegalovirus (CMV) seronegative component.[7,8,13] (V)

b. A 1-person verification process may be used with automated identification technology (eg, bar code with appropriate logic/interface application). The use of computerized bar code-based blood identification systems resulted in a large increase in discovered near-miss events. Emerging technology includes radiofrequency identification devices.[8,14-16] (IV)

F. Inspect each blood component prior to transfusion, and do not use if container is not intact or if the appearance is not normal (eg, excessive hemolysis, significant color change in blood bag compared to administration set, presence of floccular material, cloudy appearance) and return it to the transfusion service.[8,13] (V)

G. Administer blood or blood components with 0.9% sodium chloride. No other solutions or medications should be added to or infused through the same administration set with blood or blood components unless they have been approved by the US Food and Drug Administration (FDA) for this use.[7,8,13] (I A/P)

H. 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.[7,8,13] (V)
   2. Do not use microaggregate filters routinely; these are most often used for reinfusion of blood shed and collected during surgery.[8] (V)
   3. Leukoctye 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 (red cells and platelets) decreases the risk of febrile transfusion reactions, risk of human leukocyte antigen (HLA) alloimmunization, and transmission of CMV.[8] (V)
   4. Never use leukocyte filtration when transfusing granulocyte or hematopoietic progenitor cells.[7,8,13] (V)

I. Change the transfusion administration set and filter after the completion of each unit or every 4 hours. If more than 1 unit can be infused in 4 hours, the transfusion set can be used for a 4-hour period (see Standard 42, *Administration Set Change*).[8] (V)

J. Administer and complete each unit of blood or blood component within 4 hours. Consider asking the transfusion service to divide a unit of red blood cells or whole blood into smaller aliquots when slower infusion of a unit is required, such as with pediatric patients or adult patients at risk for fluid overload. Platelets should be administered over 30 minutes to 4 hours. Each unit of plasma should be administered as quickly as tolerated by the patient or over 15 to 60 minutes.[8,13] (V)

K. Electronic infusion devices (EIDs) can be used to deliver blood or blood components without significant risk of hemolysis of red blood cells. EIDs that have a labeled indication for blood transfusion should be used. Follow the manufacturers' directions for use (see Standard 24, *Flow-Control Devices*).[8,17] (IV)

L. Use only a blood-warming device, with a labeled indication, when clinically necessary, such as with large-volume or rapid transfusions, exchange transfusions, patients with clinically significant conditions, and the neonate/pediatric population. The risk for clinically important hypothermia is increased when blood is transfused through a CVAD (see Standard 25, *Blood and Fluid Warming*).[7,8] (V)

M. Consider the use of an externally applied compression device or electronic rapid infusion device, according to manufacturers' directions for use, 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. For rapid infusion, a larger-gauge catheter may be more effective than a pressure device.[8] (V)

N. Monitor for adverse transfusion events.
   1. Check the patient's vital signs prior to transfusion, within 5 to 15 minutes after initiating transfusion, after the transfusion, and as needed depending on patient condition.[8] (V)
   2. Initiate the transfusion slowly at approximately 2 mL per minute for the first 15 minutes, and remain near the patient; increase the transfusion rate if there are no signs of a reaction and to ensure the completion of the unit within 4 hours.[8] (V)
   3. Stop the transfusion immediately if signs and symptoms of a transfusion reaction are present; notify the LIP and transfusion service, and administer emergency medications as prescribed.[7,8,13,18] (V)
   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.[7,8,12,18] (V)

O. Ensure safe transfusion practice if transfusing in an out-of-hospital setting including the following: documentation showing no identified adverse events

during previous transfusions; immediate access to the LIP by phone during the transfusion; another competent adult present and available to assist with patient identification and calling for medical assistance if needed; ability to transport blood product in cooling containers verified for correct temperature; ability to appropriately dispose of medical waste; and a well-designed patient and caregiver education process, including clearly written instructions regarding transfusion reactions.[8] (V)

P. Consider participation in the National Healthcare Safety Network's (NHSN's) voluntary program to monitor recipient adverse reactions and quality control incidents related to blood transfusions. Participation provides organizations with data that can be used for interorganizational comparison and quality improvement activities.[19] (V)

REFERENCES

Note: All electronic references in this section were accessed September 14, 2015.

1. Ghiglione M, Puca KE. Patient blood management. In: Fung MK, Grossman BJ, Hillyer CD, Westhoff CM, eds. *AABB Technical Manual*. 18th ed. Bethesda, MD: AABB; 2014:599-619.
2. Tolich DJ, Blackmur S, Stahorsky K, Wabeke D. Blood management: best practice transfusion strategies. *Nursing*. 2013;43(1):40-47.
3. Carson JL, Grossman BJ, Kleinman S, et al; Clinical Transfusion Medicine Committee of the AABB. Red blood cell transfusion: a clinical practice guideline from the AABB. *Ann Intern Med*. 2012;157(1):49-58.
4. Roback JD, Caldwell SA, Carson JL, et al. Evidence-based practice guidelines for plasma transfusion strategies. *Transfusion*. 2010;50(6):1227-1239.
5. Roback J. Evidence-based guidelines for blood transfusion. *J Infus Nurs*. 2012;35(1):187-190.
6. Kaufman RM, Djulbegovic B, Gernsheimer T, et al. Platelet transfusion: a clinical practice guideline from the AABB. *Ann Intern Med*. 2015;162(3):205-213.
7. AABB. *Standards for Blood Banks and Transfusion Services*. 29th ed. Bethesda, MD: AABB; 2014.
8. Maynard K. Administration of blood components. In: Fung MK, Grossman BJ, Hillyer CD, Westhoff CM, eds. *AABB Technical Manual*. 18th ed. Bethesda, MD: AABB; 2014:545-559.
9. Phillips L, Gorski LA. *Manual of IV Therapeutics: Evidence-Based Practice for Infusion Therapy*. 6th ed. Philadelphia, PA: FA Davis; 2014:682-765.
10. Stupnyckyj C, Smolarek S, Reeves C, McKeith J, Magnan M. Changing blood transfusion policy and practice. *Am J Nurs*. 2014;114(12):50-59.
11. Hendricks M, Kolmer V. Blood and blood component therapy. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles & Practice of Intravenous Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:480-529.
12. Josephson CD, Meyer E. Neonatal and pediatric transfusion practice. In: Fung MK, Grossman BJ, Hillyer CD, Westhoff CM, eds. *AABB Technical Manual*. 18th ed. Bethesda, MD: AABB; 2014:571-597.
13. AABB. Circular of information for the use of human blood and blood components. http://www.aabb.org/tm/coi/Documents/coi1113.pdf. Published 2013.
14. Nuttal GA, Abenstein JP, Stubbs JR, et al. Computerized bar code-based identification systems and near-miss transfusion episodes and transfusion errors. *Mayo Clin Proc*. 2013;88(4):354-359.
15. Askeland RW, McGrane SP, Reifert DR, Kemp JD. Enhancing transfusion safety with an innovative bar-code-based tracking system. *Healthc Q*. 2009;12(Sp):85-89.
16. Hohberger C, Davis R, Briggs L, Guitierrez A, Veeramani D. Applying radiofrequency identification (RFID) technology in transfusion medicine. *Biologicals*. 2012;40(3):209-213.
17. Frey B, Eber S, Weiss M. Changes in red blood cell integrity related to infusion pumps: a comparison of 3 different pump mechanisms. *Pediatr Crit Care Med*. 2003;4(4):465-470.
18. Crookston KP, Koenig JC, Reyes MD, et al. Transfusion reaction identification and management at the bedside. *J Infus Nurs*. 2015;38(2):104-113.
19. National Healthcare Safety Network. Blood safety surveillance. http://www.cdc.gov/nhsn/acute-care-hospital/bio-hemo/index.html. Updated September 14, 2015.

63. MODERATE SEDATION/ANALGESIA USING INTRAVENOUS INFUSION

Standard

63.1 The registered nurse may administer moderate sedation/analgesia using intravenous (IV) infusion in accordance with rules and regulations promulgated by the state's Board of Nursing and in accordance with organizational policies and procedures.

63.2 The registered nurse is competent in the administration of moderate sedation/analgesia, including knowledge of preprocedure assessment, different sedation levels; safe medication administration; and reversal agents for moderate sedation/analgesia, as well as airway management; monitoring of physiological parameters; common complications and interventions; and resuscitation through age-appropriate cardiac life support validation.

63.3 An emergency cart and reversal agents are immediately accessible, and clinicians with expertise in airway management, emergency intubation, advanced cardiopulmonary life support, and management of potential complications are immediately available.

Practice Criteria

A. Ensure competency and advanced knowledge and skills when administering IV sedation/analgesia.[1-7] (IV)

B. Identify a list of medications that may be administered by the registered nurse: medications for moderate sedation that may be administered include benzodiazepines (midazolam, diazepam); narcotics (fentanyl, meperidine); propofol; neuroleptic

tranquilizers (droperidol); and antihistamines (diphenhydramine).[2-4,7] (IV)

C. Ensure patient informed consent was obtained according to organizational policy and procedure (see Standard 9, *Informed Consent*).[4,7] (IV)
D. 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 post procedure.[4,7] (IV)
E. Perform a comprehensive preprocedural assessment to include medical history/current condition, current medications, allergies, previous sedation experience, drug/alcohol/tobacco use, and verification of NPO (nothing by mouth) status.
   1. Consult with an anesthesia licensed independent practitioner (LIP) based on any problematic issues identified during the assessment, such as significant opioid use, history of intolerance to moderate sedation, airway issues, allergies, and significant comorbidities.[2,4,7] (IV)
F. Initiate and maintain vascular access throughout the procedure and recovery for administration of medications and for potential need for emergency resuscitative medications, oxygen, 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.[2,4,7] (IV)
G. Monitor the patient continuously throughout the procedure, including blood pressure, respiratory rate, oxygen saturation, cardiac rate and rhythm, and level of consciousness. The clinician who is monitoring the patient receiving moderate sedation should have no other responsibilities during the procedure.[2-4,7,8] (IV)
H. Use of capnography is recommended to measure adequacy of ventilation.[4,7,9] (IV)
   1. Use valid and reliable tools or established organizational criteria to assess adequacy of sedation and analgesia and readiness for discharge home or transfer to a hospital unit.[2-4,7,9-11] (II)
I. Observe the patient for at least 90 minutes after the procedure if reversal agent administration is required.[7] (IV)
J. Provide patient and caregiver education prior to, and reinforcement after the procedure, about the sedation/analgesia infusion; procedure; restrictions; potential complications related to the infusion site and the procedure; emergency instructions; and 24-hour contact phone number.[4,7] (IV)

REFERENCES

Note: All of the electronic references in this section were accessed September 14, 2015.

1. American Association of Moderate Sedation Nurses (AAMSN) [position statement]. The role of the registered nurse in the management of patients receiving conscious sedation for short-term therapeutic, diagnostic, or surgical procedures. http://aamsn.org. Published 2009.
2. American Association of Nurse Anesthetists (AANA). Registered nurses engaged in the administration of sedation and analgesia. http://www.aana.com/resources2/professionalpractice/Pages/Registered-Nurses-Engaged-in-the-Administration-of-Sedation-and-Analgesia.aspx. Published 1996. Updated November 2005.
3. Society of Gastroenterology Nurses and Associates (SGNA) [position statement]. Statement on the use of sedation and analgesia in the gastrointestinal endoscopy setting. https://www.sgna.org/Portals/0/Education/PDF/Position-Statements/Sedation_2013-FINAL.pdf. Published 1991. Updated 2013.
4. Caperilli-White L, Urman RD. Developing a moderate sedation policy: essential elements and evidence-based considerations. *AORN J*. 2014;99(3):416-430.
5. 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.
6. Conway A, Rolley J, Page K, Fulbrook P. Issues and challenges associated with nurse-administered procedural sedation and analgesia in the cardiac catheterisation laboratory: a qualitative study. *Clin Nurs*. 2014;23(3-4):374-384.
7. Amornyotin S. Registered nurse-administered sedation for gastrointestinal endoscopic procedure. *World J Gastrointest Endosc*. 2015;7(8):769-776.
8. Conway A, Page K, Rolley JX, Worrall-Carter L. Nurse-administered procedural sedation and analgesia in the cardiac catheter laboratory: an integrative review. *Int J Nurs Stud*. 2011;48(8):1012-1023.
9. American Society of Anesthesiologists. Standards for basic anesthetic monitoring. http://www.asahq.org/quality-and-practice-management/standards-and-g uidelines/search?q=basic anesthetic monitoring. Published 1986. Updated 2011.
10. Celis-Rodríguez E, Birchenall C, de la Cal MÁ, et al. Clinical practice guidelines for evidence-based management of sedoanalgesia in critically ill adult patients. *Med Intensiva*. 2013;37(8):519-574.
11. Dorfman TL, Sumamo Schellenberg E, Rempel GR. 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.

64. THERAPEUTIC PHLEBOTOMY

Standard

64.1 All hazardous waste, including that from therapeutic phlebotomy, will be disposed of according to organizational policies and procedures.

Practice Criteria

A. Include the following in orders 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, and specific volume of blood to be withdrawn.[1-3] (IV)

B. Prevent, manage, and recognize common side effects, such as hypovolemia, nausea/vomiting, or rare adverse events, by using a reclining chair or exam table/bed for the procedure; monitoring vital signs before and after the procedure; encouraging oral hydration before and after the procedure; asking about fear of needles or blood; and administering parenteral solution replacement if prescribed, indicating the type of solution, amount, and rate of infusion.[1,2,4-13] (IV)

C. Select the most appropriate vascular access device (VAD) based on patient condition, anticipated length of treatments needed, and other infusion therapies:
   1. Short peripheral catheter using an 18- to 20-gauge device and inserted before phlebotomy and removed upon completion.
   2. Central vascular access device (CVAD) if already placed, and therapeutic phlebotomy will not compromise other infusion therapies.
   3. Apheresis catheter.[1,11] (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 containers to facilitate blood flow due to risk of air embolism.[1] (V)

E. After completion of the phlebotomy, manual pressure should be maintained at the venipuncture site after removal of the peripheral catheter until bleeding has stopped, then a dressing applied. The patient should remain in a reclining position for several minutes, then instructed to rise slowly.[1,2,4] (V)

F. Provide patient education, including potential side effects such as a hematoma, syncope, and nausea/vomiting. Instructions should include the type and amount of physical activity before and after the procedure.[1,4] (V)

G. Documentation should include total volume of blood withdrawn, patient response to the procedure, vital signs, dressing applied or catheter locking, and patient instructions.[1] (V)

REFERENCES

1. Cook LS. Therapeutic phlebotomy: a review of diagnoses and treatment considerations. *J Infus Nurs*. 2010:33(2):81-88.
2. Hagle ME, Mikell M. Peripheral venous access. In: Weinstein SM, Hagle ME, eds. *Plumer's Principles and Practice of Infusion Therapy*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2014:303-334.
3. Siddique A, Kowdley K. Review article: the iron overload syndromes. *Aliment Pharmacol Ther*. 2012;35(8):876-893.
4. Antle E. Who needs a therapeutic phlebotomy? *Clin J Oncol Nurs*. 2010;14(6):694-696.
5. Brissot P, Ball S, Rofail D, Cannon H, Jin V. Hereditary hemochromatosis: patient experiences of the disease and phlebotomy treatment. *Transfusion*. 2011;51(6):1331-1338.
6. Davaine J, Sebbag U, Bardou-Jacquet E, Brissot P. Brachial artery pseudoaneurysm after phlebotomy for iron overload: first case report. *Transfusion*. 2013;53(6):1373-1375.
7. France CR, France JL, Kowalsky JM, et al. Assessment of donor fear enhances prediction of presyncopal symptoms among volunteer blood donors. *Transfusion*. 2012;52(2):375-380.
8. France CR, France JL, Menitove J, et al. How afraid are you of having blood drawn from your arm? A simple fear question predicts vasovagal reactions without causing them among high school donors. *Transfusion*. 2013;53(2):315-321.
9. Holsworth R, Cho Y, Weidman J, Sloop G, Cyr J. Cardiovascular benefits of phlebotomy: relationship to changes in hemorheological variables. *Perfusion*. 2014;29(2):102-116.
10. Powden S. Blood-injection-injury phobia: preventative intervention for syncope. *J Contin Educ Top Issues*. 2014;16(2):52-54.
11. Rombout-Sestrienkova E, Nieman F, Koek G, et al. Erythrocytapheresis versus phlebotomy in the initial treatment of HFE hemochromatosis patients: results from a randomized trial. *Transfusion*. 2012;52(3):470-477.
12. van Dongen A, Abraham C, Ruiter R, Veldhuizen I. The influence of adverse reactions, subjective distress, and anxiety on retention of first-time blood donors. *Transfusion*. 2013;53(2):337-343.
13. Wieling W, France C, van Dijk N, Kamel H, Thijs R, Tomasulo P. Physiologic strategies to prevent fainting responses during or after whole blood donation. *Transfusion*. 2011;51(12):2727-2738.

Appendix A.

Infusion Team Definition

This team is defined as a group of nursing personnel centrally structured within an acute health care facility charged with the shared mission of outcome accountability for the delivery of infusion therapy. While this team may not be directly providing each infusion, they provide the advanced knowledge for safe practices to support the primary care staff. Thus, the roles of the infusion team members include direct care providers, educators, consultants, coaches, mentors, advocates, coordinators, and managers.

This team is led by infusion nurse specialists (eg, CRNI®s) and may contain a staff mix of registered nurses, licensed practical nurses, and unlicensed assistive personnel. Unlicensed team members work under the direction of the licensed professional infusion nursing staff.

The scope of services for the infusion team consists of a variety of activities related to the safe insertion, delivery, and maintenance of all infusion and vascular access therapies including fluids and medications, blood and blood components, and parenteral nutrition. The identified services of this team should be based on the fact that infusion therapy is needed in all areas of the organization and by all ages of patients/clients. This team will provide guidance for establishing policy and practices according to the nationally recognized *Infusion Therapy Standards of Practice*.

Goals for this team include accuracy, efficiency, and consistency for safe delivery of all infusion services, along with reduction and/or elimination of complications. Meeting this goal will reduce liability, lower costs, and decrease length of stay, while promoting vascular preservation, greater patient satisfaction, and better outcomes.

Responsibility for performing direct clinical practice should be divided between the infusion team and the primary nursing staff based on documented clinical outcomes, patient populations and their specific needs and risks, and the complexity of the knowledge and skill(s) required to perform each nursing intervention.

The Centers for Disease Control and Prevention (CDC) and published research recognize that the use of teams in the health care setting reduces mistakes and enhances patient safety, thereby indicating that the use of an infusion team is strongly recommended for all health care organizations.

Source: Hadaway L, Dalton L, Mercanti-Erieg L. Infusion teams in acute care hospitals: call for a business approach: an Infusion Nurses Society white paper. J Infus Nurs. *2013;36(5):356-360.*

Appendix B. Illustrations

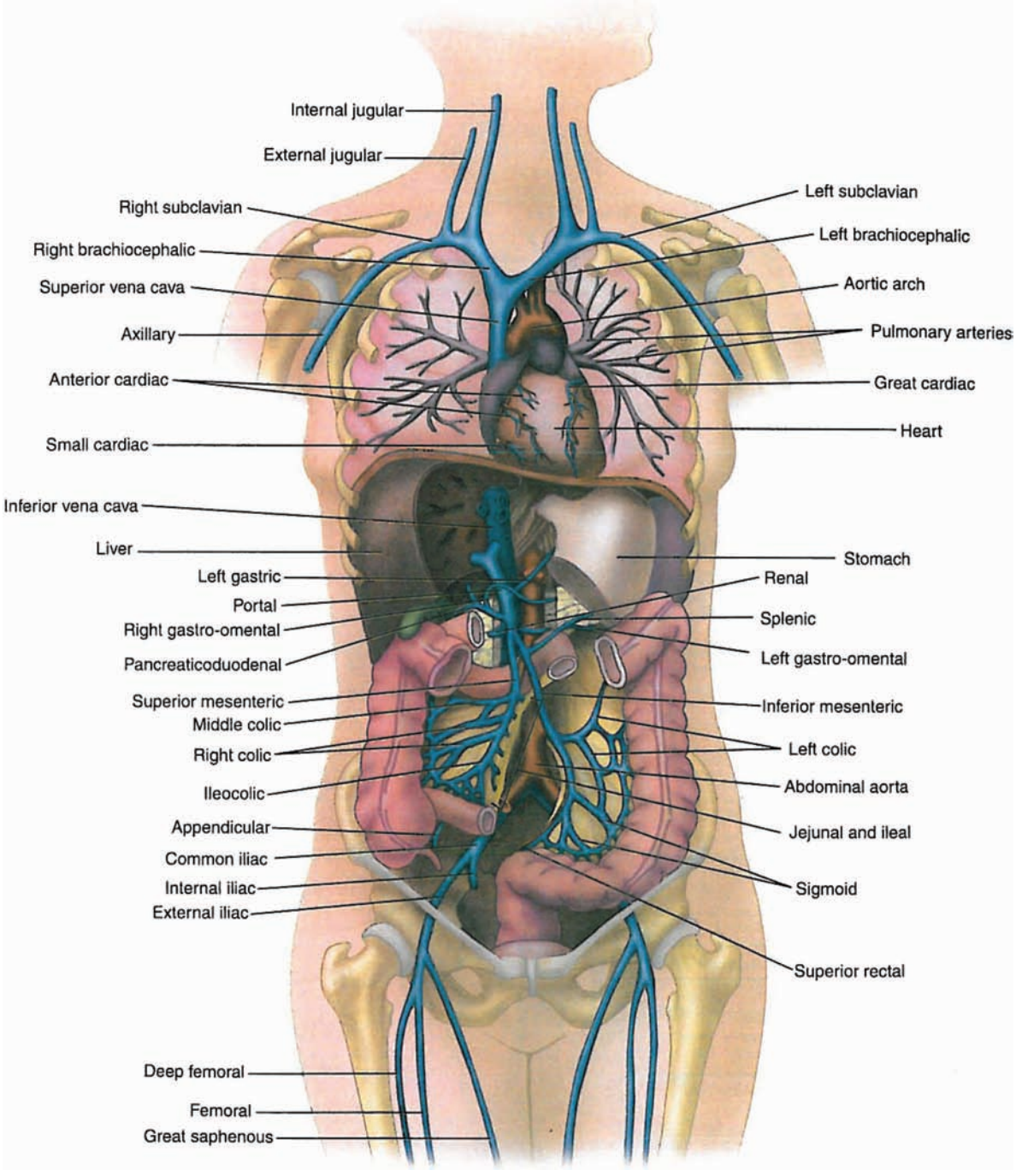

Figure 1 Principal veins of the body. From *Dorland's Illustrated Medical Dictionary*. 30th ed. Philadelphia, PA: Saunders/Elsevier; 2003: 2014. Used with permission.

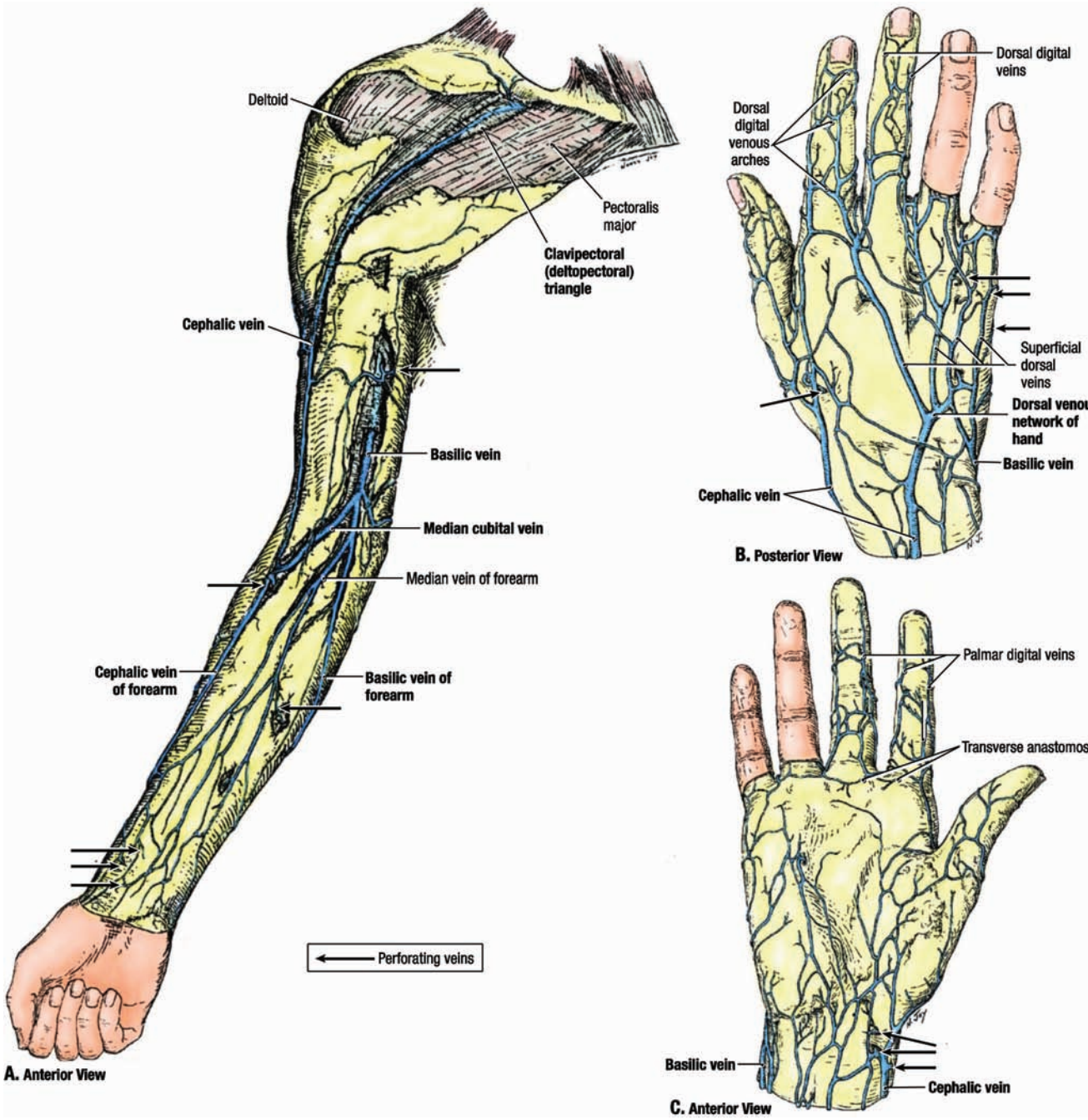

Figure 2 Superficial venous drainage of upper limb. A. Forearm, arm, and pectoral region. B. Dorsal surface of hand. C. Palmar surface of hand. The arrows indicate where perforating veins penetrate the deep fascia. Blood is continuously shunted from these superficial veins in the subcutaneous tissue to deep veins via the perforating veins. From Agur AMR, Dalley AF. *Grant's Atlas of Anatomy*. 13th ed. Philadelphia, PA: Wolters Kluwer/ Lippincott Williams & Wilkins; 2013:498. Used with permission.

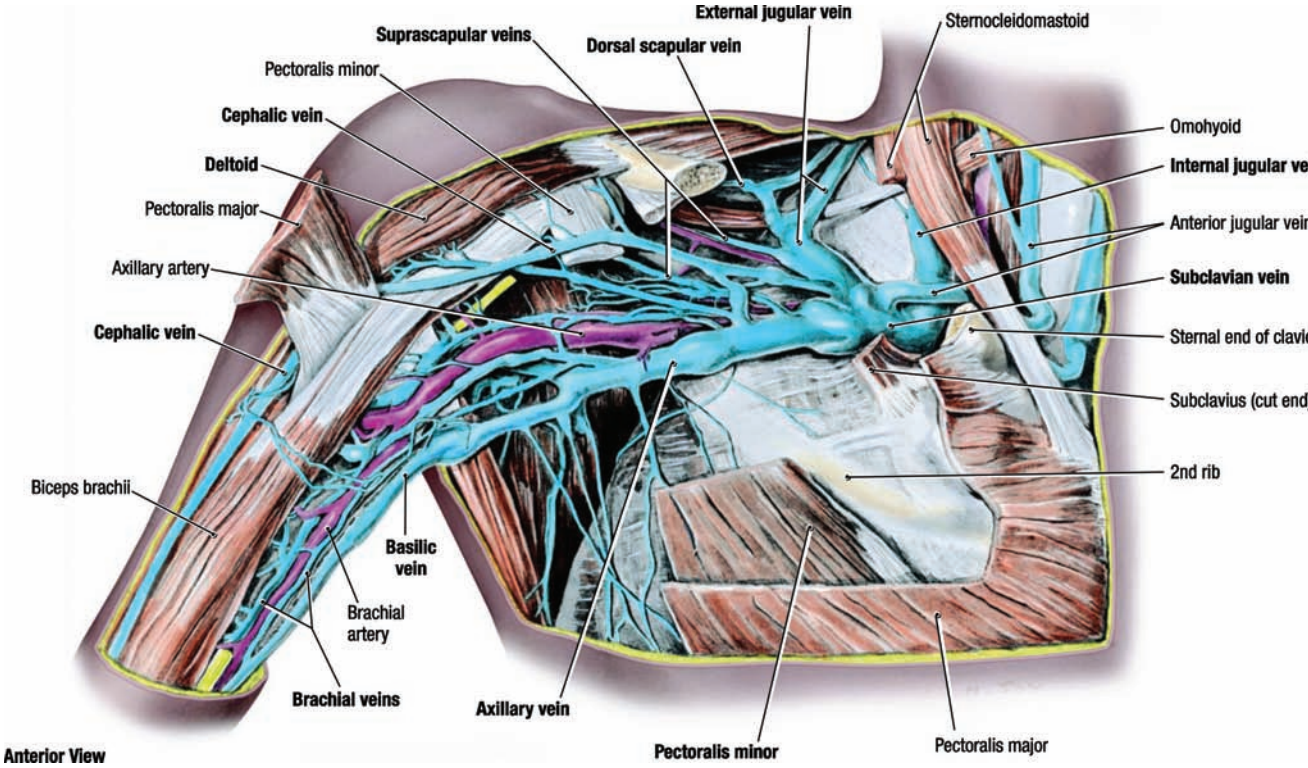

Figure 3 Veins of axilla. The basilic vein joins the brachial veins to become the axillary vein near the inferior border of teres major, the axillary vein becomes the subclavian vein at the lateral border of the first rib, and the subclavian joins the internal jugular to become the brachiocephalic vein posterior to the sternal end of the clavicle. Numerous valves, enlargements in the vein, are shown. The cephalic vein in this specimen bifurcates to end in the axillary and external jugular veins. From Agur AMR, Dalley AF. *Grant's Atlas of Anatomy*. 13th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2013:509. Used with permission.

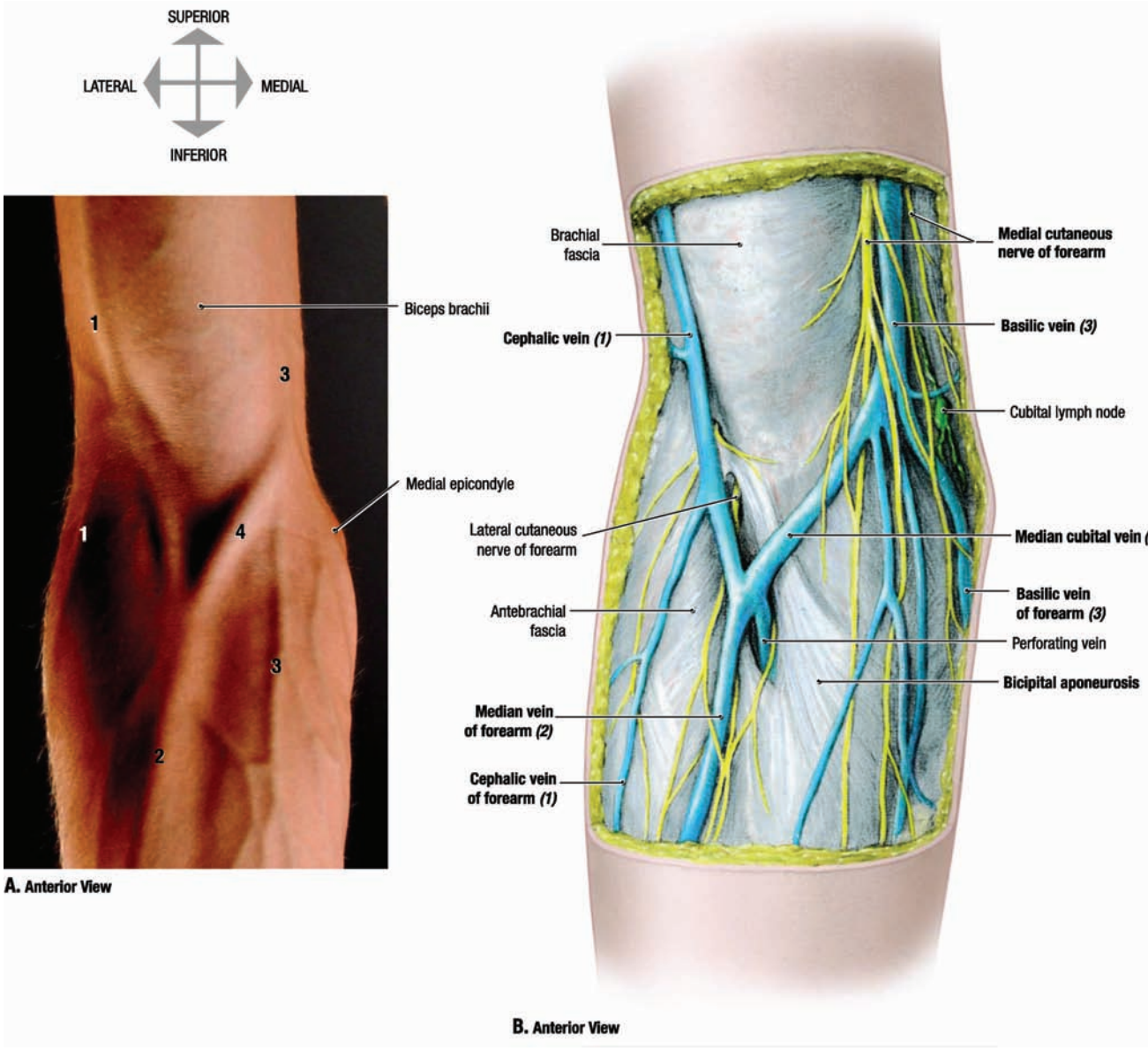

Figure 4 Cubital fossa: surface anatomy and superficial dissection—anterior view. Cutaneous nerves and superficial veins. From Agur AMR, Dalley AF. *Grant's Atlas of Anatomy*. 13th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2013:546. Used with permission.

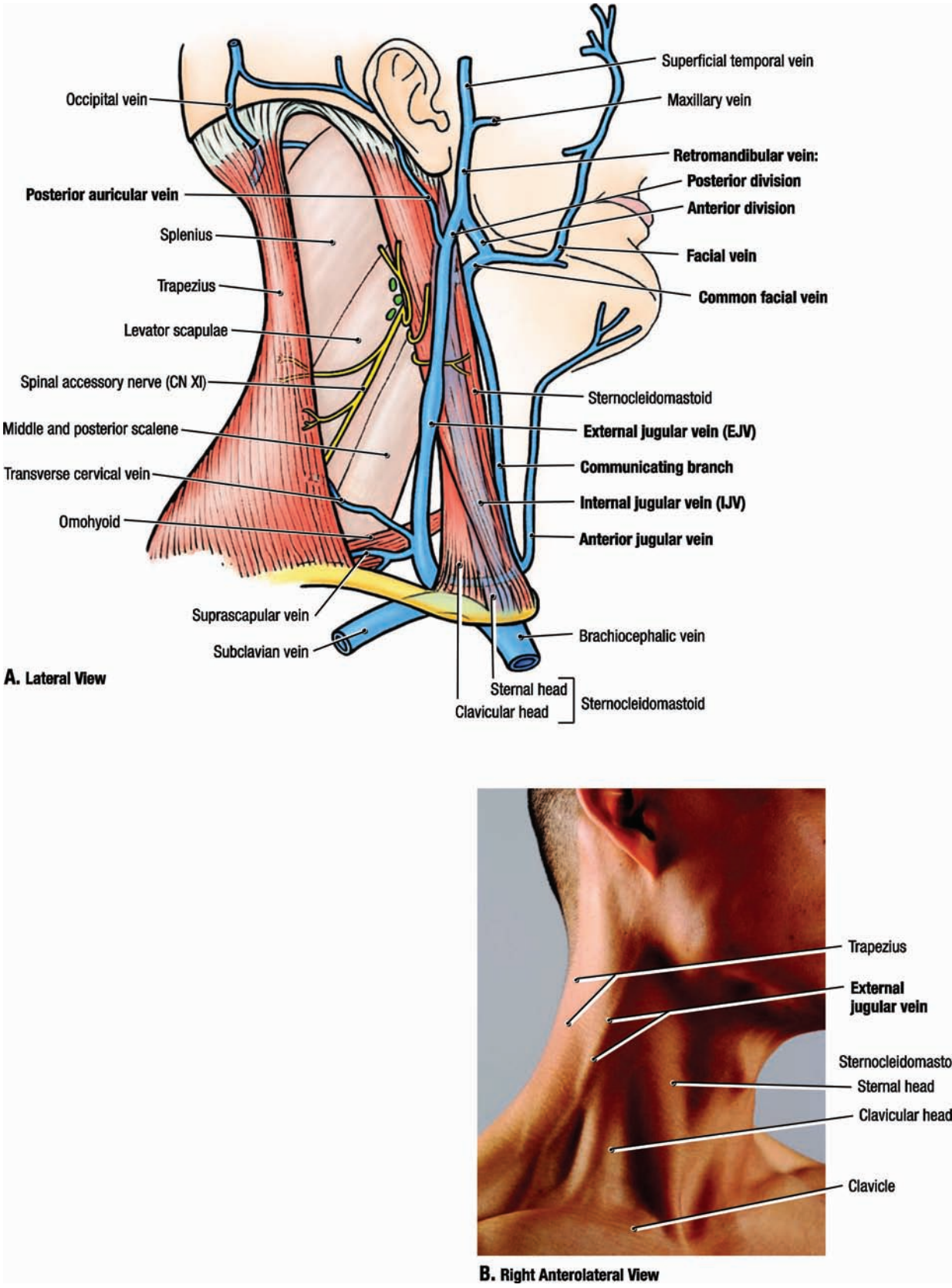

Figure 5 Superficial veins of the neck—lateral view. The superficial temporal and maxillary veins merge to form the retromandibular vein. The posterior division of the retromandibular vein unites with the posterior auricular vein to form the external jugular vein (EJV). The facial vein receives the anterior division of the retromandibular vein, forming the common facial vein that empties into the internal jugular vein. From Agur AMR, Dalley AF. *Grant's Atlas of Anatomy.* 13th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2013:754. Used with permission.

Glossary

A

Add-on Device. Additional component, such as an in-line filter, stopcock, Y-site, extension set, manifold set, and/or needleless connector, that is added to the administration set or vascular access device.

Administration Set. A tubing set composed of plastic components that is used to deliver infusions and that typically includes a spike, a drip chamber, injection ports, and a male luer-lock end. Variations may include a Y-set, integrated filter, and microbore tubing.

Admixture. To mix; to combine 2 or more medications.

Advanced Practice Registered Nurse (APRN). A nurse practitioner, clinical nurse specialist, nurse anesthetist, or nurse midwife.

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 venous 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.

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 and assisted living facility, outpatient center/clinic, and physician office.

Ambulatory Infusion Device. Infusion device specifically designed to be worn on the body to promote patient mobility and independence.

Amino Acids. Organic components of protein.

Ampoule. Hermetically sealed glass medication container that must be broken at the neck to access the medication.

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 CVAD. Central vascular access device coated or impregnated with antiseptic or antimicrobial agents.

Antimicrobial Locking Solutions. Solutions using supratherapeutic concentrations of antibiotic, or a variety of antiseptic agents, to lock the central vascular access device (CVAD) lumen for a prescribed period of time for prevention or treatment of catheter-related bloodstream infection (CR-BSI).

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. Monitoring of arterial pressure through an indwelling arterial catheter connected to an electronic monitor.

Arteriovenous (AV) Fistula. Surgical anastomosis between an artery and vein.

Arteriovenous (AV) Graft. Surgical structure created between an artery and a vein, usually of a manufactured synthetic material.

Aseptic No-Touch Technique. A theoretical framework for safe and effective aseptic practice that can be applied to all clinical procedures.

Aseptic Technique. A primary infection prevention method to maintain objects and areas maximally free from microorganisms (eg, through use of sterile supplies, barriers, and absolute separation of sterile items from those that are not sterile).

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

Bacteria. Microorganisms that may be nonpathogenic (normal flora) or pathogenic (disease causing).

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 thin coating, usually a resistant layer, 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). Used during drug compounding; a ventilated cabinet that has an open front with inward airflow to protect personnel, downward high-efficiency particulate air (HEPA)-filtered laminar flow to protect the product, and HEPA-filtered exhausted air to protect the environment.

Blood Return. A component of VAD patency assessment; blood that is the color and consistency of whole blood 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 many classes of drug dosages.

Bolus. Concentrated medication and/or solution given rapidly over a short period of time.

C

Catheter. A hollow tube made of thermoplastic polyurethane, silicone elastomer, or metal; inserted into the body and used for injecting or evacuating fluids.

Catheter-Associated Venous Thrombosis (CAVT). A secondary vein thrombosis related to the presence of a CVAD; includes the presence of an extraluminal fibrin sheath encompassing all or part of the CVAD's length, with a mural or veno-occlusive thrombosis overlying the fibrin sheath; may be located in deep veins or superficial veins when placed for CVAD use.

Catheter Clearance. The process to reestablish catheter lumen patency using medications or chemicals instilled into the lumen for a specific period of time.

Catheter Dislodgment. Catheter movement into or out of the insertion site indicating tip movement to a suboptimal position.

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). A clinical definition used when the catheter is identified through specific laboratory testing to be the source of the bloodstream infection.

Central Line-Associated Bloodstream Infection (CLABSI). A laboratory-confirmed, primary bloodstream infection in a patient with a central line in place for more than 2 calendar days before the development of the bloodstream infection (BSI), and the BSI is not related to an infection at another site. The CLABSI definition is used for surveillance purposes and may overestimate the true incidence of catheter-related bloodstream infection (CR-BSI). Refer to the Centers for Disease Control and Prevention's (CDC's) National Healthcare Safety Network (NHSN) for the current CLABSI surveillance criteria.

Central Vascular Access Device (CVAD). Catheter inserted into a peripheral or centrally located vein with the tip residing in 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 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 CVAD Malposition.** CVAD tip positioned in a suboptimal or unacceptable location occurring during the insertion procedure.
- **Secondary CVAD 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.

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 (VAD) 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.

Closed System Drug Transfer Device. A drug 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.

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.

Color Coding. System that identifies products and medications by the use of a color system.

Compatibility. Capable of being mixed and administered without undergoing undesirable chemical and/or physical changes or loss of therapeutic action.

Competence. Capability of the individual to apply knowledge, critical thinking, interpersonal, decision-making, and psychomotor skills to the performance of infusion therapy.

Competency. An integration of behaviors in the varied circumstances of the work environment demonstrating the individual's ability to perform the desired job-related activities and tasks.

Competency Assessment. The process of reviewing and documenting the individual's demonstrated ability to perform a job, role, specific tasks, or other patient care activities.

Compounding. The act of preparing, mixing, assembling, packaging, and labeling a drug, drug delivery device, or device according to a practitioner's prescription for an individual patient or based on a professional agreement between the practitioner, patient, and pharmacist.

Compounding Aseptic Containment Isolator (CACI). Used during drug compounding to provide health care worker protection from exposure to undesirable levels of airborne drugs and to provide an aseptic environment when compounding sterile preparations.

Computerized Prescriber Order Entry (CPOE). A system in which clinicians directly enter medication, test, or procedure orders into a computer system; medication orders are transmitted directly to the pharmacy.

Conscious Sedation. Minimally depressed level of consciousness in which the patient retains the ability to maintain a patent airway independently and continuously and to respond appropriately to physical stimulation and verbal commands. The drugs, doses, and techniques used are not intended to produce loss of consciousness.

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.

Contamination. Introduction or transference of pathogens or infectious material from one source to another.

Cross Contamination. The indirect movement of pathogens or other harmful substances from one patient to another patient.

Cultural Competency. The delivery of infusion services that are 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. As applied to needleless connectors, this is the internal space outside the intended fluid pathway into which fluid can move.

Decontamination. The removal of pathogenic microorganisms from objects so they are safe to handle, use, or discard.

Deep Sedation. Drug-induced depression of consciousness; the patient responds persistently to repeated or painful stimulation; the capacity to preserve respiratory function may be diminished and support to maintain the airway and spontaneous respiration may be required. Cardiovascular function is generally preserved.

Delegation. The process by which a registered nurse (RN) directs another person to perform tasks or activities not commonly performed by that person; the RN retains accountability for the outcome of the delegated tasks or activity.

Difficult Vascular Access. Multiple unsuccessful venipuncture attempts (ie, maximum of 4) 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.

Dilution. To add a diluent (eg, 0.9% sodium chloride, sterile water) to a solution of medication in order to make it less concentrated or to provide additional solution for ease of administration and titration, or to decrease the tissue irritation of a medication.

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 all microorganisms except bacterial spores.

Disinfection. A process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects.

Disinfection Cap. Plastic cap containing an antiseptic solution placed on top of the connection surface of a needleless connector to disinfect the surface and provide protection between intermittent uses.

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 System. Electronic infusion devices (EIDs) manufactured with drug libraries containing drug name and soft and hard infusion limits; EIDs designed to prevent errors in solution and mediation 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

Electronic Infusion Device (EID). Device that is powered by electricity or battery to regulate infusion rate; may be either a positive-pressure pump or controller (gravity fed) used to regulate the flow rate of the infusion therapy.

Embolus. Mass of undissolved matter present in blood or lymphatic vessel; an embolus may be solid, liquid, or gaseous.

Engineered Stabilization Device. A device or system placed subcutaneously or topically; specifically designed and engineered to control movement at the catheter hub.

Engineering Controls. Devices that isolate or remove the blood-borne pathogens hazard from the workplace, such as sharps disposal containers, self-sheathing needles, needleless systems, and sharps with engineered protections.

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 along a vein track that results from vascular irritation or capillary congestion in response to irritation; may be a precursor to or indication of phlebitis.

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.

Extrinsic Contamination. Contamination that occurs after the manufacturing process of a product.

F

Fat Emulsion (Intravenous Fat Emulsion [IVFE]). Combination of liquid, lipid, and an emulsifying system formulated for intravenous use.

Filter. A special porous device used to prevent the passage of air or other undesired substances; 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), mechanical infusion devices (see definition), and electronic infusion devices (see definition).

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

Gap Analysis. Assessment of the difference(s) between actual and required knowledge, skill, or performance; may be done on an individual, department, or organizational level.

Guidewire. A long, flexible metal structure, composed of tightly wound coiled wire in a variety of designs; contains safety mechanisms that allow it to be inserted into the vein or artery.

H

Hazardous Drugs. Drugs 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 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, containers and intravenous supplies used to administer hazardous drugs).

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.

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.

Hemodynamic Pressure Monitoring. A general term for determining 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.

Hospital Disinfectant. A disinfectant registered by the Environmental Protection Agency (EPA) for use in hospitals, clinics, dental offices, and any other medical-related facility.

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 treatment of dehydration by infusing fluids into the subcutaneous tissues at rates greater than 3 mL/hour; solutions are isotonic or near-isotonic.

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

Immediate-Use Compounded Sterile Preparations (CSPs). Used in emergent situations or in situations where adhering to low-risk compounding procedures would add additional risk due to delays in patient care (eg, medications with short stability that must be prepared immediately before administration outside health care facilities, such as in home infusion). Immediate-use CSPs do not need to be compounded in an ISO Class 5 environment, and garbing and gowning are not required, as long as *all* of the following criteria are met:

1. Hand hygiene per Centers for Disease Control and Prevention (CDC) recommendations.
2. Aseptic technique is followed.
3. No hazardous drugs are used.
4. Only simple transfer of no more than 3 sterile, nonhazardous drugs in the manufacturers' original containers are involved in the compounding, and no more than 2 entries into any 1 container occur.
5. No more than 1 hour elapses from the time compounding begins to the time of administration to the patient begins. (No intervening steps between compounding and administration should occur.)
6. No batching or storage of CSPs occurs.
7. The preparation is labeled with patient identification, names, and amounts of all ingredients, name or initials of preparer, and exact 1-hour beyond-use date (BUD) and time.

Immunocompromised. Having an immune system with reduced capability to react to pathogens or tissue damage.

Implanted Pump. A catheter surgically placed 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 surgically placed into a vessel, body cavity, or organ 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 apart from each other verify each component of a work process.

Infection. The presence and growth of a pathogenic microorganism(s) having a local or systematic effect.

Infiltration. Inadvertent administration of a nonvesicant solution or medication into surrounding tissue; rated by a standard tool.

Informed Consent. A person's voluntary agreement, based upon adequate knowledge and understanding of relevant information, to participate in research or to undergo a diagnostic, therapeutic, or preventive procedure.

Infusate. Parenteral solution administered into the vascular or nonvascular systems; infusion.

Infusion Team. A group of nursing personnel centrally structured within an acute health care facility charged with the shared mission of outcome accountability for the delivery of infusion therapy. While this team may not be directly providing each infusion, they provide the advanced knowledge for safe practices to support the primary care staff. Thus the roles of infusion team members include direct care providers, educators, consultants, coaches, mentors, advocates, coordinators, and managers. This team is led by infu-

sion nurse specialists (eg, CRNI®s) and may contain a staff mix of registered nurses, licensed practical nurses, and unlicensed assistive personnel. Unlicensed team members work under the direction of the licensed professional infusion nursing staff. (See Appendix A).

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.

Interprofessional/Interprofessional Collaboration. A cooperative approach to patient care that depends upon the overlapping 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.

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. The practice of using a device to support and stabilize a joint when veins or arteries in or near that joint must be used for VAD placement; should not be considered as 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.

Latex Safe Environment. A health care setting in which all products containing natural rubber latex intended for contact with mucosa or nonintact skin are removed or covered. The goal is to prevent contact between high-allergen and airborne latex with allergic individuals or those at risk for developing allergies. Dry, molded, or extruded rubber, such as medical vial stoppers and syringe plungers, create less risk of allergen exposure than those items formed by dipping forms in liquid latex (eg, gloves).

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.

Licensed Independent Practitioner (LIP). A practitioner permitted by law and by the organization to provide care and services, without direction or supervision, within the scope of the practitioner license and consistent with individually assigned clinical responsibilities.

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-related bloodstream infection (CR-BSI).

Long-term. Referring to vascular access devices placed for anticipated need of greater than 1 month.

Lumen. The interior space of a tubular structure, such as a blood vessel or catheter.

M

Manual Flow-Control Device. A device that controls fluid flow rate by manual adjustment of components such as a roller clamp or flow regulator; requires reliance on counting drops; is affected by factors such as dislodgment of the components or distance between the fluid container and the device; and therefore is the least accurate.

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.

Mechanical Infusion Device. A device that uses a nonelectronic method to regulate infusion flow rate; examples include the elastomeric balloon device and the spring-coil piston syringe device.

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.

Micron (μ). A unit of length equal to 1 millionth of a meter, or 1 thousandth of a millimeter.

Microorganism. Extremely small living body not perceptible to the naked eye.

Mid-arm Circumference. Measurement of upper arm at a predetermined distance above the insertion site of a peripherally inserted central catheter (PICC) or midline catheter.

Midline Catheter. A catheter inserted into the upper arm via the basilic, cephalic, or brachial vein, with the internal tip located level at or near the level of the axilla and distal to the shoulder.

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 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 (GNB) that have important infection control implications.

N

Near-Infrared Light Devices. 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 (NC). A device that allows intermittent access to a vascular access device with an administration set or syringe without the use of needles; types are categorized by description (ie, simple or complex) and function (ie, negative, positive, or neutral) upon set or syringe disconnection.

- **Anti-Reflux NC.** Contains a pressure-sensitive internal mechanism designed to prevent blood reflux into the catheter lumen when the flow of infusion solution has stopped.
- **Complex NC.** Has a variety of moving internal components that allow fluid flow in both directions; eg, mechanical valves.
- **Negative Displacement NC.** Allows blood reflux into vascular access device (VAD) lumen upon disconnection due to movement of valve mechanism or removal of syringe/set.
- **Neutral NC.** Contains an internal mechanism designed to prevent blood reflux into the catheter lumen upon connection or disconnection.
- **Positive Displacement NC.** Allows a small amount of fluid to be held in the device; upon set or syringe disconnection, this fluid is pushed through the catheter lumen to clear any blood that refluxed into the lumen.
- **Simple NC.** Allows a straight fluid pathway through the center lumen without any internal mechanism to control flow; example is a prepierced septum accessed with either a blunt cannula or male luer device; eg, split septum.

Needleless Systems. 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 blood-borne pathogens due to percutaneous injuries from contaminated sharps.

Neonate. Pertaining to the first 4 weeks of life.

Noncritical Equipment. Items that come in contact with intact skin but not mucous membranes.

Nonpermeable. Prevents passage of fluid or gases.

Nontunneled Central Venous Access Device. A vascular or nonvascular access device inserted by puncture directly through the skin and the intended location without a portion of the device allowed to remain in a subcutaneous tract.

Nonvesicant. Solutions and medications that do not produce tissue damage when inadvertently delivered into subcutaneous tissue.

Nurse Practice Act. Legislation that defines the practice of registered nurses and licensed practical or vocational nurses within each state.

Nursing Diagnosis. The patient problem identified for intervention by analysis of assessment findings in comparison to what is considered to be normal.

Nursing Intervention. In the nursing process, the step after planning; involves aspects of actual caring for the patient and requires full knowledge of assessment and planning stages of the nursing process.

Nursing Process. An orderly, logical approach to administering nursing care so that the patient's needs for such care are met comprehensively and effectively; includes steps of assessment, problem identification, outcome identification, planning, intervention, and evaluation.

O

Occlusion. The state of being occluded; the inability to infuse or inject solution into a catheter; the inability to aspirate blood from a catheter or both.

Off-Label Use (Extra-Label Use). The use of an approved drug in the treatment of a condition or for a purpose for which it has not been approved or cleared for use by the US Food and Drug Administration (FDA).

Older Adult. Greater than 65 years of age, as defined by the American Geriatric Society.

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. 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. Unwanted matter relating to or composed of fine particles found in intravenous medication and solutions, including undissolved drugs or precipitate, rubber cores, glass particles, and plastic pieces.

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.

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.)

Percutaneous. Technique performed through the skin.

Peripheral. Pertaining to or situated at or near the periphery; situated away from a center or central structure.

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 blood-borne 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, erythema, edema, streak formation, and/or palpable cord; rated by a standard scale.

Phlebotomy. Withdrawal of blood from a vein by direct venipuncture or via a central vascular access device (CVAD).

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 (CVAD) 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_20.

Power Injectable. A device (eg, vascular access device [VAD], extension set) capable of withstanding injections pressure used for radiology procedures, usually 300 to 325 pounds per square inch (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 (VAD), any add-on devices, and administration set.

Procedure. Written statement of a series of steps required to complete an action.

Process. Actual performance and observation of performance based on compliance with policies, procedures, and professional standards.

Product Integrity. The condition of an intact, uncompromised product suitable for intended use.

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 vascular access device (VAD) lumen.

Purulent. Containing or producing pus.

Q

Quality Improvement. An ongoing, systematic process for monitoring, evaluating, and problem solving.

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.

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 nonneedle 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.

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 undesirable experience associated with the use of a medical product/medication in a patient; the event is serious and should be reported to the US Food and Drug Administration (FDA) when the patient outcome is death, disability, life threatening, requires initial or prolonged hospitalization, or requires intervention to prevent permanent damage.

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-term. When used in reference to a vascular access device, a time frame of less than 1 month.

Site Protection. Method or product used to protect the external vascular access device (VAD), insertion site, and dressing.

Skill Validator. Individual with documented competency in a specific skill who is qualified by training and education to objectively assess the performance of others.

Smart Pump. Electronic infusion device (EID) with an 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. Guidelines designed to protect workers with occupational exposure to blood-borne pathogens. All blood and body fluids are treated as potentially infectious.

Statistics. The systematic science of collecting, organizing, analyzing, and interpreting numerical data.

Sterile. Free from living organisms.

Stylet. A sharp rigid metal hollow-bore object within a peripheral catheter designed to facilitate venipuncture and catheter insertion.

Stylet Wire. A long wire guide inside the catheter lumen used to provide stiffness for advancement of a vascular access device (VAD) into the vein; may be multiple pieces welded together and is not intended for advancement into the vein alone.

Subcutaneous Infusion. Administration of medications into the tissues beneath the skin.

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

Tamper-Proof. Unable to be altered.

Therapeutic Phlebotomy. Removal of a specific volume of blood from a patient as ordered by the licensed independent practitioner (LIP) for the treatment of a specific condition or disease.

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.

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 (CVAD) 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 1 of the 2 arteries or vein of the umbilical cord.

Unlicensed Assistive Personnel (UAP). A category of health care workers who work as assistants to and under the direction of licensed health care professionals, including both nursing and medical assistants.

Unusual Occurrence (or Event). An unexpected occurrence or event resulting in death, life-threatening, or serious injury to a patient that is not related to a natural course of the patient's illness or underlying condition. An unusual occurrence also includes an incident resulting in the abuse of a patient.

USP Chapter <797>. Chapter 797 "Pharmaceutical compounding—sterile preparations," in the United States Pharmacopeia (USP) National Formulary (NF) are enforceable sterile compounding standards issued by the USP that describe the guidelines, procedures, and compliance requirements for compounding sterile preparations and set the standards that apply to all settings in which sterile preparations are compounded.

V

Vascular Access Device (VAD). Catheters, tubes, or devices inserted into the vascular system, including veins, arteries, and bone marrow.

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.

Visualization Technology. Device that employs the use of sound or light waves to allow for the location and identification of blood vessels.

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