Infusion Therapy Standards of Practice

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The revised *Standards*, 9th edition, was peer-reviewed by a panel of professionals across health care specialties from 12 countries around the globe. The feedback provided helped to further strengthen the recommendations outlined in this revision. The committee would like to thank the following list of reviewers:

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

Foreword

Infusion therapy is ubiquitous regardless of the care setting, transcends all patient populations, and connects with other specialty practices. Clinicians navigate the continuum of care to ensure their patients' best interests are addressed over the course of treatment that could last a few hours, days, or a lifetime. The comprehensive nature of the specialty practice of infusion therapy demands that clinicians demonstrate competency. While not well understood, the public's expectation is that once post-secondary education is completed, health care professionals are competent in their practice.

Infusion nurses are key members of the health care team and are recognized for their critical thinking abilities, assessment skills, and technical expertise. Due to its invasive nature, the risks associated with infusion therapy and the need to mitigate them is imperative in order to provide safe, quality patient care. Preventing complications, promoting vein preservation, monitoring outcomes, implementing quality improvement measures while ensuring patient satisfaction and cost-effective care delivery are factors vital for achieving optimal outcomes. Hence, the necessity for a well-respected, reliable reference to guide practice, the *Infusion Therapy Standards of Practice* (the *Standards*).

For over 40 years, the evolution of the *Standards* has been impressive. In 1981, the first published standard was the 3-page "Hyperalimentation Standard of Practice" compiled by the Special Interest Group on Hyperalimentation. The document outlined the purpose of six hyperalimentation practices, offered recommendations of practice; however, no references were cited that supported the document's content. Compare that to the 2024 *Standards* written by a committee of clinical experts that is a 285-page publication with 66 standards, including more than 2500 references to support the standard statements and practice recommendations.

Beginning with the 3rd edition of the *Standards* in 1998, I've had the honor to be involved with the revisions of the *Standards* and appreciate the process and the necessity that it reflects current evidence. By 2006, the *Standards* were being revised every 5 years. In 2011, to further enhance the document, the Standards of Practice Committee began rating the strength of the body of evidence. A title change occurred with the 7th edition, when "nursing" was replaced by "therapy," as it was recognized that not one single discipline owned this practice, and providing safe infusion care is the responsibility of all clinicians involved with the practice. With global recognition and use worldwide, since the release of the 2021 *Standards*, the committee has included clinical experts and peer reviewers from outside the United States. With more infusion- and vascular access-related research being published, the revision cycle has been shortened to every 3 years.

The credibility and expertise of the Standards of Practice Committee are unsurpassed. The authors, practicing clinicians with many years of experience in the specialty, represent diverse areas of expertise from multiple practice settings, ensuring a global perspective is provided. This collective with their collaborative spirit, spent countless hours searching, reviewing, synthesizing the literature, and rating the published evidence and research, while coordinating meetings across international time zones. While actions matter, so do words. This committee was hypervigilant as they wrote this document, knowing that implementation of the *Standards* into clinical practice rests on its accuracy. Their dedication to the revision process is unmatched.

While the primary focus of the *Standards* is patient safety, it also supports the clinician's practice and well-being. Infusion-related adverse events have an impact on patients, but also on the clinician involved, resulting in second victim syndrome. Applying the

Standards with its guidance and practice recommendations establishes consistency and confidence in one's practice.

Where is the evidence taking us? Are the *Standards* supporting existing practice or leading to changes by setting aside traditional practices not supported by evidence? I contend it is a combination of both. Scope of practice has expanded based on education, training, and validated competency. Technological advancements are enhancing practice as well as the patient experience. As the specialty evolves, so too must the practice and the *Standards* that clinicians rely on.

I applaud INS for its commitment to "Setting the Standard for Infusion Care" and taking the lead in developing and disseminating standards of practice with a global approach. While there are differences in languages, customs, cultures, practices, and resources, a common goal is to provide safe infusion care to all patients. The *Infusion Therapy Standards of Practice* is a trusted source that informs practice. It is an invaluable reference that provides an evidence-based framework to guide the clinician in providing safe infusion and vascular access care. Our patients deserve nothing less.

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

About the Standards of Practice Committee

Barb Nickel, APRN-CNS, CCRN, CRNI®—Chair
Clinical Nurse Specialist in Omaha, Nebraska
Ms Nickel works for a large health system and is responsible for staff development, competency assessment, and process improvement to optimize outcomes in multiple areas of clinical practice, including critical care, infusion therapy, sepsis, and new graduate transition to practice. Ms Nickel has presented nationally on infusion-related topics, was coauthor of the 2021 INS *Infusion Therapy Standards of Practice*, and is chair of the 2024, 9th edition of the *Standards*. Ms Nickel has authored several publications on infusion therapy in the critical care setting and also serves as faculty in a BSN program.

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Clinical Education Specialist/Clinical Nurse Specialist, Ascension at Home
Ms Gorski has worked for more than 35 years as a clinical nurse specialist (CNS) and educator for Wheaton Franciscan Home Health and Hospice, now Ascension at Home. As a CNS, she developed and continues to provide infusion-related education for home care nurses as well as direct patient care. She is the author of several books and more than 70 book chapters and journal articles, is an INS past president (2007-2008), is a past chair of the INCC Board of Directors, and has served as the chair of the INS Standards of Practice Committee for the 2011, 2016, and 2021 editions. She was inducted as a fellow into the American Academy of Nursing in 2006, named the CRNI® of the year by INCC, and named the 2011 CNS of the Year by the National Association of Clinical Nurse Specialists. Ms Gorski speaks nationally and internationally on standards development, infusion therapy/vascular access, and home health care.

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Ms Kleidon is a nurse practitioner in paediatric vascular assessment and management at Queensland Children's Hospital and a research fellow at University of Queensland. Her dual role between clinical and research provides unique opportunities to improve vascular access outcomes for children and promotes a collaborative approach to planning and managing vascular access to ensure best practice. She is currently enrolled in a PhD program of research entitled "Techniques and technologies to improve PIVC first time insertion success and reduce complications and failure."

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Ms Keyes, who serves on the Vascular Access Specialist Team, Heart and Vascular Services at Trinity Health, has over thirty years combined experience across home health, outpatient infusion, and inpatient vascular access services. In her role at Trinity Health and with A. Kyes consulting Inc., she works with organizations to design and lead RN vascular access specialist teams (VASTs) that deliver comprehensive infusion/vascular access services based on current standards to ensure high quality patient and health care system outcomes. She is also actively involved with advancing infusion and vascular access nursing at the national level as well as a past member of the INS research committee, a Gardner research award recipient, an INS conference speaker/presenter, and an *INSider* contributing author.

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Senior Infection Control Officer, Methodist Hospitals in Gary, Indiana;
Senior Adjunct Research Fellow, AVATAR
Ms DeVries has been involved in infection prevention and hospital epidemiology for 30 years, spanning community, university, and federal health care facilities as well as postacute care settings. She is passionate about raising awareness around vascular access device complications and devotes her time to education on this topic with an emphasis on data collection and analysis. She was a reviewer for the 2016 and 2021 *Infusion Therapy Standards of Practice*, and was a committee member for the 9th edition of the *Infusion Therapy Standards of Practice.* Ms DeVries is a senior adjunct research fellow with the Alliance for Vascular Access Teaching and Research (AVATAR), a past director-at-large with Vascular Access Certification Corporation (VACC), and the president of the Association for Vascular Access (AVA) for 2024.

Samantha Keogh, PhD, RN, FACN
Joint Professor of Acute and Critical Care Nursing, Queensland University of Technology (QUT) and Metro North Health in Brisbane, Australia;
Senior Researcher, QUT's Centre for Healthcare Transformation and the Alliance for Vascular Access Teaching and Research (AVATAR)
Dr Keogh's clinical background is in intensive care (adult and paediatric), so she understands the importance of vascular access to deliver essential medication, fluids, and blood products, as well as facilitate vital monitoring and sampling. Dr Keogh is a fellow of the Australian College of Nursing (ACN) as well as a member of several other specialty-based colleges, societies, and networks, including the Australasian Nursing and Midwifery Clinical Trials Network (ANMCTN), a network developed to support, mentor, and accelerate growth in nursing and midwifery clinical trials capability and capacity across Australia.

Britt Meyer, PhD, RN, CRNI®, VA-BC, NE-BC
Chair, Infusion Nurses Certification Corporation
Dr Meyer leads the vascular access team at Duke University Hospital and presents nationally and internationally on a variety of infusion and vascular access topics. She is well-published in the specialty and is passionate about empowering clinicians to provide safe and effective care. She also serves as an adjunct faculty member for the East Carolina University School of Nursing.

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Ms Sarver has more than 37 years of experience in infusion therapy and oncology/hematology care. Her role focuses on continuity of care and seamless transitions for patients within and outside the acute care setting. She collaborates and acts as a consultant locally and on a system level for Providence, guiding staff development, competency assessment, and process improvement to improve outcomes in multiple areas of clinical practice, and new graduate transition to practice. She attends cancer care conferences as well as rounds in the clinics and hospital, and actively consults and sees patients and families for treatment and care planning. She has published, conducted research, and spoken on multiple topics within the United States. For decades, her passion has prompted her to participate both locally on the PSINS, PSONS, and ACS boards and nationally assume various roles through INS and ONS.

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Dr Crickman has over 23 years of experience as an oncology nurse working in direct patient care and as a clinical nurse specialist. She is a staunch advocate for both staff and patient safety and has published manuscripts on hazardous drug control measures, interventions to promote safety, and central venous catheter blood draws. Her expertise

includes chemotherapy administration, cellular therapies, and CLABSI prevention measures. Outside of work, Dr Crickman enjoys hiking and camping in the Pacific Northwest with her family.

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Dr Ong's special interests include cost containment and safety improvement through management of formularies, order sets, and policies and procedures. She is currently serving on the Vesicant Task Force of the Infusion Nurses Society.

Simon Clare, MRes, BA, RGN
Research and Development Director, The Association for Safe Aseptic Practice (ASAP)
Mr Clare's background is in high-risk oncology and haematopoietic stem cell transplantation (HSCT). He is currently the practice development lead for haematology at University College Hospital in London (UCLH) and has previously worked at the Myeloma Institute at the University of Arkansas for Medical Sciences (UAMS) in Little Rock, Arkansas. A former visiting lecturer and module leader at City University in London, Mr Clare received his undergraduate degree from the University of Arkansas at Little Rock (UALR) and a master's degree in health care research from King's College London (KCL). He is a former member of The European Society for Blood and Marrow Transplantation Nursing Group (EBMT-NG) Research Sub-committee (2004-2008), a 2012 runner-up in the Nursing Standard Awards: The Robert Tiffany International Award, and a joint winner of the 2008 Nursing Times Award for Infection Control Nursing. He has worked with several expert panels and is a current member of the Improving Device-Related Infection Prevention Practice (DRIPP) IV Group. He has authored or coauthored numerous papers and journal articles on infection prevention and control, aseptic technique, patient nutrition, and bone marrow transplantation donor issues. For the past fifteen years, he has been working with the ANTT® program, developing resources, teaching, and presenting both in the UK and around the world.

Mary Hagle, PhD, RN, NPD-BC, FAAN
Nurse Scientist and Codirector, Interprofessional Advanced Fellowship Program in Patient Safety at the Clement J. Zablocki Virigina Medical Center in Milwaukee, Wisconsin
Dr Hagle served as a committee member for the 2011, 2016, 2021, and 2024 revisions of the *Standards* and has extensive experience as a researcher and as an oncology clinical nurse specialist. She continues as a mentor and consultant for research, quality improvement, and evidence-based practice teams.

STANDARDS OF PRACTICE COMMITTEE

CONFLICTS OF INTEREST AND OTHER DISCLOSURES

Barb Nickel is a consultant on the advisory board for Baxter Healthcare, is a consultant and part of the speaker's bureau for Becton Dickinson Medical, and is a consultant for Kendle Healthcare. **Lisa Gorski** is on the advisory board for and receives presentation fees from BD, 3M, and Nexus Medical; owns stock in ivWatch; and receives royalties/revenue share from FA Davis, Springer Publishing, and Medbridge. **Tricia Kleidon's** employer UQ has received monies on her behalf from 3M, BD Medical, BBraun, Medical Specialties Australia, and Smiths Medical. **Amy E. Kyes** is the owner/president of A. Kyes Consulting Inc., and consults with INS as an educator. **Samantha Keogh**'s employer (QUT) has received monies on her behalf from BD Medical and ITL Biomedical for educational consultancies unrelated to this work. **Britt Meyer** is an HMP Global education consultant, a 3M consultant, on the Teleflex advisory panel, and a Bard paid researcher. **Mary Jo Sarver** is a Regeneron speaker, a G1 Therapeutics speaker, CEO of Sarver Better Living, and a consultant for the Oncology Nursing Society; and she has received a publication stipend for authoring a chapter in the upcoming new edition of vascular access guidelines. **Michelle DeVries, Rachael Crickman, Jenny Ong, Simon Clare, and Mary Hagle** have no conflicts of interest to report.

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Mary Alexander, MA, RN, CRNI®, CAE, FAAN, INS CEO emerita, for 26 years of exemplary service to the Infusion Nurses Society and for being a dedicated leader and visionary for the *Infusion Therapy Standards of Practice* and Editor of the *Journal of Infusion Nursing.* Her commitment to excellence is imprinted on this 9th edition of the *Standards* and will continue to impact the practice of infusion therapy for many, many years to come.

The INS Publications Department: Donna Knauss, Managing Editor, for her industrious and businesslike approach to editing and fact-checking. Her dedication to timeliness, attention to detail, and respect for the importance of the *Standards* was imperative to the publication process and is highly commendable. Rachel King, Editorial Production Coordinator, for her thoughtful, reflective recommendations, her willingness and ability to accept additional assignments, and her editorial excellence in all contributions. INS extends generous appreciation to each for her commitment.

Amy Nadell, MA, MSLIS, AHIP-D, Librarian, for conducting extensive literature searches for each of the 66 *Standards.* Her expertise and contribution to the 9th edition revisions is remarkable and greatly appreciated.

Medical librarians who supported committee members locally by assisting in literature retrieval and recommending alternative search strategies: Caralee Witteveen-Lane, Regional Manager Medical Library Services, Trinity Health, Grand Rapids; Lauren Jackson, Regional Medical Librarian, Trinity Health, Grand Rapids; Frances Chu, PhD, MLIS, MSN, RN, Medical Librarian, Providence Regional Medical Center, Everett; and Michele Matucheski, MLIS, AHIP, Medical Librarian, Ascension, Wisconsin. INS would also like to offer a special thank you to the University of Nebraska Medical Center, McGooghan Library for their invaluable assistance in document retrieval.

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Preface

The specialty of infusion therapy encompasses a broad spectrum of patient care that is singularly focused on patient safety, demonstrated through the comprehensive management of all patient infusion needs, including 1) planning for the intended therapy, vascular access device (VAD) and site selection, and skillful VAD insertion; 2) administration, management, and monitoring of the patient's therapeutic regimen; 3) monitoring for and recognition of complications and readily intervening and mitigating patient harm; 4) designing an ongoing plan of care for long-term patient needs or concluding treatment, and performing VAD discontinuation.

The role of infusion therapy specialists is vastly important in achieving consistency and standardization in patient care. These individuals are knowledgeable and skilled in infection prevention and control; medication and solution administration management (infusate properties, mechanism of action, indications for use); and promotion of vein preservation. This specialty care is delivered in all health care settings, across the continuum of care to all age groups and patient populations.

Organizationally, infusion therapy specialists are essential in orchestrating patient care in collaboration with the interprofessional health care team. As an integral part of the health care team, infusion clinicians remain dedicated to evidence-based practice and improving patient outcomes. These professionals are responsible for organizing and defining infusion services/vascular access specialty teams (VASTs) and are significantly involved in policy development and governance of practice within the organization. They are devoted to maintaining clinical competency for themselves and contributing to the competency and professional growth of others through the development of educational programs that promote knowledge and skill acquisition. They are active in quality improvement programs that incorporate surveillance, data aggregation and analysis, and reporting of patient quality indicators, taking action as needed to improve practice, processes, and/or systems.

Professionally, infusion specialists are leaders dedicated to ongoing growth and professional development. They are actively involved in establishing and promoting this specialty practice not only in their local environment, but also on a national, and even international level. They pursue certification that validates their knowledge and expertise within the specialty and their background of clinical experience.

Accordingly, the *Infusion Therapy Standards of Practice* (*Standards*) are written and designed specifically to direct and support the professional practice of infusion therapy clinicians of many disciplines who practice in various care settings throughout the world. Given the comprehensive nature of the specialty of infusion therapy and expectations of those who have chosen this role, it is imperative that each clinician's practice is informed and guided by standards that provide evidence-based guidance for clinical decision-making.

This edition of the *Standards* was written and developed by an international group of clinical experts who are entrenched in the altruistic pursuit of excellence in infusion therapy. Their work, exhibited on the following pages, is the culmination of expertise, passion, and dedication. The rigor applied to the revision and authorship of this edition is exceptional. Additional content addresses 3 emerging practice challenges/trends in infusion therapy through the inclusion of new standards: Standard 13, *Drug Diversion in Infusion Therapy*; Standard 64, *Vasopressor Administration*; and Standard 66, *Home Infusion Therapy*. Also new in this edition is the redistribution of content formerly presented as individual standards. The Standards of Practice Committee determined it was

prudent to join practice pieces that complemented a similar area of practice. Therefore, Site Selection was combined with VAD planning to become Standard 25, *Vascular Access Device Planning and Site Selection*. Joint Stabilization was combined with Site Protection to become Standard 37, *Site Protection and Joint Stabilization*. Content from Medication Verification was incorporated into Standard 56, *Compounding and Preparation of Parenteral Solutions and Medications*. As usual, the *Standards* statements are declarative and straightforward, establishing the practice expectations of each clinician by which the quality of practice, service, or education is judged. An additional description of this edition's revisions is outlined in *Methodology for Developing the Standards of Practice.*

As stated in INS' Mission ethics, "We are dedicated to advancing the delivery of quality infusion therapy to patients, enhancing the specialty through stringent Standards of Practice and professional ethics, and promoting research and education in the infusion nursing practice." Remaining true to that commitment, INS is proud to present the 9th edition of the *Infusion Therapy Standards of Practice.*

Dawn Berndt, DNP, RN, CRNI®
Editor, *Journal of Infusion Nursing*
Infusion Nurses Society Director of Publications and Educational Design

Methodology for Developing the Standards of Practice

STANDARDS OF PRACTICE REVISION CYCLE

As infusion- and vascular access-related research continues to be published at a rapid pace, it is imperative to update the Standards more frequently. For the 8th edition of the *Standards*, committee members reviewed more than 2500 sources of literature; for this 9th edition of the *Standards*, again in numbers greater than the previous, thousands of publications were reviewed and appraised. As this practice specialty continues to expand and change, it is incumbent upon INS to ensure that these changes are reflected in the *Standards* as quickly as possible. As a result, INS has determined that the *Infusion Therapy Standards of Practice* must undergo revisions every 3 years.

In an effort to support and enhance the goals of the *Standards of Practice* Committee, INS implemented supportive resources and technologies to assist committee members in accomplishing this important work. This *Standards* review and revision process was assisted by the work of a contracted health sciences librarian, Ovid® Synthesis Clinical Evidence Manager (Wolters Kluwer), EndNote Reference Manager (Clarivate), and SharePoint (Microsoft 365). Each of these supportive systems was selected for the express purpose of 1) developing a standardized approach to literature retrieval, evaluation, and appraisal, 2) creating an archival record of review/revision processes, and 3) utilizing a secure document control system. The committee members were introduced to the health sciences librarian and new technology software programs at the initial in-person meeting held in Boston in January 2022.

STANDARDS OF PRACTICE COMMITTEE

INS seated the 9th edition Standards of Practice Committee on January 25, 2022. The committee is comprised of an international group of nurses and clinicians who possess a wealth of clinical knowledge and expertise in the domains of infusion therapy and vascular access device (VAD) planning, placement, use, and management. The committee is charged with identifying and authoring new content and revising existing content as informed by published literature and other sources of information (eg, The Joint Commission, the US Department of Health and Human Services, Centers for Disease Control and Prevention). In addition to reviewing and synthesizing research, appraising the evidence, and drafting revisions, committee members also commit to participation/attendance in regularly scheduled meetings to discuss new evidence, reviewer feedback, and engage in consensus determination.

LITERATURE SEARCH

A health sciences librarian (HSL) was employed to conduct comprehensive literature searches for each of the 66 existing standards and 3 additional standards slated for inclusion. The HSL collaborated with each committee member to develop and refine search terms and strategies to ensure published literature in each topic area was adequately surveyed. All references were stored, labeled, and categorized on a reference citation platform. This structural approach improved consistency in process and secured a repository of evaluation data for future editions of the *Standards*. Searches were limited to mainly English-language, peer-reviewed journal articles published between January 2017 and March 2023. Additional, but narrow, literature searches were conducted through July 2023 when addressing reviewers' comments or suggestions.

Databases searched included, but were not limited to, Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINAHL), EMBASE, Google Scholar, Ingenta Connect, MEDLINE, PubMed, ScienceDirect, Scopus, UpToDate, and Web of Science. References of retrieved articles and select journal titles were reviewed for relevant literature.

Additional sources of evidence included, but were not limited to, the websites of professional organizations, manufacturers, pharmaceutical organizations, and the United States Pharmacopeia (USP). Clinical practice guidelines, publications, and websites of health care and professional organizations from select countries were reviewed; these were used as needed. Evidence was also included from the Association for the Advancement of Medical Instrumentation (AAMI), Institute for Safe Medication Practices, The Joint Commission, the US Department of Health and Human Services, Centers for Disease Control and Prevention, US Food and Drug Administration, National Quality Forum, and the US Department of Labor (eg, Occupational Safety and Health Administration). Other

evidence came from health care-related agencies in Ireland, United Kingdom, Australia, and Canada. Classic papers were included as needed. On occasion, textbooks served as sources of evidence when clinical research and scholarship are widely accepted, such as for anatomy and physiology. Because the *Standards* is written for all health care settings and all populations, evidence was included for each of these areas, as available.

COMMITTEE AUTHORING AND REVISION PROCESSES

Once literature searches were conducted and transferred to EndNote, committee subject-matter experts who were assigned to author/co-author specific standards reviewed each reference according to the scope of that Standard. Studies that did not have relevance to the topic were deleted from the EndNote folder. Studies with relevance were reviewed further. If found to be supportive of the Standard content, the article and reference were populated into the Ovid® Synthesis project. After further evaluation, the reference was either "included," and full critical appraisal and level of evidence was assigned, or it was "excluded." Once critical appraisals were completed, the research findings were incorporated into the Standard statement, by revising existing content with the most current evidence and/or by supporting/raising the level of evidence of that statement or Practice Recommendation.

After the authors reviewed and appraised all references, initial revisions were written into the master document in SharePoint. Reference citations and bibliographies were generated using "Cite While You Write," an EndNote application. All written content was reviewed during weekly virtual committee meetings to ensure consensus was reached on all statements and verbiage.

APPRAISING AND EVALUATING EVIDENCE

As noted, Ovid® Synthesis Clinical Evidence Manager was utilized by the Standards of Practice Committee to appraise each source of evidence. The standardized template in Ovid® Synthesis helped facilitate literature appraisal and ranking of level of evidence. Each item of evidence was evaluated from many perspectives, and the highest, most robust evidence relating to the Practice Recommendation was used. Research evidence was preferred over nonresearch evidence. For research evidence, the study design was the initial means for ranking. Other aspects of evaluation of quality include sufficient sample size based on a power analysis, appropriate statistical analysis, examination of the negative cases, and consideration of threats to internal and external validity.

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

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

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

The *Standards* are designed to be a compilation and summary of the highest level and most current evidence on a topic. It is not, however, a systematic review or an exhaustive list of all available published references on these topics.

RATING THE STRENGTH OF THE BODY OF EVIDENCE

The Standards of Practice Committee utilized the Strength of the Body of Evidence rating scale to determine the level of evidence for each referenced item cited in the *Standards*. The literature appraisal template in Ovid® Synthesis was modified to include the INS rating scale. In preparation for a more global approach to the *Standards,* the rating scale was modified for the 8th edition; no additional modifications or revisions were made to the scale for the 9th edition of the *Infusion Therapy Standards of Practice*.

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

The rating scale ranges from the highest ranking of "I," representing research evaluating aggregated research findings (eg, meta-analysis) to the lowest level of "V" (eg, case

study). For a standard of practice with a single item of evidence, such as a meta-analysis with its accepted methods, the body of evidence is within the meta-analysis and the strength of this body of evidence is I. When studies are cited within the larger work of a meta-analysis or systematic review, the individual studies are not cited separately unless they add to the Practice Recommendation content specifically. However, for large research-based guidelines, the level of evidence may vary based on what is cited: the whole guideline or a specific part of the guideline with its related evidence.

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

STANDARDS CONTENT ORGANIZATION

Standards Statements. All Standards statements were carefully reviewed and were revised only when new evidence informed clinical practice. New Standard statements were added when additional practice elements were validated in recently published literature or when new Standards of Practice were added (eg, Drug Diversion in Infusion Therapy, Vasopressor Administration, Home Infusion Therapy).

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

Level of Evidence Note: In systematic reviews and systematic reviews/meta-analysis, the level of evidence may reflect the overall document if used to support a main finding in the study, or may be different from the overall document based on the level of evidence for a particular statement (eg, one of the findings in the systematic review or systematic review/meta-analysis is noted to have a lower level of evidence, supported by lower quality studies). These statements will be used to adjust the Practice Recommendation Level of Evidence.

When cited literature supports a Practice Recommendation and each of the subsequent supportive statements listed below, (eg, a list of items), the reference citations were placed with the Practice Recommendation. If a subpoint under a Practice Recommendation was informed by findings of a specific study or studies, the reference citations were noted along with that statement.

In an effort to control repetition and enhance clarity throughout the *Standards*, the committee included cross-reference guidance to direct attention to specific Standards for additional reference. Statements that use "see" (eg, see Standard 19, *Aseptic Non Touch Technique [ANTT®]*) means the statement agrees with a statement in another Standard as listed, but there are references specific to the current standard that should be cited. Conversely, statements that use "refer" (eg, refer to Standard 38, *Flushing and Locking*) indicate that the statement agrees fully with a statement in the cited Standard (typically the most relevant source of that information) and related references can be found in the cited Standard.

References. Complete bibliographical information was included at the end of each Standard of Practice and prepared using American Medical Association (AMA) formatting style.

Appendices. Supplemental content was provided as a clinical reference for these topic areas: Aseptic Non Touch Technique (ANTT®), Catheter-Associated Skin Injury, and Assessment Scales/Tools for Infiltration, Extravasation, and Phlebitis.

Glossary. Some clinical definitions are included at the beginning of specific Standards, where it seemed prudent to include this information to enhance readability and understanding. However, a comprehensive glossary has also been prepared and is published in the later pages of this edition.

FIRST DRAFT PUBLIC REVIEW

Throughout the *Standards* review and revision process, the committee met regularly via virtual technology, reviewed each standard in detail, and came to consensus on the final strength of the body of evidence rating for the first draft of the *Infusion Therapy Standards of Practice,* 9th edition.

Upon completion of the first draft, more than 200 international, interdisciplinary reviewers who are experts in the field, comprising all aspects of infusion therapy and VAD management, were invited to submit a blind review via Editorial Manager. A total of 144 reviewers returned critiques, of whom 117 were from the United States and 28 were international. Including the United States, 12 countries were represented. Reviewers provided comments,

suggestions, references, and questions, which were compiled by specific standard into a comprehensive Excel document.

SECOND DRAFT REVISIONS

Second draft revisions were completed during a 6-week period, where again, weekly committee virtual meetings were held to discuss these recommendations, supporting evidence, and appropriate revisions. The committee addressed every comment, revised practice recommendations, and sought additional evidence as needed. While all references suggested by public review were carefully considered for inclusion, references were only included if they strengthened the level of evidence of a Practice Recommendation or provided new information for the statement/recommendation. The feedback provided helped to further strengthen the recommendations outlined in this revision. Each Standard had a final review by the committee for consensus on the content, evidence, recommendation, and rating.

COMPREHENSIVE COMMITTEE REVIEW

Once the second draft revision process was completed, the committee then conducted individual cover-to-cover reviews of the documents for flow and consistency. This comprehensive committee review ensured that all terminology was consistent throughout this edition, allowed committee members to consider all standards within the context of the whole, and to achieve final committee consensus.

PUBLISHING

The Infusion Therapy Standards of Practice is published as a supplement to the *Journal of Infusion Nursing,* the official publication of INS, now in its 47th year of publication. The *Journal of Infusion Nursing* is cited in Clarivate Web of Science Core Collection ESCI, *Cumulative Index to Nursing & Allied Health Literature* (CINAHL), EBSCO A-Z, EMBASE, HINARI, JournalGuide, MEDLINE, ProQuest, PubMed, Scopus, and TDNet.

The *Standard*s is written for clinicians of many disciplines who practice infusion therapy around the world in a variety of settings with various educational backgrounds, training, certifications, and licensing. As INS continues to "Set the Standard for Infusion Care," our focus is optimal patient-centered infusion care, consistency in practice, enhanced competency development and assessment, and evidence-based guidance for infusion therapy clinical decision-making around the globe.

Strength of the Body of Evidence

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

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

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

Abbreviations and Acronyms

AABB	Association for the Advancement of Blood & Biotherapies
AACA	authorized agent-controlled analgesia
ABHR	alcohol-based hand rub
ACD	automated dispensing cabinet
ACD	allergic contact dermatitis
ACF	antecubital fossa
ACHC	Accreditation Commission for Health Care
ACR	American College of Radiology
ADF	abuse-deterrent formulations
ADR	adverse drug reaction
ANTT®	Aseptic Non Touch Technique
ANVISA	Brazilian Health Regulatory Agency
AP	anteroposterior
APN	advanced practice nurse
APRN	advanced practice registered nurse
ARA-C	cytosine arabinoside
ARRT	American Registry of Radiologic Technologists
ASA	American Society of Anesthesiology
ASD	adhesive securement device
ASPEN	American Society for Parenteral and Enteral Nutrition
ASRT	American Society of Radiologic Technologists
AVF	arteriovenous fistula
AVG	arteriovenous graft
BfArM	Federal Institute for Drugs and Medical Devices
BIS	bispectral index
BMCA	barcode medication administration
BMI	body mass index
BSC	biological safety cabinet
BSI	bloodstream infection
BUD	beyond-use date
CABSI	catheter-associated bloodstream infection
CA-DVT	catheter-associated deep vein thrombosis
CAJ	cavoatrial junction
CASI	catheter-associated skin injury
CAT	catheter-associated thrombosis
CBER	Center for Biologics Evaluation and Research
CDC	Centers for Disease Control and Prevention
CFU	colony forming unit
CHAP	Community Health Accreditation Partner
CHG	chlorhexidine gluconate
CKD	chronic kidney disease
CLABSI	central line-associated bloodstream infection
CMV	cytomegalovirus
CNA	certified nursing assistant
COE	computerized order entry
CPAP	continuous positive airway pressure
C-PEC	containment primary engineering control
CPOE	computerized prescriber order entry
CQI	continuous quality improvement
CR-BSI	catheter-related bloodstream infection
CRNI®	Certified Registered Nurse Infusion
CRPS	complex regional pain syndrome
CRS	cytokine release syndrome
CRT	catheter-related thrombosis
CS	controlled substance
CSA	Controlled Substances Act
CSDP	Controlled Substance Diversion Prevention
CSTD	closed system transfer device
CT	computed tomography
CTA	computed tomography angiogram
CVAD	central vascular access device
CVC	central venous catheter
DEA	Drug Enforcement Administration
DEHP	Di[2-ethylhexyl]phthalate
DERS	dose error reduction system
DMSO	dimethyl sulfoxide
DIVA	difficult IV access
DME	durable medical equipment
DNV	Det Norske Veritas
DTP	differential time to positivity
DVT	deep vein thrombosis
EBP	evidence-based practice
ECG	electrocardiogram
ECOG	Eastern Oncology Cooperative Group
ED	emergency department
EDTA	ethylenediaminetetraacetic acid
EHR	electronic health record
ELBW	extremely low-birthweight
EMR	electronic medical record
EMS	emergency medical service
EPA	Environmental Protection Agency

ERAS	enhanced recovery after surgery
FDA	US Food and Drug Administration
FLACC	Face, Legs, Activity, Cry, Consolability [scale]
FMEA	failure mode and effects analysis
Fr	French
FT	facilitated tucking
GFR	glomerular filtration rate
HBP	Health Protection Branch of the Canada Department of National Health and Welfare
HCI	hydrochloric acid
HCW	health care worker
HD	hazardous drug
HEPA	high-efficiency particulate air [filter]
HF	heart failure
HFAP	Healthcare Facilities Accreditation Program
HFMEA	Healthcare Failure Mode and Effect Analysis
Hgb	hemoglobin
HIT	heparin-induced thrombocytopenia
HITT	heparin-induced thrombocytopenia and thrombosis
HLA	human leukocyte antigen
HPN	home parenteral nutrition
ICD	irritant contact dermatitis
ICU	intensive care unit
ID	infectious disease
IEC	Independent Ethics Committee
IFU	instruction for use
Ig	immunoglobulin
IgE	immunoglobulin E
IgG	immunoglobulin gamma
ILE	lipid injectable emulsion
INS	Infusion Nurses Society
IRB	institutional review board
ISD	integrated securement device
ISMP	Institute for Safe Medication Practices
ITDD	implanted intrathecal drug delivery [system]
IVC	inferior vena cava
IO	intraosseous
IV	intravenous
IVIg	intravenous immunoglobulin
IWS	iatrogenic withdrawal syndrome
JCI	Joint Commission International
LBW	low-birthweight
LPN	licensed practical nurse
LVN	licensed vocational nurse
Long PIVC	long peripheral intravenous catheter
MA	medical assistant
MARSI	medical adhesive-related skin injury
MAUDE	manufacturer and user facility device experience
MBPS	Modified Behavioral Pain Scale
MDRO	multidrug-resistant organism
MHRA	Medicines and Healthcare Products Regulatory Agency
MIC	minimum inhibitory concentration
ML	midline catheter
mLs	milliliters
mOsm	milliosmole
MRI	magnetic resonance imaging
MRSA	methicillin-resistant *Staphylococcus aureus*
MST	modified Seldinger technique
NCBS	Newborn Comfort Behavior Scale
NHSN	National Healthcare Safety Network
NICA	National Infusion Center Association
NICE	National Institute for Clinical Excellence
NICU	newborn intensive care unit
NIOSH	National Institute for Occupational Safety and Health
NIPS	Neonatal Infant Pain Scale
NPASS	Neonatal Pain Agitation and Sedation Scale
nIR	near infrared
OIRD	opioid-induced respiratory depression
OPAT	outpatient antimicrobial therapy
OSA	obstructive sleep apnea
OTC	over-the-counter
PA	physician assistant
PADSS	post-anesthesia discharge scoring system
PAINAD	Pain in Advanced Dementia [scale]
PAPR	powered air purifying respirator
PBM	patient blood management
PCA	patient-controlled analgesia
PCEA	patient-controlled epidural analgesia
PCT	patient care technician
PEG	percutaneous endoscopic gastronomy
PICC	peripherally inserted central catheter
PIPP	Premature Infant Pain Profile
PIVC	peripheral intravenous catheter
PLR	passive leg raise
PLSVC	persistent left superior vena cava
PN	parenteral nutrition
PNCA	patient/nurse-controlled analgesia
PPE	personal protective equipment
PPN	peripheral PN
PSI	pounds per square inch
PTS	post-thrombotic syndrome
PVC	polyvinyl chloride
PWID	persons who inject drugs
QI	quality improvement

QOL	quality of life
RA	right atrium/atrial
RBC	red blood cell
RCA	root cause analysis
RCT	randomized controlled trial
REMS	risk evaluation and mitigation strategies
RN	registered nurse
ROTEM	rotational thromboelastometry
SASS	subcutaneous anchor securement system
SCIg	subcutaneous immunoglobulin
Short PIVC	short peripheral intravenous catheter
SIRS	systemic inflammatory response syndrome
SVC	superior vena cava
SVT	supra-ventricular tachycardia
SVT	superficial vein thrombosis
TA	tissue adhesive
TACO	transfusion-associated circulatory overload
TJC	The Joint Commission
tPA	tissue plasminogen activator
TNA	total nutrient admixture
TRALI	transfusion-related acute lung injury
TSM	transparent semipermeable membrane
UAC	umbilical arterial catheter
UAP	unlicensed assistive personnel
UE-DVT	upper extremity DVT
ULPA	ultra-low particulate air [filter]
USG-PIVC	ultrasound-guided peripheral intravenous catheter
UVC	umbilical venous catheter
VAD	vascular access device
VAST	vascular access specialist team
VIP	visual infusion phlebitis
VR	virtual reality
VRE	vancomycin-resistant enterococci
VTE	venous thromboembolism
WFWB	warm fresh whole blood
WHO	World Health Organization

Section One: Infusion Therapy Practice

1. PATIENT CARE

Standard

1.1 The *Infusion Therapy Standards of Practice* is applicable to any patient population and any setting in which vascular, intraosseous (IO), subcutaneous, and epidural/intrathecal access devices are inserted and/or managed and where infusion therapies are administered.
1.2 Infusion therapy is provided in accordance with laws, rules, and regulations established by regulatory and accrediting bodies in each jurisdiction (eg, countries, states, provinces).
1.3 Infusion therapy practice is established in organizational policies, procedures, practice guidelines, and/or standardized written protocols/orders that describe the acceptable course of action, including performance and accountability, and provides a basis for clinical decision-making.
1.4 Infusion therapy is provided with attention to quality and patient/health care provider safety. Care is individualized, collaborative, evidence-based, culturally sensitive, and appropriate to patient/caregiver age and level of cognition.
1.5 Ethical principles are used as a foundation for decision-making. The clinician acts as a patient advocate; maintains patient confidentiality, safety, and security; and respects, promotes, and preserves human autonomy, dignity, rights, diversity, equity, inclusion, and accessibility.
1.6 Clinician decisions related to infusion therapy practice, including device and/or product selection, are influenced by clinical evidence of positive patient outcomes and not by commercial and/or conflicts of interest.

2. SPECIAL PATIENT POPULATIONS

Standard

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

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Practice Recommendations

A. Considerations for neonatal and pediatric patients:
   1. Recognize physiologic characteristics and their effect on drug, fluids, and nutrient selection; device selection, administration set selection (eg, free of Di[2-ethylhexyl]phthalate [DEHP]); electronic infusion pump selection; dosage, rate, and volume limitations with reference to age, height, weight, or body surface area; pharmacologic actions, interactions, side effects, and adverse effects; monitoring parameters; and response to infusion therapy (see Standard 40, *Administration Set Management*).[1-4] (III)
   2. Recognize the vulnerability of the preterm infant's skin and monitor for potential skin injury, absorption, and side effects of various skin antiseptics (see Standard 52, *Catheter-Associated Skin Injury*).[5] (II)
   3. Provide vascular access with attention to the child's anatomy, physiology, and developmental level.[6-10] (III)
      a. Use nonpharmacologic measures to promote comfort and reduce pain and anxiety associated with infusion therapy procedures (refer to Standard 30, *Pain Management for Venipuncture and Vascular Access Procedures*).
      b. Identify pediatric patients with difficult intravenous access (DIVA); utilize technology (eg, ultrasound, near infrared light) and ensure skill of clinicians to improve insertion success (see Standard 5, *Competency and Competency Assessment*; Standard 21, *Vascular Visualization*; Standard 25, *Vascular Access Device Planning and Site Selection)*.[1,8,11,12] (I)
      c. Consider novel insertion sites and techniques such as ultrasound-guided supraclavicular approach to the brachiocephalic vein or subcutaneously tunneled femoral vein cannulation in preterm infants and term infants when traditional intravenous insertion sites are compromised or not suitable for the infusion needs of the individual patient.[6,13] (IV)
   4. Consider psychosocial, sociocultural, and socioeconomic considerations that may affect the plan for infusion therapy.[1,14,15] (IV)
   5. Identify and involve family and caregivers 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*).[1,2] (IV)

6. Obtain assent from school-aged or adolescent patients as appropriate (refer to Standard 9, *Informed Consent*).

B. Considerations in pregnancy:
   1. Recognize physiologic changes related to pregnancy and its effect on drug dosage, volume limitations, and potential impact on the fetus; pharmacologic actions, interactions, side effects, adverse effects; monitoring parameters; and response to infusion therapy.[16] (IV, A/P)
   2. Educate the pregnant individual and/or their guardian(s) regarding the potential impact, risks, and benefits of each medication used during pregnancy.[16] (V)
   3. Consider indication-only peripheral intravenous catheter (PIVC) insertion in lieu of "just in case" PIVCs in pregnant patients at low risk for adverse outcomes during labor or birth. Indication-only PIVC insertion should be reserved for hospital or facilities with resources to support emergent PIVC insertion in low-risk patients. Policies to define low-risk patients and the resources/process for emergent PIVC insertion are important for patient safety.[17-19] (IV)
   4. Recognize potential risks of peripherally inserted central catheter (PICC) complications (eg, infection and thrombosis) during pregnancy.[20] (I)
      a. Enteral feeding (eg, nasogastric or nasoduodenal) is the first-line treatment to provide nutritional support to the woman with hyperemesis gravidarum, previously unresponsive to medical therapy and unable to maintain weight.[21] (IV)
         i. Potential infusion therapy needs for patients with hyperemesis gravidarum include subcutaneous antiemetics, intravenous (IV) hydration solutions, and parenteral nutrition (PN).[22] (IV)

C. Considerations for the older adult patients:
   1. Recognize physiologic changes associated with the aging process and its effect on immunity, device selection, drug dosage and volume limitations, pharmacologic actions, interactions, side effects, monitoring parameters, and response to infusion therapy. Anatomical changes, including loss of thickness of the dermal skin layer, thickening of the tunica intima/media, and loss of connective tissue contribute to vessel and skin fragility and present challenges in vascular access.[23-27] (IV)
   2. Assess for changes in cognitive abilities, dexterity, and ability to communicate or learn, and psychosocial and socioeconomic changes that may affect the patient's ability to communicate symptoms of potential complications. These factors may impact the plan for infusion therapy.[28-31] (IV)
      a. Assess the older adult's cognition, mobility, dexterity, and ability to communicate with the health care team prior to initiating home antimicrobial therapy (see Standard 66, *Home Infusion Therapy*).[32] (IV)
   3. Assess for ability to safely manage medication regimens and VADs in the presence of cognitive impairment and dexterity issues and for the presence of unsafe practices in the storage of medications in the home setting (see Standard 66, *Home Infusion Therapy*).[33] (V)
   4. Identify and interact with appropriate family members, caregivers, or surrogates as members of the patient's health care team, with consent of the patient, or as necessary due to mental status.[34-38] (IV)
   5. Identify potential for adverse events and significant drug interactions in older adults who may be prescribed multiple medications; work with the health care team to resolve medication issues and reduce risks.[39-42] (IV)
   6. Identify potential for vascular access complications and early mortality in elderly adults who require hemodialysis. Arteriovenous fistulas (AVFs) are the preferred vascular access in most hemodialysis patients. Age-related frailty and chronic disease may contribute to device-related complications and early mortality. Use a patient-centered approach, including patient preference, when considering risk/benefits associated with AVF, arteriovenous graft (AVG), and central vascular access device (CVAD) to determine the most appropriate vascular access device (see Standard 27, *Vascular Access and Hemodialysis*).[43-47] (IV)

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3. SCOPE OF PRACTICE

Standard

3.1 Clinicians prescribing and/or administering infusion therapy and performing vascular access insertion and management are qualified and competent to perform these services based on their licensure and certification and practice within the boundaries of their identified scope of practice.
3.2 The role, responsibilities, and accountability for each type of clinician involved with infusion therapy prescription and administration and vascular access insertion and management are clearly defined in organizational policy according to the applicable regulatory agencies or boards.
3.3 Members of the health care team collaborate to achieve the universal goal of safe, effective, and appropriate infusion therapy.
3.4 Infusion therapy and vascular access activities, skills, or procedures are delegated from a licensed professional to others in accordance with rules and regulations established by the appropriate regulatory agency (eg, state board of nursing) and within the policies and procedures of the organization.

Practice Recommendations

A. Recognize that many clinical roles require licensure (eg, registered nurse [RN], advanced practice registered nurse [APRN], Advanced Practice Nurse [APN]), whereas others do not have licensure requirements (eg, unlicensed assistive personnel [UAP]), and still others have variable credential requirements based on the applicable regulatory agencies or boards (eg, radiologic technologists).
   1. Know and act within the defined scope of practice for one's licensure(s) in the jurisdiction of the practice venue. The defined "scope of practice" for licensed clinicians varies by jurisdiction (eg, countries, states, provinces); practice beyond or outside the defined scope is unsafe.[1-6] (IV)
      a. Clinicians who do not require licensure may have their scope of practice defined through certification programs established by the respective professional organizations (eg, American Society of Radiologic Technologists [ASRT]).[7] (V)
      b. Educational requirements and services provided by UAP vary among countries, states, and health care organizations. UAPs usually do not have a regulated legal scope of practice, and the roles of this group vary extensively.[8-10] (V)
   2. Apply the 5 types of regulations that impact scope of practice, including the following[11]: (V)
      a. Transnational agreements across countries
      b. Laws, ordinances, or statutes authorized by the appropriate legislative body for each jurisdiction
      c. Rules and regulations created by the responsible board or council in each jurisdiction
      d. Interpretation and implementation to apply the laws as specific guidelines
      e. Standards, guidelines, position statements, and/or competency frameworks written by professional organizations.
   3. Accept responsibility and accountability for one's actions or inactions and those of others who are supervised by or receiving delegation from the licensed clinician.[11] (V)

B. Know the process for defining the scope of practice for one's profession and the appropriate framework for making scope of practice decisions.
   1. Recognize that, in some jurisdictions, governments define the scope of practice through legislation, but in others, professional organizations have the authority to define scope of practice.
      a. While establishing parameters and boundaries, the scope of nursing practice should be sufficiently broad and flexible and focus on a combination of knowledge, judgment, and skills of direct patient care, patient advocacy, supervision, and delegation to others, as well as leadership, management, research, and health care policy development.[1,2,12] (IV)
      b. Identify changing needs that require the scope of practice to evolve. Expansion or extension of the scope of practice should be accompanied by rigorous educational and competency requirements to ensure health care tasks are performed by qualified personnel. Examples of appropriate expansions occurring in some jurisdictions include RN insertion of a central vascular access device (CVAD), medication prescribing by an APRN, and insertion of a short peripheral intravenous catheter (PIVC) by UAP (see Standard 5, *Competency and Competency Assessment*).[1,2,4,13-21] (V)

C. Use scope of practice decision-making frameworks when available to determine if a task is within scope of practice. For example, in the United States, decision-making frameworks commonly include the following criteria[4,11,22]: (V)

1. Is in accordance with laws, regulations, and policies of the governing regulatory body.
2. Aligns with evidence-based practice (EBP) and other published resources.
3. Is supported by established policies and procedures.
4. All educational requirements have been completed by the individual.
5. Competency assessment and documentation have occurred.
6. Appropriate resources are readily available in the setting.
7. The individual is prepared to accept accountability for the outcome of the activity/intervention.

D. Identify and understand the roles of all team members to best collaborate and optimize performance for all clinicians.[23,24] (IV)
   1. Where scopes of practice overlap, the most skilled team member should perform a skill or intervention, considering safety, efficacy, outcomes, and costs. For example, better patient outcomes are achieved when the RN is accountable for assessment, care planning, evaluation of care, and the supervisory role of the licensed practical/vocational nurses (LPN/LVN) and UAPs.[23,25] (IV)
   2. In some jurisdictions, clinical personnel identified as providers (eg, physician, APRN) may need to be granted privileges in order to practice at a venue of care. Their scope of practice may further be limited by which privileges are granted to them.[26-28] (V)

E. Follow the *Five Rights of Delegation*, including the right task, under the right circumstances, to the right person, with the right direction and communication, and under the right supervision and evaluation. Specific guidelines for the nursing profession may be applied to other professions.[29] (V)
   1. Delegation, as permitted by applicable regulations, may occur from a clinician (delegator) to another individual whose scope of practice is encompassed within the delegator's scope of practice. For example, APRNs can delegate to RNs, LPN/LVNs, and UAP, but an RN cannot delegate to an APRN because the APRN has a broader scope of practice than the RN.[29] (V)
   2. Medical assistants (MAs) are typically UAP who may have tasks delegated to them (eg, insertion of a short PIVC or administration of blood or intravenous medication). The scope of which tasks can be delegated to the MA and which clinicians (eg, physician versus nurse) can delegate tasks to the MA vary according to jurisdictional regulations.[15] (V)
   3. Policies and procedures regarding which infusion and vascular access activities can and cannot be delegated should be developed in collaboration with the designated organizational leader on delegation activities.[29] (V)
   4. An activity requiring clinical reasoning (eg, nursing judgment, critical decision-making) cannot be delegated.[29] (V)
   5. Delegators should develop delegation skills based on rules and regulations articulated by the applicable regulatory agency or board.[29,30] (V)
   6. Those accepting delegated responsibilities should only accept assignments for which they have documented competency (see Standard 5, *Competency and Competency Assessment*).[29] (V)

F. Nursing Personnel
   1. Registered Nurse (RN)
      a. Perform independent nursing interventions using appropriate clinical reasoning, nursing judgment, and critical decision-making skills.[31,32] (V)
      b. Advocate for practice at the top of licensure and identify opportunities to remove barriers that prevent practice at the top of licensure.[1,23,33-36] (IV)
   2. LPN/LVN
      a. Practice for LPN/LVN varies greatly across the globe but may include a broad range of infusion/vascular access-related tasks (eg, venipuncture, management of CVADs); monitoring of intravenous (IV) flow rates, transfusions, and pain control devices; and administration of some IV medications.[37-39] (V)
   3. Infusion Nurse (eg, Certified Registered Nurse Infusion [CRNI®])
      a. Enhance professional growth and empowerment through specialization in infusion nursing, designated by earning board certification.[31,40,41] (V)
      b. Participate in quality improvement (QI) activities and clinical research in infusion therapy (refer to Standard 6, *Quality Improvement*; Standard 7, *Evidence-Based Practice and Research*).
      c. Serve as the educator, leader, manager, consultant, and primary resource to guide policy and procedure development of infusion therapy and vascular access derived from best evidence.[42,43] (V)
   4. APRN
      a. APRN scope of practice differs across the globe, ranging from independent to restricted with and without prescriptive authority, or with requirements for collaboration with the interprofessional team.[44-47] (IV)
      b. In the United States (US), hospitals credential APRNs and grant privileges to practice according to the policies of the organization, which may differ from their legal scope of practice.[45,48-51] (IV)
         i. Advocate for the highest level of autonomy in practice decisions: organizational bylaws (eg, hospital admitting privileges) and payer policies (eg, billing under physician's billing number) impact APRN practice.[45,52-54] (IV)

TABLE 1

Additional Clinical Disciplines Involved with Infusion Therapy and Vascular Access

Discipline	Roles/responsibilities for infusion therapy and vascular access
EMS personnel[3]	Advanced emergency medical technicians may: • Insert and access short PIVCs and IO devices • Administer IV and IO solutions without added medication(s) • Administer certain medications by the IV route. • Perform venous blood sampling. Paramedics may: • Insert and access short PIVCs and IO devices • Administer IV and IO solutions with and without added medications • Administer IV medications • Perform venous blood sampling • Access and monitor indwelling CVADs • Manage infusions of blood and blood products.
Physician[66]	• Establishes the medical plan of care • Prescribes and may administer infusion solutions or medications • Prescribes the insertion, management, or removal of infusion devices • May insert, access, manage, or remove all types of VADs, IO devices, and epidural/intrathecal catheters • Interprets radiology studies and documents final tip location for CVADs.
Physician assistant, Physician Associate[67]	• A dependent practitioner who practices under the license of and within the scope of practice of the supervising physician • May prescribe infusion solutions and medications • May insert and access all types of VADs and IO devices • May insert, manage, access, or remove other infusion devices (eg, epidural or intra-articular anesthetic infusions) • May administer infusion solutions or medications.
Registered radiology assistant[68]	• A dependent practitioner who practices under the license of and within the scope of practice of the supervising radiologist • May insert, manage access, and remove all types of VADs • May administer infusion solutions and medications.
Medical imaging and radiologic technologist (licensed or certified)[68]	• May insert, manage access, and remove all types of VADs • May administer infusion solutions and medications.
Respiratory care practitioner[69]	• May insert, access, manage, and remove all VADs, including arterial catheters • May administer infusion solutions or medications related to respiratory function • May manage cardiopulmonary systems (eg, extracorporeal life support).
Registered pharmacist[70,71]	Depending on jurisdictional protocols, authorization of independent prescribing, collaborative practice agreements or institutional protocols, pharmacists may have the authority to: • Prescribe or modify medication prescriptions • Administer medications and vaccines.

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

c. Provide leadership and opportunities in education, conducting research, and application of EBP according to the needs of the employing organization and/or patient populations served. (eg, APRN use of point of care ultrasound technology).[5,36,46,55-58] (IV)

G. UAP

1. UAP encompass medical assistants (MAs), certified nursing assistants (CNAs), patient care technicians (PCTs), and additional roles (eg, nurse extern) working under the supervision of a licensed health care professional.[59] (IV)
   a. An unofficial scope of practice for certified nursing assistants (CNAs) is derived from the US law that applies to care for residents of nursing facilities. No tasks related to vascular access device (VAD) insertion, care, or management, or to the administration of any IV solution or medications are included.[8,60] (V)
   b. Regulations for UAP vary greatly across jurisdictions, with very few identifying any form of scope of practice.[39,61-63] (IV)
   c. Managing equipment and supplies, gathering data, and assisting licensed clinicians with invasive procedures are infusion-related tasks that may be assigned to UAP. Although UAPs might not perform infusion therapy-related activities, the care provided must involve knowing how to

protect the VAD dressing and attached administration sets and infusion pumps while performing other patient care activities (eg, bathing, mobility).[9,15,64] (IV)

d. There is much variation among jurisdictions regarding what is allowed for UAP working with dialysis patients (ie, patient care technicians) who manage CVADs for hemodialysis and IV administration of medications, such as heparin and 0.9% sodium chloride.[38,65] (V)

H. Other clinical disciplines involved with infusion therapy and vascular access
   1. Refer to Table 1, which is based on local and regional (eg, state/ province) rules, regulations, and laws.
   2. Unless otherwise noted, the content is about scope of practice in the US, as comparable information for other countries is not readily found or available.
   3. The Infusion Nurses Society (INS) recognizes that there is great variation among countries in titles, licensure requirements, and scope of practice relative to infusion therapy and vascular access.

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Note: All electronic references in this section were accessed between February 26, 2023, and August 11, 2023.

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4. INFUSION AND VASCULAR ACCESS SERVICES

Standard

4.1 Infusion and vascular access services require interprofessional collaboration and clinical experts to advance patient and organizational outcomes of care.
4.2 The scope of services provided by infusion and vascular access specialist teams (VAST) is structured to meet patient and organizational needs for safe delivery/administration of quality infusion therapy.
4.3 Infusion and vascular access services follow regulations applicable to each jurisdiction.

Practice Recommendations

A. General
   1. Identify opportunities, challenges, clinical outcomes, and costs associated with delivery of infusion and vascular access services within the organization.
      a. While some health care organizations have eliminated infusion/VASTs to conserve resources, the use of VASTs is recognized for reduction in health care-acquired complications associated with central vascular access devices (CVADs), including pneumothorax and arterial puncture, and as essential to prevention of catheter-associated bloodstream infections (CABSI) in acute care hospitals.[1-18] (II)
      b. Specialty teams reduce the need to escalate from use of peripheral VADs to more invasive CVADs through clinical consultation; reduce costs associated with device-related complications, labor resources, and vascular access supplies and equipment; and improve patient satisfaction with greater first-attempt insertion success and lower rates of complications.[2,4,9,10,19-25] (II)

B. Team Leadership and Organization
   1. Provide interprofessional leadership for infusion/VAST services to advance evidence-based standards and improve patient care outcomes (eg, clinical nurse specialist, infection preventionist, quality/patient safety roles, and physician champions). Keys to the success of interprofessional teams are clarity of purpose, communication, adoption of best practices, and optimization of efficiencies to achieve patient-centered outcomes.[4,13,19,26-34] (IV)
      a. Identify the most appropriate subject matter expert to organize and lead the team. Leadership responsibilities include promotion of evidence-based practice, clinical governance, staff development, and quality improvement (QI) activities.[4,11,13,18,26,27,30,32-34] (IV)
   2. Choose the name for the designated team of clinicians that reflects procedural services, QI, and education services provided to advance safe patient care. Contemporary team names are used synonymously, including, but not limited to, vascular access specialist team, vascular access team, vascular access resource team, and infusion team.[2,4,10,15,24,35,36] (IV)
   3. Plan the process required for financial management of the infusion/VAST within the health care system in each jurisdiction. Establish the budgetary process, including operational costs, and sources of operational revenue (eg, placement of outpatient peripherally inserted central catheters (PICCs), productivity capture as a variance to the budget).
      a. Establish as a revenue and cost center in acute care hospitals, allowing the team to track and analyze services provided and document financial contributions to the organization, showing revenue to offset costs.[37] (V)
   4. Promote participation in interprofessional safety programs to reduce the incidence, risk, and costs of adverse events related to infusion/vascular access, including[38-48]: (IV)
      a. Antimicrobial stewardship programs
      b. Infection prevention committees in analysis of CABSI
      c. Analysis of IV-associated medication errors
      d. Analysis of systemic adverse drug reactions (eg, vancomycin flushing syndrome) and VAD-associated complications
      e. Collaboration with acute pain teams to reduce lapses in analgesia
      f. Extravasation prevention
      g. Collaboration with multiple disciplines and departments (eg, pharmacy infusion pump safety committee) to reduce errors related to dose error reduction systems (DERS) in electronic infusion pumps (refer to Standard 23, *Flow-Control Devices*)
      h. Coordination of product evaluation, QI, staff development, and standardized evidence-based practice (EBP), within and between health care organizations (refer to Standard 6, *Quality Improvement*; Standard 5, *Competency & Competency Assessment*).

5. Use QI methods such as failure mode and effects analysis (FMEA) and Lean Six Sigma for evaluation of patient care delivery and workflow processes toward the goals of risk reduction and improvement of infusion and vascular access services (see Standard 6, *Quality Improvement*).[19,49-55] (IV)
6. Encourage and support team membership with professional organizations and board certification to advance specialized knowledge of vascular access and infusion therapies (see Standard 3, *Scope of Practice*).[56] (V)

C. Team Care Delivery Model
1. Design the infusion/VAST services to include clinicians dedicated exclusively to vascular access and infusion practice. The team provides holistic evidence-based interventions and advances quality of care outcomes in inpatient and outpatient settings. Contemporary teams should provide expertise in procedural tasks (eg, vascular access for patients with difficult intravenous access (DIVA) and perform clinical rounding to assess staff adherence to care and maintenance practices, assess central line necessity, and provide education to staff regarding infusion/vascular access best practices.[1-9,11,15,25,57-60] (II)
2. Identify services to meet organizational and patient needs; examples include:
   a. Placement of peripheral intravenous catheters (PIVCs), peripherally inserted central catheters (PICCs), and other CVADs; VAD dressing changes, medication administration (eg, blood products, chemotherapeutic agents), and support services to specialty departments (eg, emergency department) on an as-needed basis. Combining small specialty groups with the hospital VAST into a centralized service may improve patient outcomes.[11,13,22,35,61] (II)
   b. Proactive assessment of patient needs and selection of the most appropriate VAD, using evidence-based insertion techniques, managing infusion methods and vascular access care, along with evaluation of clinical outcomes.[28,34,62,63] (IV)
   c. Urgent venipuncture services in emergency departments (EDs) and dedicated DIVA teams to insert PIVCs and draw blood samples in patients using near infrared light or ultrasound technology. Failure to successfully perform venipuncture causes significant delays in diagnostic and therapeutic infusions.[21,64-69] (IV)
3. Assess the needs of the organization to determine appropriate hours of service to meet patient needs. Comprehensive infusion/VASTs provide services on a 24-hour basis, 7 days/week, assess patient and caregiver needs, and select the most appropriate VAD using skillful insertion techniques, managing infusion methods and vascular access care, and evaluating clinical outcomes.[2,4,13,35,61] (IV)
4. Promote the consultative role rather than viewing team members solely as task performers. This approach facilitates interprofessional communication and shared decision-making about central and peripheral VAD appropriateness and provides consultation regarding clinical practice guidelines for vascular access management and appropriate removal. Infusion/VASTs functioning as valued consultants have a better relationship with physicians and other nursing staff.[25,28,58-60,70-72] (IV)
   a. Consider using an electronic communication tool to facilitate shared decision-making between the patient's health care team and the infusion/VAST (eg, line necessity checklist embedded in electronic medical record [EMR]).[57] (II)
   b. Consider expanding the scope and services to include placement of all types of CVADs, use of appropriate technologies, and insertion of arterial catheters as needed in each facility. Collaborate with members of other disciplines as needed to accomplish the required steps for this expansion (see Standard 3, *Scope of Practice*).[73-76] (V)

D. Alternative Care Settings
1. Recognize variations in the types of infusion therapies, organizational structure, and regulatory requirements for delivery in the home, outpatient, or skilled nursing facility.
   a. Adhere to the minimum threshold for operational and clinical aspects of patient safety for in-office infusion as identified by the National Infusion Center Association (NICA).[77] (V)
2. Establish methods to communicate between acute care and community care organizations. Provide details of the specific type and management of VADs and the type and methods of delivery for the infusion therapy required to enhance care by alternative care organizations. Standardizing practices across all organizations and sharing outcome data result in decreased central line-associated bloodstream infection (CLABSI).[78,79] (IV)
3. Establish clear methods of communication among all disciplines (eg, nurses, pharmacists, physicians, laboratory staff) involved in patient care, as services may be geographically separated.[80,81] (V)
4. Provide ultrasound-guided peripheral intravenous catheter (USG-PIVC) services, including USG-PIVC training to infusion clinic clinicians to improve patient satisfaction and reduce infusion delays in outpatient procedure centers.[82-84] (V)
5. Include the expertise of infusion/VAST to develop and manage alternate site infusion services (eg, nurse-run infusion centers, community monoclonal antibody therapy). Nurses with advanced knowledge in infusion therapy are critical to the success of alternate site infusion during global emergencies.[85,86] (V)

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Note: All electronic references in this section were accessed between March 1, 2023, and August 10, 2023.

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5. COMPETENCY AND COMPETENCY ASSESSMENT

Standard

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

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

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

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

Practice Recommendations

A. Provide infusion therapy education and skill development opportunities for newly graduated clinicians (eg, nurse residency programs) to promote best practice and improve confidence.[1-5] (IV)
   1. Recognize that every clinician has a unique set of prelicensure education, experience, and method for assessing individual competence. Support and feedback of coworkers should support the transition to practice.[2,6-11] (III)
   2. Although some regulatory organizations require competence with certain procedures (eg, central vascular access device [CVAD] insertion), there are no consistent guidelines to provide training or to measure outcomes.[5,8,9,12-16] (III)

B. Accept individual responsibility for developing and maintaining clinical competency with infusion therapy and vascular access practices as defined by the clinician's legal scope of practice and the requirements of the specific clinical practice venue and/or patient population.[9,13,17-20] (IV)

C. Plan interprofessional competency assessment programs as appropriate due to the need for a high level of interprofessional collaboration with infusion and vascular access practices.[1,4,8,9,15,16,21-24] (IV)

D. Promote professional growth and development. Options include participation in continuing professional education, achieving and maintaining board certification, serving as faculty at seminars and conferences, conducting clinical research, publishing in a scholarly journal, and completion of an accredited academic study program in a related field.[1,10,13,22] (IV)

E. Collaborate with staff development personnel to identify infusion and vascular access knowledge, skills, and attitudes that require competency assessment, including technical and nontechnical skills. Use standards, guidelines, and published evidence to create the competency assessment process.[1,3,4,6,7,9,20,25] (III)

1. Incorporate adult learning principles and practices by using appropriate teaching methods for adults as learners, their motivations and characteristics as learners, and methods to overcome obstacles to adult learning.[1,13,26] (V)
2. Identify the services provided by the infusion/VAST (Vascular Access Specialty Team) versus those provided by other clinicians and define the competencies associated with each role. Some skills may apply to all (eg, monitoring outcome data, use of information technology, interprofessional teamwork), whereas some may be very specific for the team members based on organization resources (eg, use of ultrasound, insertion of midline catheters and CVADs, catheter clearance procedures.[4,20,23,24,27,28] (IV)
3. Employ a systems-based approach to infusion and vascular access competencies centered on standardized policies and procedures applied across the entire organization (eg, hospital, ambulatory infusion centers, radiology, outpatient, home infusion, and emergency services).[10,13,15,29] (IV)
4. Consider implementing assessment methods to identify the clinical skills specific to individual nursing units or a specialty. This method is reported to produce greater clinician satisfaction, improve confidence, and increase independence.[1,3,15,30] (IV)
5. Consider implementing skills fairs for learning needs assessment and identify additional interventions for competency development. Skills fairs may be better designed for systemwide core competencies.[10,20,31] (V)

F. Manage competency assessment and validation in 2 phases: initial and ongoing competency.[13] (V)
   1. Perform initial competency assessment when:
      a. Orienting newly hired clinicians, both new graduates and clinicians re-entering the workforce.[3,5,32] (IV)
      b. An experienced clinician moves into a position requiring infusion/vascular access skills.[19,33,34] (V)
      c. Practice expansion occurs (eg, insertion of CVADs, administration of hazardous drugs).[19,20,24] (V)
      d. Introducing new policies, practices, and products.[24,35] (V)
   2. Perform ongoing or continuing competency assessment and validation as directed by regulatory and accreditation requirements and organizational safety and quality indicators.[15,18,19,32] (V)
      a. Follow regulatory and accreditation standards to create a competency assessment plan. Periodic competency assessment is required by accreditation organizations, but the frequency of ongoing assessments is defined by the organization.[14,32,36] (IV)
      b. Identify interventions, actions, and skills requiring ongoing assessment by using clinical outcome data; safety and quality indicators, safety events, and sentinel events; changing patient populations served; and patient satisfaction data.[20,30,34,36-38] (IV)
      c. Determine the root cause and appropriate methods for improvement of identified practice gaps through a learning needs assessment.[14,36,39] (IV)
      d. Build alliances with all stakeholders (eg, staff, clinical nurse specialist, professional development specialists/educators, or management, infection preventionist) to increase their interest and participation in the needs assessment process.[9,14,39] (IV)

G. Employ a blended learning approach by combining a variety of methods to deliver education and training. This will improve learning outcomes, maximize use of resources, and allow flexibility.[1,9,20,26,40,41] (I)
   1. For knowledge acquisition and critical thinking skills, choose instructor-led delivery or electronic-based delivery of content. Assigned reading, self-directed study, large and small group discussions, and lectures are additional teaching strategies for knowledge acquisition.[1,9,19,28,37,42] (IV)
   2. For psychomotor skill acquisition, employ simulation that encompasses the procedural aspects of the selected skill to assist in the process of learning to complete a technical skill(s).[6,30,43-48] (II)
   3. For patient assessment skills, use web-based, multimedia technology for simulation of scenarios or standardized patients.[30,45,49] (IV)

H. Use learner-centered, experiential methods to assess competency for psychomotor skills development in 4 consecutive phases, including knowledge acquisition, observation, simulation, and clinical performance. Choose the most appropriate teaching and evaluation strategies for each phase.[6,26,42,43,50] (III)

I. Use simulation method(s) most suitable to develop and refine technical and nontechnical skills using methods with the greatest degree of realism possible.[44-46] (IV)

J. VAD insertion education and competency development:
   1. Develop competency through repetitive practice until the skill can be successfully performed on patients under supervision.[21,45,51,52] (IV)
   2. Practice noninvasive steps of a skill on human volunteers, including tourniquet application and removal, vein palpation, and vascular visualization using electronic devices such as near infrared light and ultrasound.[53] (III)
      a. Do not perform invasive procedures (eg, venipuncture, catheter insertion) on live human volunteers for training purposes.[54,55] (II)
         i. The risk of performing invasive procedures on live human volunteers outweighs the benefits. This method may require higher levels of supervision from the instructor to protect the volunteer. The volunteer would be exposed to physical health risk for

infection, thrombosis, and vessel/tissue damage, plus emotional stress.[56,57] (III)

3. Use anatomical models, task trainers, or virtual reality to allow for repetitive practice in invasive procedures.[26,44,45,54] (IV)
   a. Simulation on anatomical models is learner-centered and associated with a greater number of learning actions taken (eg, checking available printed guidelines, repetitive skill performance) and a higher level of learner engagement.[54,58,59] (II)

K. Measure competency by performance and not by a time or a predetermined number of procedures. There is no established number of procedures performed that will ensure competency for any skill.[4,15,36] (IV)
   1. Repetition of the skill in the simulation phase demonstrates that the learner can show how the skill is performed. Repetition in clinical practice demonstrates that the learner can perform the skill from initial patient assessment through documentation.[26,36,43,58,60] (II)
   2. Performing greater numbers of CVAD insertion procedures is associated with lower rates of complications; however, the number of procedures performed is not an adequate surrogate for competency.[23,51,60] (V)
   3. Success rates with ultrasound-guided peripheral intravenous catheter (PIVC) and/or CVAD insertions have been shown to improve with greater number of procedures performed.[43,51] (V)
   4. Consider establishing a mastery learning process for simulation and insertion training that allows the learner to repeat training steps if the mastery rating score is less than a level established by institutional policy.[3,52,54,61] (IV)

L. Employ a variety of perspectives to assess competency, including self-assessment, peer-assisted learning, and assessment by others, such as an instructor or preceptor.[7,11,28,37,62] (III)

M. Designate qualified, competent instructors and assessors to develop and implement all phases of the competency assessment process for infusion and vascular access competencies in an unbiased, objective manner.[1,4,7,9,32,34,37,42] (IV)

N. Identify low-frequency and/or high-risk skills required in an organization and address ongoing competency by using realistic simulation to practice these skills on a frequent basis.[15,47,63,64] (V)

O. Use a validated skills checklist with a minimum passing or performance scale, a global rating scale, or both to assess and document performance in an objective, measurable manner. The tool should reflect real clinical practice and be tested for reliability and validity in the planning process.[6,26,30,43,47,49,54,58,60,65-67] (I)

P. Establish a process to revise education and competency assessment for clinicians with all levels of experience based on current evidence-based practice guidelines. Competency assessment aligned with evidence-based practices promotes improved outcomes. Recognize that length of clinical experience and/or recurrent performance of a skill (without updated and ongoing competency assessment) may not be accurate measurements of an experienced clinician's clinical knowledge or procedural competence.[1,4,7,10,15,43,68] (IV)

Q. Use a consistent process to manage and monitor outcomes produced by contracted consultants (eg, VAD insertion). Performance expectations for competency for all contracted clinicians include documentation of licensure, competency, and compliance with the organization's requirements for staff qualifications, personnel practices, and clinical policies and procedures. When contractors are acquiring initial competency of a new skill, the organization's management should be knowledgeable of the status of these contractors; that these contracted clinicians are adequately supervised while obtaining competency; and that final documentation of competency is provided to the organization.[19,38,69,70] (V)

R. Identify and address the needs of diverse patient populations by enhancing clinician competency to meet those needs (eg, anatomical models with different skin tones). Incorporate respect for all racial, ethnic, and linguistic groups, as well as geographical, religious/spiritual, and sociological characteristics, into infusion and vascular access practices.[20,71,72] (III)

S. Evaluate the competency assessment program based on learner satisfaction, degree of knowledge acquisition, behavioral changes, changes in patient indicators, and the program's return on investment.[6,17,43,71] (III)

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6. QUALITY IMPROVEMENT

Standard

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

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

Practice Recommendations

A. Foster a just culture and individual accountability through improvement of systems and processes by clinicians and leaders.[1-3] (IV)
B. Identify and prioritize organizational objectives for QI initiatives and incorporate a variety of strategies as part of a QI program.
   1. Engage the interprofessional team in development of a QI plan; include leadership and local champions (eg, infusion/vascular access specialist team [VAST]), infection preventionists, quality and patient safety clinicians, contracted specialists, and other staff) (see Standard 4, *Infusion and Vascular Access Services*).[4-10] (II)
   2. Assess current gaps in practice and identify, minimize, and/or eliminate barriers to change and improvement. Consider potential barriers, including attitudes, time, and financial and physical resources.[9] (V)
   3. Identify areas for improvement through evaluating safety and quality indicators, including close calls, errors, and adverse events (refer to Standard 11, *Adverse and Serious Adverse Events*).
   4. Use systematic methods and tools to guide activities such as Model for Improvement (Plan-Do-Check-Act), Lean Six Sigma, continuous quality improvement (CQI), root cause analysis (RCA), and Healthcare Failure Mode and Effect Analysis (HFMEA) (see Standard 11, *Adverse and Serious Adverse Events*).[5,11-21] (I)
      a. Use an implementation science framework to guide study design, implementation, and evaluation.[22] (II)
   5. Clearly define the aims of the quality improvement project and the metrics for success (refer to Standard 12, *Product Management*).
   6. Plan for sustainability of QI at the onset; integrate changes into the organization through staff engagement, education, and leadership, as well as through organizational infrastructure (including regular audit and feedback) and culture. Consider issues such as transparency, simplicity, and actionability of the plan.[5,19,23] (III)
   7. Evaluate the use of electronic health record (EHR) decision support and reporting structures to improve compliance with quality improvement activities.[16,24,25] (IV)
   8. Use audit and real-time feedback when implementing changes in practice.
      a. Include rationale for practice changes and audit activities; ensure there is a link between audit criteria and patient outcomes (eg, disinfection of needleless connector and catheter-associated bloodstream infection [CABSI]). Provide both written and verbal feedback; translate feedback into goals and action plans.[14,26-34] (I)
      b. Use consistent data definitions during data collection activities to allow meaningful comparisons.[13,35,36] (V)
      c. Include process as well as outcome measures when planning metrics for performance evaluation.[12,13,15,22,27,37] (II)
      d. Consider adopting technology (such as device-based applications) for consistency and ease of use during rounding and audit activities or the use of video for evaluation of simulation activities.[5,26,38] (IV)
   9. Provide education as part of a QI strategy.[7-9,16,17,39-41] (II)
      a. Recognize that education alone is insufficient to improve clinical outcomes and clinical practice.
      b. Employ a blended learning approach by combining various methods to deliver education and training (see Standard 5, *Competency and Competency Assessment*).
      c. Comprehensive process improvement, including updated policies, broad education, and product changes, contribute to improved outcomes and financial savings.
   10. Utilize patient education to improve professional practice by increasing clinician adherence to recommended clinical practice and improve patient outcomes (see Standard 8, *Patient Education*).[42] (I)
   11. Share improvements gained through QI programs both internally and externally.[7-10,29-33,43] (II)
C. Evaluate adverse events from all vascular or other infusion access devices (eg, epidural) for complications (eg, CABSI, reasons for removal, unnecessary central vascular access device [CVAD] placements, occlusions, venous thrombosis, infiltrations, phlebitis).[6,8,13,14,36,39,44-53] (I)
   1. Use surveillance methods and definitions that are consistent across the continuum of care and allow comparison to benchmark data, as well as reviewing for root cause (eg, CABSI).
   2. Collect data; analyze and evaluate outcomes against benchmarks for areas of improvement.
   3. Compare rates to historical internal data and external data (eg, publicly reported outcomes).
   4. Use a standard formula to calculate complication rates.
   5. Report adverse events as mandated by jurisdictional requirements to external quality initiatives or programs.
D. Consider expanding surveillance to include hospital-onset bacteremia as a broad-quality metric.[54,55] (IV)
E. Monitor and evaluate medication adverse reactions and errors according to organizational practice.
   1. Establish a strong just culture that strengthens safety and creates an environment that raises the level

of transparency and encourages reporting of medication errors (see Standard 11, *Adverse and Serious Adverse Events*).[2,56-59] (IV)

2. Establish a system that supports the reporting of close calls.[60,61] (IV)
3. Identify infusion medication safety risk factors.[62,63] (III)
4. Analyze technology analytics, such as smart pumps and barcode medication administration, for errors, overrides, and other alerts so that improvements may be made (see Standard 57, *Infusion Medication and Solution Administration*).[64-72] (IV)

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Note: All electronic references in this section were accessed between February 25, 2023, and August 11, 2023.

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7. EVIDENCE-BASED PRACTICE AND RESEARCH

Standard

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

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

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

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

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

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

Practice Recommendations

A. Promote a culture of evidence-based practice (EBP) and research that advances safe and effective infusion therapy in collaboration with patients, families, clinicians, leadership, and consultants.[1-12] (I)
B. Participate in critical evaluation, interpretation, and synthesis of the body of evidence, including research findings and current best evidence, into practice through sustainable implementation, including regular audits or clinical outcome monitoring for sustainment, and a collaborative decision-making framework. This includes, but is not limited to, policy and procedure development or revision; product technology selection; practice guideline implementation; standard of care; and evidence-based quality improvement (QI).[13-31] (I)
C. Provide support, education, and other opportunities to engage clinicians in, and increase their knowledge and skills of, EBP synthesis and implementation. Activities for engagement and learning may include participation in the organization's EBP education or EBP team/committee/council; a university online EBP education program; a professional organization's EBP education program and/or guideline development committee; or mentorship with the organization's librarian, clinical nurse specialist, EBP coordinator, or nurse scientist.[32-39] (II)
D. Participate in infusion therapy research activities that advance knowledge. This includes activities such as participating in or leading a journal club discussion, participating in or leading a research team to pilot new products, or answering clinical questions using a research framework with appropriate approval for the protection of human research subjects (eg, Institutional Review Board [IRB] or Independent Ethics Committee [IEC]).[37-55] (III)
E. Provide support, education, and opportunities to clinicians for increasing their knowledge and skills of presenting and publishing (internally and externally) their EBP project outcomes and research results that add to the body of evidence. Activities may include mentorship, workshops, or other programs that address abstract writing and the process of abstract submission, poster and presentation development, and manuscript writing and the process of peer review and publication.[39,40,56-61] (IV)

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8. PATIENT EDUCATION

Standard

8.1 The patient/caregiver is educated in all relevant aspects of the prescribed infusion therapy and plan of care to support shared decision-making and positive outcomes.
8.2 Teaching strategies and learning materials are congruent with health literacy and with the knowledge and skills being taught and encompass patient/caregiver learning needs, abilities, and resources.

Practice Recommendations

A. Develop an effective and mutually agreed upon educational plan based on identified goals to ensure the safe delivery of infusion therapy and reduce the risk of infusion therapy and vascular access-related complications.[1-3] (II)
   1. Establish specific, achievable, and measurable goals.[4-9] (II)
   2. Engage the patient/caregiver in the development of and commitment to these goals.[3-11] (II)
   3. Select effective ways to validate appropriate knowledge and skill acquisition for all aspects of infusion therapy that the patient/caregiver will be performing.[6,10-16] (II)
   4. Communicate the educational plan and the patient's progress as the patient transitions to other health care settings.[3,5-7,9,10,17,18] (II)

B. Select teaching methods based on an assessment of age, developmental and cognitive level, health literacy, access to educational resources and technology, preferred learning style, cultural influences, language preference, and readiness to learn. Also assess additional factors affecting readiness of the patient/caregiver to learn (eg, current stressors, sensory deficits, functional limitations, and relationship with the clinician).[4,7,18-25] (II)
   1. Employ strategies to address issues relative to health literacy when conducting patient teaching to ensure communication is simplified, comprehension is confirmed, and misinformation is minimized.[5,6,11,20,26-30] (I)
      a. Recognize populations at higher risk of low health literacy or low digital literacy, including older adults or those who are culturally or linguistically diverse. Use teaching strategies (eg, simplified communication, encourage questions, and provide resources) that acknowledge the varied comprehension of health-related information and ongoing learning needs.[6,11,19,24,27,30,31] (IV)
      b. Improve effectiveness of patient education through utilization of resources to evaluate and address variations in health literacy, cultural needs, accessibility/usability, and the impact of the clinician/patient relationship.[3-5,10,12,19-21,27,31-39] (II)
      c. Use educational resources that are understandable and actionable. These elements include consideration of health literacy levels (written, verbal, and numeracy), cultural congruence, primary language, and instructional methods. Avoid medical jargon and use plain language.[11,19,20,23,27,28,40-42] (IV)
      d. Use active learning strategies to prompt the learner to connect previous and new knowledge. Examples include pausing to ask for reflection or quick recall on what was just taught and the inclusion of case scenarios.[3,4,11,15,28,29] (IV)
      e. Consider sensory modalities of learning: visual, auditory, reading (or writing), and kinesthetic. Whenever possible, and if patient states a preference, adapt teaching to the patient's preferred learning style to improve uptake of education.[5,11,19,32,37,42-45] (II)
   2. Evaluate the impact of home infusion therapy upon caregivers who are required to learn or participate in infusion administration and vascular access care; caregivers as well as patients may experience anxiety, depression, and social restrictions when participating in more complex home infusion therapy such as parenteral nutrition (PN), analgesic infusions, and chemotherapy (see Standard 66, *Home Infusion Therapy*).[26,42] (I)
   3. Ensure that websites that are used/available for patient/caregiver education are reputable, usable, and accessible to the learner and incorporate national accessibility standards (eg, meets regional accessibility and usability guidelines, if applicable), such as effective use of text and page layout, clear navigation, user experience optimization, and accessibility statement.[5,20,27,46-50] (II)
   4. Use well-designed printed information and technology (eg, electronic tablets and educational videos) to enable self-paced and repetitive learning in the patient's home environment and to enhance retention of self-care practices.[5,15,20,26,27,43,46,51-54] (I)
   5. Consider providing a bundled approach to patient teaching at home, using printed and audio/visual materials.[4,27,28,44,55] (IV)

C. Advise the patient/caregiver about the benefits and challenges associated with the use of social media (ie, YouTube, Twitter, Facebook, blogs) to seek health advice or information and to seek social support. Limited research has shown benefits of patient engagement; however, there are challenges that include safety, privacy, and risk of misinformation.[26,46,48] (I)

D. Evaluate patient/caregiver learning outcomes with methods that directly measure knowledge (eg, demonstration/return demonstration for psychomotor skills), verbal feedback for cognitive knowledge (eg, teach-back), and reports of feelings and beliefs (eg, affective domain).[4,6,15-17,32,46,51,56-59] (I)

E. Educate all patients/caregivers about all aspects of infusion therapy as applicable to their clinical needs[2,5,6,13,17,20,44,46,51,57,60-69]: (I)
   1. The right for information should include the risks and benefits of therapy, the risks and benefits of foregoing therapy, and consideration for alternative treatment options, if available.
   2. Vascular access device (VAD) options, expected duration of therapy, and proper care of the VAD.
   3. Precautions for preventing infection and other complications and adherence to the principles of Aseptic Non Touch Technique (ANTT®).
   4. Self-monitoring for signs and symptoms of VAD or infusion-related complications, adverse reactions, and side effects, including those that may occur after the infusion device is removed or after the patient leaves the health care setting (eg, signs of postinfusion phlebitis, fever) and how/where to report them.
   5. For outpatients and those receiving home infusion therapy, include additional education and evaluation as appropriate (see Standard 66, *Home Infusion Therapy*).
      a. Regular evaluation of patient/caregiver comprehension and performance of infusion therapy at established intervals.
      b. Safe storage, maintenance, and disposal of solutions, supplies, and equipment.
      c. Hazardous medication handling, storage, and management of hazardous spill, if applicable (See Standard 15, *Hazardous Drugs and Waste*; See Standard 66, *Home Infusion Therapy*).

d. Infusion administration procedures required for safe administration specific to VAD, infusion device, and infusate.
e. Lifestyle adjustments required due to presence of the VAD and infusion-related devices, including activity limitations, and protecting the device during activities of daily living.
f. Symptoms of adverse events related to the VAD or infusate that should be reported and contact information to access emergency assistance, if required.

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9. INFORMED CONSENT

Standard

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

9.2 The clinician performing any invasive procedure (eg, central vascular access device [CVAD] insertion) facilitates the process and ensures informed consent is obtained.

9.3 The patient or surrogate has the right to accept or refuse treatment.

9.4 Informed consent is required for human subject participation in research in accordance with jurisdictional laws, rules and regulations, and organizational policy.

Practice Recommendations

A. Recognize that obtaining informed consent is a collaborative educational process involving the patient/surrogate in shared decision-making.[1-5] (IV)
   1. The process begins with dialogue between the patient/surrogate and the provider or qualified clinician performing the procedure; however, other clinicians have a significant role in the complete process.
   2. The process concludes with the patient/surrogate signing a consent document or providing verbal consent according to organizational policy (eg, via phone conversation).
   3. Develop an organizational process for identifying surrogate decision-makers.
   4. Continued confirmation of informed consent may be necessary for ongoing treatments (eg, blood administration, hemodialysis, or antineoplastic administration).

B. Follow requirements for obtaining informed consent from the patient/surrogate, as regulations vary across jurisdictions. Differences include documentation, the professional performing the consent process, procedures/treatments requiring informed consent, and variations in the legal approach to evaluation of informed consent.[6] (V)
   1. Adhere to organizational policy for managing exceptions to usual informed consent requirements (eg, emergency/life-threatening situations, patient incapacitation without surrogate decision-maker).[7,8] (I)
   2. Define circumstances (eg, emergent and time-sensitive situations) when exemption from obtaining informed consent is allowed. Document details of information provided, method of discussion (eg, telephone), to whom it was given, and the patient or surrogate response in the patient's health record.[1,6] (V)

C. Ensure that the process for informed consent includes the following precepts:
   1. Consent is voluntarily given and is free from coercion, persuasion, or undue influence.[9,10] (V)
   2. The patient/surrogate has received the necessary information to understand the procedure/treatment, its purpose, common risks, potential benefits, alternative procedures/treatments, common complications, and potentially serious or irreversible risks.[1,4,11] (V)
      a. When possible, include information related to vascular access device (VAD) insertion regarding site location or number of allowable cannulation attempts to ensure the patient/surrogate's consent spans most common potentialities and scope of the proposed procedure.[12] (IV)
   3. The patient/surrogate can comprehend the information, appreciates the situation and its consequences, and is able to make choices.[13-17] (II)
   4. Formal interpreter services are used to ensure understanding when a language difference exists.[4] (V)
   5. The decision is authorized by the patient/surrogate and documented on the signed form, as appropriate.[18] (V)

D. Facilitate the informed consent process by choosing learning methods most appropriate for the patient's age, relational abilities, and level of health literacy (refer to Standard 8, *Patient Education*).
   1. Use multimedia tools (eg, videos, digital programs, 3-D virtual reality) to support patient understanding and comprehension during the informed consent process.[2,13,19-27] (I)
   2. Employ interactive communication methods that facilitate shared decision-making and improve understanding and retention of information.[28-30] (IV)

E. Document the informed consent process by serving as a witness to the patient/surrogate signature on an informed consent document, if written consent is required.[4,31] (V)

F. For research-informed consent, provide a clear, concise, and accurate explanation of the research purpose(s). Allow the participant an opportunity to ask questions and have time to consider participation. In addition to the standard components of informed consent, the research-informed consent should include items listed below.[3,32-36] (I)
   1. The anticipated length of participation in the research.
   2. Identification of procedures that are experimental.

3. Management processes for confidential patient information and their identity.
4. Compensation for participation, if any.
5. Risks and benefits of participation.
6. Availability of medical treatments if injury occurs.

G. Obtain informed consent for photographs and/or videotaping of patients according to your institutional policy.[37,38] (V)

H. 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.[4,39-43] (V)

I. Assess patients with age-, trauma-, or disease-related alterations in cognitive capacity for their ability to consent. Use tools to evaluate decisional capacity or ask 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.[5,7,8,16-18,44,45] (I)

J. Verify that informed consent for neonatal, pediatric, and adolescent patients is obtained for the procedure/treatment from the parent or legal guardian. From the patient, verify assent (ie, agreement) to the procedure/treatment using language and learning methods appropriate for the age and/or cognitive stage of the individual. While there is a lack of consensus over the age of assent, it is generally considered 7 years old or school age (see Standard 2, *Special Patient Populations*).[1,19,46-50] (V)

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10. DOCUMENTATION IN THE HEALTH RECORD

Standard

10.1 Clinicians record their initial and ongoing assessments or collection of data, diagnosis or problem, intervention and monitoring, the patient's response to that intervention, and plan of care for infusion therapy and vascular access in a patient-specific physical (ie, paper) or electronic/digital document.

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

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

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

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

Practice Recommendations

A. Document the patient, caregiver, or surrogate's consent or assent to vascular access device (VAD) insertion, as

appropriate, and their participation in or understanding of VAD-related procedures including, but not limited to, the following (see Standard 8, *Patient Education;* Standard 9, *Informed Consent*)[1-5]: (I)

1. Patient responses to VAD insertion and removal procedures
2. Patient responses to VAD access and/or infusion therapy, including symptoms, side effects, or adverse events
3. Patient, caregiver, or surrogate education and understanding of VAD- and infusion therapy-related education or barriers to that education.

B. Incorporate standardized elements for VAD/infusion-related documentation into the electronic medical record (EMR).[6-13] (I)

C. Document the following upon VAD insertion[11,12,14-17]: (IV)

1. Indication for use
2. Date and time of insertion
3. Number of attempts
4. Insertion technique (eg, visualization technology, landmark technique)
5. Type of VAD/number of lumens/length and gauge/French size
6. Insertion site identification using anatomical descriptors (laterality, landmarks, or appropriately marked drawings)
7. Lot number, if included with product
8. Pain management intervention(s)
9. VAD tip location
10. VAD patency/function
11. Dressing type and VAD securement method
12. For peripherally inserted central catheters (PICCs) and midline peripheral catheters (ML):
    a. Circumference of the extremity at time of insertion and when clinically indicated to assess the presence of edema and possible catheter-associated thrombosis. Note presence of pitting or nonpitting edema (refer to *Standard 50, Catheter-Associated Thrombosis*).
    b. Catheter-to-vein ratio with placement (refer to *Standard 50, Catheter-Associated Thrombosis*) (see Standard 21, *Vascular Visualization*; Standard 30, *Pain Management for Venipuncture and Vascular Access Procedures*; Standard 32, *Vascular Access Device Insertion*).

D. Document ongoing assessment of dressing and securement integrity, external catheter length (noting any discrepancy between the length documented at insertion), dressing change, site care, patient report of discomfort/pain, and any changes related to the VAD or access site.[5,17] (IV)

E. Document VAD-related complications using a standardized assessment for signs and symptoms, including but not limited to: phlebitis, infiltration, and extravasation appropriate for the specific patient (eg, age or cognitive ability), with photography as appropriate and in accordance with organizational policy (see Standard 9, *Informed Consent*; Standard 43, *Phlebitis*; Standard 44*, Infiltration and Extravasation*).[3,5,15-19] (IV)

F. Document type of therapy, including flushing or locking, drug, dose, rate, time, route, and method of administration, including vital signs and laboratory test results as appropriate; condition of the venipuncture or VAD site prior to and after infusion therapy.[2,11] (V)

1. Avoid the practice of documenting administration of multiple intravenous (IV) medications as a single time occurrence. Failure to document actual administration times for medications administered sequentially may result in inaccurate dosing of medications requiring therapeutic drug monitoring.[20] (V)
2. Clearly indicate which solutions and medications are being infused through each device or lumen when multiple VADs or catheter lumens are used. (Committee Consensus)
3. Consider the potential benefit of integrated documentation from smart pumps data to improve accuracy of documentation on infusions (see Standard 57, *Infusion Medication and Solution Administration*).[21-23] (IV)
4. Use barcode medication administration, if available, to scan infusion medications/solutions prior to administration to capture documentation of the right dose and formulation administered to the patient at the right time (see Standard 57, *Infusion Medication and Solution Administration*).[24] (V)

G. Document type of equipment used for infusion therapy administration; depending on the venue of care, accountability for maintenance and replacement of administration sets/add-on devices, as well as identification of caregiver or surrogate for patient support and their ability to provide this care.[25] (V)

H. Assess and document the ongoing need for the VAD (see *Standard 39, Vascular Access Device Post-Insertion Care*)[5,13,14,26,27]: (I)

1. Daily for acute inpatient settings
2. During regular assessment visits in other settings, such as in the home, outpatient facility, or skilled nursing facility.

I. Document upon removal: condition of site; length of VAD compared to length documented at insertion; reason for device removal, interventions during removal, dressing applied, date/time of removal; any necessary continuing management for complications; and, if cultures are obtained, source of culture(s) (see Standard 42, *Vascular Access Device Removal*).[5,11,16] (IV)

J. Document required elements of care using standardized templates or tools (eg, for VAD insertion and infusion therapy), without limiting further description, as needed.[3,18,28] (V)

K. Complete all documentation in an electronic health record (EHR) or other electronic health information system, if available, using standardized terminology.[1,29-32] (I)

1. Electronic entries should reflect current patient status, even when an entry is pulled from another location in the health record.[3,33] (V)
    a. Consider EHR compatible technology (eg, mobile applications, portable devices, or speech recognition) to enhance real-time documentation of assessment data to improve timeliness of documentation, improve communication between the care team, and decrease potential for transcription errors.[34-36] (II)
    b. Configure the EHR to capture data for quality improvement (QI) of patient vascular access without additional documentation from clinicians.[3,37-43] (II)

L. Conduct routine audits of documentation to identify patient safety risks associated with missed care and related outcomes.[44-48] (IV)

M. Consider integration of EHR technologies to capture posttreatment patient-reported symptoms and guide appropriate interventions. Autogenerated text messages or surveys set to trigger provider follow-up may enhance patient outcomes of care.[49] (V)

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Infusion Therapy Standards of Practice 9th Edition

Section Two: Patient and Clinician Safety

11. ADVERSE AND SERIOUS ADVERSE EVENTS

Standard

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

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

Practice Recommendations

A. Use standardized tools to identify, document, and track adverse events in accordance with organization policy. Use documents and tools providing objective and specific facts about the adverse event.[1-7] (II)

B. Educate the patient and caregivers about signs and symptoms of complications, reactions, or any untoward event that could be an adverse event and how to contact the appropriate clinician (eg, home care nurse, ambulatory clinic staff) for timely management (see Standard 8, *Patient Education*).[8-11] (I)

C. Report adverse events or serious adverse events or the risk thereof (ie, close calls) associated with VADs and/or infusion products/devices and the administration of drugs, biologics, and/or infusates to the appropriate individuals and organizations in the time frame defined by organizational and regulatory requirements[1-3,12-16]: (V)

   1. Provider and other essential health care team members.
   2. Organization's designated management personnel.
   3. Organizational department(s) (eg, risk management, quality improvement [QI]).
   4. Advisory organization (eg, Institute for Safe Medication Practices [ISMP]).
   5. Regulatory organization (eg, US Food and Drug Administration [FDA]/Manufacturer and User Facility Device Experience [MAUDE] database, Health Protection Branch of the Canada Department of National Health and Welfare [HPB], Federal Institute for Drugs and Medical Devices [BfArM], Medicines and Healthcare Products Regulatory Agency [MHRA], Swissmedic, and Brazilian Health Regulatory Agency [Anvisa]).
   6. Accreditation organization (eg, The Joint Commission [TJC], Joint Commission International [JCI], Healthcare Facilities Accreditation Program [HFAP], Det Norske Veritas [DNV], Community Health Accreditation Partner [CHAP], and Accreditation Commission for Health Care [ACHC]) in accordance with institutional policy and accreditation standards.
   7. Drug and/or device manufacturer (when possible, retain defective device and return to manufacturer as part of the product incident report).[4,13-16] (V)

D. Investigate serious adverse events to ensure prompt action and improve safety. The process includes a systematic investigation and analysis to improve quality and safety. Organizations must have a process to determine which serious events require root cause analysis (RCA).[1-3,13,17-22] (IV)

   1. Describe and analyze the event and contributing factors to discern the cause(s) of the event.[19-22] (V)
   2. Implement specific strategies and/or actions for improvements that protect patients. An interprofessional approach to patient safety is comprehensive and focuses on systems issues, procedures, human resources, peer and/or clinical review, products/equipment, processes, and training gaps. Domains of patient safety likely to be associated with improved outcomes include 8 identified domains: transformational leadership (leadership style to encourage positive change), patient engagement, human resources management quality, innovation technology, skill competency, education in patient safety, teamwork, and effective communication.[1,19,22-24] (IV)
   3. Participate in the development, implementation, and evaluation of the improvement plan.[1,13] (V)
   4. Use a systematic investigation or analysis for complex and/or recurrent problems and for near misses.[18,20-22] (IV)

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5. Consider aggregate analysis of serious events to identify organization-specific trends impacting multiple events.[19,21,25] (IV)

E. Improve safety within the organization through a prevention-focused approach:
   1. Develop a culture of safety, shared learning, and high reliability.[7,26-32] (IV)
   2. Focus on correction of the system(s) and processes rather than blaming the clinician.[27-29,33] (V)
   3. Examine at-risk behaviors and coach individuals to make safe behavioral choices according to the precepts of a just culture.[27,29] (V)
   4. Advocate for teamwork interventions, including training and education (eg, focus on communication and leadership), work redesign (eg, change interactions such as interprofessional rounds or local team "huddles"), use of structured tools and protocols (eg, handoff communication tools and checklists), and management support.[31,32,34,35] (IV)
   5. Standardize and simplify the reporting processes throughout the organization, as practicable.[36] (IV)
   6. Use a systematic method to guide safety initiatives, such as Healthcare Failure Mode and Effect Analysis (HFMEA) (see Standard 6, *Quality Improvement*).[37-42] (IV)
   7. Monitor recommendations from investigations for implementation and effectiveness.[6,22,25,43-45] (II)
   8. Remind clinicians to include patient safety in rounds to identify and report adverse events.[46] (IV)

F. Establish a culture that promotes safety transparency, shared learning, encourages reporting, and empowers the clinician to identify and implement appropriate actions to prevent adverse events and close calls (see Standard 6, *Quality Improvement*).[6,27-29,33,35,47,48] (II)

G. Promote organizational learning and communicate necessary practice changes to staff at all levels.[19,24,49-51] (IV)

H. Ensure responsible disclosure of errors to the patient/caregiver or surrogate; promote interprofessional collaboration in planning and discussing information with the team responsible for disclosing information about the adverse event.[13,21,52] (IV)

I. Include the patient/caregiver or surrogate in adverse event review when appropriate.[7,11,12,25,53-55] (II)

J. Identify levels of clinical knowledge and skills necessary to reduce adverse events. Fewer adverse events are documented when there is adequate staffing.[13,24,56-58] (IV)

K. Support health care clinicians who may be considered second victims as a result of involvement in an adverse patient event or injury or unintentional health care error.[21,59-63] (IV)

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Note: All references in this section were accessed between February 21, 2023, and July 27, 2023.

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12. PRODUCT MANAGEMENT

Standard

12.1 Clinician end users are involved in the evaluation of vascular access device (VAD) and infusion products, equipment, and technologies, including clinical application, performance, infection/complication prevention, safety, efficacy, ease of use, acceptability, reliability, and cost.

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

12.3 Infusion and vascular access equipment and supplies are inspected for product integrity and function before, during, and after use; products are visually inspected for damage before use to ensure that the packaging is clean, dry, and intact and the product expiration date is verified.

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

12.5 Clinical experts participate with product substitution decisions as required during supply chain disruptions and ensure that there is a plan for communication, education, and outcome monitoring.

Practice Recommendations

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

B. Report problems associated with the use of any product; remove the product from use and follow organizational policies and procedures for reporting.
   1. Monitor for product recalls and hazard alerts.[6] (V)
   2. Use a structured and objective approach when investigating problems associated with medical devices, which may include issues such as device malfunction, user error, and surrounding infrastructure. Identify the need for additional clinician education versus review of compliance and accountability.[7] (V)
   3. Develop an organizational environment conducive to reporting.
      a. Recognize that clinicians may switch to different devices or develop work-around strategies to continue to use problematic products and may be uncertain regarding what to report and be fearful of incident reporting.[8] (IV)

b. Explore systems to facilitate the ease of reporting, including electronic error reporting. Contribute to medical device surveillance programs to increase patient safety and promote manufacturer accountability.[4,9] (II)

4. Report adverse events or serious adverse events (eg, sentinel events), or the risk thereof (ie, close calls) associated with VADs and/or infusion products/equipment to the appropriate department(s) within the organization (eg, risk management, quality improvement [QI]) and authoritative reporting organizations as required (refer to Standard 11, *Adverse and Serious Adverse Events*).

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13. DRUG DIVERSION IN INFUSION THERAPY

Standard

13.1 Organizations that procure, dispense, handle, and/or administer controlled substances (CSs) establish policies, procedures, and processes that ensure proper management of CSs throughout the medication pathway.

13.2 An organizational culture of safety is fostered to promote prompt reporting and confidential, nonpunitive investigation of suspected diversion of CSs.

13.3 Members of the health care team with access to CSs are trained and are competent in role-specific processes related to CS handling and use.

13.4 Each CS administration is accompanied by a valid order from an authorized prescriber.

Practice Recommendations

A. Implement a program for prevention of diversion to optimize patient safety during procurement, dispensing, handling, and/or administration of CSs (eg, Controlled Substance Diversion Prevention [CSDP]).[1-4] (IV)
   1. Empower health care workers and leadership to implement strategies to create a safe, healthy work environment.[3,5] (IV)
   2. Establish expectations within the organization for professional behaviors and norms that discourage abuse of CSs.[4,6-9] (V)
   3. Establish policies and procedures that accurately reflect local and regional regulatory requirements in all aspects of CS management, including consistent monitoring of CS procurement, storage, dispensing, handling, administration, and waste processes, and a clear communication structure.[1-4,6-16] (IV)
   4. Collaborate with key stakeholders (eg, pharmacy, providers, nursing, local law enforcement officials, vendors, health care leaders, infection prevention, contracted services, risk management, human resources, bio-med) to ensure that the CSDP is comprehensive and effective.[1,4,6] (V)
      a. Use a secure chain of custody of CSs throughout the medication pathway.[1,4,10,11,13] (IV)
         i. Consider use of a locked device when transporting CS from pharmacy to unit-based storage unit.[12,13] (V)
      b. Establish consistent surveillance processes:
         i. Collaborate with an interprofessional team in selection and effective utilization of technology for CS (eg, medication-related automated systems, automated dispensing cabinets), including initial and ongoing staff training and competency, regular validation of proper user access, regular review of override list, ongoing system maintenance, and downtime procedures.[1,3,4,6,10-13,17-23] (IV)
            a) Consider establishing interoperability between medication storage unit and the electronic health record to improve system support.
   5. Develop an interprofessional process to conduct a thorough investigation of each suspected or confirmed diversion event to determine potential for system improvements.[1,4,7,10,15,16,24,25] (IV)
      a. Consider use of Failure Modes and Effects Analysis (FMEA) to identify vulnerabilities through the entire medication pathway.[3,12,20] (IV)

6. Ensure that infusion devices operate according to manufacturer specifications.[15] (V)

B. Diversion Prevention
   1. Establish an opioid stewardship program to optimize dosing, provide multimodal pain relief, and provide patient/caregiver education on diversion prevention.[7,26-30] (III)
      a. Develop processes to prevent diversion in home care and hospice programs, including proper CS waste procedures and screening of patient/caregivers for history of addiction or risk of misuse where CS is in use.[29,31] (IV)
      b. Recognize the risk of immediate release opioids that may be converted to non-oral routes.
         i. Investigate abuse-deterrent formulation (ADF) preparations of oral opioids.[32,33] (V)
   2. Implement pre-employment background checks for health care workers (HCWs) with access to CS.[4,11,29,34,35] (IV)
   3. Review orders for CS carefully for accuracy and appropriateness for the individual patient.[4] (V)
   4. Use electronic prescribing of CS and minimize use of paper prescriptions. When paper prescriptions are required, secure prescription pads to ensure that only authorized individuals have access.[4,7,8,10] (V)
   5. Limit access to CS through restricted access to storage (eg, key, biometrics, badge access).[4] (V)
      a. Identify high-risk and high-volume areas where diversion may occur to facilitate increased surveillance and control of the medication pathway.[4,8,36] (V)
         i. Consider camera surveillance for high-risk areas.[4,6,10,14,20,37] (V)
   6. Ensure chain of custody of CS is always maintained throughout the medication management process.[1,4,8,29,36] (IV)
      a. Store a CS that is removed from main medication storage in a secured, locked receptacle, accessible only to authorized staff.
      b. Ensure a process to maintain chain of custody of keys when used to access and administer CS (eg, locked box, refrigerated storage, infusion pumps).
      c. Ensure that authorized staff do not delegate their access to CS in a way that alters chain of custody.
      d. Ensure security of CS that a patient brings into a facility or arrives with a patient transferred from another facility.
   7. Conduct CS diversion education (including unlicensed and contracted personnel) at initial orientation and regularly. Information should include, but is not limited to, the following[2-5,7,8,10-12,16,21,24,25,29,34,35,37-50]: (IV)
      a. Responsibility to protect public safety.
      b. Risk factors for substance use disorder, addiction, and diversion (eg, work-related injuries, workplace trauma, burnout, work role strain, personal/family history of addiction, childhood adverse events, illicit drug use).
      c. Signs, symptoms, and patterns of behavior that may indicate diversion.
      d. Medications at high risk for diversion (eg, opioids, sedatives).
      e. Preventative measures in place in the organization (eg, auditing, reporting structure).
      f. Proper documentation processes for all CS transactions.
      g. Processes used to conduct a diversion investigation.
      h. Potential for civil and/or criminal penalties if diversion is confirmed.
      i. Potential for disciplinary actions for failure to report.
   8. Integrate curriculum within health care education programs (eg, provider, pharmacy, nursing) regarding prevention and recognition of CS diversion.[41,42,46,51] (IV)
   9. Ensure compliance with approved CS administration processes, including, but not limited to:
      a. Consider stocking CSs in a "ready-to-administer" form in the lowest available units typically prescribed to patients to limit volume required to be wasted.[4,10,21,52] (IV)
      b. Prepare CSs as close to administration time as possible.
         i. Identify optimal time allowed from CS removal to administration.[1,4,10] (V)
      c. Limit dose preparation to single dose when possible.
         i. If sequential dosing is delivered from a single syringe, ensure a method exists to accurately track and document delivery.[4,11,21] (IV)
      d. Maintain chain of custody when there is a delay between preparation and administration.[4,10,15] (V)
         i. Label syringe containing CS per organization policy, if not immediately used, and maintain control of the medication at all times.
         ii. Administer continuous infusions or patient-controlled CS through a secure device that does not allow access/tampering (see Standard 60, *Patient- Controlled Analgesia*).
   10. Ensure proper adherence to CS waste processes for unused CSs.[1,4,7,10,11,20,21,40,53-55] (IV)
      a. Ensure that waste occurs at medication removal or promptly after administration (within an established time frame).
      b. Use an independent witness to physically watch and validate the accuracy of volume/dose of the medication to be wasted.
      c. Secure and track all waste receptacles.
      d. Dispose of CS in a manner that renders it irretrievable and unusable.

i. Consider utilization of a waste product that converts the CS to a nonretrievable state and is allowable for landfill waste.

e. Establish processes for CS tracking, with prompt resolution of CSs that are expired, unusable, returned, or subject to loss of chain of custody.[4,8-13,29,36] (IV)

C. Diversion Recognition

1. Establish a culture that communicates each employee's obligation to recognize and promptly, anonymously report behaviors that may be associated with diversion.[8,10,16,25,34,38,46,50] (IV)
2. Implement drug testing as appropriate to detect potential diversion and impaired practice according to local jurisdiction and governing boards.[4,7,11,16,25,29,40] (IV)
   a. Consider implementation of waste-testing technology to detect saline replacement of CS as a diversion tactic.[2] (V)
3. Promptly investigate and resolve controlled substance discrepancies.[4,6-8,10,56] (IV)
4. Conduct routine audits of aspects of the medication pathway to detect potential for diversion, including reports listed below.[1,4,8,10,20,21,35,40,57-59] (IV)
   a. Review prescribing practices for patterns that may indicate potential diversion.
   b. Identify system-generated reports and processes to investigate patterns and trends of medication retrieval as allowed by technology (eg, blind narcotic count, override list review, CS removal per staff).
      i. False-positive reports may occur in system-generated reports and should be investigated carefully. One retrospective study indicated that medication administration timing discrepancies may be more accurate than reports based on standard deviation.[59] (IV)
   c. Review documentation for accuracy and unusual patterns.
   d. Review patient response to documented medication delivery and to pain management trends to identify potential deviations in actual medication delivery compared to documented administration.
   e. Consider monitoring the pathway of high-risk medications (eg, propofol) that have an increased risk of diversion but do not have a controlled substance designation.
5. Implement a process to rapidly remove an HCW suspected of being impaired from patient care delivery, preventing access to CS while investigation is conducted.[4,38] (V)
6. Report confirmed diversion and unaccounted loss of CS to the proper entities in accordance with licensing, local laws, and regulations.[1,4,7,16,34,35,50] (IV)
7. Establish systems and processes to rapidly identify and manage infectious outbreaks that may be due to CS diversion.[1,4,35,60,61] (IV)

D. Diversion Recovery Program

1. Establish a process to support the confidentiality and recovery of an HCW substance abuse disorder.[4,16,34,43,46,47] (IV)
   a. Alternative-to-discipline programs that implement evidence-based strategies have been associated with increased success.[40,42,43,51,62] (IV)
2. Establish a culture that regards substance use/addiction as a chronic illness, with clear goals of retention, rehabilitation, and reentry into practice.[5,7,16,34,38,41-43,47,63] (IV)
3. Establish a process to monitor the practice of health care workers returning to the workforce after recovery to assure that patient safety is protected.[25,38,42,43,51] (IV)

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Note: All references in this section were accessed between March 17, 2023, and June 18, 2023.

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14. LATEX SENSITIVITY OR ALLERGY

Standard

14.1 Exposure to latex in the environment is minimized.

14.2 Personal protective equipment (PPE), patient care equipment, and other supplies where natural rubber latex is not a part of the material formulation are provided to latex-sensitive or latex-allergic clinicians and patients and are used during patient care.

Practice Recommendations

A. Identify health care providers with latex allergy/sensitivity. Exposure to latex gloves is the most common cause of latex allergy/sensitivity.[1-8] (IV)
B. Identify patients at increased risk for or with known latex allergy/sensitivity.[1-3,6,7,9-11] (IV)
   1. Children with birth defects, neurologic and genitourinary disorders/populations with diseases requiring multiple surgical procedures and indwelling urinary catheters, history of atopy.
   2. Patients with myelomeningocele; an important risk factor for these patients is having more than 5 surgical procedures.
   3. Patients with allergy to tropical fruits and some vegetables (eg, avocado, banana, chestnut, kiwi, tomato) have a high cross-reactivity to latex, as such fruits and vegetables contain proteins with allergenic similarities to latex. Fifty percent of patients with latex allergies will have reactions to one or more fruits and vegetables that contain similar proteins.
C. Document and communicate the positive screen for latex sensitivity or allergy in the patient's health record so all health care providers involved in the patient's care can incorporate precautions into the patient's plan of care.[12,13] (V)
D. Distinguish between the signs and symptoms associated with latex sensitivity versus latex allergy; educate clinicians in recognition and treatment.[6,14-16] (IV)
   1. Latex sensitivity/allergic contact dermatitis: type IV immunologic reaction/delayed T cell-mediated reaction to chemicals used in latex manufacturing; begins with an acute eczema-like skin rash, vesicles, and pruritus, erythema, or hives. With continued exposure to latex, sensitivity can become latex allergy.
   2. Latex allergy: type I immunoglobulin E (IgE)–mediated hypersensitivity reactions occur within minutes of exposure to latex. Reactions range from mild (eg, urticaria, rhino conjunctivitis) to severe (eg, bronchospasm, hypotension, anaphylaxis).
   3. Sublingual immunotherapy has been shown to be effective in decreasing severity of reactions in sensitized individuals.
E. Recognize potential exposure routes to latex, including direct skin contact, airborne exposure (largely reduced with powder-free gloves), and food/medicine contamination (eg, medical devices, vials).[3,5,7,12,17-19] (V)
F. Use nonpowdered, nonlatex gloves; a change to non-powdered latex and synthetic gloves has resulted in dramatic reduction in sensitization.[2,6,20] (IV)
   1. The U.S. Food and Drug Administration (FDA) has banned the use of powdered surgeon's gloves, powdered patient examination gloves, and absorbable powder for lubricating a surgeon's glove.
G. Minimize exposure to latex for those at risk or with known latex allergy/sensitivity, as frequent exposure to

latex remains the primary cause of sensitization.[2,5,6,18,21] (IV)

1. Review the label on medical devices, equipment, and supplies prior to use for the presence of latex, which is a component of product labeling required by the FDA.
2. Remove latex-containing products from the patient care setting to reduce exposure to latex.
3. Recognize that latex products are ubiquitous and that prevention of contact with latex is challenging; examples of items within homes include balloons, condoms, adhesives, gloves, baby bottle nipples/pacifiers, and toys. Refer to available lists of products that contain latex.
4. Access medication vials with latex stoppers only once; most multidose vials no longer contain latex; the Centers for Disease Control and Prevention (CDC) provides a list of vaccines indicating presence or absence of latex in the packaging (eg, syringe/vial).
5. Provide patient education about how to avoid latex exposure.

H. Consider involving an allergist in formation of interprofessional procurement committees within health care organizations.[1,2] (V)

I. Instruct patients/clinicians with latex allergy in recognizing signs/symptoms of anaphylaxis; to wear a medical alert bracelet/necklace; to inform all health care providers and caregivers (eg, teachers, babysitters) about latex allergies; to carry two (2) epinephrine auto-injectors (20% of patients will require a second dose), and to ensure patient/caregivers receive education on proper use.[1,2] (V)

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Note: All references in this section were accessed between April 18, 2022, and July 12, 2023.

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15. HAZARDOUS DRUGS AND WASTE

Standard

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

15.2 Safe handling practices are used at all times, including, but not limited to, during transportation, preparation, administration, and disposal of all hazardous drugs.

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

Practice Recommendations

A. Follow guidelines for handling hazardous drugs to protect clinicians and nonclinicians from unintentional exposure. Compliance may be voluntary or mandatory based upon the jurisdiction.[1,2] (II)

B. Prepare and distribute a list of HDs used in the organization. Review and update the HD list annually and as needed, including before use of a drug begins.[3-6] (V)
   1. Compile the HD list in accordance with the current National Institute for Occupational Safety and Health (NIOSH) list of HDs. Additionally, consult other trustworthy sources to identify HDs that are excluded from the NIOSH list, such as radiopharmaceuticals, veterinary drugs, or biologic products approved through the US Food and Drug Administration's (FDA's) Center for Biologics Evaluation and Research (CBER). Until enough safety data is available to determine whether a new drug is hazardous or not, first-in-class drugs with a mechanism of action suggestive of harm from incidental exposure should be treated as hazardous.[4,5,7-10] (II)
   2. Categorize HDs according to hazardous potential to delineate appropriate handling precautions. Consider utilizing the following NIOSH risk categories[10]: (V)
      a. Group 1: known to be or probably carcinogenic to humans (may or may not pose other toxicity risks).
      b. Group 2: meets NIOSH criteria for HD but is not categorized as known to be or probably carcinogenic to humans.

C. Ensure HDs are physically labeled at all times with the drug identity and the appropriate hazard warning; where possible, also distinguish HDs electronically (eg, in the electronic health record, electronic medication administration record, infusion pump library).[3,4,7,11] (II)

D. Identify risk points for HD exposure and implement a comprehensive HD exposure control program. For many HDs, there is no established safe threshold of exposure. Exposure can occur in any venue of care at any point in the HD chain of custody, including, but not limited to, receipt of drug shipments, storage, compounding, preparation, transportation, administration, waste handling, contaminated bodily fluid contact, cleaning, spill response, and through environmental contamination.[5,7,12] (II)
   1. Recognize that HDs are not limited to oncology settings, as many nonantineoplastic drugs are hazardous and certain antineoplastic drugs are administered for nononcology disease states. Personnel in all settings who handle hazardous drugs and waste should be provided appropriate PPE and engineering controls to reduce exposure (see Standard 58, *Antineoplastic Therapy*).[4,7] (II)

E. Use multiple levels of controls to decrease HD exposure risk. From most effective to least effective, the hierarchy of controls includes[5,13]: (V)
   1. Elimination: removing the hazard (eg, avoiding unnecessary doses by selecting an appropriate duration of therapy)
   2. Substitution: replacing the hazard with a nonhazard or a lesser hazard (eg, switching from intravenous [IV] administration to oral administration)
   3. Engineering: isolating from the hazard (eg, compounding in a biological safety cabinet [BSC])
   4. Administrative: changing the way people interact with HDs (eg, through organizational policies and procedures)
   5. Personal protective equipment (PPE): wearing a physical barrier to prevent transmission.

F. Wear PPE both to protect the user from the anticipated route(s) of exposure and to protect others from environmental exposure due to transmission of HDs. Remove PPE upon leaving the HD handling area.
   1. Include instructions for appropriate PPE donning and doffing in organizational policies and procedures, including goggles, face shields, head covers, fit-tested respirators, gloves, and gowns.[3,11,13,14] (IV)
   2. Assess and document competency in donning and doffing for all employees who may experience environmental exposure and monitor compliance.[3,13] (V)
   3. Improve compliance with appropriate use of PPE by identifying and removing barriers to compliance.[3,7,11] (II)

G. Allow clinicians who are actively trying to conceive, are pregnant, or are breastfeeding to refrain from exposure to HDs and waste. Guidelines from some countries suggest that avoidance of handling chemotherapy drugs is needed only for those trying to conceive and during the first trimester of pregnancy.[11,13,15] (II)

H. Participate in environmental wipe sampling at least every 6 months to identify surface residue of HDs in the areas where compounding/preparation and administration are conducted.[3,7,11,15-19] (II)
   1. Identify, document, and contain the cause of contamination. This could include a thorough deactivation and decontamination, along with adjustments in engineering controls or administrative controls to prevent recontamination.

I. Participate in a program of medical surveillance if handling of HDs is a regular part of the job assignment.[3,5,7,11,20] (II)
   1. Monitor individuals who have experienced an acute exposure (eg, spill).

J. Document that training and assessment of competency for clinicians who handle HDs is completed prior to handling HDs.[3,7,11] (II)

1. Include the list of HDs and their associated risk, review of all policies and procedures, appropriate use of PPE and other equipment or devices, management of known or suspected exposure, spill management, and proper disposal.
2. Reassess and document competency at least every 12 months (United States).

K. Sterile HD compounding (see Standard 56, *Compounding and Preparation of Parenteral Solutions and Medications*):
1. Where possible, use closed-system drug transfer devices (CSTDs) to further reduce the risk of HD exposure.[3-5,7,13,15,19,20] (II)

L. Administration of HDs:
1. Use protective devices such as needleless connectors and CSTDs for administration of all HDs when dosage form allows.[3,7,11,13,21] (II)
   a. Select CSTDs with containment reduction demonstrated by independent, peer-reviewed studies.
2. Utilize the protection of the containment primary engineering control (C-PEC) to perform preadministration activities, such as spiking the bag and priming the administration set.[3,6,11,15,21] (V)
   a. Spiking the bag and priming the administration set with a compatible fluid prior to addition of HD to the IV bag further reduces exposure risk since leaking that could occur when the administration set is first connected to the vascular access device (VAD) would be fluid that does not contain the HD.
3. Dispose of the HD container with the administration set still attached; do not disconnect them. This requires a new administration set to be used for each HD dose (see Standard 40, *Administration Set Management*).[6,11,15,21] (V)
4. If spiking and priming must be done outside the C-PEC, attach the unprimed set to the primary (non-HD) solution and back-prime to move the air into the secondary (HD) container. This method should only be used with CSTDs that have proven capability to produce a dry connection.[3,6,11] (V)
5. To prevent spills, perform a visual inspection of solution container, administration set, and VAD connections before starting the infusion.[22] (IV)

M. Protect staff, visitors, and patients from HD exposure by preparing for and appropriately responding to spills.
1. Ensure that a spill kit containing all the materials needed is available wherever HDs are prepared, transported, and administered. The spill kit should include a sign to restrict access to the contaminated area.[3,11,23] (IV)
2. Establish appropriate spill response through written procedures, including the appropriate agents, dilutions (if any), documentation and reporting requirements, involved personnel, and use of a spill kit according to the affected surface (eg, hard surface, carpet, C-PEC).[3,6,11] (V)
   a. Include appropriate steps of spill response: immediately contain, deactivate, and decontaminate the surface, followed by cleaning the spill.
   b. Spills that exceed the capabilities of the spill kit should be handled by health care workers who are trained in hazardous waste handling, and a cartridge respirator or powered air purifying respirator (PAPR) must be used.

N. Immediately apply appropriate measures for exposure to hazardous drugs.[6,11] (V)
1. Immediately following skin exposure, remove contaminated clothing and wash skin with soap and water.
2. For eye exposure, flush the eye with saline or water for at least 15 minutes and obtain emergency treatment.
3. For inhalation, move away from the area and obtain emergency treatment if symptoms are severe.
4. Let the wound of a skin puncture injury (eg, needlestick) bleed freely. Thoroughly cleanse the wound under running water using soap.
5. Report employee exposure to the organization's occupational health and safety department. Follow organizational policy for reporting patient or visitor exposure.

O. Dispose of and segregate hazardous waste in accordance with jurisdictional regulations; segregation of types and source of waste, while necessary for safe disposal, may not be performed in some jurisdictions.[6,24] (V)
1. Place contaminated materials, including empty vials/syringes/containers, administration sets, gloves, and gowns, into sealable, leak-proof bags.[3,6,24,25] (V)
   a. Place needles, open ampoules, and other sharps in a puncture-proof hazardous waste container.
2. Clearly label containers designated for hazardous waste. Use color-coded waste containers to segregate waste. Do not place hazardous waste in medical waste containers because medical waste and hazardous waste are processed and disposed of differently (see Standard 16, *Medical Waste and Sharps Safety*).[6,24] (V)
   a. Specify disposal process for unused HD in written procedures to comply with jurisdictional regulations. Bulk HD disposal regulations may differ from trace contaminated waste.

P. Employ safety precautions when handling patient body fluids and during patient care activities where contact with body fluids (eg, sweat, saliva, emesis, urine, feces, blood) is anticipated or likely for at least 48 hours after receipt of an HD and until the known excretion time is exceeded, as some HDs may be present in body fluids for longer than 48 hours. Consult with pharmacy for

questions regarding metabolism and excretion time for the drug in question.[6,13,26] (V)

1. If possible, use disposable linens and leakproof pads to contain contaminated body fluids.
2. Place washable linens in a leakproof bag and handle as contaminated.
3. Educate the patient and/or caregiver on safe handling of body fluids.
4. Identify patients with HD-contaminated body fluids through posted signs/warnings or labels.

Q. In the home setting:

1. Provide spill kits whenever HD is administered in the home setting. Cleansing may be performed with dishwashing or laundry detergent using disposable cloths or paper towels followed by cleansing with water using disposable towels.[3,6,13] (V)
2. Store contaminated clothing or linens in a plastic bag until ready to wash them. Place contaminated linens and clothing in a washable pillowcase and machine wash twice, separate from other items, with regular detergent.[6,13] (V)
3. Discard disposable diapers in plastic bags and discard used gloves in hazardous waste containers, if available. Place this container in an area away from pregnant individuals, children, and pets.[13,24] (V)

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16. MEDICAL WASTE AND SHARPS SAFETY

Standard

16.1 Safe handling and disposal of regulated medical waste are based on laws, rules, and regulations established

in each jurisdiction (eg, countries, states, provinces) and defined in organizational policies, procedures, and/or practice guidelines.

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

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

16.4 Safety-engineered devices that isolate or remove the bloodborne pathogens hazard are available in the workplace and used in accordance with manufacturer's directions for use.

Practice Recommendations

A. Reduce the risk of needlestick injury associated with parenteral medication preparation and administration, vascular access device (VAD) insertion, and blood sampling procedures.
   1. Use safety-engineered devices to prevent needlestick injury.[1-8] (I)
   2. Use passive safety-engineered devices whenever possible.[3,4,7,9,10] (I)
   3. Do not recap, break, or bend sharps; discard directly into sharps container.[11-14] (I)
      a. Activate built-in safety controls during use, and discard as a single unit after use.
   4. Dispose of sharps in a sharps container large enough to accommodate the disposal of the entire blood collection assembly (ie, holder and needle).[8,11-13,15] (I)
      a. Consider additional or enhanced security measures where a higher risk of tampering is possible (eg, pediatric or mental health units, correctional facilities) (see Standard 13, *Drug Diversion in Infusion Therapy*).[15] (V)

B. Educate clinicians and patients/caregivers in safe practices relative to handling sharps, medical waste disposal, and use of safety-engineered devices; the risk of needlestick injury is reduced when education is combined with the implementation of sharps safety products.
   1. Address the importance of reporting needlestick injuries and exposure to bloodborne pathogens; needlestick injuries are prevalent and underreported in several countries.[2,7,16-21] (I)
   2. Involve clinician end users in evaluation of safety-engineered devices (see Standard 12, *Product Management*).[3,11,12,14] (I)
   3. Educate health care workers in proper use and activation of safety-engineered devices in accordance with manufacturer's directions for use.[3,5,6,22] (IV)

C. Identify, report, and document exposure to potentially infectious materials or injury from sharps; follow organizational protocol for postexposure follow-up.[1,8,9,11-14,23-27] (I)
   1. Monitor and analyze data for trends and implement appropriate QI activities (see Standard 6, *Quality Improvement*).

D. Consider the use of a checklist as a guideline for handling medical waste.[28] (V)

E. Consider the impact of medical waste on the environment.[29-31] (IV)

F. Reduce potentially unnecessary sterile packaging; consider Standard-ANTT instead of Surgical-ANTT using the ANTT Risk Assessment framework (see Appendix A, *Aseptic Non Touch Technique Clinical Practice Framework)*.[32-35] (V)

G. Instruct patients/caregivers who receive home infusion therapy in proper disposal of medical waste (unused nonhazardous drugs/solutions and infusion-related supplies) in accordance with organizational procedures. (Committee Consensus)

H. Sort and segregate medical waste. Handle regulated medical waste in accordance with federal, state, and local guidelines and regulations.[30,31,36,37] (IV)
   1. Medical waste segregation and appropriate recycling, together with improved education and waste handling training, may improve medical waste disposal through improved medical waste handlers' knowledge and practice (see Standard 8, *Patient Education*).[30,31,36] (I)

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Infusion Therapy Standards of Practice 9th Edition

Section Three: Infection Prevention and Control

17. HAND HYGIENE

Standard

17.1 Hand hygiene is performed routinely during patient care activities.

Practice Recommendations

A. Mitigate the transfer of microorganisms by performing hand hygiene, as follows[1-4]: (I)
   1. Before having direct contact with the patient (eg, entering a patient room, before donning gloves)
   2. After having direct contact with the patient (eg, removing wound dressings, after removing gloves)
   3. After body fluid exposure (eg, body excretions, including mucous membranes)
   4. After touching the patient's surroundings (eg, medical devices, equipment, or furniture)
   5. Before, during, as required, and after clinical procedures requiring Aseptic Non Touch Technique (ANTT®) (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*), including the following:
      a. Insertion and removal of indwelling invasive medical devices, including vascular access devices (VADs)
      b. Ongoing management and manipulation of indwelling medical devices
      c. Infusion administration
      d. Immediately following the removal of gloves
   6. Before/after eating and after using a restroom
   7. Before moving from work on a soiled body site to a clean body site on the same patient.

B. Use an alcohol-based hand rub (ABHR) containing at least 60% ethanol or 70% isopropyl alcohol routinely for hand hygiene, unless the hands are visibly soiled or if the patient is suspected of having/or there is an outbreak of a spore-forming pathogen or norovirus gastroenteritis.[1,3-7] (I)
   1. Unless hands are visibly soiled, an ABHR is preferred over soap and water in most clinical situations due to evidence of better compliance compared to soap and water. Hand rubs are generally less irritating to hands and are effective in the absence of a sink.[1,8] (V)
   2. Perform hand hygiene using an ABHR for 15 seconds or according to manufacturer's recommendations.[3,7] (II)
   3. After handling hazardous drugs, avoid the use of ABHR until after hands have been washed with soap and water to avoid cutaneous absorption of hazardous drugs (refer to Standard 15, *Hazardous Drugs and Waste*).
   4. Consider ethanol-based preparations at a high concentration between 70% and 95% in environments with high viral load.[5] (IV)

C. Use either a nonantimicrobial or antimicrobial soap and water for hand hygiene and wash hands for at least 15 seconds.[1,4,7,9-11] (I)
   1. When the hands are visibly contaminated with blood and or other body fluids.
   2. After providing care or having contact with patients suspected or confirmed of being infected with norovirus/rotavirus gastroenteritis or a spore-forming pathogen during an outbreak (eg, *Clostridioides difficile*).

D. Use chlorhexidine gluconate with caution for routine hand hygiene.[10] (II)

E. Ensure that supplies necessary for adherence to hand hygiene are readily accessible in all areas where patient care is being delivered.[1,4,8] (IV)

F. Include fingernail care in organization-specific policies related to hand hygiene.[3,12-14] (II)
   1. Keep nails clean and nail length short.
   2. Health care workers who provide direct or indirect care in high-risk areas (eg, intensive care unit [ICU], perioperative) should not wear artificial fingernails or extenders; artificial or false nails have been associated with higher levels of infectious agents, especially Gram-negative bacilli and yeast, compared to natural nails.
   3. Nails should not extend past the fingertip.
   4. Prohibitions against fingernail polish (standard or gel shellac) are at the discretion of the infection prevention program, except among scrubbed individuals who interact with Critical Aseptic Fields during surgical procedures; these individuals should not wear fingernail polish or gel shellac.

G. Remove wrist jewelry for Surgical-ANTT procedures and finger jewelry as per facility-specific policies.[4,14] (I)

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H. Educate the patient, caregivers, and family members on when and how to perform hand hygiene and promote asking the clinician to perform hand hygiene before having direct contact with the patient if it was not observed.[15-18] (III)
    1. Consider using a systematic, structured, multistep technique that can be readily taught and replicated.[1,2,4,7] (I)
I. Implement organizational strategies to improve hand hygiene compliance and subsequently reduce infection and colonization rates.[7,17,19-21] (I)
    1. Use a systematic, multimodal approach to deliver and evaluate strategies.[7,17,19,22] (I)
    2. Use activities that demonstrate improved hand hygiene compliance, such as visualization of bacterial contamination, leader engagement, testing, knowledge, and performance feedback, including sharing progress during regular staff meetings.[23-28] (I)
J. Monitor hand hygiene and provide education and feedback regarding hand hygiene performance.[24,28-33] (I)
    1. Consider the use of electronic monitoring to improve the objectivity of hand hygiene compliance and associated feedback.[34,35] (IV)
K. Involve the clinician with the evaluation of hand hygiene products to assess for product feel, fragrance, and skin irritation. Provide alternatives for clinicians who have sensitivity to a particular product. Other products for skin care, such as gloves, lotions, and moisturizers, should be assessed for compatibility with hand antisepsis products.[3,6] (IV)

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18. STANDARD PRECAUTIONS

Standard

18.1 Standard precautions are used during all patient care procedures and in all clinical settings that potentially expose the clinician to blood and body fluids, secretions, excretions (except sweat), nonintact skin, and mucous membranes.

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

18.3 Surfaces that are in close proximity to the patient and frequently touched surfaces in the patient care environment are cleaned and disinfected more frequently than other surfaces using health care grade disinfectant.

18.4 Spills of blood or other potentially infectious materials are promptly cleaned and decontaminated according to facility policy.

18.5 Durable medical equipment (DME) is cleaned and disinfected after each use with appropriate germicides in accordance with manufacturer's directions for use and organizational institutional policies and procedures.

Practice Recommendations

A. Perform hand hygiene, as it is a major component of Standard Precautions.
   1. Ensure access to hand hygiene facilities and appropriate supplies (alcohol-based hand rub and/or water, soap, and paper towels).
   2. Perform hand hygiene immediately if the hands become contaminated during PPE removal, immediately after removing all PPE, and before leaving the patient's environment (refer to Standard 17, *Hand Hygiene)*.

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

C. Wear gloves that fit appropriately and extend to cover the wrist of an isolation gown (if worn) when there is potential contact with blood (eg, during phlebotomy, venipuncture), body fluids, mucous membranes, nonintact skin, or contaminated equipment.[1-10] (II)
   1. Change gloves during patient care when torn, when heavily contaminated, or if moving from a contaminated body site to a clean body site within the same patient.
      a. Gloves should not be considered as a substitute for hand hygiene. Understand the potential inverse relationship between glove usage and hand hygiene.
      b. Be aware of the risk of touch contamination when gloves are used.
   2. Gloves are single use; do not reuse or use for more than one patient.

D. Wear a single-use or disposable gown or apron according to manufacturer's directions for use to protect skin

and clothing during procedures or activities in which contact with blood or body fluids is anticipated. Local and institutional requirements vary and will define the required attire.[1-6] (II)
    1. Do not wear the same gown/apron when caring for more than one patient.
    2. Ensure gown removal is performed in a manner to prevent contamination of the clothing.

E. Wear eye and face protection, which may include goggles with a face mask, or face shield, to prevent the potential splash or spray of blood, respiratory secretions, or other body fluids to the mouth, nose, and eyes.[1-6] (II)
    1. Ensure reusable eye protection is appropriately decontaminated between uses and if visibly soiled.

F. Universal PPE may be indicated during times of high transmission of communicable disease; recommendations may vary based upon pathogen and degree of communicability but may include universal respiratory protection (mask or respirator) and universal eye protection.[11] (II)

G. Educate the clinician, patient, family, and caregivers 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.[1,3,4] (II)
    1. Place face mask on the coughing person if tolerated. Source control does not replace the need for caregivers to wear PPE when indicated.
    2. Educate the clinician to stay home when ill.

H. Clean and disinfect DME (eg, intravenous [IV] poles, flow-control devices, vascular visualization devices) using an appropriate disinfectant (eg, Environmental Protection Agency [EPA]–registered disinfectant) after each use.[12,13] (II)
    1. Develop organizational procedures based upon manufacturers' instructions for cleaning and disinfection.
    2. Maintain separation between clean and soiled equipment to prevent cross-contamination.

I. Employ practices to reduce the risk for transmission of microorganisms from patient to patient when providing care in all settings.[14,15] (IV)
    1. Clean the inside and the outside of the clinical bag carried between homes or other patient care settings at an interval defined by organization policy.
    2. Perform hand hygiene before opening the clinical bag to retrieve needed supplies and equipment, after removing supplies and before direct patient contact, after contact with the patient's intact skin (eg, taking blood pressure), and after contact with inanimate objects in the patient's vicinity.

J. Use a multimodal approach to Standard Precautions education and training for all disciplines.[16-20] (I)

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19. ASEPTIC NON TOUCH TECHNIQUE (ANTT®)

KEY DEFINITIONS

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

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

The Standardized Practice Terminology of ANTT®:

- **Key-Site:** Any portal of entry into the patient (eg, VAD site, injection site, open wound) that could transfer harmful microorganisms and cause infection.
- **Key-Part:** The component of equipment within the procedure that, if contaminated, is likely to contaminate the patient (eg, syringe tip, male Luer end, spike of administration set, injection needle).
- **General Aseptic Field:** A decontaminated and disinfected surface (eg, procedure tray, cart, or single-use procedure kit/barrier) used to promote, but not ensure, asepsis. Key-Parts placed onto this surface must be protected by Micro Critical Aseptic Fields (see below) when not in use.
- **Critical Aseptic Field:** A sterile drape/barrier. Used to ensure asepsis; all procedure equipment is placed upon the drape and managed collectively.
- **Micro Critical Aseptic Field:** A small protective sterile surface/housing (eg, sterile caps, covers, the inside of recently opened sterile equipment packaging) that protect Key-Parts individually.

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

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

Standard

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

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

Practice Recommendations

A. Standardize the use of aseptic technique with the international standard approach of ANTT for all invasive clinical procedures.[1-3] (V)
B. Document the clinical competency of ANTT as a core competency for all clinicians. This encompasses all aspects of infusion therapy, including but not limited to, preparation and administration of infusion solutions and medications and insertion and management of vascular access devices

(VADs) and other infusion devices (see Standard 5, *Competency and Competency Assessment*).[1,2,4-8] (IV)

1. Clinicians are ultimately responsible for ensuring the safe and consistent application of the components of ANTT for all clinical interventions requiring an aseptic technique (refer to Standard 5, *Competency and Competency Assessment*).
2. Incorporate standardized ANTT practice within the organization, including ANTT education, initial/ongoing competency assessment, and monitoring of practice standards through audit.[1,3,6,7,9] (IV)
3. Use multimodal standardized resources for clinician education and training as outlined in the ANTT Clinical Practice Framework.[7,10,11] (IV)

C. Employ ANTT through Key-Part and Key-Site Protection, routine integration of Standard Precautions, and appropriate use of aseptic fields and non-touch technique. Hand hygiene is a fundamental component of ANTT (see Standard 17, *Hand Hygiene*; Standard 18, *Standard Precautions*).[1,3,6,8,12-14] (I)

D. Select either Standard-ANTT or Surgical-ANTT for the procedure using the defined ANTT risk assessment.

The decision is guided as follows:

1. For a given procedure, the clinician asks if they can protect all Key-Parts individually.[6,7] (IV)
   a. If yes, then Standard-ANTT is used. If no, then select Surgical-ANTT.
   b. The clinician considers a few practice variables, including:
      i. The number and size of Key-Parts and Key-Sites
      ii. The invasiveness of the procedure
      iii. The duration of the procedure
      iv. The environment within which the procedure will take place
      v. The level of personal protective equipment (PPE) required.
2. Use Standard-ANTT for simpler procedures of shorter duration, involving fewer and smaller Key-Parts (easily and readily protected by Micro Critical Aseptic Fields and non-touch technique). Examples include infusion of medications, phlebotomy, and short peripheral intravenous catheter (PIVC) insertion indicated; nonsterile gloves are typically worn. If Key-Parts or Key-Sites require direct touch, wear sterile gloves.[1,6,7,15,16] (IV)
3. Use Surgical-ANTT for longer, complex procedures involving multiple or large Key-Parts (eg, central vascular access device [CVAD] insertion, CVAD exchange), while employing barrier precautions and appropriate use of PPE.[1,6,7,17] (I)
   a. For Surgical-ANTT, in addition to wearing sterile gloves, use a non-touch technique to protect Key-Parts whenever practical to do so.[1,3,6,8] (V)

E. Ensure the aseptic state of Key-Parts and Key-Sites by appropriate device disinfection and skin antisepsis (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*; Standard 32, *Vascular Access Device Insertion*; Standard 34, *Needleless Connectors*; Standard 41, *Blood Sampling*).

F. Use ANTT to apply sterile dressings and appropriate securement devices to maintain asepsis during VAD dwell (refer to Standard 36, *Vascular Access Device Securement*; Standard 39, *Vascular Access Device Post-Insertion Care*).

G. Ensure effective management of the patient care setting prior to clinical procedures, including purposeful decontamination to help reduce the transmission of pathogenic microorganisms.[8,12,14,18-21] (I)
   1. Perform appropriate decontamination and disinfection (before, during, and after clinical intervention) of durable medical equipment (DME) used with an ANTT procedure (eg, ultrasound, electronic infusion pump) (see Standard 18, *Standard Precautions*; refer to Section Four, *Infusion Equipment*).[6] (V)

H. Adopt a process of continuing practice development; periodically audit clinical practice to evaluate clinician competency in ANTT and compliance with the ANTT Clinical Practice Framework and local clinical procedure guidelines.[7,22] (IV)
   1. Aseptic Non Touch Technique (ANTT) is a core clinical competency that must be maintained by periodic reeducation and competency reassessment.

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

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20. TRANSMISSION-BASED PRECAUTIONS

Standard

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

20.2 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.

20.3 Droplet Precautions are implemented for patients known or suspected to be infected with pathogens transmitted by respiratory droplets that are generated by a patient who is coughing, sneezing, or talking.

20.4 Airborne Precautions are implemented for patients known or suspected to be infected with pathogens transmitted by the airborne route (eg, tuberculosis, measles, chickenpox, disseminated herpes zoster).

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

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

Practice Recommendations

A. Select and use personal protective equipment (PPE) for Transmission-Based Precautions, in addition to Standard Precautions, based on the nature of the patient interaction and potential for exposure to blood, body fluids, or infectious agents and isolation precaution guidelines in effect at the time of the patient encounter for specific communicable diseases.[1-14] (II)
   1. Ensure users are adequately trained on safe donning and doffing of required PPE.
   2. Understand the impact of isolation precautions on patient experience.
   3. Plan tasks allowing adequate time for safe donning and doffing of required PPE.

B. Perform hand hygiene before donning PPE, immediately if the hands become contaminated during PPE removal, immediately after removing all PPE, and before leaving the patient's environment (refer to Standard 17, *Hand Hygiene*).

C. Maintain Transmission-Based Precautions until it is determined that the cause of the symptoms is not due to an infectious agent, or the duration of the recommended isolation precautions has been met.[4,15,16] (IV)

D. Observe Contact Precautions, in addition to Standard Precautions, when there is potential for transmission of epidemiologically significant organisms through direct or indirect contact with the patient or the environment by donning gown and gloves before entering the clinical environment when contact may occur.[17-27] (I)

1. There is emerging and conflicting evidence regarding the role of contact precautions, as well as universal gloving and gowning for control of endemic, epidemiologically significant organisms.

E. Observe Droplet Precautions, in addition to Standard Precautions, when there is potential contact with respiratory secretions or sprays of blood or body fluids; wear a face mask and eye protection when there is potential contact with respiratory secretions and sprays of blood or body fluids.[1,4,5,14] (II)

F. Observe Airborne Precautions, in addition to Standard Precautions, by wearing a fit-tested, certified, N95-or-higher respirator if an infection spread by airborne route is suspected or confirmed or when microbial agents become airborne transmissible during aerosol-generating procedures (eg, intubation).[1,4,13,14,28-35] (II)
   1. Perform fit testing prior to initial respirator use and repeat at least annually and as needed if there are significant changes to facial structures.
   2. Instruct clinicians to perform a seal check every time the respirator is worn and adjust as needed.
   3. If reusable elastomeric respirators are selected by the organization, ensure that devices are maintained and cleaned according to established policies and filters are changed as indicated. If exhalation valves are present, additional measures are needed if source control is also indicated. Reusable respirators offer an advantage of protecting against supply chain disruption challenges.[30-33] (IV)
   4. Establish and maintain a Respiratory Protection Program.
   5. For patients receiving aerosol-generating procedures in which an airborne transmitted disease is not suspected, staff should minimally wear one of the following: a face shield that fully covers the front and sides of the face, a mask with attached shield, or a mask and goggles.

G. Employ "enhanced barrier precautions," a specific strategy required as part of a containment response for United States (US) nursing homes (skilled nursing facilities) when performing high-contact resident care activities that provide opportunities for transfer of multidrug-resistant organisms (MDROs) and epidemiologically significant organisms to staff hands and clothing.[36,37] (III)
   1. Wear gloves and gown when performing any high-contact care activity in a nursing home, which includes care required for wounds and/or indwelling medical devices (eg, central vascular access device [CVAD], urinary catheter, feeding tube, tracheostomy/ventilator) for those who reside on a unit or wing where a resident known to be infected or colonized with a novel or targeted MDRO resides.

H. Notify accepting facilities and transporting agencies about suspected infections and the need for Transmission-Based Precautions when patients are transferred.[38] (II)

I. Throughout the continuum of care, when caring for a patient with an MDRO or on Transmission-Based Precautions, limit reusable patient care equipment and dedicate equipment to the patient (leave in the room or in the home until no longer necessary) whenever possible. Clean and disinfect equipment before removing from the patient environment or place in a container (eg, plastic bag) for transport to an appropriate site for cleaning and disinfection per organizational policy.[3,4,39-41] (II)
   1. When caring for a home care patient with an MDRO or on Transmission-Based Precautions, consider using disposable patient care equipment (eg, stethoscope/blood pressure cuff). Otherwise, dedicate patient care equipment that remains in the patient's care setting until no longer needed. Decontaminate the equipment (ie, rendering it safe for handling) at the point of use and transport it to another location for cleaning and disinfection before reuse.

J. Implement strategies during crises, such as pandemics, by reducing health care facility risk (eg, limit visitors, cancel elective procedures), isolate symptomatic patients, and protect clinicians (eg, barriers at triage; limit number of staff caring for patient; ensure availability of PPE where most needed, eg, N95 respirators in the presence of aerosol-generating procedures; and adoption of technology, eg, wireless probes, electrocardiogram [ECG] technology to minimize the need for radiological confirmation of device tip location).[42] (IV)
   1. Care decisions in a crisis are necessarily constrained by specific conditions under a crisis, such as a pandemic.
   2. Implementation of crisis standards of care are done within the health care organization and in collaboration with health care professionals, policy makers, and the community.
   3. PPE conservation strategies may be necessary and adjusted based on local circumstances. Ensure compliance with current recommendations, which may rapidly evolve during times of crisis.

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Infusion Therapy Standards of Practice 9th Edition

Section Four: Infusion Equipment

Section Standards

I. To ensure patient safety, the clinician is competent in the use of infusion or vascular access equipment, including knowledge of appropriate indications, contraindications, and manufacturers' directions for use.
II. The use and maintenance of infusion or vascular access equipment is established in organizational policies, procedures, and/or practice guidelines.
III. Infusion or vascular access equipment is cleaned and disinfected after each patient use with disinfectants that have antimicrobial activity against pathogens likely to contaminate the equipment and in accordance with manufacturers' directions for cleaning and disinfecting.

21. VASCULAR VISUALIZATION

Standard

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

Practice Recommendations

A. Assess the patient's medical history (including previous vascular access) to determine the need for vascular visualization technology to assist in locating appropriate peripheral intravenous or arterial insertion sites. Factors likely to increase difficulty of peripheral intravenous and intra-arterial insertion using observation and palpation only (known as landmark techniques) include, but are not limited to, the following[1,2]: (II)
   1. Patient's age (both neonates and older adults)
   2. History of frequent venipuncture and/or lengthy courses of infusion therapy
   3. Disease processes that result in structural vessel changes (eg, diabetes mellitus, hypertension)
   4. Variations in skin between patient populations, such as darker skin tones and excessive hair on the skin
   5. Skin alterations, such as the presence of scars or tattoos
   6. Obesity
   7. Fluid volume overload or deficit.

B. Use ultrasound to assess the size and caliber (diameter and length of intravenous path), as well as other anatomical structures prior to insertion to identify vascular anomalies (eg, occlusion or thrombosis), and location of other structures, such as valves, arteries, and nerves.[3,4-7] (II)
   1. Select the most appropriate vessel to cannulate based on vessel size, shape, depth, flow, and patency; identification of potential structures to avoid (eg, nerves, arteries) within the vicinity of insertion; respiratory variation; catheter-to-vein ratio; and operator.
   2. Minimize damage to surrounding structures; identify vessels in the short (transverse) axis and proceed with insertion, or, alternatively, if the long (longitudinal) axis for needle insertion is preferred for adult patients, redirect the probe to this plane upon completion of initial assessment.

C. Consider the use of visible light devices that provide transillumination of the peripheral veins.
   1. Visible light devices aid in locating superficial veins in neonates; however, their usefulness in infants, older children, and adults is limited due to the thickness of subcutaneous tissue and size of the arm circumference.[3,8] (II)
   2. Use only cold light sources in devices designed for vascular visualization. Thermal burns have been reported due to close contact between skin and the light source when the device emits heat (eg, traditional flashlights).[8] (V)

D. Use near infrared (nIR) light technology to aid peripheral intravenous catheter (PIVC) insertion in children and adults with difficult intravenous access (DIVA).
   1. Compared to no technology, nIR provides information about vein selection (ie, bifurcating veins, tortuosity of veins, palpable but nonvisible veins, location of venous valves), particularly in infants and neonates. Small, single-center randomized controlled trials (RCTs) have demonstrated that nIR improves first-time insertion success, and overall PIVC insertion success, and decreases procedural time compared to traditional visual assessment and palpation

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in some populations, such as neonates and infants with difficult intravenous access.[3,9,10] (II)

2. In adults, small cohort and nonrandomized clinical trials have demonstrated improved first-time insertion success, reduced time to insertion, and fewer extravasation injuries.[11-13] (IV)

E. Use ultrasound to measure the catheter-to-vessel ratio prior to insertion of an upper extremity VAD; ensure a catheter-to-vessel ratio of less than 45%. The research underpinning this recommendation is specific to peripherally inserted central catheter (PICC) insertion. Consider application of this ratio to midline catheters as well, as they are placed in the same veins (refer to Standard 25, *Vascular Access Device Planning and Site Selection*; Standard 50, *Catheter-Associated Thrombosis*).

F. Use ultrasound for PIVC and midline catheter insertion.
   1. Adults: Increased patient satisfaction, fewer venipuncture attempts, and decreased escalation to central vascular access device (CVAD) insertion have been reported when ultrasound guidance is used for insertion of short/standard length and long PIVC.[14-17] (I)
   2. Pediatric patients: Increased first-time insertion success and overall PIVC insertion success have been demonstrated when ultrasound guidance is used for PIVC insertion compared to palpation and visualization. This effect increases when used in children with difficult intravenous access.[3,18,19] (I)
      a. Consider use of short axis (out of plane view) vs long axis (in plane view) for PIVC insertion; this technique has shown improved insertion success in pediatric patients.[20] (IV)
      b. Use dynamic needle tip positioning to complement ultrasound-guided (USG) insertion success compared to static USG technique to improve first-time insertion success, overall PIVC insertion success within 10 minutes, fewer PIVC insertion attempts, and shorter time to cannulation.[21] (III)

G. Use real-time ultrasound guidance and a systematic approach to insertion of CVADs in adults and children to improve insertion success rates, reduce number of needle punctures, and decrease insertion complication rates.[9,22-25] (I)
   1. Consider use of long axis in plane approach as an alternative to short axis out of plane approach to internal jugular vein to improve first-time insertion success, overall insertion success, and to reduce posterior wall puncture in neonate, pediatric, and adult patients.[5-7,26,27] (II)

H. Use ultrasound guidance for arterial puncture and catheter insertion in adults and children.[28-34] (I)
   1. Ultrasound-guided insertion of the radial artery increases first-attempt success and lowers failure rate compared to palpation, reduces time to insertion, mean number of insertion attempts, and hematoma formation.[28-33] (I)
   2. Consider use of real-time ultrasound-guided axillary arterial line insertion. A small RCT demonstrates improved overall insertion success.[34] (III)
   3. Use real-time, ultrasound-guided femoral arterial line insertion, as it has been associated with reduced hematoma formation and vascular complications.[35] (II)

I. Use a sterile single-use gel packet and an appropriate sterile barrier over the probe and disinfect before and after each use to reduce the risk for ultrasound probe contamination and subsequent risk for infection; refer to manufacturers' directions for use.[36] (V)
   1. For preassessment only (intact skin and no needle puncture), use single-use gel; however, a sterile barrier is not required unless institutional guidelines require this.

J. Establish comprehensive ultrasound guided training programs to support clinicians through the novice-to-expert continuum.[37-41] (III)

K. Assess and document clinician competency in the use of vascular visualization technology for insertion of VADs. This knowledge includes, but is not limited to, assessment of vessels, size, depth, location, potential complications, and adherence to and awareness of Aseptic Non-Touch Technique (ANTT®) (refer to Standard 5, *Competency and Competency Assessment*; Standard 19, *Aseptic Non Touch Technique [ANTT®]*).

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22. CENTRAL VASCULAR ACCESS DEVICE TIP LOCATION

Standard

22.1 Tip location of a central vascular access device (CVAD) is confirmed radiographically or by other imaging technologies prior to initiation of infusion therapy or when clinical signs and symptoms suggest tip malposition.

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

22.3 The safest CVAD tip location in adults and children is the superior (upper limb) or inferior (lower limb) cavoatrial junction (CAJ).

Practice Recommendations

A. Approximate the catheter length for insertion by anthropometric measurement, including, but not limited to, external measurement from the planned insertion site to the third intercostal space, use of formulas to calculate length based on body surface area, or measurement from preprocedural chest radiographs.[1-3] (IV)

B. Position the tip of a CVAD in the lower third of the superior vena cava (SVC) or upper third of the right atrium (RA) at or near the CAJ for adults and children.
   1. For upper body insertion sites, respiratory variation, arm movement, and changes in body position will cause the CVAD tip to move in a caudal or cephaloid direction. Tip location deeper in the right atrium near the tricuspid valve or in the right ventricle is associated with cardiac arrhythmias (refer to Standard 51, *Central Vascular Access Device Malposition*). Tip location proximal to the SVC is associated with increased risk of thrombosis (refer to Standard 51, *Central Vascular Access Device Malposition;* Standard 50, *Catheter-Associated Thrombosis).*
   2. For lower body insertion sites, position the CVAD tip in the inferior vena cava (IVC) above the level of the diaphragm.[4-6] (IV)
   3. For hemodialysis CVADs, position the CVAD tip at the mid-right atrium to avoid vessel and right atrial trauma or complications.[7] (IV)

C. Avoid suboptimal tip position, except in rare circumstances, including anatomical or pathophysiological changes, where alternative tip positions might be clinically indicated.[1,8-10] (III)

D. Avoid intracardiac catheter tip location in neonates and infants less than 1 year of age, as this tip location has been associated with vessel erosion and cardiac tamponade. This complication has been described in the literature in catheters of various size and particularly with the use of small-gauge catheters typically less than 3 French (Fr).[9-11] (IV)

E. Use tip locating methods to identify CVAD tip location during the insertion procedure (ie, "real-time") for neonate, pediatric, and adult patients. Studies have demonstrated greater accuracy, more efficient initiation of infusion therapy, and reduced costs.[1,12] (IV)
   1. Use electrocardiogram (ECG) methods with either a metal guidewire or a column of normal saline inside the catheter lumen and observe the ECG tracing to place the CVAD tip at the CAJ. Follow manufacturers' directions for use with other ECG-based technology using a changing light pattern to detect tip location.[1,12-30] (I)
      a. 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 tip confirmation. Contraindications to the use of ECG technology include patients with an abnormal ECG rhythm with an absence or alteration in the P wave (eg, presence of pacemakers, extreme tachycardia). Prospective observational studies have demonstrated safety and efficiency of using ECG to confirm catheter tip position in patients with atrial fibrillation.[20,29,31,32] (III)
   2. Consider the use of ultrasound for CVAD tip location. The clinical applicability of this is currently limited by the small sample sizes used to demonstrate its efficacy as a reliable and safe method to replace chest radiographs in all ages, and its usefulness is limited by the knowledge, skill, and experience of the operator.[6,33-38] (III)
      a. The addition of agitated saline to enhance transthoracic echocardiography has been shown to be effective in detecting catheter tip position in the lower third of the SVC, as well as detecting catheter malposition through delayed opacification and reduced echogenicity.[6,39] (IV)
   3. Consider using ultrasound to confirm catheter tip position in neonates and in the emergency department or other critical care environments where immediate confirmation of tip location is time critical.[6,33,40] (IV)
   4. Use fluoroscopy when CVAD placement is difficult or has failed at the bedside.[41] (II)
   5. Postprocedure radiograph imaging is not necessary if alternative catheter tip location technology confirms appropriate tip placement.[1,12-30,42,43] (I)
      a. Most evidence is specific to peripherally inserted central catheter (PICC), and further research is needed to confirm applicability to other CVADs. Recognize that radiographic or ECG tip location

technology does not differentiate between venous and arterial placement. If arterial placement is suspected, use other methods to confirm or refute arterial placement.

F. Re-evaluate CVAD tip position if there are signs and symptoms of malposition (refer to Standard 51, *Central Vascular Access Device Malposition*).
G. Verify the CVAD tip position with ECG, ultrasound, or assessing the postprocedure chest radiograph prior to initiating infusion therapy. (Committee Consensus)
H. Assess the catheter tip position when a patient is transferred from an external health care facility; if all the following criteria are met, it is appropriate to use the catheter without additional tip confirmation: (Committee Consensus)
    1. Documentation exists confirming catheter tip position at the lower third of SVC, CAJ, or superior RA on insertion
    2. Ability to aspirate blood and flush the catheter without resistance
    3. External catheter length remains the same as documented upon insertion
    4. When any of these criteria are not met, catheter tip placement should be confirmed with a chest radiograph.
I. Document the time of insertion and CVAD tip location by including a copy of the ECG tracing, chest radiograph note, or other appropriate report in the patient's health record (refer to Standard 10, *Documentation in the Health Record*).

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23. FLOW-CONTROL DEVICES

Standard

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

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

Practice Recommendations

A. Choose a method for flow-control based upon factors such as age, condition, mobility, self-administration ability, preference, and lifestyle of the patient; type of vascular access device (VAD); type of therapy, frequency, dosing, drug stability, and rate of infusion; the potential for side effects or adverse effects of the therapy; health care setting; and reimbursement.[1-10] (III)
   1. Use nonelectronic, flow-control devices according to manufacturer's directions for use to infuse low-risk infusions where some variation in flow rate is not critical. These may include gravity infusion sets, mechanical pumps such as elastomeric balloon pumps, spring-based pumps, and negative-pressure pumps.
      a. Choose gravity infusions as an alternative to electronic infusion pumps as clinically appropriate (eg, intravenous [IV] hydration, some IV antibiotics, medications that are not high-alert, peripheral vesicant infusions) (see Standard 58, *Antineoplastic Therapy*).[10-13] (V)
      b. Consider use of a manual flow regulator in lieu of a roller clamp (eg, allows for setting the infusion rate in milliliters per hour) for gravity infusions to allow for easier regulation and more consistent flow; there are also electronic drip monitors that can be used with a gravity

administration set that provides more accurate rate monitoring.[1,7,10,14-18] (IV)

c. Recognize that the use of manual flow regulators may not provide precise control of flow rates with highly viscous infusions (eg, colloids). An electronic infusion pump should be utilized in clinical situations that require precise infusion rates.[19] (V)

2. Consider the use of an elastomeric device as an alternative to electronic infusion pumps for the administration of medication in the home care setting to reduce the constraints associated with infusion by gravity or electronic pumps and limit the number of nurse interventions.[16,20-22] (I)
   a. For all infusions, including elastomeric pumps, fully connect the needleless connector to eliminate flow restriction.[23] (V)
   b. Consider the impact of the environment on drug stability for continuous infusions via elastomeric pumps, which is a potential concern for home infusion, especially in very warm climates (see Standard 66, *Home Infusion Therapy*).[17] (IV)
3. Use electronic infusion pumps according to manufacturer's directions for use for infusion therapies that require precise flow control for safe infusate administration.[2,7,8,24,25] (IV)
   a. Ensure safe and consistent use of electronic infusion pumps by using anti—free-flow protection, air-in-line detection, and pressure and occlusion alarms.[8,10,26,27] (IV)
   b. Ensure electronic infusion pump alarm limits are set appropriately for the patient's current condition and that alarms are turned on, functioning properly, and audible to patients and staff.[28] (V)
   c. Use electronic infusion pumps with dose-error reduction systems ([DERS] ie, smart pumps) for IV administration of medication and solutions (eg, continuous, intermittent, secondary infusions, patient-controlled analgesia [PCA], and epidural, spinal, and nerve block infusions) throughout the acute care setting, including ambulatory settings such as perioperative/procedural/radiology care areas, emergency departments, and infusion centers, as they are associated with reduced risk for infusion-related medication errors, including error interceptions (eg, wrong rate) and reduced adverse drug events (see Standard 57, *Infusion Medication and Solution Administration*).[4,12,29-33] (III)
   d. Organize an interprofessional team of key stakeholders (eg, pharmacy, clinical nurse specialist) to monitor compliance with use of smart pump dose error-reduction software on a monthly basis and maintain a compliance rate of 95% or greater.[13,34] (IV)
   e. Use a smart pump that allows programming of the bolus (or loading dose) and continuous infusion rate with separate limits for each, if available.[13] (V)
   f. Follow standards, guidelines, and manufacturer's instructions for safe use of IV smart pumps.[35,36] (V)
      i. Use the drug library in accordance with organizational policy, avoiding manual programming and overrides of drug library alerts.[4,12,29-33,37] (IV)
      ii. Update drug libraries regularly (to address new drugs, new drug protocols, and drug shortages) to avoid unnecessary alerts, and involve end users in the design of the library.[12,29,30,33,37-43] (IV)
      iii. Consider the use of smart pumps with electronic health record (EHR) interoperability to further reduce manual programming errors, decrease infusion pump alarms, improve documentation, and decrease wrong patient infusion administration.[12,44,45] (IV)
   g. Use multichannel infusion pumps only for a single patient for the simultaneous delivery of therapies by the same route (eg, IV and epidural infusions are not infused on the same individual pump).[12] (V)

B. Monitor flow-control devices during the administration of infusion therapy to ensure safe and accurate delivery of the prescribed infusion rate and volume (See Standard 57, *Infusion Medication and Solution Administration and Table 1: Medication/Infusion Delivery: Dose Accuracy and Error Prevention)*.[10,35] (V)
   1. Identify medications that should be administered as uninterrupted primary infusions (eg, rapid infusion, critical medications).[12,46,47] (V)
   2. Ensure accurate dose delivery, compatibility, and reduced risk for infection when administering secondary or piggybacked medications (refer to Standard 40, *Administration Set Management*).
   3. Use only accessory devices (eg, administration sets, syringes, filters) that are designed to work with the flow-control device according to the manufacturers' directions for use (refer to Standard 33, *Filtration*).
      a. If using syringe pumps for delivery of small-volume infusions, use accessory devices that offer the smallest internal volume (eg, microbore tubing, shorter length) to minimize residual volume.[48] (V)
   4. Assess manually regulated infusion sets at regular intervals; always verify flow by counting drops and monitoring the infusion volume infused.[18] (V)
   5. Routinely assess the VAD site to detect infiltration or extravasation, as electronic infusion pumps do not detect infiltration or extravasation (see Standard 44, *Infiltration and Extravasation*).[9,10] (V)

C. Standardize the types of pumps used in an organization to promote user familiarity with its operation (see Standard 12, *Product Management*).[10,12,43] (IV)
   1. Use differentiated infusion pumps for epidural infusions, enteral infusions, and irrigations to differentiate from vascular access infusions.[12,49] (V)
   2. Ensure pumps follow and stay with patients to help minimize the need to re-establish infusions after patient transfers.[50] (V)
   3. Collaborate with the health care team, including end users, in the evaluation, selection, and launch of flow-control devices (see Standard 12, *Product Management*).[9,27,31,50] (IV)

D. Recognize the problem of alarm and alert fatigue with multiple electronic monitoring and therapeutic devices. Implement evidence-based recommendations (eg, alarm parameter settings, pump/infusate height) from professional organizations and device manufacturers utilizing continuous quality improvement (CQI) in collaboration with the health care team to assist in identifying areas of high alerts.[31-33,43,51,52] (III)

E. Follow organizational policy regarding use of a flow-control device during care transitions (eg, hospital admission of patient with an insulin pump).[53,54] (V)

F. Teach patients and/or caregivers in the home care setting about safe and effective use of flow-control devices and the back-up plan for pump malfunction/failure, identification of potential problems, and available resources (see Standard 8, *Patient Education*).[10,27,29,37,38] (V)

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24. BLOOD AND FLUID WARMING

Standard

24.1 Blood and fluid warming are performed only with devices specifically designed for that purpose.

24.2 Blood is warmed in a manner to reduce hemolysis.

Practice Recommendations

A. Ensure competency of clinicians operating blood and fluid warming devices, including the device functionality, the appropriate administration set for the device, the impact of add-on devices, and the proper monitoring of device function and patient tolerance.[1,2] (IV)

B. Use blood and fluid warmers when warranted by patient history, clinical condition, and prescribed therapy, including, but not limited to, preventing or treating intraoperative hypothermia, during plasma exchange for therapeutic apheresis, for patients known to have clinically significant cold agglutinins, for neonatal exchange transfusions, during replacement of large blood volumes,

during vaso-occlusive episodes, or when treating trauma, hypothermia, or cold exposure.[3-21] (I)
   1. Warm intravenous (IV) fluids reduce postoperative shivering.[5,9,16,22,23] (I)
   2. Warm IV fluids may enhance a patient's thermal comfort.[21,24] (III)

C. Use only a blood or fluid warming device that is indicated for this purpose in accordance with the manufacturers' directions for use; is equipped with warning systems, including audible alarms and visual temperature gauges; and is within the maintenance date.[25-28] (IV)
   1. Ensure that equipment used to warm blood, IV fluids, contrast media, and irrigation solutions (eg, infusion device, warming cabinet) is monitored for proper function, including consistent temperature and alarm function. Remove from service if malfunction is suspected.[3-5,26,29] (I)
   2. Never use warming methods where temperature and infection risks cannot be controlled (eg, microwave oven, hot water bath).[3,10,25,26] (IV)
   3. Further research is needed to identify optimal methods of fluid and blood warming in the prehospital setting. Studies indicate that latent heat (eg, products that produce an exothermic effect) and external warming of tubing may be alternatives in resource-limited environments.[30,31] (IV)

D. Do not warm solutions and blood above a set temperature recommended by the manufacturer of the warming device or solution.[12,25,32] (II)
   1. Follow organizational policies and manufacturer instructions on warming during administration of specific blood components (eg, platelets, cryoprecipitate). Studies indicate that warming may not reduce platelet function during warming of apheresis platelets and whole blood.[33,34] (IV)
   2. Monitor the patient's temperature with a device that accurately estimates core temperature to ensure the desired temperature is maintained.[20,22,23,35] (I)
   3. Recognize factors that impact the ability to accurately infuse blood/fluids at the set temperature, including, but not limited to, characteristics of vascular access device, infusion device, infusion flow rate, length of tubing, presence of add-on devices that may restrict flow rate (eg, needleless connectors), interruptions in administration, initial temperature of blood/fluid, total volume infused, environmental conditions, and other warming methods used (eg, forced air or radiant warming).[5-8,12,14,15,22,26,27,32,36-42] (I)
      a. Use caution with add-on devices that may restrict flow during rapid infusion. A case report indicates the potential for rupture of the warming device administration set due to partially closed stopcock during pressure bag delivery (see Standard 34, *Needleless Connectors*).[43] (V)
   4. Consider insulating the administration set to reduce heat loss if longer tubing is used and if environmental conditions warrant.[6,7,14] (IV)
   5. Shield the blood component and tubing from phototherapy source (eg, ultraviolet) or heat lamps when administering blood to an infant; inappropriate warming by exposure of blood to heat lamps or phototherapy lights may produce hemolysis.[4] (V)

E. Consider warming contrast media to reduce the viscosity. This may help reduce extravasation in the following: higher-viscosity contrast media, flow rates greater than 5 mL/s, and some arterial infusions. When contrast media is warmed, use a temperature log for the warmer and follow the device 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.[29,44,45] (V)

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Infusion Therapy Standards of Practice 9th Edition

Section Five: Vascular Access Device Selection and Insertion

KEY DEFINITIONS

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

INS categorizes 3 types of PIVCs:

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

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

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

Section Standards

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

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

25. VASCULAR ACCESS DEVICE PLANNING AND SITE SELECTION

Standard

25.1 Infusion therapy and vascular access decisions are collaborative (health care team, the patient/caregiver), with consideration to the patient's diagnosis and clinical presentation, vasculature, device selection, and risk versus benefit of alternative routes of therapy.

25.2 The appropriate vascular access device (VAD), peripheral or central, is selected based on the prescribed therapy or treatment regimen, anticipated duration of therapy, vascular pathway, patient's age, comorbidities, history of infusion therapy and vascular access, patient preference for VAD type and location, overall vascular health (history of difficult intravenous access, vessel, and skin health at insertion site), and ability and resources available to care for the VAD.

25.3 The least invasive VAD with the smallest outer diameter and fewest number of lumens needed to complete the duration and prescribed therapy is selected.

25.4 Site selection is chosen based on vessel health and preservation strategies (thorough vessel assessment), the planned therapy, patient comfort and preference, and VAD type, beginning at the most distally appropriate site.

Practice Recommendations

I. General Information for Vascular Access Device and Site Selection

A. Use all available resources, including, but not limited to, evidence-based drug monograph warnings, precautions, and toxicology, and interprofessional collaboration to identify medications that should and should not be given through peripheral veins. Peripheral infusion therapy should be isotonic and of physiological pH. When this is not

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achievable, peripheral intravenous infusion of extremes of pH and osmolarity should be avoided to reduce vascular endothelial damage. In clinical practice, many parameters, including administration site, number of infusion therapies, vein selected, related venous blood flow, infusion volume, infusion time, and planned duration of therapy contribute to vessel damage. There is no well-defined or generally recognized pH or osmolarity limit. Furthermore, some infusates with physiological pH and osmolarity can be cytotoxic, potentiating cell damage or death. Factors to consider include, but are not limited to[1-11]: (I)

1. The final osmolarity of the infusion, which is influenced by the diluent (refer to Standard 61, *Parenteral Nutrition*; Standard 43, *Phlebitis*)
2. Infusate pH
3. Method of administration (eg, continuous or intermittent infusion or manual injection [ie, IV push]), including infusion durations and frequency of administration.
4. Infusion rate and pressure (eg, power injections)
5. Number of infusion therapies (single vs multiple)
6. Pharmacological effect of the medication on the vein (eg, vasodilation vs vasoconstriction) (see Standard 65, *Vasopressor Administration)*
7. Anticipated duration of therapy (as a guide see below):
   a. (≤4 days): Insert a peripheral intravenous catheter (PIVC) when all the above elements indicate peripherally compatible therapy.
   b. (5–14 days): Insert a midline catheter in hospitalized adult patients when all the above elements indicate peripherally compatible therapy. A long PIVC may remain appropriate if patient's vasculature, patient's preference, and local health care outcomes support this practice. More high-quality clinical trials are needed to confirm the safety and efficacy of midline catheter use in neonates and infants.
   c. (>15 days): Consider insertion of a peripherally inserted central catheter (PICC). Midline catheters or PIVCs may remain appropriate when all the above elements indicate peripherally compatible therapy and if patient's vasculature, patient preference, and local health care outcomes support this practice. More high-quality clinical trials are needed to confirm the appropriate use (eg, single vs multiple therapies) and duration of these catheters.

B. Discuss the preferred site of PIVC insertion with the patient and/or caregiver, including recommendations to use sites of the nondominant side.[12] (IV)
C. Use vascular visualization technologies to identify and select the most appropriate vein for midline catheter insertion (refer to Standard 21, *Vascular Visualization*).
D. Avoid the following PIVC insertion sites when possible due to increased risk of nerve damage (refer to Standard 45, *Nerve Injury*):
   1. Cephalic vein at the radial wrist with potential injury to the superficial radial nerve
   2. Volar (inner) aspect of the wrist with potential injury to the median nerve
   3. At/above the antecubital fossa with potential injury to the median and anterior interosseous nerve and the lateral and medial antebrachial nerves.
E. Avoid PIVC insertion in areas of the following:[7,10,12] (II)
   1. Flexion
   2. Pain on palpation
   3. Compromised skin and sites distal to these areas, such as areas with open wounds
   4. Extremities with an infection
   5. Planned procedures
   6. Veins that are compromised (eg, previous cannulation, bruised, reddened/streaked, infiltrated, sclerosed, corded, or engorged).
F. Do not use visible veins of the chest, breast, abdomen, or other locations on the trunk, as there is no evidence supporting their safe outcomes. These veins are visible due to pathological reasons that might prevent safe infusion. (Committee Consensus)
G. Do not use veins of the lower extremities (except for neonates and infants), unless needed for an emergent insertion.[4,12] (V)
H. Avoid insertion of a PIVC or midline catheter as a central line-associated bloodstream infection (CLABSI) prevention strategy when central venous access is indicated. (Committee Consensus)
I. Access a patient's implanted vascular access port, unless contraindicated (eg, existing complication with the device), in preference to insertion of an additional VAD when intravenous access is required. (Committee Consensus)

II. Short Peripheral Intravenous Catheters

A. Select PIVC insertion site based on depth of vein and expected duration of infusion therapy. Remove as soon as PIVC is no longer needed.[10,12,13] (I)
   1. Use a forearm vein, where possible, to prolong the dwell time, reduce pain during dwell, and reduce overall device failure. Choose veins found on the dorsal and ventral surfaces of the upper extremities, including the metacarpal, cephalic, basilic, and median veins.[4,7,9,10,12] (I)
   2. Consider hand veins for short-term therapy (eg, less than 24 hours).[4,12] (III)
   3. Avoid the antecubital fossa. PIVC insertion in areas of flexion are associated with higher rates of failure over time.[4,7,9,10,12] (I)
   4. Consider use of the external or internal jugular vein in patients in acute care settings and in emergency situations when other veins cannot be accessed; collaborate with the provider for an alternative vascular access site as soon as possible.[14,15] (IV)
B. Use vascular visualization technology (eg, near infrared, ultrasound) to increase success for patients with difficult

intravenous access (DIVA); (refer to Standard 21, *Vascular Visualization*).

C. Avoid use of short PIVC for continuous infusion of medication with irritant or vesicant properties.[1,2,10] (I)
   1. For time-critical infusions (eg, vasopressors), consider the type and dose of medication and its mode of action (vasoconstriction vs vasodilation). Where appropriate, begin the infusion through a PIVC. The PIVC should be replaced with a central venous access device (CVAD) as early as possible, balancing the acuity of the patient and the potential harm of peripheral infusion of peripherally incompatible medication (see Standard 65, *Vasopressor Administration*).[9,10] (I)

D. Use a restricted dextrose and protein concentration (≤10% and/or 5%, respectively) if it is medically necessary to administer parenteral nutrition (PN) through a peripheral device (refer to Standard 61, *Parenteral Nutrition*).

E. Do not use a short PIVC when the vein lies deep in subcutaneous tissue or for veins classified as deep veins (lying underneath muscle). This reduces the catheter (length) to vein ratio, which might be a precursor to failure.[7,16,17] (III)

F. Select the smallest-gauge PIVC that will accommodate the prescribed therapy and patient need.[4,7,10,12] (II)
   1. Monitor the insertion site for signs and symptoms of complications (eg, pain and redness) and remove when clinically indicated.[7,10,13,18] (I)
   2. Consider a larger-gauge PIVC for adult and pediatric patients when rapid fluid replacement is required (eg, trauma), or a fenestrated catheter for a contrast-based radiographic study, recognizing maximum psi (pounds per square inch) recommended by manufacturer.[19,20] (IV)
   3. Use a 24- to 20-gauge PIVC based on vein size for blood transfusion. A larger-gauge PIVC is appropriate if rapid transfusion is required (refer to Standard 62, *Blood Administration*).
   4. Use steel-winged devices for single-dose administration only. Do not leave the device in situ. (Committee Consensus)

III. Long Peripheral Intravenous Catheters

A. Choose when all aspects of a short PIVC are met, but the vessel is difficult to palpate or visualize with the naked eye. Use ultrasound guidance to improve first-time insertion success (refer to Standard 21, *Vascular Visualization*).

B. Consider veins found on the dorsal and ventral surfaces of the upper extremities, including the cephalic, basilic, and median veins. Insertion should be in the forearm with the tip below the antecubital fossa (ACF). If this is not possible, commence insertion above the ACF.[16] (III)

IV. Midline Peripheral Catheters

A. Assess the peripheral compatibility of all infusates (eg, antimicrobials, fluid replacement, and analgesia) and planned duration of infusion therapy for appropriateness of peripheral vein therapy.[3-8,21,22] (I)
   1. Select the least number of lumens that will accommodate the anticipated infusion therapy.
      a) Single therapy and single lumen midlines have fewer complications than multiple lumen devices.[6,22-24] (II)

B. Ensure the midline tip is appropriately positioned distal to the axillary fold to reduce the risk of complications associated with catheter tip crossing a joint.
   1. Recent studies have demonstrated similar catheter-related outcomes when the midline catheter tip is positioned in a specific position in the intrathoracic cavity, although some conjecture exists whether this is at the axillary vein, proximal to the subclavian, or at the subclavian vein. Increased observation for signs and symptoms of catheter malfunction is recommended, as the safety and efficacy of midline catheter tip position outside this exact location in the intrathoracic cavity has not been assessed in clinical practice.[25-28] (III)

C. Assess the clinical benefit of inserting a midline catheter that inhibits bacterial attachment and biofilm formation.[29,30] (IV)

D. Do not use a midline for continuous infusion of vesicant therapy, PN, or other infusates with extremes of pH or osmolarity (refer to Standard 61, *Parenteral Nutrition*; Standard 65, *Vasopressor Administration*).
   1. Further clinical trials evaluating the appropriate use of midlines for vasopressors (drug type and duration) are needed (see Standard 65, *Vasopressor Administration*).[31] (IV)

E. Increase catheter site surveillance when administering intermittent infusions for any duration of known irritants and vesicants due to increased risk of phlebitis or extravasation (see Standard 39, *Vascular Access Device Post-Insertion Care*; Standard 44, *Infiltration and Extravasation*).[22-24,32] (II)

F. Avoid the use of a midline when the patient has a history of thrombosis, hypercoagulability, decreased venous flow to the extremities, or end-stage renal disease requiring vein preservation.[6,8,22,23] (III)

V. Neonate and Pediatric Patient Considerations for Peripheral Catheters

A. Use similar criteria as for adults, and based on expected infusion therapy, remove PIVC as soon as no longer needed.
   1. In addition to adult PIVC insertion sites, consider veins of the foot if patient activity does not impact the status of the PIVC.
   2. For neonates and infants, when no alternative site is available, veins of the scalp may be used as a last resort. Avoid the hands, fingers, and thumbs.[4,33,34] (III)
   3. Long PIVC: Consider veins in the forearm and the saphenous vein in nonambulatory pediatrics.[4,33,34] (III)

4. Midline catheter: For neonates and pediatric patients, select an upper arm site using the basilic, cephalic, and brachial veins. Additional site selections include veins in the leg (eg, saphenous, popliteal, femoral) with the tip below the inguinal crease and in the scalp with the tip in the neck, above the thorax.[4,6] (IV)

VI. Special Considerations for Peripheral Access

A. Lymphedema: Avoid venipuncture of the ipsilateral upper extremities in patients with lymphedema and those at increased risk for lymphedema (eg, axillary surgical dissection or radiation therapy). This recommendation is based on the risk of decreased perfusion, impaired immune function, and increased risk of infection due to compromised axillary drainage.[7,35-38] (IV)
   1. Consider early referral to an infusion nurse/vascular access specialist.[7] (IV)
   2. If emergent vascular access is needed, choose the most readily accessible vein for access in either upper extremity, then establish a plan for ongoing vascular access.[35-38] (IV)

B. Renal dysfunction, if an arteriovenous fistula (AVF) or arteriovenous graft (AVG) is planned or existing (refer to Standard 27, *Vascular Access and Hemodialysis*).
   1. Use dorsum of the hand for PIVC insertion whenever possible and avoid the cephalic vein, regardless of arm dominance.
   2. Avoid the use of forearm and upper arm veins for peripheral catheter insertion.
   3. Avoid insertion of midline and PICC whenever possible due to an increased risk of thrombosis.
   4. Collaborate between patient and provider (eg, nephrology) to discuss the benefits and risks of using a vein in an affected extremity.

C. Paralysis or hemiparesis: where possible, avoid venipuncture on the affected extremity (eg, traumatic injury, cerebrovascular accident) due to alteration in normal blood flow and decreased sensation.[10] (II)

VII. CVADs (PICCs, Nontunneled, Tunneled, Cuffed and Non-cuffed Catheters, Implanted Vascular Access Ports)

A. CVAD Selection Considerations
   1. Consider the risk versus benefit of direct venous approach compared to subcutaneous skin tunnel approach. A skin tunnel can be either a pseudo tunnel using the length of the needle to access the vein or a surgical tunnel, whereby a tunneling probe is directed through the subcutaneous tissue to the point of vein insertion and the catheter is drawn through this tunnel prior to being advanced into the venous system (refer to Standard 32, *Vascular Access Device Insertion*).
   2. Implement an evidence-based list of indications for CVAD insertion to minimize unnecessary use, including, but not limited to[1,2,4,5,14,22,39-41]: (I)
      a. Clinical instability of the patient (eg, alteration in vital signs, oxygen saturation)
      b. Infusion therapy inappropriate for peripheral infusion (eg, vesicant, non-peripherally compatible PN, and/or electrolytes)
      c. Physical incompatibility and/or complexity of infusion regimen (eg, multiple infusates)
      d. Insufficient peripheral venous access for planned treatment (eg, periodic chemotherapy)
      e. Invasive hemodynamic monitoring
      f. Long-term intermittent infusion therapy (eg, IV therapy for chronic disease, such as cystic fibrosis)
      g. History of failed or difficult peripheral IV access when use of ultrasound guidance has failed.
   3. Consider use in context of history of failed or difficult peripheral IV access when use of ultrasound guidance has failed. Recognize risks associated with CVADs, including venous thrombosis and CLABSIs.[4,5,22,39,42] (I)
      a. Consider thrombosis and infection risk vs benefit of PICC in patients who have cancer or are critically ill.[5,22,39] (I)
      b. Choose a catheter appropriate to the patient's vasculature and therapy requirements (refer to Standard 32, *Vascular Access Device Insertion*).
      c. Consider antithrombogenic PICC to reduce thrombosis risk, particularly in pediatric patients.[42] (III)
      d. Use a CVAD with the least number of required lumens to reduce the risk of thrombosis, infection, and occlusion.[4,5,42,43] (I)
   4. Consider the need for a power-injectable CVAD and know the pressure limits and other limitations (eg, maximum number of power injections) of the device, including all attached or add-on devices (eg, implanted port access needle, extension set, needleless connector) to avoid catheter rupture (refer to Standard 12, *Product Management*).
   5. Collaborate with the health care team to choose the most appropriate CVAD:[4,5,39,44] (II)
      a. Consider use of anti-infective CVADs in patients with increased risk of infection.
      b. Avoid PICCs and other intravenous devices that might compromise future fistula sites for patients with chronic kidney disease (CKD), and plan proactively for an arteriovenous fistula (AVF) or an arteriovenous graft (AVG) as a permanent access for dialysis (refer to Standard 27, *Vascular Access and Hemodialysis*).

B. PICCs
   1. Select the basilic, brachial, or cephalic vein above the antecubital fossa that is most appropriate for PICC insertion, preferably the basilic vein; ensure a

catheter-to-vessel ratio of less than or equal to 45%.[43,45,46] (III)

a. Consider the use of a subcutaneous skin tunnel when the vein of choice is at its largest in the upper third of the upper arm near the axilla. This optimizes the point of needle entry and subsequent catheter exit site in the middle third of the upper arm (refer to Standard 32, *Vascular Access Device Insertion*).
b. For neonates and pediatric patients, additional site selection includes the axillary vein, temporal vein, and posterior auricular vein in the head and the femoral, saphenous, and popliteal veins in the lower extremities.[4] (III)
c. Lower extremity PICCs are associated with greater risk of thrombosis; however, other complications are comparable with upper extremity PICCs.[47] (II)
d. Use the best available vein in neonates and infants; however, where possible, avoid[4,48]: (III)
    i. Lower limb veins for PICC insertion in patients with abdominal pathology
    ii. Upper limb veins for neonates, infants, and children with single ventricle physiology.

2. Avoid areas of pain on palpation or areas with wounds and veins that are compromised (eg, previous cannulation, bruised, reddened/streaked, infiltrated, sclerosed, corded, or engorged).[5,22] (III)

C. Nontunneled Central Venous Catheters

1. Use ultrasound in adult and pediatric patients for vein identification, assessment, and insertion in all sites to decrease risks of cannulation failure, arterial puncture, hematoma, pneumothorax, and hemothorax (refer to Standard 21, *Vascular Visualization*).
2. Use a risk/benefit approach to site selection based on patient physiology, vascular history, infusion needs, and emergent nature of insertion:
    a. Jugular approach: associated with greater first-time insertion success, fewer needle punctures, and lower mechanical complications on insertion.[49] (III)
    b. Consider low internal jugular vein or brachiocephalic to improve first-time insertion success, securement, and patient comfort, and reduce complications such as thrombosis and infection.[18,50] (IV)
    c. Femoral approach: associated with higher risk of infection but easily accessed with use of ultrasound in emergent/short-term situations and when all other sites are exhausted.[50,51] (V)
    d. Axillo-subclavian approach: associated with lower risks of infection and of symptomatic deep vein thrombosis (DVT) but may be associated with increased mechanical complications on insertion (eg, pneumothorax if inserted medially). DVT and stenosis risk increases with long-term use of the subclavian site.[49] (IV)
    e. Use ultrasound-guided lateral axillo-subclavian or internal jugular approach to reduce risk of pinch-off syndrome and to avoid acute angle of catheters inserted into the internal jugular vein (refer to Standard 32, *Vascular Access Device Insertion*).
    f. Avoid placing a CVAD via the subclavian vein for patients with CKD (refer to Standard 32, *Vascular Access Device Insertion*).

D. Tunneled Noncuffed Central Venous Catheters

1. Consider atypical insertion of PICC (tunneled noncuffed central venous catheter [CVC]) as an alternative to tunneled cuffed central venous catheter or when peripheral veins of the upper and lower limbs are insufficient to accommodate the catheter required for medical treatment.
    a. Intravenous access is via a large vein of the chest (internal jugular or brachiocephalic); the catheter is predominantly tunneled to exit the anterior chest wall; however, alternative exit sites can be determined based on individual patient preference and/or risk factors.[52] (IV)
2. Consider tunneling a PICC from superficial femoral vein to midthigh when upper limb PICC insertion is not possible.[53-56] (IV)
    a. Advance the catheter tip to inferior vena cava/right atrial (IVC/RA) junction (catheter tip should sit just above diaphragm) (refer to Standard 22, *Central Vascular Access Device Tip Location*).
    b. Insertion of midthigh femoral catheter can be safely performed at the bedside.
    c. Recognize and accept potential risk/benefit of suboptimal catheter tip location in larger adult patient, as current non-cuffed catheters may be of insufficient length to ensure tip advancement above the level of diaphragm. (Committee Consensus)

E. Tunneled Cuffed Central Venous Catheters and Implanted Vascular Access Port

1. Collaborate with the health care team and patient in assessment and site selection for the insertion of tunneled, cuffed catheters and implanted vascular access ports.[4,39,44] (III)
2. Select internal jugular vein in preference to subclavian and femoral vein.[49,57,58] (III)
3. Use ultrasound to provide thorough assessment of chest veins (subclavian, internal jugular, and brachiocephalic), improve insertion success, and reduce risk of insertion-related complications (arterial puncture, hematoma, pneumothorax, and hemothorax) (see Standard 21, *Vascular Visualization*).[59,60] (III)
4. Consider a tunneled, cuffed CVAD for continuous long-term infusion therapy (eg, antineoplastic therapy, PN).[4,39] (II)

5. Consider use of an implanted vascular access port in patients who require infrequent/intermittent vascular access.[4,39,44] (III)
    a. Arm ports are an alternative site; however, compared to chest wall ports, they have an increased risk of post-insertion complication such as thrombosis (see Standard 50, *Catheter-Associated Thrombosis*).[61-63] (II)
6. Consider use of nonconventional intravenous access sites (eg, recanalization, intrahepatic, and trans-lumbar) by experienced interventional radiologists for patients in whom traditional venous access sites have been exhausted, such as those patients with end stage renal disease.[64] (IV)

VIII. Arterial Catheters

A. Insert an arterial catheter for hemodynamic monitoring, obtaining blood samples, and analyzing blood gas in critically ill patients.[65] (IV)
B. Use the smallest gauge catheter possible for radial arterial access to reduce the risk of complications.[65] (IV)
C. Use ultrasound for arterial catheter insertion to reduce insertion-related complications (refer to Standard 21, *Vascular Visualization;* Standard 32, *Vascular Access Device Insertion*).
    1. Consider use of smart glasses to improve first-time insertion success in pediatric patients requiring arterial catheter insertion.[66] (III)
D. Assess the circulation to the hand prior to puncturing the radial artery; perform a physical examination of hand circulation (assess radial and ulnar pulses with the Allen test, pulse oximetry, or a Doppler flow study). Review the medical history (eg, trauma, previous radial artery cannulation, radial artery harvesting); assess for the use of anticoagulants (refer to Standard 41, *Blood Sampling*).
E. For adults, the radial artery is the most appropriate access for percutaneous cannulation.[67] (V/AP)
F. For pediatric patients, use the radial, posterior tibial, and dorsalis pedis arteries. The brachial artery is not used in pediatric patients due to the absence of collateral blood flow. (AP)

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26. IMPLANTED VASCULAR ACCESS PORTS

Standard

26.1 Skin antisepsis is performed prior to each access of an implanted vascular access device port.

26.2 Implanted vascular access devices (ports) are accessed only with noncoring needles. Only a power injectable noncoring needle is used with power-injection equipment for radiologic imaging in accordance with manufacturers' directions for use.

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

Practice Recommendations

A. Assess patient needs and preferences related to pain management during port access (refer to Standard 30, *Pain Management for Venipuncture and Vascular Access Procedures*).

B. Access a patient's implanted vascular access port, unless contraindicated (eg, existing complication with the device), in preference to insertion of an additional vascular access device (VAD) when intravenous access is required. (Committee Consensus)

C. Adhere to Aseptic Non-Touch Technique (ANTT®) during port access (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*).
   1. Assess port site in preparation for port access: observe/palpate for swelling, pain, erythema, and drainage; presence of venous collaterals on the chest wall that may signal occlusion; erosion of the portal body through the skin; or signs of catheter-associated deep vein thrombosis (CA-DVT). If present, do not access port and collaborate with the health care team for further evaluation (see Standard 47, *Vascular Access Device-Related Infection*; Standard 50, *Catheter-Associated Thrombosis*).[1-5] (V)
   2. Perform skin antisepsis and allow to fully dry prior to port access (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).
   3. Adhere to either Standard-ANTT or Surgical-ANTT during port access.
      a. Don sterile gloves to palpate or locate port site after skin antisepsis and prior to insertion of noncoring needle (see Standard 19, *Aseptic Non Touch Technique [ANTT®]*).[3,4,6-8] (V)

D. Access the port with the smallest-gauge noncoring needle to accommodate the prescribed therapy; use of a safety engineered noncoring needle is recommended and required in some jurisdictions (see Standard 16, *Medical Waste and Sharps Safety*).[7] (V)
   1. Reduce the risk of needle dislodgement after access; use appropriate length that allows the external components (eg, wings/disc) to sit level with the skin and securely within the port hub (needle touches bottom of port upon insertion).[2,7,9] (V)
   2. Orient the bevel of the noncoring needle in the opposite direction from the outflow channel where the catheter is attached to the port body. In vitro testing demonstrates that a greater amount of protein is removed when flushing with this bevel orientation.[7,10-12] (IV)
   3. Replace the noncoring needle according to manufacturer's directions for use or in accordance with organizational procedures; there is insufficient evidence to recommend the frequency of replacement

of the noncoring needle when the port is used for a continuous infusion.[3] (V)

4. Consider use of a needle insertion assistive device, which may improve first-attempt success with insertion of the noncoring needle into the port.[9,13] (V)
5. Use the manufacturer-recommended catheter when accessing an implanted port with a funnel design for apheresis (refer to Standard 29*, Vascular Access and Therapeutic Apheresis*).

E. Flush and lock the port to assess function and maintain patency.
   1. Ensure presence of a blood return upon insertion of a noncoring needle and prior to each infusion to ensure patency (refer to Standard 38, *Flushing and Locking*).
   2. There is insufficient evidence to recommend the optimal frequency, solution, or volume to maintain the patency of implanted vascular access ports not accessed for infusion (refer to Standard 38, *Flushing and Locking*).
      a. Use at least 10 mL of 0.9% sodium chloride (adult).
      b. Use of 0.9% sodium chloride alone may be as effective as heparin in maintaining patency.
      c. Extending maintenance flushing to every 3 months with 10 mL of 0.9% sodium chloride and 3 or 5 mL of heparin (100 units/mL) was found to be safe and effective in maintaining patency.
      d. Flush accessed but non-infusing implanted vascular access ports daily.

F. Use a transparent semipermeable membrane (TSM) dressing that covers the noncoring needle and access site when the port is accessed.[6,8] (V)
   1. Change the TSM dressing at least every 7 days; if gauze is used over the noncoring needle and access site, change the dressing every 2 days (refer to Standard 39, *Vascular Access Device Post-Insertion Care*).
      a. If gauze is used under the TSM dressing to solely support the wings of a noncoring needle, does not obscure the access site, and its integrity is not compromised (eg, not visibly soiled and remains free of moisture, drainage, or blood), change the TSM dressing at least every 7 days. (Committee Consensus)
   2. Consider chlorhexidine-containing dressings in adults and patients over 2 months of age. Guidelines for oncology patients suggest use of a chlorhexidine-containing dressing around the needle insertion site based on duration of infusions exceeding 4 to 6 hours (see Standard 47, *Vascular Access Device-Related Infection*).[6,7] (V)
   3. Secure the noncoring needle to reduce the risk for needle dislodgement and subsequent risk for infiltration/extravasation (eg, sterile tape strips), assuring protection of skin integrity around the insertion site.[7,8] (V)

G. Confirm that a port and the noncoring needle are indicated for power injection before using it for this purpose.[2,14] (V)
   1. Ports are assigned a unique device identifier, an alphanumeric code, specific to that product. When used in the patient's health record in a retrievable manner, this code is used to obtain all information about that device (eg, product and manufacturer name, lot and serial number, date manufactured).[15-17] (IV)
   2. Other identification methods include review of operative procedure documentation, presence of identification (eg, cards) provided by the manufacturer, radiographic scout scan, and palpation of the port; however, do not use palpation of the port as the only identification method, as not all power-injection–capable ports have unique characteristics identifiable by palpation. (Committee Consensus)
   3. During and after power injection, be aware of the potential for catheter rupture, which can lead to extravasation, catheter fragment embolism, and the need for port removal and replacement. Suspect catheter rupture if the patient shows signs of localized swelling or erythema or reports pain (refer to Standard 48, *Catheter Damage [Embolism, Repair, Exchange]*).

H. Consider an annual chest radiograph-imaging assessment of port position and integrity (see Standard 48, *Catheter Damage [Embolism, Repair, Exchange]*).[18,19] (IV)

I. Provide patient/caregiver education:
   1. Prior to port implantation surgery, provide information about: procedure, type of port, routine care (flushing frequency, ANTT during access, use for power injection, if indicated), and identification of potential complications and interventions.[15,16,20-22] (IV)
   2. Provide written information about ports before insertion to decrease anxiety and improve knowledge.[3,16,17,20,22,23] (IV)
   3. Home infusion: educate patient/caregiver to check dressing daily, manage activities of daily living (bathing, clothing, seatbelts) to prevent needle dislodgement, report signs or symptoms of complications (pain, burning, stinging, or soreness) and follow-up actions (see Standard 8, *Patient Education*).[3,17,22,24] (V)
   4. Post-treatment device: provide information and education on port removal versus maintenance and the potential for complications related to prolonged dwell time (eg, infection, thrombosis, tip migration).[1,6,23,25-31] (III)

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27. VASCULAR ACCESS AND HEMODIALYSIS

Standard

27.1 Selection of the most appropriate vascular access device (VAD) for hemodialysis occurs in collaboration with the patient/caregiver and the health care and nephrology teams based on the projected treatment plan.

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

27.3 Only nephrology/dialysis clinicians access hemodialysis VAD lumens unless there is a life-threatening condition

and/or when there is validation of clinician training and competency.

Practice Recommendations

A. Use principles of vessel health and preservation for both peripheral and central vasculature for patients on hemodialysis or likely to require future hemodialysis.[1,2] (IV)
   1. Begin planning for hemodialysis vascular access with the patient and family beginning at chronic kidney disease (CKD) stage 4 (glomerular filtration rate [GFR] $<$30 mL/min/1.73m^2).[1,3,4] (IV)
      a. Preserve vessels in patients with acute kidney injury; in the 2-year period prior to hemodialysis, acute kidney injury was associated with significantly lower odds of transitioning to hemodialysis with an AVF/AVG.
   2. Determine the access method in preparation for hemodialysis; the order for access preference is AVF, AVG, and long-term central venous access device (CVAD) (tunneled, cuffed hemodialysis catheter); nontunneled hemodialysis CVADs may be placed for short-term immediate hemodialysis needs in the hospitalized patient.[1,5-8] (IV)
   3. Limit use of temporary, non-cuffed, nontunneled hemodialysis CVADs to a maximum of 2 weeks due to increased risk for infection and consider their use only in patients with need for emergent access.[1,9] (IV)
      a. Recognize that some temporary dialysis catheters have a center third lumen appropriate for infusions. This lumen has a 1% recirculation rate during dialysis or continuous renal replacement therapy (CRRT). Collaborate with the interprofessional team to determine optimal timing of infusions, as well as any filter changes that may be necessary on the dialysis equipment. Organizational policies and procedures should outline which clinicians are responsible for care of the infusion lumen with regard to flushing, tubing, and needleless connector changes.[9] (V)
      b. Avoid placement of a CVAD via the subclavian vein and avoid peripherally inserted central catheters (PICCs) and midlines whenever possible due to an increased risk for thrombosis, central vein stenosis, and occlusion; the order of preference for CVAD placement is internal jugular, external jugular, femoral, subclavian, and lumbar vein.[10] (IV)
         i. PICC placement before or after hemodialysis initiation is associated with failure to transition to a working fistula; consult with the nephrology team, when available, before PICC placement.
   4. AVF or AVGs should be created as distally as possible in patients with heart failure, as fistula/graft formation affects cardiac function and can worsen heart failure.[11] (V)
      a. Evaluate life expectancy, surgical risk, patient preferences, and quality of life for older patients requiring hemodialysis when considering an AVF or AVG vs a hemodialysis catheter.[1,2,7,12,13] (IV)
   5. For both phlebotomy and peripheral intravenous catheter (PIVC) placement, use the dorsum of the hand whenever possible, regardless of arm dominance, in patients with an actual or planned dialysis fistula or graft. Avoid use of forearm and upper arm veins, including the antecubital fossa, for phlebotomy or peripheral catheter placement in patients with an actual or planned dialysis fistula or graft.[14] (V)

B. Provide access, dressing changes, and site care for hemodialysis access devices, including AVFs and AVGs (when dressings are present), in accordance with Aseptic Non Touch Technique (ANTT®)[15-19] (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*). (I)
   1. Use a rope ladder or buttonhole technique for needle insertion into the AVF/AVG; while the buttonhole technique is less painful for patients, the risk for infection may be higher as compared to rope ladder technique.
   2. Consider use of point-of-care ultrasound to assess AVF vessel maturation and vessel abnormalities and to assist with difficult AVF access.
   3. Use an alcohol-based chlorhexidine solution as a first-line antiseptic solution for VAD exit site care; if sensitive to chlorhexidine, use povidone iodine preferably with alcohol.
   4. Consider the use of a chlorhexidine-containing dressing as a strategy to reduce infection risk.
   5. In addition to site cleansing, apply topical antiseptic or antimicrobial barrier at the CVAD exit site during the site care and catheter dressing change if not using a chlorhexidine-containing dressing; alternatives include triple antibiotic ointment (bacitracin/neomycin/polymyxin B).
      a. Recognize that ingredients in antibiotic and povidone-iodine ointments may interact with the chemical composition of certain catheters; check with the catheter manufacturer to ensure that the selected ointment will not interact with the catheter material.
      b. Avoid use of mupirocin ointment at the catheter insertion site due to the risks of facilitating mupirocin resistance and the potential damage it can cause to polyurethane catheters.

C. Provide hub care in accordance with ANTT (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*).
   1. Wear appropriate personal protective equipment (PPE) with additional thought to wearing a mask (both clinician and patient) to reduce the risk of droplet transmission of oropharyngeal flora.[14] (V)
   2. Disinfect hemodialysis catheter lumens before and after every access. If a dead-end cap is used, disinfect the connection between the cap and the lumen

before removing the dead-end cap. Disinfect the threads and sides of the lumen using friction to remove any residue. If a closed system, high-flow needleless-style connector is used, follow the manufacturer's directions for cleaning and changing of caps (see Standard 34, *Needleless Connectors*).[1,20,21] (II)

3. For patients receiving hemodialysis through a CVAD, consider the use of an antimicrobial barrier cap as a strategy to reduce bloodstream infections (Refer to Standard 47, *Vascular Access Device-Related Infection*).

D. Lock hemodialysis CVADs with heparin solution or low-concentration citrate (<5%); consider locking CVAD with tissue plasminogen activator (tPA) prophylactically once per week to reduce the risk of CVAD occlusion; other antimicrobial solutions may be used in accordance with organizational policies, procedures, or practice guidelines (see Standard 38, *Flushing and Locking*). When locking with heparin, dose to the fill volume stamped on the lumen. Typical concentration is 1000 u/mL in adults. Consider using lower-concentration heparin to decrease systemic exposure and risk for heparin-induced thrombocytopenia (HIT).[1,16,22,23] (IV)
   1. Choose a locking solution based upon nephrology team preferences due to inadequate evidence to demonstrate a difference between solutions.

E. Conduct ongoing surveillance for bloodstream infections and other dialysis adverse events and share outcomes with the health care team (refer to Standard 6, *Quality Improvement*).

F. Promote patient engagement through activities, including shared decision-making and empowerment, such as monitoring clinician infection prevention practices (eg, hand hygiene before each hemodialysis access procedure); provide patient education as an integral part of patient engagement. Address the following patient education topics[1,7,21,24-28]: (IV)
   a. Hemodialysis vascular access when the patient is at CKD stage 4
   b. Vein preservation
   c. Infection prevention
   d. Protection and care of AVF, AVG, or CVAD
   e. Assessment and management when away from the dialysis unit
   f. Signs/symptoms of VAD dysfunction, infection, or other complications and how to report.

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28. UMBILICAL CATHETERS

Standard

28.1 Assess daily the continued clinical need for the umbilical catheter. Promptly remove the catheter when it is no longer needed.

Practice Recommendations

A. Establish organizational guidelines to guide appropriate use of umbilical arterial catheters (UACs) and umbilical venous catheters (UVCs), including gestational age and birth weight, severity of illness, and intended therapy to minimize unnecessary use and potential complications.[1-7] (II)
   1. Use UACs for obtaining frequent blood samples and continuous blood pressure monitoring.
   2. Use UVCs for the infusion of medications and solutions, parenteral nutrition (PN), and blood products.
   3. Maintain patency and reduce risk of thrombosis by continuous infusion of heparin 0.25 to 1.00 unit/mL (total dose of heparin: 25–200 units/kg/d).
   4. Insert smallest gauge catheter to reduce risk of complications.

B. Perform skin antisepsis prior to insertion.[8-11] (II)
   1. Use povidone-iodine, alcohol-based chlorhexidine solution, or aqueous chlorhexidine solution.
   2. Use both aqueous and alcohol-based chlorhexidine with caution in preterm neonates, low birthweight neonates, and within the first 14 days of life due to risks of chemical burns to the skin. Systemic absorption is possible due to skin immaturity; however, systemic effects are not documented. Use chlorhexidine antiseptic agents with caution in infants under 2 months of age. Studies have not established one antiseptic solution as superior for safety or efficacy in neonates.
   3. Avoid the use of tincture of iodine in premature neonates (<32 weeks) due to the potential deleterious effect on the neonatal thyroid gland (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).
   4. Remove antiseptics after the procedure is complete using sterile water or saline (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).

C. Place the catheter tip for:
   1. UACs in the thoracic portion of the descending aorta below the aortic arch (ie, between the thoracic vertebrae 6 and 9 for high position) or below the renal arteries and above the aortic bifurcation into the common iliac arteries (ie, between lumbar vertebrae 3 and 4 for low position).[12] (V, A/P)
      a. The high position is associated with decreased risk of complications.[12,13] (IV, A/P)
   2. UVCs in the inferior vena cava (IVC) at, or superior to, the diaphragm below the junction with the right atrium.[2,14] (IV)
      a. Emergently placed UVCs with the tip sited in a noncentral position should be replaced with more definitive intravenous access as soon as practicable, due to higher risk of infection and complications.[1,2,15,16] (IV)

D. Estimate the length of catheter to be inserted by anatomical measurements and equations based on body weight, or with other research-based protocols to achieve successful tip placement. However, these methods are relatively unreliable and catheter tip position should be confirmed with imaging prior to use.[2,14,17-23] (I)

E. Use radiography, echocardiography, or ultrasonography to confirm catheter tip position before use.[2,21,22] (I)
   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, or alternative form of imaging, such as ultrasound.[21,24-26] (II)
   2. For UAC, obtain AP radiographic view of the chest and abdomen to verify tip location. Various formulas exist to guide approximate catheter length; however, observational studies have demonstrated low level of accuracy.[22] (V)

3. Consider real-time ultrasound-guided (USG) UVC insertion to reduce mispositioned catheter tips at insertion.[2,15,26-30] (I)
4. Ultrasound imaging using parasternal long- and short-axis views for UVC tip location compares favorably to radiography. Injection of normal saline through the catheter may assist in visualizing the exact tip location.[21,24,25,31,32] (IV)
5. Neonatal echocardiography may be superior to chest and abdominal radiography in extremely low-birthweight neonates or for identifying malpositioned catheters.[33-35] (IV)
6. Consider regular surveillance of catheter tip position, as malposition is common, particularly in patients of low-birthweight and diagnosis of necrotizing enterocolitis.[2,12,29,33,36,37] (II)

F. Use sterile tape to secure the UVC or UAC based on promotion of security, skin integrity, decreasing complications such as infection, and ease of utilization and management. There is currently a lack of evidence demonstrating the superiority of one method over others. These catheters are at risk for significant complications resulting from migration and dislodgement, such as extravasation, thrombosis, and necrotizing enterocolitis. Powered randomized controlled trials (RCTs) are needed to establish the superiority of one securement method over another.[2,13,38] (II)
   1. Organizational protocols should be developed also recognizing that neonates are at high risk for catheter-associated skin injuries (refer to Standard 52, *Catheter-Associated Skin Injury*).

G. Do not use topical antibiotic ointment or creams on umbilical sites due to the risk of fungal infections and antimicrobial resistance.[39] (IV)

H. Monitor for signs and symptoms of potential complications, including, but not limited to, bleeding from the umbilical stump, extravasation, hemorrhage, air embolism, infection, thrombosis, pleural effusion, pericardial effusion, cardiac tamponade, cardiac arrhythmias, liver damage, and peripheral vascular constriction. Anticipate the use of point-of-care ultrasound, as available, or echocardiogram for diagnostic purposes.[1,3,12,32,39] (III)

I. Consider implementing a bundle of care to reduce risk of umbilical catheter-associated bloodstream infection.[40] (IV)

J. Remove umbilical catheters promptly when no longer needed or in the event of a complication.
   1. Consider limiting UVC dwell time to 7 to 10 days; risks of infectious and thrombotic complications are increased with longer dwell times.[1-3] (III)
   2. Consider UVC removal at 4 days, followed by insertion of a peripherally inserted central catheter (PICC) for continued infusion as one infection-preventive strategy, particularly for patients at greater risk of infection.[2,3,6,28,39,41] (III)
   3. Consider limiting UAC dwell time to no more than 5 days.[3] (IV)
   4. A small cohort study demonstrated peripheral arterial lines might be as effective with fewer complications than UAC. A larger, randomized controlled trial is needed to confirm this.[42] (V)
   5. 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/minute to allow vessel constriction. (V, A/P)

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29. VASCULAR ACCESS AND THERAPEUTIC APHERESIS

Standard

29.1 The most appropriate vascular access device (VAD) for therapeutic apheresis is selected in collaboration with the patient/caregiver and the interprofessional team based on the projected treatment plan.

Practice Recommendations

A. Choose the most appropriate VAD for therapeutic apheresis based on the type of apheresis procedure (centrifugation-based or filter-based systems); adequacy of superficial and deep peripheral veins; patient acuity; anticipated duration and frequency; inpatient vs outpatient; patient preference; underlying disease state(s);

and availability of staff and resources to obtain vascular access.[1-3] (IV)

B. Consider either peripheral or central VADs for therapeutic apheresis; peripheral venous access is the primary access method in European countries, while central vascular access devices (CVADs) are used primarily in North America, South America, and Central America, and increasingly in Asia.[2,4,5] (V)
   1. Consider an ultrasound-guided peripheral intravenous catheter (PIVC) for apheresis in selected patients, as peripheral insertion is associated with fewer risks of complications compared to CVADs for apheresis and may decrease the need for CVADs.[4,6-9] (IV)
   2. Insert 2 PIVCs for peripheral apheresis: 1 for access or withdrawal of blood for apheresis and 1 for return of the patient's cells and replacement fluid. Single-needle procedures have been used for patients with limited access but may significantly increase procedure time.[10] (IV)
   3. Use a large-gauge PIVC or dialysis cannula (eg, 16- to 20-gauge) in the antecubital vein or other large veins, such as the basilic or cephalic veins, in the forearm for access and in smaller veins for the return.[2,5,11] (III)
   4. In one study, direct venipuncture of the femoral vein was used in a patient with unsuitable upper extremity vessels.[12] (V)
   5. Peripheral vein access is not recommended in young children due to small veins but may be possible with older children and adolescents.[1] (IV)
   6. There have been case reports of small-gauge CVADs being used successfully in neonates.[13] (V)

C. Consider the benefits of dialysis-capable CVADs that provide reliable blood flow, ability to withstand high negative pressures during blood draws, and a catheter size of at least 11.5 French (Fr) for adults.[2,3,14] (IV)
   1. Appropriate catheter sizes for use of a nontunneled or tunneled cuffed CVAD in pediatric patients range from 6.0 to 7.0 Fr for patients weighing less than 10 kg, 6.0 to 8.0 Fr for patients weighing between 10 and 30 kg, 8.0 to 10.0 Fr for patients weighing between 30 and 50 kg, and 11.5 Fr or larger for children weighing more than 50 kg. Consider vessel size as well when selecting catheter size.[3,14] (IV)
   2. Peripherally inserted central catheters (PICCs) are not appropriate for apheresis due to small catheter gauge and higher failure rates.[2] (IV)
   3. Midline catheters may provide sufficient flow rates. New catheters are required for each procedure. Follow manufacturer's directions for use.[15] (IV)
   4. General recommendations for locking CVADs used for apheresis include high-concentration heparin and sodium citrate (see Standard 38, *Flushing and Locking*).[2,16,17] (IV)
      a. Heparin-induced thrombocytopenia (HIT) was identified as a particular risk in patients with multiple myeloma who required stem cell harvesting for autologous hematopoietic stem cell transplantation. An unusually high frequency of HIT was identified (4%).[18] (IV)

D. Consider specially designed apheresis implanted vascular access ports for patients requiring long-term treatment; specialized port design allows for high flow.[2,3,19,20] (V)
   1. Infection, thrombotic occlusion, migration, and fibrin sheath and sludge formation are complications associated with implanted vascular access ports.[19,21,22] (IV)
   2. Determine port access device requirements based on port type and assess proper positioning prior to beginning apheresis procedures.[23,24] (V)

E. Avoid arteriovenous fistulas (AVFs) and arteriovenous grafts (AVGs) for long-term apheresis; the failure rate associated with AVFs is high.[2,25] (V)

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30. PAIN MANAGEMENT FOR VENIPUNCTURE AND VASCULAR ACCESS PROCEDURES

Standard

30.1 All patients undergoing painful procedures have the right to safe and effective pain management.

30.2 Appropriate strategies are implemented to reduce pain associated with needle-related procedures (eg, vascular access device [VAD] insertion, venipuncture, implanted vascular access port access, implanted intrathecal drug delivery access) based upon assessment of age, developmental level, patient condition, and engagement of patients and families to determine preferences.

Practice Recommendations

A. Educate patients and caregivers about realistic expectations about the potential for pain or discomfort involved with procedures and engage them in decision-making to reduce pain.[1] (IV)

B. Employ interventions to increase first-time success with VAD insertion (see Standard 21, *Vascular Visualization*; Standard 25, *Vascular Access Device Planning and Site Selection*; Standard 32, *Vascular Access Device Insertion*).[2-5] (IV)

C. Identify barriers that influence clinician's use of pain management strategies. These might include underestimation of procedural pain, focusing on the technical task, time constraints, lack of orders/protocols, workload, and cost.[2,6,7] (II)
   1. Preterm infants have sensitive developing nervous systems; long-term changes in response to the pain and stress involved with preterm hospitalizations have been identified (eg, reduced white matter microstructure and subcortical gray matter, dorsal horn central desensitization).[8-10] (IV)
   2. Repeated needle-related procedures, particularly in early to middle childhood, increase the risk for development of long-term consequences such as procedural anxiety and hospital avoidance.[11,12] (III)
   3. Adolescents experience similar values of pain and distress associated with peripheral intravenous catheter (PIVC) insertion yet receive less in terms of pain relief interventions.[13] (IV)

D. Use age and developmentally appropriate pain assessment tools.
   1. Infants: crying, facial expression, and body posture/limb movements are indicative of pain; a variety of pain evaluation tools are available, including the Neonatal Infant Pain Scale (NIPS); Premature Infant Pain Profile (PIPP); Neonatal Pain Agitation and Sedation Scale (NPASS); Face, Legs, Activity, Cry, Consolability (FLACC); Modified Behavioral Pain Scale (MBPS); and the Newborn Comfort Behavior Scale (NCBS).[14] (IV)
   2. Toddlers: behaviors such as facial expression, bodily movement, and crying; FLACC may be used.[15] (IV)
   3. Preschoolers and school-aged children can self-report pain; FACES® pain rating scale; FLACC may be used in conjunction with self-report for preschoolers; numerical pain scale for older children.[15] (IV)
   4. Children with intellectual disabilities may be unable/less able to communicate pain verbally and experience more pain and anxiety during needle-related procedures compared to children without disability; FLACC may be used.[16] (IV)
   5. Adults: patient self-report is the most valid and reliable indicator of pain; asking about pain in different ways may be necessary; for adults with mild-to-moderate cognitive impairment, tools such as Pain in Advanced Dementia (PAINAD) and Doloplus 2 are recommended.[17] (II)

E. Provide appropriate pain management strategies with every painful procedure for neonates/infants.
   1. Involve parents when present in the neonatal intensive care unit (NICU) and when the infant is exposed to a painful procedure. Educate parents about infant pain and their role in pain management; consider timing of procedures/visitation policies to allow for parental involvement.[18-21] (IV)
   2. Use nonpharmacologic interventions (sucrose/glucose, non-nutritive sucking (pacifier), breastfeeding, olfactory/auditory stimulation, skin-to-skin care ["Kangaroo Care"], therapeutic massage, swaddling, facilitated tucking [FT], acupressure, white noise/music/lullabies), as they are safe, effective, and easily applied. FT, oral sucrose, and kangaroo care decreased behavioral and physiologic pain response alone and in combination with other behavioral and environmental interventions in preterm infants.[8,10,14,22-35] (I)
   3. Avoid lidocaine/prilocaine cream, as it is inferior to sucrose or breastfeeding in controlling pain, and there are safety concerns, including methemoglobinemia and increased skin blanching.[36,37] (I)
   4. Consider culturally based strategies (eg, acupuncture, foot massage/reflexology, aromatherapy). Positive results are reported from various countries; however, it is recognized that such interventions are difficult to standardize and to measure impact.[38] (IV)
   5. Consider massage therapy; it may be effective for neonates during procedural pain based upon a literature review. However, there is substantial variation in body part(s) massaged, duration, and intensity of massage; the risk for inappropriate pressure is a risk for potential trauma.[39] (I)

F. Provide nonpharmacologic pain management strategies to children, with attention to growth and developmental level:
   1. Encourage parents to take an active role in managing a child's procedural pain to reduce child's fear, anxiety, and distress; the presence of parents was beneficial for the child's pain response, especially when the parents successfully implement the interventions that they were instructed to do (eg, distraction).[40-42] (I)
      a. Instruct parents to avoid restraining or "holding down" a child during the procedure, which may be inadvertently forceful or punitive and increase fear; rather emphasize "hugging" and use of distraction techniques.[43] (V)
   2. Use distraction techniques feasible for implementation in the health care setting and desirable to the child:
      a. The use of any type of distraction technique is associated with reduced anxiety and perception of procedural pain in school-aged children and children with cancer. Reported distraction techniques include television, DVDs, videos, computers/tablets, smartphones, video games, virtual reality (VR), humanoid robots, therapeutic clowning, breathing exercises, hypnosis, and toys. Despite low quality of evidence among systematic reviews, the efficacy of such interventions is supported.[42,44-49] (I)
         i. Distraction was not effective for children who have received solid organ transplants and required venipuncture; frequent exposure to painful procedures may have impacted the ability to detect a reduction in pain using distraction.[50] (III)
      b. "Peekaboo," blowing bubbles, and reading books are effective with toddlers.[15] (II)
      c. VR was effective in several populations (children ages 4-18; children with kidney disease undergoing venipuncture, intrathecal pump refills; pediatric oncology patients). VR is well-tolerated and well-liked by patients; however, the risk for cybersickness is a consideration.[51-62] (I)
      d. Music intervention provided an analgesic effect in both infants and children; classical, kids', and pop music have the greatest impact on alleviating pain delivered via headset, earphones, or speakers.[34] (I)
      e. Use of a vibrating cold device can provide distraction, reduce anxiety, and decrease self-reported, parent-reported, and observer-reported pain through blocking of pain impulses consistent with gate control theory of pain management.[63-67] (I)
      f. Massage therapy may alleviate distress associated with burns and cancer.[68] (I)
      g. Acupressure was significantly associated with reduced pain with venipuncture in a single randomized controlled trial (RCT); specific clinician training in acupressure is required.[69] (III)

G. Consider application of ice for several minutes prior to venipuncture, as this was cost-effective, simple, and efficacious in reducing pain in children.[70,71] (III)

H. Provide an appropriate pharmacologic pain management strategy for children.
   1. All anesthetics were effective in pain prevention in a large RCT. Anesthetics included 10% lidocaine spray allowed to act for 5 minutes; lidocaine HCL 2% gel onset of action at 5 minutes and lasts 20-30 minutes; lidocaine/prilocaine for 60 minutes; ethyl chloride 5-second spray; and lidocaine cream for 30 minutes. Application time and costs are considerations when selecting the anesthetic.[72] (III)
   2. Topical lidocaine/prilocaine for PIVC insertion was more effective than subcutaneous needleless lidocaine; however, needleless lidocaine should be considered when a delay in treatment is contraindicated.[73,74] (III)

3. Vapocoolant spray is associated with a significant reduction in pain compared to placebo.[75,76] (I)

I. Provide appropriate pain management interventions to adults with consideration for patient preferences.
   1. Recognize that some patients may have a significant fear of needles (ie, needle phobia) and that pain management strategies may reduce fear.[77] (IV)
   2. Nonpharmacologic interventions:
      a. Use of heat packs reduced pain and anxiety before PIVC insertion.[78] (III)
      b. Cold therapy before port needle removal was associated with reduction in pain and anxiety; aromatherapy was associated with decreased pain during port needle access.[79,80] (III)
      c. Behavioral interventions such as distraction, relaxation, breathing exercises, hand massage.[2,81] (IV)
      d. Valsalva maneuver to alleviate the severity of pain in noncardiac patients; also avoid in patients with retinopathy and intraocular lens implantation due to rise in intraocular pressure.[82,83] (I)
      e. Cold and vibration.[84] (III)
   3. Pharmacologic interventions:
      a. Injectable (eg, intradermal lidocaine) or topical (eg, lidocaine/prilocaine) anesthetic prior to PIVC insertion.[85-88] (I)
         i. Intradermal lidocaine (2% lidocaine most effective); bacteriostatic saline (containing benzyl alcohol) has analgesic properties but is not as effective as lidocaine.[85] (I)
         ii. Lidocaine buffered with saline resulted in pain relief during peripherally inserted central catheter (PICC) insertion and was comparable to lidocaine buffered with bicarbonate.[89] (V)
         iii. Topical diclofenac and topical ketamine were efficacious in pain reduction with PIVC insertion.[90-92] (III)
      b. Vapocoolant to reduce pain during PIVC insertion and blood collection; recognize that it is associated with mild discomfort during application.[75,76,93] (I)
      c. Application of room-temperature lidocaine (1-2 mL) to the skin prior to a 1% lidocaine subcutaneous injection for bedside procedures insertion resulted in a small absolute reduction in pain scores, particularly for PICC insertion.[94] (III)

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31. VASCULAR ACCESS SITE PREPARATION AND SKIN ANTISEPSIS

Standard

31.1 Skin antisepsis is performed prior to vascular access device (VAD) insertion.

31.2 The intended VAD insertion site is visibly clean prior to application of an antiseptic solution; if visibly soiled, the intended site is cleansed with soap and water prior to application of antiseptic solution(s).

Practice Recommendations

A. Remove excess hair at the insertion site if needed to facilitate application of VAD dressings. Use single-patient-use scissors or disposable-head surgical clippers; do not shave, as this may increase the risk for infection.[1,2] (I)

B. Evaluate patient history of any allergy or sensitivity to skin antiseptics (see Standard 52, *Catheter-Associated Skin Injury*).[3,4] (I)

C. Perform skin antisepsis using alcoholic chlorhexidine gluconate (CHG) as the preferred antiseptic solution.[4-14,] (I)
   1. Use an alcoholic CHG solution containing at least 2% chlorhexidine gluconate.[10,15] (I)
   2. Use an iodophor (eg, povidone-iodine) or 70% alcohol if there is a contraindication to chlorhexidine solution.[4,7,11,12] (I)
   3. Consider use of aqueous chlorhexidine if there is a contraindication to alcohol-based chlorhexidine (see Standard 52, *Catheter-Associated Skin Injury*).[14] (I)
   4. For preterm neonates, low-birthweight infants, and within the first 14 days of life[16-19]: (III)
      a. Use povidone-iodine, alcohol-based or aqueous chlorhexidine solution.
      b. Use both aqueous and alcohol-based chlorhexidine with caution, weighing the benefits versus the risks of chemical burns to the skin. Systemic absorption has been reported due to skin immaturity; however, systemic effects are not documented. Studies have not established one antiseptic solution as superior for safety or efficacy in neonates (see Standard 52, *Catheter-Associated Skin Injury*).[16,20] (III)
      c. Avoid the use of tincture of iodine due to the potential deleterious effect on the neonatal thyroid gland.[17,20,21] (I)
      d. Remove povidone-iodine after the procedure is complete using sterile water or saline; while there is no evidence of sustained toxicity resulting from CHG remaining on the skin, an aqueous formulation may require removal due to its soapy consistency, which may affect dressing adherence.[16,20] (IV)

D. Use a single-use applicator containing an antiseptic solution.[4,8,21] (V)
   1. Follow manufacturers' directions for use to determine appropriate product application and dry times; always allow product to naturally dry completely without wiping, fanning, or blowing on skin.[8,9] (V)
   2. Adhere to Aseptic Non Touch Technique (ANTT®) while performing skin antisepsis. (see *Standard 19, Aseptic Non Touch Technique [ANTT®]*) .[8,9] (V)

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32. VASCULAR ACCESS DEVICE INSERTION

Standard

32.1 A new, sterile vascular access device (VAD) is used for each catheterization attempt, including needle for venipuncture/arterial puncture and introducer.
32.2 The VAD is not altered outside the manufacturers' directions for use.
32.3 Appropriate tip location for central venous access devices (CVADs) is verified prior to use.
32.4 The patient and caregiver are educated about the rationale for VAD insertion and expectations during the procedure.

Practice Recommendations

I. Peripheral Intravenous Catheters (PIVCs): Short PIVCs, Long PIVCs, and Midline Catheters

A. Consider implementation of a local PIVC insertion bundle to improve insertion success and reduce complications. Although no specific bundle has been defined, evidence supports application of local bundle to improve outcomes.[1-3] (I)
B. Consider early referral to an infusion/vascular access specialist if patient assessment yields no visible or palpable veins.[4-10] (IV)
    1. Use population-specific difficult intravenous access (DIVA) assessment tools to guide early referral to an infusion/vascular access specialist. Further research is needed in various clinical settings to ensure generalizability of these tools.[5,7,8,10] (I)
C. Use pain relieving measures to reduce insertion-related pain (refer to Standard 30, *Pain Management for Venipuncture and Vascular Access Procedures*).
D. Use visualization technology to improve peripheral vein assessment, identification, and selection, particularly for patients with DIVA (refer to Standard 21, *Vascular Visualization*).
    1. Consider use of dynamic needle tip positioning to increase first-attempt and overall success rates of ultrasound-guided peripheral venous catheterization in pediatric patients.[11] (III)
E. Choose a long PIVC as follows:
    1. When all aspects of a short PIVC are met, but the vessel is difficult to palpate or visualize with the naked eye, ultrasound guidance is recommended.[12-15] (II)
    2. Evaluate depth of vessel when choosing a long PIVC to ensure sufficient catheter lies within vein. A small observational study in an adult emergency department demonstrated significant reduction in PIVC failure when two-thirds of the PIVC length was within the vein.[12,13] (III)
    3. Long PIVCs should be used in well-monitored clinical environments, as few adequately powered

randomized controlled trials have investigated the safety and generalizability in all clinical settings.[12] (II)

F. Use appropriate aids such as a single patient tourniquet, warming, or blood pressure cuff to promote vascular distention when inserting a PIVC.[16] (IV)
G. Adhere to principles of Aseptic Non Touch Technique (ANTT®) for PIVC insertion (refer to Standard 19*, Aseptic Non Touch Technique [ANTT®]*).
    1. Use Standard-ANTT for simple PIVC insertion.
        a. Use single-patient-use tourniquets.[17,18] (III)
        b. Don a new pair of disposable, nonsterile gloves for PIVC insertion; do not touch/palpate the insertion site after skin antisepsis.
        c. Use sterile gloves if re-palpation of the vein is necessary after skin antisepsis. Contamination of nonsterile gloves is well documented.[3] (II)
    2. Consider Surgical-ANTT for more complex insertion techniques (eg, accelerated/Seldinger).
H. Restrict PIVC insertion attempts to no more than 2 attempts per clinician. Multiple unsuccessful attempts cause pain to the patient, delay treatment, limit future vascular access, increase cost, and increase the risk for complications.[1,4,5,19] (IV)
    1. After 2 unsuccessful attempts, escalate to a clinician with a higher skill level and technological support and/or consider alternative routes of medication administration. (Committee Consensus)
I. Choose a midline catheter of appropriate length to achieve appropriate tip location relative to site of insertion.
    1. Adult: tip location should be at level of axilla.[20,21] (IV)
    2. Neonates and pediatric patients: select an upper arm site using the basilic, cephalic, and brachial veins. Additional site selections include veins in the leg (eg, saphenous, popliteal, femoral) with the tip below the inguinal crease and in the scalp with the tip in the neck above the thorax (refer to Standard 25, *Vascular Access Device Planning and Site Selection*).[22,23] (II)
    3. Measure baseline circumference of the extremity with a midline catheter upon insertion, noting location for future measurements to ensure consistent measurement. Assess circumference when edema or signs and symptoms of deep vein thrombosis (DVT) present, noting the location and characteristics of edema (refer to Standard 50, *Catheter-Associated Thrombosis*).
J. Immediately remove the PIVC in the following situations:
    1. Suspected nerve damage: patient reports severe pain on insertion (ie, electrical shock-like pain) or paresthesia (eg, numbness or tingling) related to the insertion; promptly notify the provider (refer to Standard 45, *Nerve Injury*).
    2. Inadvertent arterial puncture: remove the catheter and apply pressure to the peripheral site until hemostasis is achieved. Assess circulatory status and, if impaired, notify the provider promptly.[24] (V)

II. CVADs

A. Implement the central line bundle when placing CVADs (hand hygiene, skin antisepsis with alcohol-based chlorhexidine, maximal sterile barrier precautions, upper body insertion, if able) (refer to Standard 47, *Infection*).
    1. Use a standardized checklist to ensure adherence to mandatory insertion practices. The checklist should be completed by an educated health care clinician assisting with the CVAD procedure.[25,26] (III)
    2. Use a standardized supply cart or kit that contains all necessary components for the insertion of a CVAD.[26-28] (IV)
B. Use ultrasound when inserting CVADs to improve vessel assessment, insertion success, and reduce insertion-related complications (refer to Standard 21, *Vascular Visualization*).
    1. For tunneled, cuffed CVADs and implanted vascular access port insertion: use an ultrasound-guided modified Seldinger technique (MST) with micropuncture kit for large bore catheters rather than venous cutdown or landmark percutaneous technique to improve insertion success and reduce postinsertion complication rates in both adult and pediatric patients.[29-32] (I)
    2. Consider level of skill of clinician/proceduralist and insertion technique to improve internal jugular catheterization success. Varying degrees of success have been reported when using syringe-free, long-axis in-plane, and dynamic short axis insertion. Studies consistently reported improved outcomes when the needle tip is constantly visualized (see Standard 21, *Vascular Visualization*).[33-36] (I)
C. Consider right-sided peripherally inserted central catheter (PICC) insertion, unless contraindicated during patient assessment to reduce risk of catheter-related complications, such as tip malposition.[37] (III)
    1. Ensure a catheter to vein ratio of less than 45% (refer to Standard 25, *Vascular Access Device Planning and Site Selection*).
    2. Consider the use of a subcutaneous skin tunnel when the vein of choice is at its largest in the upper third of the upper arm near the axilla. This optimizes point of needle entry and subsequent catheter exit site in the middle third of the upper arm.[38-42] (II)
    3. Measure baseline circumference of the extremity with a PICC upon insertion, noting location for future measurements to ensure consistent measurement. Assess circumference when edema or signs and symptoms of DVT present, noting the location and characteristics of edema (refer to Standard 50, *Catheter-Associated Thrombosis*).
D. Implement appropriate actions to manage insertion-related complications:
    1. Inadvertent arterial puncture: remove and apply direct digital pressure until hemostasis is achieved.

a. Inadvertent arterial puncture during insertion of a large-bore CVAD or dilator may be a life-threatening complication. Leave the device in situ and immediately consult with a surgeon or interventional radiologist. Treatment options include open operative approach and repair and, more commonly, endovascular management (refer to Standard 51, *Central Vascular Access Device Malposition*).

2. Cardiac arrhythmias: typically resolve with reposition of guidewire or catheter. If arrhythmias persist, notify the provider.[32,43,44] (V)
3. Pneumothorax: notify provider.[32,43,44] (IV)
4. Potential related symptoms of nerve damage include diaphragmatic paralysis, hoarseness, impaired muscle strength, and dysfunction of sympathetic nervous system (refer to Standard 45, *Nerve Injury*).
5. Air embolism (refer to Standard 49, *Air Embolism*).
6. Catheter malposition (refer to Standard 51, *Central Vascular Access Device Malposition*).

E. Advance catheter tip to cavoatrial junction (CAJ), lower one-third of the superior vena cava (SVC), or superior aspect of right atrium (refer to Standard 22, *Central Vascular Access Device Tip Location*).
   1. For lower body insertion sites, advance the CVAD tip to the inferior vena cava (IVC) above the level of the diaphragm.
   2. Prior to using the CVAD for infusion, the inserter should verify tip position using a recognized tip locating technique, eg, fluoroscopy, electrocardiography, etc. (refer to Standard 22, *Central Vascular Access Device Tip Location*).

F. Evaluate and assess complex CVAD insertion (site and catheter), eg, CVAD insertion in the presence of a cardiovascular implantable electronic device.
   1. Preference is for the contralateral side.[45] (V)
   2. Determine the integrity of a pre-existing cardiovascular implantable electronic device and leads before and after CVAD insertion. There are currently no practice guidelines developed related to pacemakers and CVADs.[45] (V)
   3. Consider options that preserve vessel health in the patient with chronic kidney disease (CKD) who requires insertion of a CVAD and a cardiovascular implantable electronic device. Nontunneled catheters should be avoided, with rapid progression to fistula/graft creation recommended (refer to Standard 27, *Vascular Access and Hemodialysis*).

III. Arterial Catheters

A. Use ultrasound to assess arterial access and insertion site (refer to Standard 21,*Vascular Visualization*).

B. Use dynamic needle tip positioning to increase first-time arterial catheter insertion success.[46,47-49] (I)

C. Wear a cap, mask, sterile gloves, and eyewear, and use a small fenestrated sterile drape when inserting a peripheral arterial catheter (refer to *Standard 19, Aseptic Non Touch Technique [ANTT®]*).

D. Use Surgical-ANTT, including maximal sterile barrier precautions when inserting a pulmonary artery catheter and arterial catheters via the axillary or femoral artery (refer *to Standard 19, Aseptic Non Touch Technique [ANTT®]*).

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Infusion Therapy Standards of Practice 9th Edition

Section Six: Vascular Access Device Management

Section Standards

I. To ensure patient safety, the clinician is competent in vascular access device (VAD) management, including knowledge of relevant anatomy, physiology, and VAD management techniques aimed at maintaining vascular access and reducing the risk of complications.
II. Indications and protocols for VAD management are established in organizational policies, procedures, and/or practice guidelines and according to manufacturers' directions for use.

33. FILTRATION

Standard

33.1 Parenteral nutrition (PN) solutions are filtered using a 1.2-micron filter.
33.2 Blood and blood components are filtered using a filter appropriate for the prescribed component.
33.3 Intraspinal infusion solutions are filtered using a surfactant-free, particulate-retentive, and air-eliminating filter.
33.4 Medications in glass ampoules are withdrawn using a filter needle or filter straw (eg, 5 micron); medications are never administered through a filter needle.

Practice Recommendations

A. Use a filter only when the benefits outweigh the risks and according to the medication or solution and manufacturer's instructions (indications, contraindications, and filter type).[1-3] (III)
   1. While as yet poorly understood, filter risks include sorption of active or solution-stabilizing inactive ingredients onto the filter; leaching or extraction of filter components into the infusate; shedding of filter particles; elevated line pressure, which can mask infiltration or extravasation; shearing of liposomal globules; and increased risk of hypersensitivity reactions.[3-8] (III)
   2. Choose a filter that is compatible with the medication or solution (pore size, filter composition, electrical charge, and filter manufacturer), especially for small doses or medications with a narrow therapeutic index. Infusate filter compatibility data is an area of needed research. In the absence of compatibility information, consult with a pharmacist to determine an appropriate filter.[1,2,9,10] (IV)
   3. For protein-based medications, including biologic therapies, follow the manufacturer's directions for filtration (eg, should, should not, or may be filtered) to prevent immune system reactions or dose trapping.[2,9-11] (IV)

B. Use air-eliminating filters, unless otherwise contraindicated, for all infusions in patients with a medical diagnosis involving right-to-left cardiac or pulmonary shunting to reduce the amount of air and particulate matter that reaches the arterial circulation, also known as *paradoxical embolization*. The presence of microbubbles in the arterial system can also impede endothelial lining-mediated arterial contractility potentially through damage to endothelial lining or decreased perceived shear stress.[12,13] (III)
   1. A relative contraindication to filtration would be a small dose or narrow therapeutic index medication without filter infusate compatibility information.[2,10] (IV)

C. Consider filtration of solutions and medications in high-risk patients to reduce microemboli-mediated inflammation and microcirculation impairment resulting from administration of microbubbles of air (<1000 microns) or particles entrained in infusion solutions and medications. The patient populations most likely to benefit from particle and microbubble reduction have yet to be determined but might include neonates, critically ill patients, or those with tissue injury.[14,15] (II)
   1. Avoid routine, indiscriminate filtration in neonates. Use filtration when indicated by the infusate or by patient-specific risk factors (eg, right-to-left shunting).[16-18] (I)
   2. Consider the routine use of in-line filters outside a definitive indication in pediatric critical care patients for a potential protective effect against lung, renal, or hematologic dysfunction and systemic inflammatory response syndrome (SIRS).[19,20] (III)
   3. Avoid routine, indiscriminate use of filtration in adult critical care patients.[21,22] (III)

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4. Recognize that many factors, including the identity of the medications or solutions, compounding and preparation environment, supplies, and techniques, as well as infusion rates and VAD components, can influence the particle and microbubble sizes and quantities in infusions.[10,23] (IV)
5. Understand that not all particles and bubbles are dangerous. Infused microbubbles can be absorbed by the blood, or coagulation on the bubble's surface can cause platelets and fibrin to encapsulate the bubble. In the absence of right-to-left shunting or venous-arterial shunting, encapsulated bubbles or particles larger than pulmonary capillaries (ie, >5-6 microns in diameter) tend to deposit in the lungs, where particles smaller than 13 microns can be phagocytized. After passage through the lungs, smaller emboli can deposit in other capillaries that range from 4-9 microns in diameter, but predominantly particles 1 micron in diameter are taken in by the liver, and particles between 3 and 6 microns-wide lodge in the spleen or hepatic lymph nodes. Frequent, repeated exposure to exogenous microbubbles, such as those introduced via hemodialysis, can result in pulmonary fibrosis (in patients without right-to-left shunting).[12,15,24] (II)
6. Recognize that filters are effective in removing about 84%-98% of particles larger than their pore size, but that in some instances, as a result of infusate-filter interactions, infusate precipitation, or filter shedding, the particulate count downstream of the filter can actually be higher than prefiltration particle counts.[1,4,10,25] (III)

D. Do not infuse incompatible medications or solutions together with or without the use of a filter. The mixing of physically incompatible solutions or medications that occurs downstream from the filter, even after entering the bloodstream, can result in deadly intravascular precipitation. Upstream precipitation from the drug–drug incompatibility can also clog the filter, leading to interruptions in life-sustaining continuous infusions.[25-27] (IV)

E. Avoid routine use of in-line filters as a thrombophlebitis prevention measure since the patient population most likely to benefit from this intervention has yet to be determined.[15,28,29] (I)

F. In patients with a history of allergy to a particular filter, select an appropriate alternative filter for all subsequent infusions.[7] (V)

G. Prime and position filters adhering to manufacturers' directions for use.
1. Locate the in-line filter on the administration set as close to the VAD hub as possible. Shedding from add-on components (eg, extension sets, stopcocks) below or after the filter can result in additional particulate matter infusing into the patient.[25,30] (V)
2. Secure all air-eliminating filters at the level of the VAD insertion site to prevent negative flow rates or an inadvertent bolus of the infusion. When the air-eliminating filter is located below the insertion site, a back-siphoning of blood into the tubing by force of gravity occurs, along with an inadvertent pause in drug administration. When the filter is positioned above the level of the insertion site, the reservoir of fluid in the air-venting chamber drains by force of gravity into the patient. An inadvertent pause or bolus of a rate-sensitive continuous infusion could be life threatening. To prevent inadvertent rate changes during repositioning, place a clamp between the air-venting filter and the VAD insertion site. Close the downstream clamp temporarily whenever the position of the filter relative to the insertion site is adjusted.[31] (IV)

H. Change add-on filters to coincide with administration set changes without exceeding the filter's approved length of use. Use a primary administration set with an integrated in-line filter whenever possible to reduce tubing manipulation and risks of contamination, misuse, and accidental disconnection/misconnection (refer to Standard 40, *Administration Set Management*).

I. Use a 1.2-micron filter for administration of all parenteral nutrition (PN) solutions with or without lipid injectable emulsions (ILEs) and for ILE infused separately from PN. PN and ILE infused without a filter can cause death by pulmonary embolism (refer to Standard 61, *Parenteral Nutrition*).
1. Change the filter every 24 hours for PN with or without ILE and every 12 hours for separately infused ILE (refer to Standard 61, *Parenteral Nutrition*).

J. 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-μm filter. Sets for other components (eg, platelets) may have similar filter pore size but also have a smaller total priming volume (refer to Standard 62, *Blood Administration*).

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34. NEEDLELESS CONNECTORS

Standard

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

Practice Recommendations

A. Use a needleless connector attached directly and securely to the VAD hub, the female hub of an attached extension set, or an injection site on an administration set to facilitate intermittent infusion of solutions and medications. The primary purpose of needleless connectors is to eliminate the use of needles when connecting administration sets and/or syringes to the VAD or injection sites and reduce subsequent needlestick injuries and exposure to bloodborne pathogens.[1-5] (I)
   1. Avoid using a needleless connector for red blood cell (RBC) transfusion and when rapid flow rates of continuous infusion of crystalloid solutions are required. In vitro testing with all types of needleless connectors demonstrates the greatest reduction in flow rates through large-bore catheters. Negative clinical outcomes (eg, hypothermia or rapid blood loss) might result when therapies with rapid flow rates (eg, above 1000 mL/hour) are required and impeded.[6,7] (V)

B. Needleless connectors are designed to allow bidirectional fluid flow within the device through a variety of

mechanisms (eg, mechanical valve, internal blunt cannula, pressure sensitive antireflux valve) and are categorized by how they function, although there are no established criteria for which devices fall into each group. All needleless connectors allow some fluid movement and blood reflux upon connection, disconnection, or both.[8-12] (IV)

1. Know the internal mechanism for fluid displacement of the needleless connector in use (eg, negative or positive displacement or antireflux). Follow manufacturers' directions for use for flushing, clamping, and disconnection when provided. The category names of needleless connectors are derived from clinical application of their functionality; however, there are no established criteria from device regulatory agencies that determine which device is assigned to each category.[2] (V)
2. In the absence of manufacturer directions, consider the reported reflux volume for each type as recorded in the published studies and use the following sequence[8-12]: (IV)
   a. Negative displacement – flush, clamp, disconnect;
   b. Positive displacement – flush, disconnect, clamp;
   c. Antireflux – no specific sequence recommended but clamping advised, as some displacement is unavoidable.
   d. The term neutral may be used to describe needleless connector function; no specific sequence recommended but clamping advised, as some displacement unavoidable.
3. Fluid reflux is documented by in vitro studies in all types of needleless connectors, with quantities ranging from 0.02 to 50.37 μL. Observational studies demonstrated benefits of antireflux valves in minimizing amount of reflux. Overall, different needleless connectors demonstrated variable risks and performance. Recommendation currently is to use best flushing and clamping sequence to minimize reflux and potential associated occlusive or infection risks.[2,9-16] (III)

C. The type of needleless connector that produces the least amount of thrombotic VAD lumen occlusion remains controversial and requires further study. The quantity and frequency of thrombolytic drugs used for catheter clearance have been used as surrogates for monitoring VAD lumen occlusion and correlated to the type of needleless connector in use.[1,17,18] (IV)

D. Evaluate published outcomes of infection risks associated with each type of needleless connector when making product purchase decisions, focusing on risks, benefits, and educational requirements. Clinical studies comparing different types of needleless connectors demonstrate that all types allow microbial ingress, if not properly and effectively disinfected, and one type is not superior to another if the disinfection step is not performed prior to access. A recent in vitro study identified connector design features associated with the least bacterial transfer and biofilm formation were connectors with a split septum, minimal seal length, internal cannula, low internal surface area and volume, minimal displacement, and simple hydrodynamics of the flow path.[19-26] (II)

E. Disinfect the connection surface and sides of the needleless connector attached to any VAD to reduce introduction of intraluminal microbes. Use active or passive disinfection. Follow manufacturers' directions for use of both the needleless connector and disinfectant agent and/or product. Primary factors influencing this practice include the disinfection agent, the time required (ie, application and drying), and the method of application.

1. Perform active disinfection by a vigorous mechanical scrub using a flat swab pad containing 70% isopropyl alcohol or alcohol-based chlorhexidine suitable for use with medical devices.
   a. Laboratory simulation demonstrated greatest bacterial elimination rates associated with scrubbing in a straight line (compared with rotational scrubbing), using a force equal to that when applying arterial compression, and when the connector is scrubbed twice with a new swab each time.[27] (V)
   b. Recent studies show varied effectiveness of scrub time between 5 and 15 seconds with 70% isopropyl alcohol and alcohol-based chlorhexidine gluconate. One study showed comparable decontamination, and another demonstrated superior decontamination with longer decontamination time.[28,29] (III)
   c. Similarly, varied effectiveness has been reported with different solutions. Some studies showed comparable effectiveness in decontamination between 70% isopropyl alcohol or alcohol-based chlorhexidine and others demonstrated superior decontamination with alcohol-based chlorhexidine. International guidelines recommend either solution as part of good Aseptic Non Touch Technique (ANTT®) practice.[30-32] (II)
2. Adequate needleless connector drying time after disinfection is essential to reduce microbial load and potential for entry into the bloodstream, thus reducing bloodstream infections. Observational research demonstrated drying time with 70% isopropyl alcohol is 5 seconds; alcohol-based chlorhexidine requires 20 seconds. Povidone-iodine requires longer than 6 minutes to be thoroughly dry, making it less favorable to clinical practice. Drying times in clinical practice depend on the humidity and climate in the care setting.[33] (IV)
3. Consider passive disinfection by applying a cap or covering containing a disinfectant agent (eg, 70% isopropyl alcohol, iodinated alcohol, chlorhexidine gluconate) over the needleless connector. A systematic review (of randomized and nonrandomized studies) has demonstrated high level of decontamination

compliance and reductions in central line-associated bloodstream infection (CLABSI) rates and related health care costs associated with avoided harm. When using caps, follow manufacturers' directions for use regarding time for effectiveness after attaching and the maximum length of effectiveness. Once removed, discard used disinfection caps and do not reattach to the needleless connector. Use multidisciplinary implementation strategies, including staff education and leadership support, and provide consistent feedback to staff regarding outcomes, as this has been shown to decrease catheter-associated bloodstream infection (CABSI) rates.[34-37] (II)

4. Studies comparing active and passive methods of disinfection show both processes to be effective.
   a. Active disinfection with alcohol-based chlorhexidine gluconate swab pads or passive disinfection with caps containing 70% isopropyl alcohol were associated with lower rates of CABSI, while swab pads containing 70% isopropyl alcohol were the least effective, according to a meta-analysis of quasi-experimental studies.[30] (II)
   b. Recent research has demonstrated that passive decontamination with 70% isopropyl alcohol–impregnated caps was associated with reduced phlebitis and infection. This may be associated with the improved consistency with decontamination practice and/or prolonged exposure to disinfectant agent.[38-45] (II)
   c. Compared to active disinfection, passive disinfection has been associated with increased clinician compliance largely due to the continuous dwell nature of the device.[46,47] (IV)
      i. However, other studies show no difference between passive decontamination with caps and active decontamination with swabs. More high-quality trial research is required.[48,49] (III)
5. Disinfect the needleless connector before re-entry on contamination or suspicion of contamination of a Key-Part (eg, tip of syringe, needleless connector access) to provide protection for the intraluminal fluid pathway. Studies focus on disinfection practices before the initial entry into the needleless connector; however, studies do not address the need for disinfection before each sequential re-entry to administer one or more intermittent medications (eg, saline flush before and after each medication administration) (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*). (Committee Consensus)
6. Adhere to Standard-ANTT when accessing and changing a needleless connector.[1,3,4,50,51] (I)
   a. Attach only a sterile syringe tip or sterile male luer end of the intravenous (IV) administration set to the needleless connector.
   b. Ensure that disinfecting supplies are readily available at the bedside to facilitate staff compliance with needleless connector disinfection (see Standard 19, *Aseptic Non Touch Technique [ANTT®]*).
7. Consider the use of an antimicrobial needleless connector when there is an increased risk of infection. Use of needleless connectors with an antimicrobial coating (eg, silver, chlorhexidine/silver) does not negate decontamination, as technology alone does not replace disinfection practices. Silver-coated needleless connectors have been shown to decrease rates of CABSI, although significant amounts of biofilm and microorganisms were recovered from coated and noncoated connectors.[52,53] (V)
8. Monitor clinician compliance to ensure that the chosen method for disinfection is applied consistently for needleless connectors on all peripheral VADs and central vascular access devices (CVADs), as this is a critical element for reduction of intraluminal contamination and subsequent bloodstream infection (BSI).[34,35] (V)

F. Use manifolds with a bonded needleless connector or close by adding a needleless connector rather than a solid cap. The method of closure has greater influence on contamination than the type of fluid displacement inside the needleless connector. Replace the stopcock with a needleless connector as soon as clinically indicated (see Standard 35, *Other Add-On Devices*).[54,55] (I)

G. Change the needleless connector in the following circumstances: if the needleless connector is removed for any reason; prior to drawing a sample for blood culture from a CVAD; as per local policies, procedures, and/or practice guidelines; and per manufacturers' directions for use or when clinically indicated (eg, any loss of product integrity such as contamination, dysfunction, or any residual blood or debris within the needleless connector), whichever occurs sooner (see Standard 47, *Vascular Access Device-Related Infection*).[2] (V)
   1. When used within a continuous infusion system, change the needleless connector when the primary administration set is changed (eg, up to every 7 days) (refer to Standard 40, *Administration Set Management*).
   2. One clinical study reported that changing the needleless connector every 24 hours with blood or lipid infusion increased CLABSI rates in pediatric stem cell transplant patients.[3,56] (IV)
   3. A recent in vitro study identified connector design features associated with the least bacterial transfer and biofilm formation, indicating that different designs may drive frequency of device changes.[26] (IV)
   4. Variation in research and context reiterates the need for sound product knowledge and regular device assessment to ascertain optimal function and integrity. (Committee Consensus)

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Note: All electronic references in this section were accessed between December 8, 2022, and August 7, 2023.

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35. OTHER ADD-ON DEVICES

Standard

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

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

Practice Recommendations

A. Use add-on devices of luer-lock or integrated design (eg, single lumen and multilumen extension sets, manifold sets, extension loops, cannula caps, needleless connectors, in-line filters, stopcocks [3-way tap], closed system transfer devices [CSTD], and safety release valves/connectors) to add length, enable filtration capabilities, for safe handling, or to enhance function of the infusion system (eg, adding an extension to decrease movement/manipulation at the peripheral intravenous catheter [PIVC] hub)(see Standard 33, *Filtration*; Standard 34, *Needleless Connectors*.[1,2] (IV)

B. Limit the use of add-on devices whenever possible to decrease excessive manipulations, accidental disconnections or misconnections, and risk of contamination and subsequent infection. Add-on devices may cause challenges with drug delivery and increase costs.[3] (IV)
   1. Use a stopcock or manifold with an integrated needleless connector rather than a solid cap, or replace the solid cap with a needleless connector to maintain a closed system, reduce risk for infection, and ensure adequate priming and flushing prior to and after use.[4-6] (I)

2. Avoid routine use of in-line filters as a thrombophlebitis prevention measure since the patient population most likely to benefit from this intervention has yet to be determined; infusate contaminants are potential etiologic factors for phlebitis; however, results of clinical studies regarding the clinical benefit of filtration are uncertain/controversial, with further studies needed to identify beneficial effects, potential disadvantages, and cost-effectiveness (see Standard 33, *Filtration*).[7-10] (IV)
3. Check instructions for use (IFU) for pump manufacturer concerning the use of in-line devices with extra-long tubing. All add-on devices would potentially contribute to alterations in flow rate; as a result, accuracy of medication delivery may be compromised (refer to Table 1, Medication/Infusion Delivery: Dose Accuracy and Error Prevention, in Standard 57, *Infusion Medication and Solution Administration*).
4. Before accessing the add-on device, disinfect the hub with active or passive disinfection (refer to Standard 34, *Needleless Connectors*).
5. Consider use of emerging devices such as CSTDs and safety release valves/connectors on a case-by-case basis, as research is limited and caveats within recommendations reflect this.[11,12] (V)

C. Change an add-on device with new vascular access device (VAD) insertion, with each administration set if integrated (eg, filter portion of administration set), on removal from the VAD for any reason, as per local policies, procedures, and/or practice guidelines; as per manufacturers' directions for use; or when clinically indicated (eg, any loss of product integrity such as contamination or dysfunction), whichever occurs sooner (see Standard 47*, Vascular Access Device-Related Infection*).[1] (V)
D. Disinfect catheter hub prior to replacement of an add-on device and/or if evidence of blood, residue, or suspected contamination. Check manufacturer IFU about the compatibility of disinfectant agent with add-on device material to minimize material degradation and compromise. (Committee Consensus)

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36. VASCULAR ACCESS DEVICE SECUREMENT

KEY DEFINITIONS

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

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

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

Tissue adhesive (TA): a medical-grade cyanoacrylate glue that can seal the insertion site and temporarily bond the catheter to the skin at the point of insertion and under the catheter hub. Depending on the chemical makeup, TA may be reapplied at each dressing change. Various formulations of TA for wound closure are commercially available, including first generation *N*-Butyl-2-cyanoacrylate (quick drying, rigid/brittle), second generation 2-octyl-cyanoacrylate (longer dry time, more flexible) and *N*-Butyl-2octyl cyanoacrylate formation (increased tensile strength and flexibility) with an additional indication for vascular access securement. Each TA formulation has varied properties and the clinical decision to use should be based on research outcomes relative to the chosen product.

Standard

36.1 VADs are secured to prevent complications associated with VAD dislodgement and VAD motion at the insertion site.
36.2 Methods used to secure the VAD do not interfere with the ability to routinely assess and monitor the access site or impede vascular circulation or delivery of the prescribed therapy.

Practice Recommendations

A. Use a securement method, such as adhesive securement device (ASD), integrated securement device (ISD), subcutaneous anchor securement system (SASS), or tissue adhesive (TA), in addition to the primary dressing, to stabilize and secure VADs. Inadequate securement can cause dislodgement and complications requiring premature removal.
   1. Additional securement as an adjunct to the primary dressing reduces motion at the insertion site and associated complications. Adequate securement can reduce pain, fear, and anxiety and reduces health care costs associated with VAD replacement.[1-11] (I)

B. Choose the most appropriate method for VAD securement based on factors including VAD type, patient age, skin turgor and integrity, anticipated duration of therapy, previous adhesive skin injury, and any type of drainage from the insertion site.[12-14] (III)

C. Avoid the use of sutures, as they are not an effective alternative to a securement method; sutures are associated with needlestick injury, support the growth of biofilm, and increase the risk of catheter-associated bloodstream infection (CABSI).[15,16] (III)

D. Evaluate the effectiveness of a combination of securement measures to reduce complication and failure. More randomized controlled trials (RCTs) with appropriate sample sizes are needed to confirm this bundled approach.[17-20] (III)
   1. Do not use rolls of nonsterile tape; rolls of nonsterile tape can become contaminated with pathogenic bacteria.[21-24] (II)

E. Evaluate the use of securement options, such as TA, in addition to a primary dressing or an ISD for enhanced catheter stabilization for peripheral intravenous catheters (PIVCs), particularly in high-risk patients such as those with difficult intravenous access (DIVA) and prolonged catheter dwell.[3,8,25-27] (II)
   1. There is some evidence that additional securement, either an ISD or TA, for PIVCs reduces complication rates. These small studies are inconclusive, and more large efficacy trials are needed.[2,3,6,8,21,28,29] (II)
   2. Two small studies (one in adults and one in pediatric patients) did not show a reduction in complications or failure of short PIVCs when an ASD was used as an adjunct to the primary dressing.[5,6] (III)
   3. Various formulations of cyanoacrylate TA for securement have been studied in vitro, in vivo, in pilot PIVC and arterial RCTs, and in 2 large superiority PIVC RCTs. Conflicting results have been reported. One large RCT in an adult emergency department, along with a small pediatric pilot RCT and observational studies, demonstrated reduced failure and increased dwell time when TA is applied in addition to a transparent dressing with or without a border. However, a large superiority PIVC securement RCT in adult inpatients demonstrated no reduction in PIVC failure, concluding that larger RCTs are needed to confirm the safety and cost effectiveness of innovative

dressing and securement methods, and clinicians should use inpatient populations most likely to benefit (DIVA and dwell time greater than 48 hours), as well as consider the TA formulation used in these trials when applying the results to their clinical practice.[3,8,25,30] (III)

F. Use a securement method in addition to the primary dressing or an ISD to secure midline catheters.[31,32] (III) (Committee Consensus)

G. Use an ASD, ISD, SASS, or TA for peripherally inserted central catheters (PICCs) as an alternative to sutures; they are safer than sutures and reduce risk of complications, including infection and dislodgement.[4,32-43] (I)
   1. Small pilot and observational studies report improved outcomes when securement methods, including SASS, ISD, and TA, are used compared to ASDs. More powered clinical trials are needed to confirm the safety and efficacy of various securement methods in all patient populations.[4,32-43] (II)

H. Evaluate the potential for clinical and fiscal efficacy of SASS for PICCs and CVADs, including both tunneled cuffed and tunneled noncuffed catheters in adult and pediatric patients.[44- 47] (III)
   1. Studies comparing the use of ASD and SASS as effective and acceptable securement for PICCs; tunneled cuffed and tunneled noncuffed CVADs are limited to one pilot RCT and several small descriptive studies. Single-center observational studies demonstrate SASS to be more effective than traditional sutures and ASD in preventing catheter failure, especially dislodgement in patients with altered skin integrity. Patient and clinician satisfaction with SASS has been favorable; however, more powered clinical trials are needed to confirm clinical safety and efficacy.[44-47] (III)
   2. The National Institute for Clinical Excellence (NICE) in the United Kingdom advocates improved patient safety and cost benefit of SASS, particularly for use greater than 15 days.[48] (IV)

I. Use TA as an adjunct to the primary method of dressing and securement, as it immediately seals the insertion site, prolonging the interval between VAD insertion and the first dressing change.[3,32,49] (III)
   1. In vivo, in vitro, and some small clinical trials demonstrate TA at the catheter insertion site might provide a barrier to microorganism growth on the catheter tip. Confirmatory clinical trials are inconclusive. A pediatric pilot RCT reported a reduction in catheter tip colonization; however, one large, adult RCT reported no reduction in microorganisms cultured on catheter tips, suggesting more larger clinical RCTs are required to confirm these results.[3,49-51] (IV)
   2. Consider cautious use of novel catheter securement, such as TA, in the neonatal population. Few robust, prospective clinical trials have adequately studied the safety and efficacy of this novel securement in early premature neonates and low to extremely low birthweight neonates.[52,53] (V)

J. For nontunneled CVADs inserted into veins of the neck and groin, the most effective method of dressing and securement remains challenging and unclear. Pilot trials undertaken in adult and pediatric patients in critical care units demonstrate that alternatives such as ISDs and TA used in conjunction with sutures might reduce failure and increase dwell time compared to ASDs and traditional sutures alone; however, further trials are necessary.[7,33,54] (III)

K. Consider innovative securement strategies such as TA or keyhole dressing (foam-bordered dressing with clear membrane window) in addition to the primary dressing for peripheral arterial catheters to reduce failure. Both have demonstrated reduced failure compared to keyhole dressing alone or primary dressing alone.[55-57] (III)
   1. More large clinical trials are needed to examine additional innovative securement technologies to improve peripheral arterial catheter securement.

L. Do not use rolled bandages, with or without elastic properties, as a primary method of VAD securement, as they do not adequately secure the VAD.
   1. A single tubular sleeve that can be easily removed to inspect the insertion site is preferred to a rolled bandage if additional site protection is required (see Standard 37, *Site Protection and Joint Stabilization*).[21] (IV)
   2. The presence of skin disorders that contradict the use of medical adhesives (ie, pediatric epidermolysis bullosa, toxic epidermal necrolysis, and burns) may necessitate the use of tubular gauze mesh rather than conventional securement. Single-center observational studies demonstrate SASS might be effective and safe in this patient population; however, these studies are small, and close observation of this vulnerable patient group is recommended (see Standard 52, *Catheter-Associated Skin Injury*).[37,47,48,58] (III)

M. Assess the integrity of VAD securement with each dressing change and change the securement device according to the manufacturers' directions for use. Remove ASDs with each dressing change to allow for appropriate skin antisepsis and apply a new ASD. TA should be reapplied at each dressing change. A securement device designed to remain in place for the life of the VAD (eg, SASS) does not need to be removed and replaced regularly with each dressing change; however, it should be assessed during catheter care and management to ensure its integrity.[39,46,59-61] (I)

N. Be aware of the risk of catheter-associated skin injury.
   1. Assess skin when the securement device is changed; anticipate potential risk for skin injury due to age, joint movement, and presence of edema.[39,46,60,61] (III)
   2. Apply barrier solutions to skin prior to dressing and securement to reduce the risk of catheter-associated

skin injury (refer to Standard 52, *Catheter-Associated Skin Injury*).

O. Never readvance a dislodged VAD into the vein. Secure the VAD at the current location, assess the position of the new tip location, the infusion therapy (peripheral or central), and other influencing factors such as remaining duration of therapy. Reinsertion at a new site or exchange might be the most appropriate intervention if the catheter is no longer in an appropriate position for infusion of the required therapy (refer to Standard 51, *Central Vascular Access Device Malposition*).

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37. SITE PROTECTION AND JOINT STABILIZATION

KEY DEFINITIONS

Site protection. Strategies used in addition to vascular access device (VAD) insertion site securement (may also be called secondary securement), including:

- Interventions/products used to reduce the risk of VAD dislodgement due to the pulling/tugging of the administration set
- Interventions/products (eg, VAD covers, mitts, vests) to protect/disguise the VAD from patient manipulation, such as with pediatric patients, those with cognitive impairment/confusion, and/or other risk factors for VAD misuse
- Strategies to prevent exposure of the VAD site to water or other contaminants.

Joint stabilization. Use of a device to support and stabilize a joint (eg, arm board, splint) when veins or arteries used for VAD insertion are located in an area of flexion.

Physical restraint. A manually applied method that immobilizes or reduces the ability of a patient to move arms, legs, or body.

Standard

37.1 Site protection methods are used to protect VADs or VAD sites from patient manipulation, inadvertent dislodgement, and exposure to contaminants.

37.2 Physical restraints are avoided, except in cases where behavior that hinders medical treatment, such as repeated removal of a VAD; the least restrictive form of restraint should be used.

37.3 Joint stabilization devices, such as arm boards or splints, are used when appropriate to facilitate infusion delivery, maintain device functionality, minimize infusion therapy complications, and are not considered restraints.

Practice Recommendations

A. Recognize that inadvertent VAD dislodgement is a clinically important problem for patients with VADs due to movement and subsequent risk for pulling at the VAD site.[1-5] (II)
   1. Pediatric patients and those with cognitive issues (eg, delirium, dementia) are at increased risk.

B. Consider the use of appropriate site protection products/interventions for patients at increased risk for accidental VAD dislodgement, tampering, or removal; such interventions are in addition to VAD site securement interventions (see Standard 36, *Vascular Access Device Securement*).[6-12] (III)
   1. Small studies have shown efficacy for devices that separate if there is excessive force or devices that reduce tension at the administration set/VAD junction (eg, central line vest).
   2. Mittens ("mitts") may be used as a site protection intervention as an alternative to physical restraints; mitts are not considered a physical restraint if they are applied without any other restraint and when a patient can easily remove the mitt.
   3. A single tubular sleeve that can be easily removed may provide additional site protection in addition to a VAD securement strategy (refer to Standard 36, *Vascular Access Device Securement*).
   4. Use of tamper-evident procedures/products is considered when patients are at risk for VAD misuse, including hospitalized persons who inject drugs (PWID). While studies report that misuse of VADs is low in PWID who receive home infusion therapy, some programs use a tamper-evident procedure/product at the catheter hub as a form of site protection (refer to Standard 66, *Home Infusion Therapy*).

C. Use a site protection product/barrier to protect the VAD site/dressing and infusion connections from water (eg, during bathing/showering).[13] (V)

D. Avoid routine use of physical restraints as a site protection intervention.[1,8,14-19] (IV)
   1. The use of physical restraints (eg, wrist restraints) impacts patient dignity and may increase or aggravate anxiety and agitation. There is a lack of data substantiating the efficacy of restraints in preventing device removal. Restraint use is a common practice, particularly in intensive care units, as an intervention to maintain integrity/prevent the loss of a device (eg, VAD or other invasive devices).
   2. The use of temporary physical restraints may be considered in situations such as central vascular access device (CVAD) insertion to ensure maintenance of patient positioning and adherence to Aseptic Non Touch Technique (ANTT®).
   3. Reduce the need for physical restraints in children during painful procedures (eg, venipuncture) by use of age-appropriate pain management strategies (eg, distraction, analgesia), including hugging rather than "holding down" (refer to Standard 30, *Pain Management for Venipuncture and Vascular Access Procedures*).

E. Improve clinician knowledge about alternatives to physical restraint use; there is a need for nurse-directed education, as nurses are most likely to consider use of restraints, and for high-quality practice guidelines. A decision-making tool for physical restraint use resulted in a reduction in the use of restraints.[8,14,15,17,20] (IV)

F. Recognize and assess for complications related to physical restraint use, including skin trauma, pressure ulcers, muscle atrophy, limb/nerve injury, contractures; the use

of physical restraints may increase anxiety, agitation, and delirium.[17,21] (V)

G. Consider application of a joint stabilization device (eg, armboard, "splint") when the VAD is inserted in an area of flexion to reduce the risk of complications (eg, phlebitis, infiltration).[22,23] (III)
   1. Apply any joint stabilization device in a manner to reduce risk of pressure and skin breakdown, padding the joint stabilization device as needed and supporting the area of flexion (eg, hand, arm, elbow, foot) to maintain a functional position.[24,25] (V)
   2. There are limited data supporting the use of a splint in neonatal patients to improve duration of catheter dwell time. Use of an arm board for pediatric patients with a peripheral arterial catheter was associated with increased risk of catheter failure in a single study, as an unexpected finding; further investigation is required.[26,27] (III)
   3. Do not use wooden tongue depressors as joint stabilization devices in preterm infants or immunocompromised individuals due to the risk of fungal infection.[28] (V)

H. Use the selected site protection, joint stabilization, or physical restraint device in a manner that allows for visual inspection and assessment of the VAD site and that does not interfere with the infusion and vascular pathway. Ensure that it does not exert pressure that will cause circulatory constriction, pressure injuries, or nerve damage, and is in accordance with manufacturers' directions for use (eg, indications, device cleaning).[9,17,21,24] (IV)
   1. Remove device at established intervals to allow assessment of the circulatory status of the extremity and provide an opportunity for supervised range-of-motion activities.
   2. Regularly assess the need for the device and discontinue it as soon as the patient's condition allows.

I. Educate the patient/caregiver on the need for and appropriate use and care of any site/joint/physical immobilization devices (refer to Standard 8, *Patient Education*).

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38. FLUSHING AND LOCKING

Standard

38.1 Vascular access devices (VADs) should be assessed for patency (ie, flushed and aspirated for a blood return) prior to each infusion to assess catheter function and prevent complications.

38.2 VADs are flushed after each medication administration with sufficient volume and appropriate rate to complete the medication administration and to reduce the risk of contact between incompatible medications.

38.3 Each VAD lumen is locked after completion of the final flush and infusion ceased to decrease the risk of intraluminal occlusion and/or to reduce catheter-associated bloodstream infection (CABSI) risk, depending on the solution used.

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

Practice Recommendations

A. Use single-dose systems (eg, single-dose vials and syringes or prefilled labeled syringes) for all VAD flushing and locking.[1,2] (V)
   1. A syringe or needle should be considered contaminated once it has been used to enter or connect to a patient's intravenous (IV) solution container or administration set.[1] (V)
   2. Use commercially manufactured prefilled flush syringes (when available) to reduce the risk of catheter-associated bloodstream infection (CABSI) and device failure, save time for syringe preparation, and aid optimal flushing technique and objectives.[3-8] (II)
   3. Do not use IV solution containers (eg, bags or bottles) as a source for obtaining flush solutions (see Standard 56, *Compounding and Preparation of Parenteral Solutions and Medications*).[2,9] (IV)
   4. Use new, unopened, single-use, commercially available prefilled syringes for flushing before and after medications. Using the same prefilled syringe to flush a VAD before and after the medications can potentially contaminate the prefilled syringe tip and thereby transfer the contamination to the VAD.[2,9,10] (IV)
   5. If a patient reports disturbance in taste and odor/smell, inform them that prefilled flush syringes are occasionally associated with this and that it has been found to be more prominent when flushing central venous access devices (CVADs) than with peripheral intravenous catheters (PIVCs). The cause is thought to be substances leaching from the plastic syringe due to sterilization methods. These sensations may be significant enough to impact appetite and may increase nausea, especially if administered rapidly. This sensation can be minimized with a slower injection rate. Reassure patient that sensation will subside when injection/flush has ceased.[11] (III)

B. Disinfect 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.[12] (V)
   1. Use a minimum volume equal to twice the internal volume of the catheter system (eg, catheter plus add-on devices). Larger volumes (eg, 5 mL for PIVC, 10 mL for CVADs) may remove more fibrin deposits, drug precipitate, and other debris from the lumen. Factors to consider when choosing the flush volume include the type and size of catheter, age and weight of the patient, and type of infusion therapy being given. Blood sampling or infusion of blood components, parenteral nutrition (PN), contrast media, and other viscous solutions may require larger flush volumes.[13-16] (V)
   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.[12] (V)
   3. Use only preservative-free solutions for flushing all VADs in neonates and infants to prevent toxicity.[12] (V)
   4. Use 5% dextrose in water followed by preservative-free 0.9% sodium chloride when the medication is incompatible with sodium chloride. Do not allow dextrose to reside in the catheter lumen, as it provides nutrients for biofilm growth.[2,9] (IV)
   5. Never use sterile water for flushing VADs.[17] (V)

D. Assess VAD function using a 10-mL syringe or a syringe specifically designed to generate lower injection pressure (ie, 10-mL diameter syringe barrel), taking note of any resistance.[13,15,16] (V)
   1. Use a single-use prefilled 0.9% sodium chloride syringe to slowly aspirate the VAD for free-flowing blood return that is the color and consistency of whole blood, an important component of assessing catheter function during the initial flush and prior to administration of medications and solutions (see Standard 46, *Vascular Access Device Occlusion*;

Standard 51*, Central Vascular Access Device Malposition*).[9,10] (IV)

a. When blood return is sluggish/absent or assessment of blood return is contraindicated due to the patient's condition (eg, hemodynamic instability dependent on vasopressor delivery), VAD patency should be evaluated through alternative signs, including ongoing clinical response to an infusing medication, lack of resistance to flushing, site evaluation, and patient symptom report. This assessment can assist in determining patency.
    i. For a peripheral VAD (eg, short/long PIVC, midline) that no longer has a positive blood return, increase the frequency of assessment of the insertion site and the venous pathway of the VAD to minimize the risk and severity of complications, such as infiltration, extravasation, and occlusion. If using the PIVC for vesicant administration, plan to transition the infusion to a new VAD when clinically possible. Peripheral administration of certain antineoplastic vesicants is contraindicated in the absence of blood return (refer to Standard 58, *Antineoplastic Therapy*).
    ii. In situations with increased line/luminal volume and high-risk medications (eg, vasopressors, inotropes), aspirating for blood return might be contraindicated in patients where interruptions of the infusion or inadvertent bolus could cause a clinically relevant decline in the patient's condition. In these patients, blood return could be evaluated when the infusion is paused for other reasons (eg, bag change, blood draw, tubing change). Increase the frequency of assessment of the insertion site and clinical response to the medications. Promptly evaluate and treat CVAD occlusion (refer to Standard 44, *Infiltration and Extravasation;* Standard 46, *Vascular Access Device Occlusion*; Standard 65, *Vasopressor Administration*). (Committee Consensus)

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, conducting a thorough patient and site assessment) 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 50, *Catheter-Associated Thrombosis*; Standard 51, *Central Vascular Access Device Malposition*).[13,14,18] (V)
3. After confirming catheter patency, use an appropriately sized syringe for medication dose. Do not transfer the medication to a larger syringe (see Standard 56, *Compounding and Preparation of Parenteral Solutions and Medications*).[2] (V)
4. Do not use prefilled flush syringes for dilution of medications. Differences in gradation markings, an unchangeable label on prefilled syringes, partial loss of the drug dose, and possible contamination increase the risk of serious medication errors with syringe-to-syringe drug transfer (see Standard 56, *Compounding and Preparation of Parenteral Solutions and Medications*).[2] (V)

E. Flush the VAD lumen with preservative-free 0.9% sodium chloride following the administration of an IV push medication at the same rate of injection as the medication. Use an amount of flush solution to adequately clear the medication from the lumen of the administration set and VAD.[2,9,13,15,16] (V)

F. Use positive-pressure techniques to minimize blood reflux into the VAD lumen.[13,15,16,18,19] (I)
1. Prevent syringe-induced blood reflux by leaving a small amount (eg, 0.5 mL to 1.0 mL) of flush solution in a traditional syringe (ie, one without a positive pressure plunger) to avoid compression of the plunger rod gasket and prevent this type of reflux.[13,15,16,18,19] (V)
2. Prevent connection/disconnection reflux by using the appropriate sequence for flushing, clamping, and disconnecting determined by the type of needleless connector being used (refer to Standard 34, *Needleless Connectors*).
3. Use a gentle pulsatile flushing technique to deliver flush into the catheter.
    a. In vitro studies have shown that intermittent, pulsatile (eg, 10 short boluses of 1-mL solution interrupted by brief pauses) may be more effective at removing solid deposits (eg, fibrin, drug precipitate, intraluminal bacteria) compared to continuous low-flow techniques.[20,21] (IV)
    b. The Centers for Disease Control and Prevention (CDC) recommends flushing CVADs vigorously using pulsating technique.[22] (V)
    c. Other computational, in vitro, and animal studies have demonstrated that the vessel endothelium is vulnerable to damage with repeated, high-pressure injection, and blood components are vulnerable to clotting through stasis at the catheter tip.[18,23-25] (IV)
    d. A further laboratory study and small clinical trial demonstrated no significant differences in device clearance or occlusion rates between continuous or pulsatile flush techniques, suggesting that either method is acceptable.[26,27] (III)
    e. Larger clinical trials are needed to provide more clarity on the most appropriate flush technique

contextualized to the population and situation. Consequently, the current recommendation is to use a gentle, pulsatile flush technique to balance the need to maintain catheter patency, reduce the risk of mixing incompatible medications/fluids, and optimize vessel health and preservation. (Committee Consensus)

4. Consider flushing all lumens of a multilumen catheter after obtaining blood samples to reduce the possibility of changing intraluminal pressure causing blood reflux into the other lumens. (Committee Consensus)
5. Follow manufacturers' directions for use regarding clamping the VAD when not in use. Clamping can prevent contamination and exsanguination in the event of inadvertent disconnection of any set or add-on device, per manufacturer instructions for use (IFU) (refer to Standard 34, *Needleless Connectors*).

G. Lock short and long PIVCs and midline catheters immediately following each use.
   1. In adults, use preservative-free 0.9% sodium chloride for locking.[28,29] (II)
   2. In neonates and pediatric patients, use preservative-free 0.9% sodium chloride or heparin 0.5 to 10 units/mL. Outcome data in these patient populations are inconclusive.[19] (II)
      a. In one prospective trial, intermittent flushing with 0.9% sodium chloride was associated with a lower rate of complication and similar duration of patency when compared to continuous infusion in PIVCs placed in newborns.[30] (IV)
   3. For PIVCs and midline catheters not being used for intermittent infusion or medication administration, remove as soon as no longer required; but if they must be maintained, assess, flush, and relock at least once every 24 hours using a volume reflective of the device and any add-on devices, as per minimum flush calculation stated prior and with a 10-mL syringe or syringe with same barrel size as a 10-mL syringe (see Standard 42, *Vascular Access Device Removal*).[14,31] (III)

H. Lock CVADs with either preservative-free 0.9% sodium chloride or heparin according to the provider order for the VAD and needleless connector.[13,15,18,32,33] (I)
   1. In adults, randomized controlled trials (RCTs) and systematic reviews have shown equivalent outcomes with heparin and sodium chloride lock solutions for multilumen, nontunneled CVADs, peripherally inserted central catheters (PICCs), and implanted vascular access ports while accessed and when the access needle is removed.[15,16,18,32,34] (I)
   2. Use heparin or preservative-free 0.9% sodium chloride for locking CVADs in children. There is insufficient evidence regarding the best antithrombotic lock solution in CVADs in children.[35] (II)
   3. The volume of the lock solution should equal the internal volume of the VAD and add-on devices plus 20% (10% in infants/neonates). 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. Careful monitoring of patient and device response is required.[13] (V)
   4. There is insufficient evidence to recommend the optimal frequency, solution, volume, or technique to maintain the patency of implanted vascular access ports not accessed for infusion.[36] (II)
      a. Use at least 10 mL of 0.9% sodium chloride (adult).
      b. Use of 0.9% sodium chloride alone may be as effective as heparin in maintaining patency (see Standard 26, Implanted Vascular Access Ports).[37] (III)
      c. Extending maintenance flushing to every 3 months with 10 mL of 0.9% sodium chloride and 3 or 5 mL of heparin (100 units/mL) was found to be safe and effective in maintaining patency.[38] (II)
      d. Flush implanted vascular access ports daily when accessed but are without regular medication or a continuous infusion in progress (see Standard 26, *Implanted Vascular Access Ports*).[36,39-41] (V)
      e. In vitro studies demonstrated that flushing with 10-20 mL of 0.9% sodium chloride solution and sequencing parenteral nutrition administration post-intravenous lipid emulsion (ILE) may reduce ILE build up and prolong device dwell time (see Standard 61, *Parenteral Nutrition*).[42] (V)

I. Because of potential conflicts with religious beliefs, inform patients when using heparin derived from animal products (eg, porcine, bovine) and obtain assent. Use preservative-free 0.9% sodium chloride instead of heparin when possible in this patient population.[43] (V)

J. When locking hemodialysis CVADs with citrate or heparin lock solution, low-concentration citrate (<5%) is recommended to reduce the risk of central line-associated blood stream infections (CLABSI) and CVAD dysfunction. Tissue plasminogen activator (tPA) may be used prophylactically once per week to reduce CVAD occlusion. The choice of locking solution is based upon clinician discretion due to inadequate evidence to demonstrate a difference between solutions (refer to Standard 27, *Vascular Access and Hemodialysis*).

K. General recommendations for maintaining patency in CVADs used for apheresis include high-concentration heparin and sodium citrate.
   1. Use heparin and citrate cautiously in some patient populations and monitor patient tolerance closely, as heparin-induced thrombocytopenia (HIT) was identified as a risk in patients with multiple myeloma who required stem cell harvesting for auto transplantation. An unusually high frequency of HIT was

identified (4%) (refer to Standard 29, *Vascular Access and Therapeutic Apheresis*).

L. Use solution containing heparin (eg, 1 unit/mL of heparin) or preservative-free 0.9% sodium chloride as a continuous infusion to maintain patency of arterial catheters used for hemodynamic monitoring. The decision to use preservative-free 0.9% sodium chloride instead of heparin infusion should be based on the clinical risk of catheter occlusion, the anticipated length of time the arterial catheter will be required, and patient factors such as heparin sensitivities.[44] (III)

M. Apply the following recommendations for neonates and pediatric patients:
   1. Use a continuous infusion of heparin 0.5 units/kg for all CVADs in neonates. There is insufficient evidence to support use of intermittent heparin vs 0.9% sodium chloride in long-term CVADs in infants and children.[19,45] (II)
   2. Maintain patency and reduce risk of thrombosis by continuous infusion of heparin 0.25 to 1 unit/mL (total dose of heparin: 25-200 units/kg/d) for umbilical arterial catheters in neonates (refer to Standard 28, *Umbilical Catheters*).

N. Change to an alternative locking solution when the heparin lock solution is thought to be the cause of adverse drug reactions from heparin; when heparin-induced thrombocytopenia and thrombosis (HITT) develops; and when there are spurious laboratory studies drawn from the CVAD that has been locked with heparin. High concentrations of heparin used in hemodialysis catheters could lead to systemic anticoagulation. HIT has been reported with the use of heparin lock solutions, although the prevalence is unknown.[13,15] (IV)

O. Use antimicrobial locking solutions for therapeutic and prophylactic purposes in patients with long-term CVADs in the following circumstances: patients with a history of multiple CABSIs, high-risk patient populations, and in facilities with unacceptably high rates of CLABSI, despite implementation of other methods of infection prevention (see Standard 61, *Parenteral Nutrition*).[15,39,46-53] (II)
   1. There is insufficient evidence to indicate the optimal locking solution for long-term CVADs. Factors associated with increased risk of complication (eg, occlusion, infection, altered catheter integrity) in outpatients with CVADs include devices with more than 1 lumen, female gender, and administration of PN.[15,51] (III)
      a. Antibiotic lock solutions contain supratherapeutic concentrations of antibiotics and may be combined with heparin; however, heparin may stimulate *Staphylococcus aureus* biofilm formation. Anticipate the chosen antibiotic to be based on the specific infecting organism or on prevalent organisms within the organization when prophylaxis is the indication. For therapeutic use, start the antibiotic lock solutions within 48 to 72 hours of diagnosis; however, the optimal duration of use is not established.[15,39,46-48,52] (II)
      b. Antiseptic locking solutions include solutions used alone or in numerous combinations, including, but not limited to, ethanol, sodium bicarbonate, taurolidine, citrate, concentrated sodium chloride, and ethylenediaminetetraacetic acid (EDTA).[15,49-51,53-56] (II)
   2. Consult with pharmacy to assure that combination lock solutions are physically compatible, chemically stable, and produce the desired antimicrobial effect. (Committee Consensus)
   3. Consider and evaluate compatibility of the catheter material with the lock solution.
      a. While ethanol lock solution has been proven to be effective in eliminating bacterial growth within biofilm, it has also been associated with negative outcomes: altered catheter integrity, systemic symptoms, and plasma precipitation with potential for catheter occlusion. The impact on catheter integrity is related to the concentration of ethanol lock solution used and the duration of exposure to the catheter inner lumen.[15] (II)
   4. Monitor patients treated with 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%.[15,46,49-51] (III)
      a. Monitor trisodium citrate for protein precipitation, which could cause lumen occlusion.[15] (V)
   5. The length of time that antimicrobial lock solutions should reside inside the CVAD lumen is inconclusive; up to 12 hours per day may be required, thus limiting use in patients receiving continuous or frequent intermittent infusions.[15,57] (IV)
   6. Aspirate all antimicrobial locking solutions from the CVAD lumen at the end of the locking period. Do not flush the lock solution into the patient's bloodstream, as this could increase development of antibiotic resistance and other adverse effects. Gentamicin-resistant bacteria from gentamicin lock solution have been reported to increase CABSI rates.[15,49] (V)

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39. VASCULAR ACCESS DEVICE POST-INSERTION CARE

Standard

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

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

39.3 Site care, including skin antisepsis and dressing changes, is performed at established intervals and immediately if the dressing integrity becomes compromised.

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

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

Practice Recommendations

A. Implement a post-insertion care bundle in conjunction with a culture of safety and quality during care and management to reduce the risk of catheter-related infection (refer to Standard 47, *Vascular Access Device-Related Infection*).
B. Assess and discuss daily with the patient's health care team the continuing need for the VAD (refer to Standard 42, *Vascular Access Device Removal*).
C. Assess the entire infusion system through visual inspection, from the solution container, progressing down the administration set to the patient and VAD insertion site with each infusion intervention.[1-7] (IV)
    1. Assess VAD patency (refer to Standard 38, *Flushing and Locking*).
    2. Assess the VAD site and surrounding area by palpation and inspection, including catheter pathway, for integrity of skin, dressing, and securement device. Identify signs of complications (eg, evidence of malposition, redness, tenderness, swelling, infiltration, induration, body temperature elevation, and drainage) by visual inspection and palpation through the dressing and through patient reports about any discomfort (eg, pain, paresthesia, numbness, or tingling) (refer to Section Seven: Vascular Access Device Complications).
        a. Remove nontransparent dressing to visually inspect site if patient has local tenderness or other signs of possible local infection; otherwise, use palpation for assessment.
        b. Measure the external vascular access device (VAD) length at each dressing change and when catheter malposition is suspected and compare to the external length documented at time of insertion (refer to Standard 10, *Documentation in the Health Record*; Standard 51, *Central Vascular Access Device Malposition*).
        c. Measure circumference of the extremity and compare to baseline measurement when clinically indicated to assess the presence of edema and possible catheter-associated deep vein thrombosis (CA-DVT) for midline catheters and peripherally inserted central catheters (PICCs) (refer to Standard 10, *Documentation in the Health Record*; Standard 50, *Catheter-Associated Thrombosis*).
D. Assess VAD site, entire infusion system, and patient for signs of complications at a frequency dependent on patient factors, such as age, condition, and cognition; type/frequency of infusate; and health care setting.[2,3,8-11] (V)
    1. In inpatient and nursing facilities, assess central vascular access devices (CVADs) with each infusion and at least daily.
    2. In inpatient and nursing facilities, assess peripheral intravenous catheters (PIVCs) at least every 4 hours; every 1 to 2 hours for patients who are critically ill/sedated or have cognitive deficits; hourly for neonatal/pediatric patients; and more often for patients receiving infusions of vesicant medications (refer to Standard 43 *Phlebitis*; Standard 44, *Infiltration and Extravasation*).
    3. In outpatient or home care settings, assess VAD at every visit, and teach the patient or caregiver to check the VAD site with each infusion or at least once per day or, for continuous PIVC infusions, every 4 hours during waking hours for signs of complications and to report signs/symptoms or altered dressing integrity immediately to their home care or other health care provider (refer to Standard 66, *Home Infusion Therapy*).
E. Assess the integrity of securement devices designed to remain in place for the life of the VAD (eg, subcutaneous anchor securement systems [SASS]) with each dressing change (refer to Standard 36, *Vascular Access Device Securement*).
F. Change transparent semipermeable membrane (TSM) dressings at least every 7 days (except neonatal patients) or immediately if dressing integrity is disrupted (eg, lifted/detached on any border edge or within transparent portion of dressing; visibly soiled; presence of moisture, drainage, or blood) or evidence of compromised skin integrity under the dressing, and following manufacturer's instruction for use.[2,5,8,9,12-14] (III)
    1. In neonatal patients, perform dressing change as needed per patient or clinical indications (eg, soiled, damp, or loose, regardless of gestational age and not according to a specific time interval) due to risk of catheter dislodgement, patient discomfort, or skin injury (see Standard 52, *Catheter-Associated Skin Injury*).[4,13,15-17] (V)
    2. Change sterile gauze dressings every 2 days or earlier if dressing integrity is disrupted (eg, if damp, loose, or visibly soiled); note that a gauze dressing underneath a TSM dressing is considered a gauze dressing, unless the site is not obscured (eg, to support wings of an implanted VAD noncoring needle).[7,9,14] (III)
G. Perform dressing changes on VADs using either Standard-ANTT or Surgical-ANTT (based on ANTT risk assessment of ability to prevent touching Key-Sites and Key-Parts) (see Standard 19, *Aseptic Non Touch Technique [ANTT®]*).[7,8] (V)
H. Use a dressing change kit to standardize the procedure and improve efficiency.[1,18] (V)
I. Prepare skin for optimal skin health and dressing adherence.
    1. Remove dressing and adhesive-based securement device, maintaining skin integrity and preventing VAD dislodgement (eg, avoiding rapid and/or vertical pulling or insufficient support of skin when removing the dressing). Use sterile gloves if there is a need to touch the insertion site, as this is a Key-Site in accordance with ANTT.[3,19,20] (IV)

2. Remove excess hair at the insertion site if needed to facilitate application of VAD dressings; use single-patient-use scissors or disposable-head surgical clippers; do not shave, as this may increase the risk for infection (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).
3. Perform skin antisepsis at VAD site, ensuring all solutions are allowed to dry per manufacturer's instructions (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).
4. Assess and protect skin integrity at VAD site with each dressing change (see Standard 52, *Catheter-Associated Skin Injury*).[3] (V)
5. Do not apply antimicrobial ointment to VAD insertion sites as part of routine catheter site care, with the exception of hemodialysis catheters (see Standard 27, *Vascular Access and Hemodialysis*).[14] (I)
6. Adding tissue adhesive to the insertion site at the time of insertion may be associated with decreased dressing changes and increased survivability for peripheral as well as central lines secondary to the hemostatic effect of the product (see Standard 36, *Vascular Access Device Securement*).[21-25] (II)
7. Consider the beneficial use of gum mastic liquid adhesive on adult patients when enhanced adhesive dressing adherence is needed (eg, diaphoresis); consider use of skin barrier film prior to application. Use correct technique in dressing removal to prevent catheter-associated skin injury due to increased bonding of adhesives to skin (see Standard 52, *Catheter-Associated Skin Injury*).[24,26-28] (III)
8. Select the type of sterile dressing (TSM or gauze) considering factors such as the type of VAD, risk of bleeding or infection, skin condition, known allergies or sensitivities, patient size, patient preference, cost, sterility, wear time, and ease of use of dressing, with the goal of selecting and applying a dressing that will have minimal dressing disruptions, as multiple dressing changes increase the risk of infection.[24,29-48] (I)
    a. Limited evidence suggests that a TSM dressing is associated with longer dwell times and fewer catheter failures due to dislodgement or accidental removal.[32,49] (I)
    b. Use sterile gauze or sterile absorbent dressing for drainage from the catheter exit site (unless hemostatic agent used to absorb serosanguinous drainage) or if patient is diaphoretic.[9,37,50-52] (IV)
        i. Consider frequency of dressing change and risk for infection when selecting a dressing to achieve hemostasis. Follow manufacturer's instructions for use with hemostatic agents.[5] (IV)
    c. Use chlorhexidine gluconate (CHG)-containing dressings unless contraindicated (eg, sensitivity or allergy to CHG) to prevent central line-associated bloodstream infections (CLABSI) in patients greater than 2 months of age with short-term CVADS (refer to population specific recommendations in Standard 47, *Vascular Access Device-Related Infection*).
    d. Consider an alternative dressing if catheter-associated skin injury is present and not resolved with use of a transparent or gauze dressing (refer to Standard 52, *Catheter-Associated Skin Injury*).
    e. For tunneled, cuffed CVADs, a dressing may no longer be required when the subcutaneous tunnel is healed. Time to heal is patient specific, although one study cited 3 weeks.[9,48,53] (V)
J. Use a securement method to stabilize and secure VADs, considering a bundled approach (refer to Standard 36, *Vascular Access Device Securement*).
K. Consider the need for an additional site protection strategy to reduce the risk of VAD dislodgement or joint stabilization when the VAD is in an area of flexion (refer to Standard 37*, Site Protection and Joint Stabilization*).
L. Label the dressing with the date performed or date to be changed, avoiding placement of the label over the insertion/exit site.[1,54] (V)
M. Use chlorhexidine bathing to minimize the risk of CLABSIs in hospitalized patients. Consult manufacturer's instructions regarding potential risk of dressing integrity with VAD dressing exposure to bathing products (refer to Standard 47, *Vascular Access Device-Related Infection*).
N. Do not use rolled bandages, with or without elastic properties, as a primary method of VAD securement or site protection, as they do not adequately secure the VAD (refer to Standard 36, *Vascular Access Device Securement*).
    1. Use a single tubular sleeve that can be easily removed to inspect the insertion site rather than a rolled bandage (refer to Standard 36, *Vascular Access Device Securement*).
    2. The presence of skin disorders that contradict the use of medical adhesives (eg, pediatric epidermolysis bullosa, toxic epidermal necrolysis, and burns) may necessitate the use of tubular gauze mesh rather than adhesive securement devices (ASDs). Single-center observational studies demonstrate that the use of SASSs might be effective and safe in this patient population; however, these studies are small, and close observation of this vulnerable patient group is recommended (refer to Standard 36, *Vascular Access Device Securement*; Standard 52, *Catheter-Associated Skin Injury*).
    3. If using medical tape for additional securement of add-on devices or portions of catheter beyond the dressing, select the type of tape based on the intended use and patient's skin condition; use a roll of sterile tape dedicated to a single-patient use.[54-57] (IV)
O. Keep sharp objects away from the VAD; never use scissors, hemostats, or pins on or near the catheter.[1] (V)

P. Protect VAD when patient is showering or bathing by covering the entire catheter dressing site with a clear plastic wrap or device designed for this purpose. Cover the connections and protect hub connections from water contamination (see Standard 37, *Site Protection and Joint Stabilization*).[1] (V)

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

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40. ADMINISTRATION SET MANAGEMENT

KEY DEFINITIONS

Sorption. A complex process including both adsorption and absorption that varies greatly with components within the infusion container, the administration set, type of infusate, the flow rate of infusates, and the contact duration and conditions during storage, preparation, and administration.

- **Absorption.** Drug penetration inside of the infusion system.
- **Adsorption.** Interaction of the drug with the surface of the infusion container and/or administration set; results in patient receiving a smaller amount of the drug.

Leaching: Process of a solute becoming detached or extracted from its carrier substance.
Shedding: Particle release (solids) from an infusate container, administration set, or filter.
Intermittent administration set: A primary or secondary administration set that has been disconnected from the initial access point (eg, needleless connector, vascular access device [VAD] hub) and left disconnected due to completion or a pause in an infusion. It must be disconnected aseptically, with the distal tip protected by a new sterile end cap.
Continuous administration set: A primary or secondary administration set that remains connected to the vascular access device (VAD) for the duration of an infusion or until the scheduled administration set change occurs. This set may be disconnected from the VAD for a brief period (eg, blood sampling, transition to a new VAD lumen) and reconnected to the VAD with adherence to ANTT and needleless connector cleansing.
Continuous infusion: A controlled method of intravenous administration given over at least several hours or longer without interruption.
Intermittent infusion: A small volume given by manual push or short infusion (eg, 30 or 60 minutes); an infusion technique that would easily allow for patency assessment before, during, and after the medication infuses.

Standard

40.1 Administration set use and replacement is performed with adherence to Aseptic Non Touch Technique (ANTT®) at a frequency based upon factors such as patient condition, solution administered (type, rate, and frequency), immediately upon suspected contamination, and when the integrity of the product or system has been compromised.
40.2 Administration sets are designed with anti–free-flow mechanisms to protect against inadvertent bolus and are of a luer-lock design to ensure a secure connection, reduce manipulation, and minimize the risk of leaks, disconnections, or misconnections.
40.3 Administration sets are single-patient use only.
NOTE: This Standard addresses administration set selection, preparation, and replacement. Also see Table 1: Medication/Infusion Delivery: Dose Accuracy and Error Prevention in Standard, 57, *Infusion Medication and Solution Administration.*

Practice Recommendations

I. General

A. Standardize flow-control devices, related administration sets, and drug concentrations, when possible, to reduce potential for errors.[1] (V)
B. Educate clinicians on factors that impact accurate dose delivery to reduce errors in administration: proper use of flow-control devices and their respective administration sets, flow rate variability, residual or dead space volume, compliance and function of administration sets, and proper use of add-on devices (see Table 1: Medication/Infusion Delivery: Dose Accuracy and Error Prevention in Standard 57, *Infusion Medication and Solution Administration;* Standard 35*, Other Add-On Devices*).[1-8] (IV)
C. Use administration sets with integrated add-on devices (eg, filters) to minimize the number of connections, thus reducing the risk of contamination, misuse, and accidental disconnection (see Standard 35, *Other Add-On Devices*).[9,10] (IV)
D. Use an administration set without any injection ports with external epidural/intrathecal infusions to reduce the risk of inadvertent epidural/intrathecal access (refer to Standard 53, *Epidural and Intrathecal Access Devices*).
E. Use administration sets with composite material recommended for drugs at risk of tubing sorption, which may affect accuracy of drug delivery and desired therapeutic effect (eg, nitroglycerin, diazepam, insulin, propofol, therapeutic proteins, granulocyte colony stimulating factor, certain antibiotics, amiodarone). Monitor clinical response to medication.[5,11-18] (IV)
    1. Sorption may be reduced with concomitant fluid delivery and/or flush after medication delivery.
    2. Further study is needed to quantify sorption risk for specific medications and to develop administration sets that limit the risk of dose reduction.
F. Consider the risks of leaching or shedding products from the infusate container or administration set into the infusate solution before or during administration. Factors that may increase the risk of leaching or shedding include type of infusate; compressive and shear

forces exerted on the administration set with clamping and with infusion device functions; contact duration; storage condition (eg, temperature); agitation during transport (eg, pneumatic tube system). These contaminants can be administered to the patient as subvisible particles within the infusate, with the potential to produce an inflammatory response. Further study is needed to reduce the risk of administration of leachable components.[19-25] (IV)

1. Avoid the use of polyvinyl chloride (PVC) (containing di(2-ethylhexyl)phthalate [DEHP]) infusion bags for therapeutic protein dilution and administration due to risk of DEHP droplet formation that may bind to proteins within the bag or administration set.[22] (IV)
2. Filters prevent a large percentage of subvisible particles from reaching the patient; however, filters can also cause sorption of medication and shedding of particles (See Standard 33, *Filtration*).[17,21] (IV)

G. Label all the administration sets (see Table 1: Medication/Infusion Delivery: Dose Accuracy and Error Prevention in Standard, 57, *Infusion Medication and Solution Administration*):[1,8,26] (V)

1. Indicate the date of placement on the administration set according to organizational policies, procedures, and/or practice guidelines.
2. When there are different access sites (ie, peripheral, central, epidural, intraosseous [IO], subcutaneous) or multiple fluid containers connected to a vascular access device (VAD), label the tubing with the route and/or medication/solution near the connection to the solution container and near the patient's access site.

H. Organize the infusion administration system to minimize errors related to multiple infusions and variations in infusion delivery methods. Trace all catheters/administration sets/add-on devices between the patient and solution container to the VAD before connecting or reconnecting any infusion/device, at each care transition to a new setting or service, and as part of the handoff process.[1,8,26] (V)

II. Primary and Secondary Continuous Infusions

A. Replace primary and secondary continuous administration sets used to administer solutions other than lipid, parenteral nutrition, blood, or blood products at least every 7 days (unless otherwise stated in manufacturers' directions for use) or when clinically indicated (eg, any loss of product integrity such as contamination or dysfunction), whichever occurs sooner.[27-29] (III)

1. Additional high-quality study is needed to provide clear evidence to inform optimal replacement of administration sets, including the impact of flexural and compressive stress on administration sets with extended use.[25,27,30] (IV)
2. A single-center study found no bacterial growth in intravenous (IV) solution from prespiked bags that were prepared in advance of surgical procedures. With appropriate monitoring and application of ANTT, priming IV solutions and administration sets within 4 hours of a procedure was not associated with bacterial growth.[31] (IV)

B. Plan to change the primary administration set to coincide with the VAD change (eg, transition from a peripheral intravenous catheter [PIVC] to a newly inserted central vascular access device [CVAD]) and/or initiation of a new solution container, with consideration of the impact on the patient's clinical condition.[29] (IV)

C. Secondary administration set (see Table 1: Medication/Infusion Delivery: Dose Accuracy and Error Prevention in Standard, 57, *Infusion Medication and Solution Administration*).

1. Use a primary continuous administration set that contains a back-check valve or use a dedicated pump set with integrated mechanisms to prevent retrograde flow of the secondary medication into the primary solution container.[10,32] (IV)
2. Develop a standardized method and ensure staff competency in administration for intermittent medication delivery. Significant variation exists in practice, resulting in increased potential for dosing errors.[1,33] (IV)
3. Avoid disconnecting primary and secondary continuous administration sets whenever possible.
   a. If disconnection of a continuous or an intermittent infusion administration occurs, aseptically attach a new, sterile, compatible covering device to protect male luer ends on administration sets, ensuring correct connection of catheters/administration sets/add-on devices. Do not attach the exposed male luer end of the administration set to a port on the same administration set (ie, looping). Replace an administration set that is suspected of contamination.[8,34] (V)
   b. If the secondary administration set is disconnected from the primary set, the secondary administration set is now considered a primary intermittent administration set and is changed every 24 hours. (Committee Consensus)

III. Primary Intermittent Infusions

A. Change intermittent primary and secondary administration sets every 24 hours.

1. There is an absence of studies addressing administration set changes for intermittent infusions. When an intermittent infusion is repeatedly disconnected and reconnected for infusion delivery/administration, there is increased risk of contamination at the spike end, catheter hub, needleless connector, and the male luer end of

the administration set, potentially increasing risk for catheter-associated bloodstream infections (CABSI). (Committee Consensus)

IV. Parenteral Nutrition (PN) (refer also to Standard 61, Parenteral Nutrition).

A. Replace solution containers and administration sets used for PN (total nutrient admixture [TNA] and amino acid/dextrose formulations) and lipids every 24 hours; replace administration sets used for lipid injectable emulsion (ILE) with each new infusion. Hang time for PN should not exceed 24 hours.
B. Limit separate ILE infusion to a 12-hour maximum time; if volume limitations require separate ILE administration for a period longer than 12 hours, the American Society for Parenteral and Enteral Nutrition (ASPEN) recommends strong consideration for a new ILE container and administration set for the second 12-hour portion. The hang time of a TNA can be extended to 24 hours because bacterial growth in these solutions is inhibited due to reduced pH and to increased total osmolarity compared to infusing ILE separately. Use administration sets free of DEHP to administer lipid-based infusates, such as ILE or TNA. DEHP is lipophilic and leaches into the lipid solution with commonly used PVC administration sets and containers. DEHP is considered a toxin, and studies have demonstrated increased DEHP levels in lipid solutions, which is a risk especially with neonatal, pediatric, and long-term home care patients.

V. Propofol Infusions

A. Replace administration sets (and any add-on devices such as stopcocks) used to administer propofol infusions at least every 6 to 12 hours, per the manufacturers' directions for use.[9,35] (V)

VI. Blood and Blood Components

A. Change the transfusion administration set in conjunction with manufacturers' directions for use.[36] (V)
    1. Clinical studies establishing the maximum time for administration set use are lacking; in accordance with the Association for the Advancement of Blood and Biotherapies (AABB), if the first unit requires 4 hours or more for transfusion, the administration set and filter are not reused. National guidelines from other countries recommend changing the administration set every 12 hours.
    2. Note that most standard filters have a 4-unit maximum capacity; follow manufacturers' directions for use (refer to Standard 62, *Blood Administration*).
    3. Consider whether add-on devices (eg, stopcock, needleless connectors) would limit the blood infusion rate in patients requiring rapid blood resuscitation.[37] (VI)

VII. Hemodynamic and Arterial Pressure Monitoring

A. Replace the disposable or reusable transducer and other components of the system, including the administration set, continuous flush device, and flush solution used for invasive hemodynamic pressure monitoring after 96 hours, immediately upon suspected contamination, or when the integrity of the product or system has been compromised.[24] (II)
    1. In a noninferiority trial, 7-day peripheral arterial line set replacement was found to be noninferior when compared to 4-day replacement regarding infection.[28] (III)
    2. Current recommendations for hemodynamic administration sets are generally based on guidelines for venous access. Further research is needed to guide optimal frequency for hemodynamic administration set change.[38,39] (III)

VIII. Quality Improvement

A. Monitor and review quality data (ie, accurate dose delivery, impact of practice change regarding administration set replacement frequency) through an interprofessional review process. Adjust clinical practices to ensure optimization of patient outcomes (see Standard 6, *Quality Improvement*).[1,7,8,26] (V)

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Note: All electronic references in this section were accessed between January 28, 2023, and August 18, 2023.

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41. BLOOD SAMPLING

Standard

41.1 Patient identification and proper labeling of all blood sample containers are performed at the time of sample collection and in the presence of the patient.
41.2 Blood conservation techniques are employed to reduce the risk of iatrogenic anemia.
41.3 Monitor use of blood sampling through collaboration from all departments (managers, clinicians, and providers) to reduce overuse of blood sampling and reduce preanalytical errors.
41.4 Adherence to Aseptic Non Touch Technique (ANTT®) is maintained when obtaining blood samples (skin cleansing for direct venipuncture, needleless connector cleansing, and when accessing a vascular access device) to prevent contamination.

Practice Recommendations

I. General

A. Educate the patient about the purpose and process for blood sampling.
   1. Advise the patient to avoid any exercise for 24 hours before blood sampling. Exercise and changes from supine to upright positions can alter plasma volume because of gravity, venous hydrostatic changes, and distribution of body fluids. Changes may include alterations in hemoglobin, hematocrit, and other cell counts.[1,2] (V)
   2. If fasting is required, inform the patient of the fasting time period prior to specimen collection. Assess adherence prior to obtaining the sample.[1] (V)

B. Reduce the risk of iatrogenic anemia by collaborating with laboratory management, managers from other patient care areas, and providers to limit blood tests to only those that are necessary for diagnosis and treatment decisions. Health care–acquired anemia impacts patients of all ages and may increase the need for blood transfusion and its inherent risks.[3-6] (IV)
   1. Use strategies to reduce blood loss, including drawing specimens based on clinical need of individual patient (ie, targeted testing), establishing minimal volume required, using small volume collection tubes if validated for a specific test, point-of-care testing methods when appropriate, closed-loop systems for venous and arterial sampling that returns blood to the patient, use of the push-pull (mixing method), and delay in umbilical cord clamping in stable term and preterm infants.[7-33] (I)

C. Provide educational programs to preserve the patient's own blood supply through effective treatment of anemia and to improve blood sample ordering and collection practices.[34-36] (II)
   1. Goals include reduction of needed transfusions, the frequency of daily blood tests, the number of rejected samples, contamination of blood cultures, and hemolysis rates (see Standard 62, *Blood Administration*).
   2. Systematic reviews have identified specific educational and competency processes that produce improvement in outcomes of blood sampling, including standardization of blood sampling protocols (see Standard 5, *Competency and Competency Assessment*).

D. Employ a standardized procedure to prevent errors (hemolysis, clotted samples) in the preanalytical phase. These errors delay treatment decisions due to spurious laboratory values, enhance the potential for patient harm, and increase costs of care. Preventative measures may include strategies listed below.[3-6,22,35,37-49] (II)
   1. Develop standardized processes for direct venipuncture and blood sampling from peripheral and central vascular access devices (CVADs), including use of flush, amount of discard, site selection, and amount of hold time for infusion, if drawn from a VAD.
      a. Consider the use of the common femoral vein under ultrasound guidance for neonatal and infant patient population for large-volume phlebotomy.[50] (V)
   2. Confirm patient identification. Electronic patient identification systems (eg, barcoding) for labeling have been shown to reduce errors when compared to manual methods.
   3. Use the correct supplies in the correct sequence (eg, color of the collection tube closure, order of draw) according to manufacturers' directions for use.
   4. Complete the specimen preparation (eg, proper fill volume, gentle inversion) per manufacturers' instructions.
   5. Label each specimen in the presence of the patient.
   6. Document pertinent specimen information (eg, source, sequence) per facility policy.
   7. Send samples for processing promptly after collection. If delivery of the specimen is delayed, properly store the specimen until it can be transported for processing.
   8. Prior to transport, ensure the specimen is prepared and secured per manufacturers' instructions.

E. Monitor and reduce blood specimen rejection through mitigation of risks. Compromised technique during collection or whole specimen destruction during transport is the most common cause of blood sample rejection by the laboratory and causes erroneous values for many tests (eg, electrolytes, glucose, cardiac biomarkers, coagulation times). Consider potential for risk factors listed below.[3,48,51-54] (I)
   1. Drawn in the emergency department (ED) compared to non-ED areas.[26,55] (IV)
   2. Drawn by nurses and medical staff compared to phlebotomists.[3,56,57] (IV)

3. Drawn from peripheral intravenous catheters (PIVCs) when compared to a direct venipuncture by straight needles or steel-winged needles.[56,58] (IV)
    a. A small tube device advanced through an existing short PIVC is associated with decreased blood specimen rejection rates in studies of volunteers and patients. Follow manufacturers' recommendations related to wait times and waste volumes.[58-60] (V)
4. Drawn from veins of the hand and forearm compared to the antecubital fossa.[29] (V)
5. Pneumatic systems not designed or maintained for blood transportation or improperly secured samples when compared to hand transport.[61,62] (IV)
6. Filling less than half of evacuated tubes compared to those filled more than halfway.[3,5,22,44,63] (IV)
7. From venipunctures with greater than 1 minute of tourniquet time.[3,46] (V)
8. There is a need for further research in the impact of specific specimen equipment, collection technique, and patient characteristics on blood specimen rejection.[3,22,23,52,63,64] (I)

F. Therapeutic drug level: draw the blood sample from a dedicated or separate lumen or VAD not used for administration of the drug being monitored, if possible. Therapeutic drug monitoring is most common for anticoagulants, antibiotics, insulin, and immunosuppressants, with dosage adjustment based on test results. Concerns and variables include, but are not limited to, medication/drug, flush volumes, device design, device material (eg, silicone, polyurethane, and polyurethane with silver), waste/discard vs push-pull technique in obtaining samples.[29,38,65,66] (IV)
    1. Evaluate elevated test results based on clinical exam prior to dose adjustment; retesting via direct venipuncture may be necessary. Provide drug name, dose, time of last infusion, and specimen collection time to the laboratory.

G. Blood Cultures:
    1. Use precautions for obtaining blood cultures to avoid false-negative and false-positive results and to reduce incorrect classification as a catheter-associated bloodstream infection (CABSI), unnecessary antibiotic delivery, potential increased length of stay, and related costs.[67-71] (IV)
        a. Consider standardized methods (eg, a dedicated phlebotomy team, a standardized sterile collection kit) to reduce blood culture contamination rates.[57,70,72,73] (III)
        b. Obtain blood for culturing prior to administering antibiotics and prior to drawing other specimens, when possible.[67,68] (IV)
        c. Drawing the blood culture specimen:
            i. Peripheral venipuncture:
                a) Avoid drawing blood cultures from a PIVC on insertion due to increased risk of contamination. Do not draw blood cultures from a PIVC or peripheral arterial line during the dwell of the catheter.[35,70,74-76] (IV)
                1) Ensure proper ANTT is used throughout the procedure if drawing a blood culture from a newly inserted PIVC.[74] (V)
                b) Monitor contamination rates to inform process improvements.[74-76] (V)
                c) Consider the costs and benefits in implementing a consistent process to divert and discard the initial blood sample when drawing blood cultures. Studies have demonstrated reduction in blood culture contamination with use of a diversion device.[60,75-78] (IV)
            ii. CVAD:
                a) Use a CVAD for drawing blood cultures only when the catheter is suspected of being the source of infection. Use of a clinical decision tool, such as a blood culture decision algorithm, has been associated with reduced CVAD blood culture draws.[29,67,68] (IV)
                b) Draw a set of blood cultures from a peripheral vein simultaneously with the CVAD sample to confirm a catheter-related bloodstream infection (CR-BSI) diagnosis.[48,70,75] (V)
                c) Recognize that the presence of antimicrobial locking solution in the CVAD may interfere with culture results. (Committee Consensus)
                d) Replace the needleless connector before obtaining the blood culture sample.[48] (V)
                e) If using a blood culture bottle designed for direct filling from the CVAD, maintain the bottle upright and follow manufacturers' directions for use to avoid reflux of the broth medium into the CVAD and vein.[40,48] (V)
                f) Use the initial blood volume aspirated from the CVAD for the blood culture without a discard volume.[48,75] (V)
    d. For multilumen CVADs, studies recommend obtaining separate samples from each lumen for blood cultures. One small comparative study on adults found that pooled blood cultures had the same sensitivity as individually cultured lumens.[79,80] (V)
    e. Obtain 2 sets of blood cultures to increase the sensitivity for detecting organism growth.[72] (III)
    f. Draw a quantity of blood that is sufficient for isolating organisms per manufacturers' and age-related guidelines for aerobic and anaerobic containers. Disinfect and inoculate the blood

culture containers per manufacturers' instructions.[81] (IV)

g. Recognize that differential time to positivity (DTP) may be used to diagnose CR-BSI; however, continuous monitoring blood culture systems and shorter incubation times have reduced the use of DTP.[67] (IV)

h. Transport blood culture bottles to the laboratory within 2 hours; do not refrigerate, as this may kill some organisms.[38,48,67,82] (IV)

II. Considerations in Blood Sampling Based on Device

A. Carefully analyze risks vs benefits before deciding to use a direct venipuncture versus a VAD for obtaining blood samples.[28,35,48,56,83] (II)

1. Risks of direct venipuncture include contamination; pain; damage to skin, vessel, and nearby nerves; and hematoma in patients receiving anticoagulants or with bleeding disorders, as well as psychological stress, anxiety, and dissatisfaction with care. Benefits may include reduced hemolysis rate and improved accuracy of resulted value.
2. Risks associated with sampling from a PIVC include hemolysis of the sample, contamination of the sample from infusing solutions and medications, local complications from excessive catheter movement (eg, phlebitis, infiltration), and dislodgement from the insertion site.
   a. A systematic review found that hemolysis rates were higher with sampling via a PIVC versus direct venipuncture but could be reduced with the use of a standard protocol.[35] (II)
   b. A prospective cohort study found that technique (eg, increased tourniquet time, repeated attempts) and patient age were risk factors for hemolysis but found that PIVC drawn versus direct venipuncture was not a factor.[49] (IV)
3. Risks associated with sampling from a CVAD include increased hub manipulation and the potential for intraluminal contamination, alterations in VAD patency, and erroneous laboratory values associated with adsorption of medications infused through the VAD or inadequate flushing. Benefits include reduction in risks of peripheral venipuncture, as listed above.

B. Blood sampling via direct venipuncture:

1. Prevent venous stasis and other causes of inaccurate laboratory data by avoiding repetitive fist clenching or hand pumping, limiting tourniquet time to less than 1 minute, and removing tourniquet as soon as blood begins to flow into evacuated tube. Use of infrared visualization devices will identify the vein and may eliminate the need for a tourniquet (see Standard 21, *Vascular Visualization*). (A/P)
2. 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.[29,56,65] (IV)
3. Restrict venipuncture for blood sampling to the dorsum of the hand whenever possible, regardless of hand dominance, in patients with an actual or planned dialysis fistula or graft (see Standard 27, *Vascular Access and Hemodialysis*).[84] (V)
4. Consider restricting venipuncture for blood sampling to the contralateral upper extremities in patients with lymphedema and those at risk for lymphedema (axillary surgical lymph node dissection, radiation therapy).[85-90] (IV)
   a. Avoidance of the ipsilateral arm has been based on the risk of infection from punctures due to compromised axillary drainage. Evidence for avoiding all venipuncture on the at-risk upper extremity comes from conflicting studies; however, there remain recommendations to avoid all venipuncture procedures on at-risk extremities.
5. When feasible, avoid venipunctures on an extremity with alteration in normal venous blood flow (eg, paralysis or hemiparesis from a cerebrovascular accident) and/or decreased sensation that could prevent perception of pain, such as needle-to-nerve contact (see Standard 45, *Nerve Injury*).[29] (V)
6. Use caution in venipuncture of the median cubital, cephalic, or basilic veins of the antecubital fossa using a straight needle or steel-winged needle. Nerve damage at/above the antecubital fossa may occur due to injury to the median and anterior interosseous nerve and the lateral and medial antebrachial nerves (refer to Standard 45, *Nerve Injury*).
7. Perform venipuncture in neonates by a skilled phlebotomist instead of heel lance methods due to the increased pain from the heel lance. Automatic lancing devices are preferred over manual devices to control the depth of puncture and to reduce the risk of bone or cartilage infection.[91,92] (V)

C. Blood sampling via direct arterial puncture:

1. Assess the circulation to the hand prior to puncturing the radial artery; perform a physical examination of hand circulation, such as assessing radial and ulnar pulses with an Allen test, pulse oximetry, or Doppler flow study. Review medical history (eg, trauma, previous radial artery cannulation, radial artery harvesting); assess presence of anticoagulants.[47,93-95] (IV)
2. Use a 20-gauge or smaller needle to reduce pain associated with radial artery puncture and to reduce arterial damage; however, smaller needles could cause hemolysis. Choose a needle with sufficient length to access the artery.[47] (V)
3. Use ultrasound guidance to improve insertion success (refer to Standard 21, *Vascular Visualization*).

D. Blood sampling via indwelling PIVC:

1. Pause infusing solutions for 1 to 2 minutes and waste 1 to 2 mL of blood prior to obtaining sample.[56,65] (IV)
2. Sampling of blood from indwelling short PIVCs produced results for complete blood count, blood chemistry, and coagulation studies that are not different from a direct venipuncture.[56,58,65,92,96] (IV)
3. Midline catheters may be labeled for obtaining blood samples; however, limited evidence is available regarding the techniques or outcomes of this procedure. A prospective observational study noted a low hemolysis rate of 0.69% in 1021 blood samples drawn from midline catheters. Further high-quality research is needed to establish a standard procedure for blood sampling via the midline catheter.[97,98] (IV)

E. Blood sampling via CVADs:
1. Accuracy of coagulation values from a blood sample obtained from a heparinized CVAD is inconclusive due to many confounding variables. These include specific procedures used (eg, waste/discard, push-pull), adherence of heparin to the catheter material and/or intraluminal biofilm, and discard volumes that could be detrimental to the patient.[66] (V)
2. Evaluate the use of the push-pull vs discard vs closed-loop methods for obtaining a sample from CVADs.
   a. The push-pull method produces clinically useful laboratory values in adults and pediatric patients, while reducing the amount of wasted blood and reducing hub manipulation. Studies include complete blood count, electrolytes, renal and liver function tests, glucose, coagulation studies, blood gases, C-reactive protein, and therapeutic drug monitoring for gentamicin.[28,56,83,99] (IV)
   b. For the discard method, volume for discard depends upon the internal volume of the CVAD, intraluminal lock solution, saline flush prior to drawing the discard volume, and the specific laboratory tests needed. Coagulation studies require the largest discard volume to produce accurate results. Do not reinfuse the discard sample from a disconnected syringe due to risk of contamination and blood clot formation.[66,100,101] (II)
   c. Use of a closed-loop blood collection system for arterial and venous catheters in adults and pediatric patients allows return of blood withdrawn for the purpose of clearing the catheter lumen.[100] (II)
3. Consider avoiding routine blood sampling in CVADs where parenteral nutrition (PN) is infused, as manipulation may increase the risk factor for CABSI (refer to Standard 61, *Parenteral Nutrition*).

F. Blood sampling via intraosseous access devices:
1. Consider reserving the initial intraosseous (IO) aspirate for laboratory analysis when there are no other options. Use caution in interpretation of laboratory results of IO aspirate, as IO blood samples have been found to have inconsistent correlation with venous and arterial samples in the critically ill (refer to Standard 54, *Intraosseous Access Devices*).

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Note: All electronic references in this section were accessed between March 28, 2023, and August 4, 2023.

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42. VASCULAR ACCESS DEVICE REMOVAL

KEY DEFINITIONS

Removal when clinically indicated

- Effective removal when clinically indicated is predicated on the following:
  - Accurate and consistent vascular access device (VAD) assessment based on patient and infusate risk
  - Adherence to Aseptic Non Touch Technique (ANTT®) principles (refer to Standard 19, *Aseptic Non Touch Technique, ANTT®*)
  - Early recognition and management of complications.
- Remove the VAD when:
  - It is no longer clinically needed; evaluation of this should occur at least daily and with each VAD assessment (inpatient), or with each outpatient event
  - There has been a suspected contamination of a Key-Site or Key-Part
  - It has evidence of:
    - a complication that cannot be readily resolved (eg, lack of blood return due to mechanical obstruction that cannot be consistently and readily restored) or
    - a complication that might indicate the need for VAD removal (eg, edema, erythema, leakage, skin color and temperature changes, patient report of pain or discomfort with and without flushing or infusion, palpable cord)
  - It is no longer functioning in an optimal fashion or contains substances that may impact patient safety (eg, precipitate, blood products that cannot be cleared by flush).

Standard

42.1 The clinical need for each vascular access device (VAD) is assessed daily for acute inpatient settings and during regular assessment visits in other settings, such as the home, outpatient facility, or skilled nursing facility.

42.2 VADs are removed when clinically indicated (eg, unresolved complication, discontinuation of infusion therapy, or when no longer necessary for the plan of care).

Practice Recommendations

I. Short and Long Peripheral Intravenous Catheters (PIVCs) and Midline Catheters

A. Remove if no longer included in the plan of care or if not used for 24 hours or more.[1-4] (III)
B. Remove PIVCs and midline catheters in pediatric and adult patients when clinically indicated, based on findings from site assessment and/or clinical signs and symptoms of systemic complications and not solely on dwell time (refer to Standard 43, *Phlebitis*; Standard 44, *Infiltration and Extravasation*; Standard 45, *Nerve Injury*; Standard 47, *Vascular Access Device-Related Infection*).
C. Label catheters inserted under suboptimal aseptic conditions in any health care setting (eg, "emergent"). If peripheral access is still indicated, remove and insert a new catheter as soon as possible, within 24 to 48 hours.[2,5] (IV)
D. Assess the removed catheter to ensure it is fully intact. If a retained fragment is suspected, notify the provider immediately. Fracture of a catheter and potential embolization can occur from excessive force during infusion therapy, the force of inadvertent removal, or from adherence to internal structures.[6] (V)
E. Notify the health care team of signs and symptoms of suspected catheter-associated infection, including purulence, and discuss the need for obtaining blood cultures or a culture of drainage at the insertion site before removing a PIVC (see Standard 47, *Vascular Access Device-Related Infection*).[7,8] (IV)
F. If extravasation with a vesicant occurs, detach all administration sets and aspirate from the catheter hub prior to peripheral catheter removal (refer to Standard 44, *Infiltration and Extravasation*).

II. Nontunneled Central Vascular Access Devices (CVADs), Including Peripherally Inserted Central Catheters (PICCs) and Tunneled Noncuffed CVADs

A. Assess and discuss daily with the health care team the continued need for the CVAD and remove when no longer needed for the planned treatment. Criteria for justification of continued use of a CVAD include, but are not limited to, the following[9-12]: (IV)
    1. Clinical instability of the patient (eg, alteration in vital signs, oxygen saturation)
    2. Prescribed continuous infusion therapy that is not peripherally compatible
    3. Hemodynamic monitoring
    4. Physical incompatibility and/or complexity of infusion regimen (multiple infusates)
    5. Documented history of difficult peripheral venous access (see Standard 25, *Vascular Access Device Planning and Site Selection*).
B. Employ strategies to facilitate timely CVAD removal, including, but not limited to, the following[11,13-15]: (II)
    1. Daily patient rounds by the health care team
    2. Use of a standardized tool, including factors to be considered for making the decision to remove the CVAD
    3. Regular assessment by designated infusion/vascular access specialists or qualified nurse/clinician
    4. Removal within 24-48 hours if the catheter is inserted under suboptimal aseptic conditions
    5. Consider using an electronic communication tool to facilitate shared decision-making between the patient's health care team and the infusion team/vascular access specialist team (VAST) regarding CVAD removal. The infusion team/VAST would provide consultation regarding clinical practice guidelines for appropriate removal, thus decreasing complications and costs and avoiding premature and unnecessary CVAD removals.
C. Assess and report signs and symptoms of CVAD complications and changes in catheter function. Consider the need for alternative vascular access if removal is necessary (refer to Section 7, *Vascular Access Device Complications*).
D. Collaborate with the health care team, including infusion/vascular access specialists when applicable, to plan removal and insertion of a new VAD to meet vascular access needs in the presence of unresolved complication(s) and/or a continued need for infusion therapy (refer to Standard 4, *Infusion and Vascular Services*).
    1. Removal of a CVAD may be the goal with changes in the patient's infusion needs and/or transfer to another level of care. Continuing needs for vascular access are based on assessment of the condition of the patient's peripheral veins, risk of complications, and characteristics of the remaining infusion therapy. Further research is needed on clinical indications for CVAD removal (see Standard 25, *Vascular Access Device Planning and Site Selection*).[9,10,14,16-20] (IV)
    2. Determine the removal or salvage of a CVAD due to suspected or confirmed catheter-associated bloodstream infection (CABSI) on blood culture results, specific cultured organism(s), patient's current condition, available vascular access sites, effectiveness of antimicrobial or ethanol lock therapy, and provider direction (see Standard 47, *Vascular Access Device-Related Infection*).[12,13,15,19,21-29] (II)
    3. Do not remove a CVAD solely due to catheter-associated deep vein thrombosis (CA-DVT) when the catheter is correctly positioned at the lower third of the superior vena cava (SVC) at or near the cavoatrial junction (CAJ), is functioning properly with a blood return, has no evidence of any infection, and patient comfort can be maintained. The decision to remove the CVAD should 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 50, *Catheter-Associated Thrombosis*).[9,21] (IV)

a. In a small retrospective study, in patients with upper extremity superficial or deep vein thrombosis, there were no symptomatic pulmonary emboli upon PICC removal.[30] (IV)

4. Remove a CVAD with a primary or secondary catheter tip malposition that cannot be repositioned to the lower third of the SVC at or near the CAJ (see Standard 51, *Central Vascular Access Device Malposition*).[31] (IV)
5. Consult with the health care team regarding diagnostic imaging studies and the appropriate medical management prior to removal of a CVAD in the event of infiltration or extravasation (refer to Standard 44, *Infiltration and Extravasation*).

E. Implement precautions to prevent air embolism during removal of CVADs, including, but not limited to, the following (see Standard 49, *Air Embolism*)[6,32-35]: (IV)
1. Place the patient in a supine flat or Trendelenburg position (unless contraindicated; Trendelenburg position is contraindicated in premature infants) when removing the CVAD, so that the insertion site is below the level of the heart.
   a. While there are no published cases of air embolism associated with PICC removal, there may be risk due to an intact skin-to-vein tract and fibrin sheath. Position patient so that the exit site is at or below the level of the heart during PICC removal and place an air-occlusive dressing (eg, petroleum gauze, covered with gauze and transparent semipermeable membrane) over the insertion site. (A/P; Committee Consensus)
   b. Documentation of air embolism from removal of a CVAD inserted via the femoral vein has not been published, although there is evidence of air entering the femoral catheter during insertion and during other procedures. Because the exit site will be at or below the level of the heart, the risk of air embolism on removal would be minimal, unless the patient is in Trendelenburg position.
2. Instruct the patient to perform a Valsalva maneuver at the appropriate point during catheter withdrawal.
   a. The Valsalva maneuver may increase intra-abdominal and intrathoracic pressures and, thus, be contraindicated in patients with cardiac dysfunction, glaucoma, and retinopathy. If the Valsalva maneuver is contraindicated, use a Trendelenburg or left lateral decubitus position, have the patient hold their breath, or time removal to exhalation.
3. Apply digital pressure with a sterile dry gauze pad at and just above the insertion site until hemostasis is achieved by using manual compression.
4. Apply an air-occlusive dressing (eg, petroleum gauze, covered with gauze and transparent semipermeable membrane) to the access site for at least 24 hours for the purpose of occluding the skin-to-vein tract and decreasing the risk of retrograde air emboli.
5. Encourage the patient to remain in a flat or reclining position, if able, for 30 minutes after removal.

F. Never forcibly remove a CVAD if resistance is encountered. Contact the provider and collaborate with the interprofessional team to discuss appropriate interventions for successful removal. Over-the-wire technique may be useful in removing retained catheters. Maximal sterile barriers should be employed for this procedure.[36] (V)

G. Assess the removed catheter to ensure it is fully intact after planned or inadvertent CVAD removal. If a retained fragment is suspected, notify the provider immediately. Fracture of a catheter and potential embolization can occur from excessive force during infusion therapy, the force of inadvertent removal, or from adherence to internal structures.[32,33,36-39] (IV)
1. 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.

III. Surgically Placed CVADs: Tunneled, Cuffed Catheters and Implanted Vascular Access Ports

A. Assess the clinical need for a tunneled cuffed catheter or implanted vascular access port on a regular basis.[40] (V)

B. Arrange for removal with the provider (which may include consultation to interventional radiology or surgery, depending on the type of VAD) when infusion therapy is completed, in the presence of an unresolved complication, or when it is no longer needed for the plan of care. Before removal, consider the possibility for infusion therapy to resume in the future (eg, patients with sickle cell anemia, cystic fibrosis, or cancer diagnoses).[12,40,41] (II)

C. Consult with the health care team regarding the decision to remove or salvage a CVAD due to suspected or confirmed CABSI (see Standard 47, *Vascular Access Device-Related Infection*).[22-24,42] (IV)

D. Immediately report cuff, port body exposure, or catheter fracture to the health care team, and anticipate appropriate interventions (eg, repair, resuture of incision), including CVAD removal.[38] (V)

E. Ensure complete removal of the CVAD, including subcutaneous cuff, to prevent subcutaneous abscess and delayed healing. Fluoroscopy and ultrasound guidance may be necessary to verify CVAD or cuff location and facilitate surgical removal.[37,38] (V)

IV. Arterial Catheters

A. Remove the catheter on evidence of signs/symptoms of infection, unresolved catheter dysfunction, complication (ie, occlusion, hematoma, altered circulatory status), or when it is no longer needed for the plan of care. Recognize the risk of an arterial catheter as a potential source for CABSI.[43] (V)

B. Apply digital pressure at and just above the insertion site using a sterile gauze pad until hemostasis is achieved by using manual compression. A sterile dressing should be applied to the access site.[44] (V)

C. Assess and document the circulatory status distal to the area of cannulation after removal of the arterial catheter and notify the provider if circulatory and/or sensory abnormalities are noted.[44] (V)

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Section Seven: Vascular Access Device Complications

Section Standards

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

43. PHLEBITIS

Standard

43.1 The clinician assesses the vascular access site for signs and symptoms of phlebitis; determines the need for and type of intervention; educates the patient and/or caregiver about phlebitis, the intervention, and any follow-up; and assesses patient response to treatment.
43.2 The clinician collaborates with the interprofessional team about the need for continued or alternative vascular access when the VAD is removed due to phlebitis.

Practice Recommendations

A. Recognize causal factors for phlebitis:
   1. Chemical phlebitis associated with endothelial inflammation/injury: infusion of irritating infusates (eg, amiodarone, nicardipine, norepinephrine, levetiracetam, dextrose [>10%]; cancer chemotherapy agents; antibiotics, including flucloxacillin, vancomycin; dobutamine; potassium chloride; iron sucrose; infusates with extremes of pH or osmolarity); inadequate hemodilution; excessive infusion rate for a short peripheral intravenous catheter (PIVC); increased number of infusion medications; particulate matter in the infusate; and skin antiseptic solution that is not fully dried and pulled into the vein during catheter insertion (see Standard 25, *Vascular Access Device Planning and Site Selection*; Standard 61, *Parenteral Nutrition*).[1-17] (II)
   2. Mechanical phlebitis may be related to effects on the endothelial cells, eg, high catheter-to-vein ratio, catheter insertion in an area of flexion, angle of catheter insertion and tip position, polytetrafluoroethylene (Teflon™) catheters; rapid infusion rate, inadequate securement, insertion trauma, or catheter material and stiffness. Improvements in catheter materials may reduce VAD-related complications, including phlebitis.[1,9,10,13,18-22] (II)
   3. Infectious phlebitis (septic or suppurative thrombophlebitis): bacterial contamination via extraluminal contamination (inadequate skin antisepsis, contamination of the catheter during insertion); intraluminal contamination through the hub; intraluminal contamination due to contaminated fluids/medications; and hematogenous seeding from an infection elsewhere in the body (eg, emergent VAD insertions, poor aseptic technique, and contaminated dressings).[1,13,23] (IV)
   4. Postinfusion phlebitis occurs 48-96 hours after catheter removal due to any of the factors above; the only risk factor cited in a large study was PIVC insertion in the emergency department.[24-26] (IV)

B. Recognize patient-related risk factors, including, but not limited to, current infection, immunodeficiency, reduced mobility, family history of deep vein thrombosis, and comorbidities; insertion in the patient's dominant side; insertion in a lower extremity, except for infants; female gender; and age (≥60 years). Based upon a systematic review, the overall rate of phlebitis may be lower in pediatric patients than in adults.[4,6,7,27-29] (II)
C. Reduce risk for phlebitis:
   1. Consider use of a peripherally inserted central catheter (PICC) or other central vascular access device (CVAD) for infusates identified as causing phlebitis based upon length of infusion time and anticipated duration of therapy (refer to Standard 25, *Vascular Access Device Planning and Site Selection*).
   2. Use skilled clinicians to insert PIVCs. PIVC insertion in adults by infusion/vascular access specialist teams produced greater first-attempt insertion success and lower rates of complications (refer to Standard 4, *Infusion and Vascular Access Services*).

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3. Allow skin to thoroughly dry after application of antiseptic solution (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*; Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).
4. Choose the smallest catheter for intended therapy. Consider larger veins, secure catheter with securement technology, avoid areas of flexion and lower limb insertion except in neonates and nonmobilizing infants, and stabilize joint as needed (see Standard 25, *Vascular Access Device Planning and Site Selection*; Standard 36, *Vascular Access Device Securement*; Standard 37, *Site Protection and Joint Stabilization*).[4,10,11,18-20,27,30-33] (III)
5. Evaluate/mitigate drug-related factors, including dilution. One study reported that standardized drug administration measures supervised by a pharmacist, including attention to drug composition, choice of administration rate/route, and any contraindications to compounding were associated with a reduction in phlebitis in an intensive care unit (ICU) setting.[10,11,14] (IV)
    a. Administer continuous vancomycin infusions via a CVAD. In a small study, thrombophlebitis occurred in all patients receiving the infusion via a midline catheter, regardless of dilution, as assessed via daily ultrasound.[34] (IV)
    b. Avoid routine use of in-line filters as a thrombophlebitis prevention measure since the patient population most likely to benefit from this intervention has yet to be determined. Infusate contaminants are potential etiologic factors for phlebitis; however, results of clinical studies regarding the clinical benefit of filtration are uncertain/controversial, with further studies needed to identify beneficial effects, potential disadvantages, and cost-effectiveness (see Standard 33, *Filtration*).[1,3] (IV)
6. Consider a PIVC insertion and maintenance bundle to reduce PIVC complications, including phlebitis (see Standard 32, *Vascular Access Device Insertion*).[33,35-39] (II)
7. Replace a catheter inserted emergently under suboptimal aseptic technique when the patient is stabilized and within 48 hours. Move a catheter inserted in a lower extremity to an upper extremity in adults; move to a new proximal site or opposite side for pediatric patients, if possible (refer to Standard 42, *Vascular Access Device Removal*).

D. Regularly assess the vascular access sites of PIVCs, midline catheters, and PICCs, based on patient population, type of therapy, and risk factors for signs and symptoms of phlebitis (swelling, erythema, leakage, palpable venous cord, purulent discharge, warmth, and pain/tenderness). Instruct the patient to report pain or tenderness at the vascular access site (refer to Standard 39, *Vascular Access Device Post-Insertion Care*).
    1. Remove and reinsert PIVCs based upon clinical indication; there is no clear difference in the rate of thrombophlebitis between clinically indicated or routine replacement of PIVC, based upon a systemic literature review and meta-analysis (see Standard 42, *Vascular Access Device Removal*).[40,41] (I)
    2. Evaluate pain as a potential early indicator of phlebitis.[10,42] (III)
    3. Based upon a meta-analysis, the incidence of phlebitis was not significantly different between midline catheters and PICCs.[43] (I)
    4. Use a standardized phlebitis scale or definition consistently within an organization; however, recognize the limitations of existing tools.
        a. The type, number, or severity of signs and symptoms, and definitions that indicate phlebitis differ among published studies; studies have shown low interrater reliability for signs, symptoms, and scales commonly used in phlebitis assessment. Further study is recommended for valid and reliable assessment tools.[42,44-47] (III)
    5. Monitor the PIVC site for postinfusion phlebitis for 48 hours or upon discharge; provide the patient/caregiver written instructions about signs and symptoms of phlebitis and whom to contact if this occurs. Reported postinfusion phlebitis rates vary widely, ranging from 1% to 23%.[25,26] (IV)
    6. Recognize the potential future role of technology in identifying phlebitis, such as ultrasound and infrared thermography. Infrared thermography may be a promising and helpful technique in objective identification of early development of phlebitis, based upon findings, including an increased difference in temperature.[17,18,48,49] (V)

E. Intervene and manage vascular access in the presence of phlebitis:
    1. Remove PIVC upon signs/symptoms of phlebitis (see Standard 42, *Vascular Access Device Removal*).[33,47] (V)
    2. Consider management of transient mechanical phlebitis after midline catheter/PICC insertion: ensure catheter securement, apply heat, elevate limb, and monitor for 24 hours postinsertion. If signs and symptoms persist, remove catheter. (Committee Consensus)
    3. Provide interventions for comfort/decrease of symptoms of phlebitis.
        a. Application of warm or cold compresses; elevate limb; provide analgesics as needed; and consider other pharmacologic interventions such as anti-inflammatory agents.[50,51] (V)
        b. A variety of topical interventions have been reported in the prevention and treatment of phlebitis (eg, nonsteroidal anti-inflammatory drugs, glycerine, aloe vera, chamomile) without clear evidence for efficacy.[52-55] (I)

4. Re-evaluate the need for ongoing vascular access when chemical phlebitis is suspected; evaluate need for alternative vascular access, different medication, slower infusion rate, infusate dilution.[14] (V)
5. Infectious phlebitis: if suspected or purulence present, remove catheter; obtain a culture of the purulent exudate and catheter tip, document findings of site assessment, and monitor for signs of systemic infection; surgical intervention may be required. Antibiotic and anticoagulation therapy were associated with resolution of septic thrombophlebitis in 57% of pediatric patients, as reported in a small retrospective study (see Standard 42, *Vascular Access Device Removal*; Standard 47, *Vascular Access Device-Related Infection*).[23] (V)
    a. In United States (US) hospitals performing CLABSI surveillance following National Healthcare Safety Network (NHSN) protocols, matching cultures from purulent drainage at a noncentral line site are relevant in determining CLABSI attribution for public reporting metrics.[56] (V)

Note: The INS Phlebitis Scale and Visual Infusion Phlebitis Scale are located in Appendix C.

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44. INFILTRATION AND EXTRAVASATION

Standard

44.1 The risk of infiltration and extravasation is reduced through careful selection of the most appropriate vascular

access device (VAD) and insertion site and through validation of VAD position and patency prior to and during infusion therapy.

44.2 Peripheral and central vascular access device (CVAD) sites are regularly assessed for signs and/or symptoms of infiltration and extravasation before and during each infusion.

44.3 Appropriate intervention(s) are implemented immediately upon recognition of infiltration/extravasation, as determined by the characteristics of the solution or medication escaping from the vein.

Practice Recommendations

A. Select the most appropriate VAD and insertion site to reduce the risk for infiltration/extravasation. Escalate VAD insertion to a vascular expert or infusion/vascular access specialty team as early as possible in patients with difficult venous access risk factors present (see Standard 25, *Vascular Access Device Planning and Site Selection*).[1-17] (I)
   1. Studies indicate the need to address significant learning needs within nursing regarding risk factors, optimal VAD selection, recognition, and treatment strategies for infiltration and extravasation across health care settings and populations.[1,5,9,11,13,15,18-21] (I)
   2. In a controlled before-and-after study in a neonatal unit, implementation of clinical practice guidelines for peripheral intravenous catheter (PIVC) insertion and management was associated with a significant reduction in extravasation events.[11] (IV)

B. Recognize the differences between vesicant, nonvesicant, and irritant solutions and medications. Each organization should reach a consensus on what medication is considered to be a vesicant and irritant based on their internal formularies and the populations they serve.[1,2,4,7,13,22-27] (I)
   1. Identify the vesicant nature of certain antineoplastic and nonantineoplastic medications prior to administration; be prepared to use the recommended pharmacologic and nonpharmacologic treatments in the event of extravasation or to escalate to a clinician capable of managing these injuries.[1,5,9,11,12,15,20,22-24,26-29] (II)
      a. There is a paucity of data on extravasation incidence and treatment recommendations (often based on animal and case studies). This is an area in need of further study, with the recommendation to form an extravasation registry to improve dissemination of outcomes.[20,23,27,29-33] (II)

C. Evaluate risk factors associated with infiltration/extravasation to determine the frequency of monitoring and to evaluate alternative vascular access options for patients at increased risk (eg, use of a CVAD) (see Standard 25, *Vascular Access Device Planning and Site Selection*; Standard 39, *Vascular Access Device Post-Insertion Care*).[1,5,9,11,13,15,17,20] (I)
   1. Identify patient-specific factors associated with an increased risk of infiltration and extravasation, as identified in multiple studies[1,4,5,7,9,12,17,21,24,28,32,34-39]: (II)
      a. Female gender
      b. Current infection
      c. Patients with altered sensation near the VAD (eg, neuropathy, application of preinsertion pain relief product) and/or who have difficulty communicating the onset of pain, tightness, or other discomfort
      d. Patients with altered mental status or cognition (eg, encephalopathy, confusion, sedating medications)
      e. Diseases that produce changes in vasculature or impaired circulation (eg, cancer, diabetes mellitus, lymphedema, systemic lupus, Raynaud's disease, peripheral neuropathy, peripheral vascular disease)
      f. Difficulty with peripheral venous access related to history of multiple venipunctures and obesity
      g. Age-related changes to vasculature, skin, and subcutaneous tissue.
         i. Neonates and young children are at increased risk for infiltration and extravasation due to factors such as inability to communicate discomfort/nonverbal, fragile vasculature and skin, limited resources to repair cellular damage, and a lack of safe and effective VAD securement and dressing options.[5,13,14,17,20,21,27,33,40,41] (I)
         ii. Anatomical changes in the elderly patient, including loss of thickness of the dermal skin layer, thickening of the tunica intima/media, and loss of connective tissue contribute to vein fragility and present challenges in vascular access (refer to Standard 2, *Special Patient Populations*).
   2. Assess the risk of mechanical causes of infiltration/extravasation and take preventative action as needed. Risk factors include the following:
      a. Reduction or loss of patency of the VAD and/or vessel due to abnormalities such as fibrin sleeve, venous thrombosis, pinch-off syndrome, and catheter fracture.[1,9,11,42] (II)
      b. Patient movement and positioning that impact VAD performance, such as normal body movements, unpredictable patient activity (eg, infants/children, confused patient); events that can increase tension on or malposition of the VAD (eg, patient repositioning, patient transport); and procedures that require specific positions (eg, "tucked arm" during a procedure).[17,43,44] (IV)
      c. Events that increase the risk of vessel trauma, including:

i. Rapid infusions, use of a bolus feature on a pump.[3,4,9,32,45] (II)
ii. Insertion of the VAD in an area of flexion.[5] (IV)
a) Infiltration and extravasation rates were found to be significantly higher in PIVCs inserted in the emergency department as opposed to other units, likely due to high volume infusions, frequent insertion at the antecubital fossa, large bore catheters, and blood sampling.[3] (I)
iii. Multiple insertion attempts, especially in the same anatomic location.[1,4,17,25,38,41,46,47] (IV)
iv. Catheter malposition during the lifespan of the VAD.

d. Reduce the risk of VAD malposition during insertion and postinsertion care.
i. Ensure adequate length of the intraosseous (IO) needle for the patient per manufacturers' recommendations (see Standard 54, *Intraosseous Access Devices*).[34,44] (V)
ii. Ensure an adequate vein purchase or length of the catheter that resides within the vessel (see Standard 21, *Vascular Visualization*).[6,41,48] (IV)
iii. Extravascular CVAD tip malposition, dislodgement, or fracture can occur in many anatomical locations and at any point during dwell time (refer to Standard 51, *Central Vascular Access Device Malposition*).
a) Measure vessel depth in tissue using ultrasound prior to CVAD insertion to ensure all lumen exit sites are within the patient's vasculature. Partial dislodgement can result in more proximal lumen exit sites infusing into the subcutaneous tissue.[49,50] (V)
b) Monitor daily catheter position and compare it to insertion measurements in an inpatient setting and on a regular basis in an outpatient setting. Ensure all catheter lumens aspirate for blood return, and flush prior to use. Do not assume appropriate intravascular tip position of all lumens when blood aspirate is possible from one lumen but not all.[49,50] (V)
c) In addition to mechanical risk factors listed above, the CVAD may gradually become malpositioned due to growth of the infant or child with a long-term CVAD.[51] (IV)
d) Monitor for sudden changes in clinical condition in patients of all ages that may indicate extravascular administration of medication involving a centrally administered vesicant (eg, new onset hypoxia, respiratory distress, hypotension, abdominal distension and/or pain, edema, airway impingement).[11,24,27,51-55] (IV)
1) Evaluate clinical criteria (eg, radiologic imaging, laboratory values, aspiration of fluid) to determine presence of infiltration/extravasation versus other clinical complications in the setting of new pleural effusion, abscess, or lesion in an area related to the CVAD. Administration of a vesicant (eg, hypertonic parenteral nutrition in fragile vessels) and/or the mechanical forces of the catheter may cause vessel erosion, allowing the vesicant to invade surrounding structures (liver, mediastinum, abdomen, thoracic cavity).[50,52,53] (V)
2) The neonate is at high risk for extravasation with CVAD insertion (eg, umbilical, peripherally inserted central catheter (PICC), femoral catheter), resulting in morbidity and mortality, including ascites, abdominal compartment syndrome, hepatic laceration/necrosis/abscess, pleural and pericardial effusion, and hemi-diaphragmatic paralysis.[51,52,54,56-64] (V)
e) Anticipate use of radiographic tests to validate the CVAD tip location (refer to Standard 51, *Central Vascular Access Device Malposition*).
1) Timing of CVAD removal depends on the plan of care, which is based on identified extravascular location of the catheter tip.
2) Assess the location of a subcutaneous tunnel or port pocket and its proximity to the wound to determine if the long-term CVAD should be removed for healing to occur. Consider consultation with a wound care specialist. (Committee Consensus)

3. Assess for additional PIVC-related factors that may increase the risk of infiltration/extravasation (see Standard 39, *Vascular Access Device Post-Insertion Care*; Standard 37, *Site Protection and Joint Stabilization*)[2,3,8,9,12,16,21,24,25,28,31,32,37,38,41,65,66]: (II)
a. PIVC sites in the hand, wrist, foot, ankle, antecubital fossa, and areas with minimal subcutaneous tissue coverage
i. If it is deemed necessary to insert the PIVC in an area of flexion, more frequent monitoring is required, joint stabilization may be needed, and consideration should be given to early removal and reinsertion in a location with reduced risk of complication.

b. Use of steel "butterfly" needle
c. Inadequate catheter securement
d. Short PIVC dwell time longer than 24 hours
e. Increased manipulation of the PIVC at the catheter hub
f. Inability to establish patency through positive blood return or site assessment during flushing (eg, diffuse edema)
g. Delivery of a vesicant in an insertion site below a recent (eg, less than 24 hours) venipuncture
h. Depth of PIVC (eg, delayed visual signs and symptoms of PIVC failure when tip of the PIVC lies in a deep vein), particularly in nonverbal population
i. PIVC administration of contrast media.

4. Evaluate the pharmacologic or physiochemical properties associated with infiltration/extravasation and severity of tissue damage. These include length of infusion of vesicant via a PIVC, drug concentration, and volume escaping into the tissue; ability of surrounding tissues to absorb the drug; hyperosmolarity and nonphysiological pH; the medication's ability to bind DNA, kill replicating cells, and/or cause vascular constriction; and excipients, such as alcohol or polyethylene glycol, used in the formulation of some medications.[1,5,7-9,12,16,22-24,27,36,64,67] (II)

D. Limit the extent of infiltration/extravasation injury through preventative measures and early recognition of signs and symptoms of infiltration/extravasation with regular visual inspection and palpation of limbs bilaterally.

1. Assess the VAD insertion site at a frequency based upon the specific patient population and characteristics of the infusion therapy (see Standard 39, *Vascular Access Device Post-Insertion Care*).[1,8,9,11,12,28,34,36,64,68,69] (II)
   a. An area for further research is establishment of monitoring standards for VADs utilized in the intraoperative and intraprocedural areas with inherent barriers to visualization, including sterile drapes, tucked limbs, competing priorities, and rapid infusions.[41,43,70-72] (IV)
2. Promptly recognize and report acute abnormalities in pain, sensation, or circulation. Compartment syndrome and arterial and nerve damage may be caused by infiltration or extravasation of a sufficient infusate volume to cause tissue ischemia/injury. Significant long-term complications may include complex regional pain syndrome, neurovascular compromise, or limb amputation.[12,28,31,32,34,70-74] (II)
   a. Recognize high risk with VAD insertion in small vessels, areas of flexion, and/or areas with tight subfascial compartments (eg, hand, wrist, forearm).
   b. If suspected, elevate the affected extremity to level of the heart to optimize perfusion.
   c. Notify the surgeon/plastic surgeon immediately if circulatory or neurological compromise is suspected.
3. Observe the VAD site and areas proximal and distal to the insertion site for abnormalities[1,4,23,27,34,75]: (IV)
   a. Fluid leakage from the puncture site, subcutaneous tunnel, or port pocket, which may be visible or subcutaneous.
   b. Skin injury, including vesicle formation, may appear within hours (eg, contrast media) or may be delayed for days (eg, antineoplastic agents); progression to ulceration may vary from a few days to 1 to 2 weeks, depending on the vesicant administered.
   c. Discoloration or hyperpigmentation.
4. Rule out other conditions that may have similar symptoms (eg, phlebitis, flare reactions, rash).[4,76] (V)
   a. A notable case report illustrates a subdural infiltration from a scalp PIVC in a neonate used to deliver fluid and blood products. The changes in neurovascular status were thought to be due to an intracranial hemorrhage but were found to be due to a significant intracranial infiltration.[77] (V)
5. Consider the use of infiltration/extravasation detection technology to aid in early recognition. Further research is needed to determine optimal use. Options that are under investigation include thermosensitive crystal film, near infrared camera, radiofrequency, gamma scintillation, color flow doppler, impulse oscillometry, and point-of-care ultrasound.[10,12,45,78-83] (IV)
   a. Use careful assessment in conjunction with detection technology, as the device may fail to detect abnormalities or fail to adequately warn clinicians, especially in settings where the VAD is not readily accessible.[10,79] (IV)
   b. Do not rely on the alarm from an electronic infusion pump to identify infiltration and extravasation; alarms are not designed to detect the presence or absence of complications. Electronic infusion pumps do not cause infiltration/extravasation; however, they may mask or exacerbate the problem until the infusion is stopped.[10,43] (V)
6. Assess the extremity and areas proximal and distal to the insertion site and compare to the contralateral limb.[4,8,11,27,49] (IV)
   a. Palpate the insertion site to assess for swelling and pain.
      i. Swelling/edema may appear as a raised area under the skin near the peripheral VAD site or as an enlarged and tense extremity due to fluid accumulating in compartments of the extremity. Edema from a CVAD may appear as a raised area on the neck, chest, or groin.

b. Compare the circumference of both extremities if unilateral edema is noted. Compare to baseline measurement at insertion, if available.
c. Changes in color may include redness and/or blanching; however, infiltration/extravasation into deep tissue may not produce visible color changes.

7. Elicit the patient's report of pain; observe the nonverbal patient for other cues indicating pain.
   a. Pain may be the initial symptom and may be sudden and severe when associated with a rapid injection of solution or medications; may be out of proportion to the injury; or may appear with passive stretching of the muscles in the extremity. Pain intensity may increase over time, which may indicate compartment syndrome.[4,5,9,26,27,32] (IV)
8. Insert a VAD designed for contrast administration in an optimal location to ensure adequate monitoring during contrast administration. Assess for proper function prior to, during, and postcontrast media infusion. Adjust delivery of contrast to conform to the chosen VAD.[12,32,37,84] (II)
   a. Extravasation can occur with manual and with automated delivery of contrast. Automated power or pressure injectors produce a jet of fluid exiting the catheter tip. Distal tip malposition has been documented following power injection in PICCs. It has also been postulated that this jet could induce vessel perforation and extravasation.[12,32,73,74] (II)
   b. Fluid warming may be associated with lower rates of extravasation. Fluid with high viscosity, such as contrast media, requires less force to administer when it is warmed to 37°C (see Standard 23, *Flow-Control Devices*; Standard 24, *Blood and Fluid Warming*).[12,32,37,74,85] (II)
   c. Consider use of extravasation detection accessories, such as equivalent dose rate monitoring, to provide early detection, automated interruption of power injection, and guidance for contrast extravasation management.[12,86,87] (IV)

E. Immediately stop the infusion upon identification of an infiltration/extravasation injury, and initiate appropriate intervention(s).[1,4,9,11,12,23,24,26,84] (II)
   1. Do not flush the VAD, as this will inject additional medication into the tissue. Disconnect the administration set from the catheter hub and aspirate from the catheter or implanted port access needle with a small syringe, even though a very small amount of fluid may be retrieved. The role of aspiration is not clear with extravasation of contrast media.[1,4,9,11,12,23,24,26,27,29,31,32,36] (II)
   2. Remove the peripheral catheter or implanted vascular access port access needle.[1,4,26,29,88] (IV)
   3. Avoid application of pressure to the area.[4,24,26] (IV)
   4. Elevate the extremity to encourage lymphatic reabsorption of the solution/medication, unless compartment syndrome is suspected.[2,9,12,23,26,30,32,36] (II)
   5. Avoid use of the affected extremity for subsequent VAD insertion until resolved.[89] (V)
   6. Assess the insertion site and surrounding tissue.
      a. Assess the area distal (located below) to the VAD site for capillary refill, sensation, and motor function.[23,26,32,34] (II)
      b. Using a skin marker, outline the area suspected of infiltration/extravasation to assess progression.[9,12] (IV)
      c. Photograph the area to identify progression or exacerbation of the tissue injury in accordance with organizational policy.[1,9,15] (IV)
   7. Estimate the volume of solution that has escaped into the tissue based on the original amount of solution in the container, the amount remaining when stopped, and rate and duration of injection or infusion.[24,36,74] (V)
      a. Estimated extravasated volumes of contrast media of less than 50 mL are more likely to resolve with conservative treatment, while volumes of greater than 50 mL are at higher risk to cause tissue damage, requiring treatment. However, the patient's symptoms should dictate treatment options over the estimated extravasated volume. Radiologic imaging to evaluate a contrast extravasation is rarely indicated.[12,32,37,74] (IV)
   8. Notify the provider about the event and activate the established treatment protocol or the prescribed treatment.[1,4,9,12,24,26,28,32,36] (II)
      a. The need for surgical consultation is based on organizational policy, clinical signs and symptoms and their progression, volume of injury, and/or the tissue-destroying nature of a vesicant medication.
         i. Consider options for treatment that include subcutaneous irrigation with or without hyaluronidase, open incision and irrigation, small incisions followed by massage to force drainage, and debridement; skin graft/flap as indicated. There is a paucity of evidence to support one surgical intervention over another, so consideration should be given to the risks and benefits of conservative versus invasive treatment.[2,27,28,32,90] (IV)

F. Initiate treatment promptly as appropriate for the type and volume of solution/medication in the tissue surrounding the VAD, with the goal of limiting the damage from medication/solution exposure. Provide convenient access to the list of vesicants and irritants, infiltration/extravasation management protocols, electronic order forms, supplies, and other materials needed to manage the event.[2,11,23,26,31,36] (IV)
   1. Avoid wet compresses, as they may cause maceration.[24,26] (V)

2. There is a lack of high-quality evidence to recommend use of heat or cold application in the treatment of extravasation injury.[23,27,32] (V)
    a. Cold application is used to decrease absorption, to keep the infusate localized, and to decrease inflammation, while heat is used to encourage vasodilatation and to improve blood flow to disperse the medication through the tissue.[1,4,26] (IV)
        i. Use of cold and heat applications are recommended in contrast extravasation, with a general preference for cold due to the potential to reduce inflammation.[12,32] (V)
        ii. A scoping review on treatment of extravasation in infants and children found that cold and heat application is rarely used in this population.[91] (II)
    b. Apply dry, cold compresses for DNA-binding agents and valproate because the goal is to cause vasoconstriction to localize the medication in the tissue and reduce inflammation.[1,4,9,24,36] (II)
    c. Do not use cold compresses with extravasation in the presence of agents that may cause vasoconstriction or in the presence of vaso-occlusive events (eg, sickle cell anemia).[23,26] (IV)
    d. If dexrazoxane is indicated, remove the cold compress 15 minutes before the infusion of dexrazoxane begins.[1,9,24,29] (II)
    e. Apply dry, warm compresses for non-DNA binding agents to encourage vasodilation.[1,4,36] (IV)
3. Administer the appropriate antidote for the solutions or medication in the tissue.
    a. Daily IV infusion of dexrazoxane over 3 days is the recommended antidote for anthracycline extravasation (also used with liposomal and pegylated anthracycline)[1,9] (II)
        i. Begin the infusion within 6 hours of the extravasation and infuse into the opposite extremity.[1,9,24] (II)
        ii. Topical dimethyl sulfoxide (DMSO) should not be applied to patients receiving dexrazoxane, as it may diminish dexrazoxane efficacy.[9,24] (II)
    b. Inject other antidote or dispersal enzyme into the subcutaneous tissue surrounding the extravasated site per facility protocol and the specific manufacturer's directions for dose and administration.
        i. Hyaluronidase is not considered to be an antidote to a specific vesicant; it is an enzyme that increases absorption and dispersion of the medication or solution in the tissue. Its use is reported with cytotoxic and noncytotoxic agents, including both acidic and alkalotic drugs (eg, amiodarone, phenytoin), vinca alkaloids, as well as hyperosmolar solutions (eg, parenteral nutrition [PN]) and calcium salts). Recombinant hyaluronidase is not derived from animals and may have a lower risk of allergic response. Subcutaneous injection within 1 hour of the extravasation event produces the best response. Use of dry heat in conjunction with hyaluronidase works synergistically to increase blood flow and disperse the extravasated drug. Hyaluronidase is not considered first-line treatment for contrast extravasation.[1,9,11,12,23,24,26,32,38,92] (II)
            a) Consider subcutaneous saline irrigation or saline irrigation with prior hyaluronidase administration for vesicant removal/dispersion in neonates. Further study is needed in the use of this practice, as resolution with conservative treatment is common.[10,64,91] (IV)
        ii. Sodium thiosulfate is recommended for mechlorethamine extravasation and has been suggested for bendamustine, calcium, and large extravasations of cisplatin.[1,8,9,92] (IV)
        iii. Phentolamine is preferred for vasopressor extravasation. Normal perfusion of the area may be seen within 10 minutes of administration. Repeated injection may be necessary if hypoperfusion is still present or if vasoconstriction is extending to a greater area.[23,26,36] (IV)
        iv. Terbutaline injection has been used for vasopressor extravasation when phentolamine is not immediately available.[8,23] (V)
        v. Topical nitroglycerin 2% may be applied as a 1-inch strip to the site of vasopressor extravasation in the absence of phentolamine; repeat every 8 hours as clinically indicated.[8,23,93] (V)
        vi. Consider use of oral, topical, or intralesional steroid on a case-by-case basis. Single-center studies and case reports have reported reduced inflammation and swelling; however, evidence of benefit is inconsistent and may not be recommended.[8,9,12,24] (V)
4. Consider use of irrigation or washout to assist in removal of specific infusates from surrounding tissue (eg, acidic, alkalotic, contrast, specific cytotoxic agents, PN).[9,12,27,30,36,42,94] (IV)
    a. Other treatments that have been reported in the treatment of severe tissue injury due to extravasation include negative pressure wound therapy, needle aspiration, emergency evacuation with low-pressure suction, ethacridine lactate dressing with phototherapy, acellular fish skin graft dressing, and dehydrated human amniotic membrane allograft.[2,28,39,76,94-97] (IV)

b. Avoid injection of an acidic or alkaline medication to neutralize the pH of an extravasated acidic or alkaline vesicant, as the resulting chemical reaction could cause gas formation and exacerbate the tissue injury.[8,98] (V)
c. While skin discoloration from iron infiltration may be permanent, laser treatment has been reported to be successful in reducing staining.[99] (V)

G. Use a standardized age/population-specific tool or definition to consistently evaluate infiltration/extravasation events from all types of VADs that is valid, reliable, and clinically feasible. The chosen scale should also be accompanied by appropriate interventions to manage each level of the scale of injuries. Several scales have been published; however, further research is needed to establish validity and interrater reliability for specific populations.[4,11,12,20,21,23,25,26,30,33,64,100] (II)
1. An infant infiltration scale was recently revised and found to be valid and reliable for this population in an observational, prospective study.[100] (IV)

H. Use a standardized format to document initial and ongoing assessment and monitoring of the infiltration/extravasation site and all factors involved with the event.[9,10,23,26,29,32,36,40] (II)
1. Accuracy of PIVC complication rates (eg, phlebitis, extravasation, occlusion) is reduced by clinical knowledge deficits in symptom recognition, gaps in documentation, and a lack of consistent PIVC outcome definitions used in the literature.[1,3,5,13,18,20,101] (I)

I. Continue to monitor the site as needed based on severity of the event and the venue of care, as signs and symptoms of infiltration and extravasation may be delayed in presentation. Assess changes in the area by measurement and/or photography; observe skin integrity, level of pain, sensation, and motor function of the extremity.[8,9,15,20,36,40,76] (II)
1. Inflammation post-contrast media extravasation generally peaks at 24-48 hours from the event.[32] (V)
2. Consider conducting follow-up phone calls or a follow-up visit to evaluate progression of an extravasation in the outpatient setting.[12,15,26,32] (IV)

J. Educate the patient and caregivers regarding extravasation risk to improve prompt recognition of symptoms (see Standard 8, *Patient Education*).[1,4,8,9,11,12,24,25,32,75] (II)
1. Preinfusion: the risks of receiving an infusion prior to administration, emphasizing the signs and symptoms to immediately report.
2. Postinfusion: the possible progression of the signs and symptoms of infiltration/extravasation; the need to protect the site from sunlight; the frequency of follow-up visits to the provider as needed.

K. Review infiltration/extravasation incidents causing harm or injury, using adverse event reports and health record reviews for quality improvement opportunities (see Standard 6, *Quality Improvement*; Standard 11, *Adverse and Serious Adverse Events*).[1,9,15,28,41,90] (V)
1. Consider performing an investigation of each significant extravasation event (eg, root cause analysis) to identify and implement needed quality improvement strategies.

Note: The INS Infiltration Scale and Extravasation Staging tool are located in Appendix C.

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45. NERVE INJURY

Standard

45.1 A vascular access device (VAD) or phlebotomy needle is immediately removed upon patient report of paresthesia-type pain during venipuncture and during VAD dwell time.

45.2 During the insertion or dwell of central vascular access devices (CVADs), the possibility of nerve injury is considered and evaluated whenever the patient complains of respiratory difficulty or unusual presentations of pain or discomfort.

Practice Recommendations

A. Recognize the risk for nerve injury during phlebotomy and during VAD insertion/dwell time. There are some sites associated with a greater risk for injury; use caution with these sites, while also recognizing that anatomical variations in veins, arteries, and nerves are common.[1-3] (V)
   1. Peripheral venous sites associated with increased risk of nerve damage:
      a. Cephalic vein at the radial wrist, with potential injury to the superficial radial nerve
      b. Volar (inner) aspect of the wrist, with potential injury to the median nerve
      c. At/above the antecubital fossa, with potential injury to the median and anterior interosseous nerve and the lateral and medial antebrachial nerves.[1,2,4-23] (V, A/P)
   2. Peripheral arterial sites associated with risk for nerve damage:
      a. Brachial artery, with potential injury to the median nerve
      b. Radial artery, with potential injury to the median and radial nerve.[24,25] (V, A/P)
   3. Nerve injuries associated with central vascular access devices are rare, but axillary/subclavian and internal jugular insertions with injury to the phrenic nerve or nerves of the brachial plexus and Horner's syndrome have been reported.[15,22,26-33] (V, A/P)

B. Reduce the risk for nerve injury:
   1. Avoid multiple attempts at venipuncture (see Standard 32, *Vascular Access Device Insertion*).
      a. Repeated peripheral and central venous access device venipuncture attempts, subcutaneous probing techniques, and multiple passes of the

needle are associated with an increased risk for nerve injury.[9,13,16,18,22,29,33] (IV)

2. Use ultrasound guidance to improve first-time insertion success and to identify veins, arteries, and associated structures, including nerves, to reduce the risk of nerve injury when placing short or long peripheral catheters in patients with difficult intravenous access and when placing peripheral arterial catheters, CVADs, and midline catheters (see Standard 21, *Vascular Visualization*).[14,17,18,24,25,29,32,34-39] (I)
3. Assess vein depth and avoid a steep angle when inserting a phlebotomy needle or when inserting a peripheral intravenous catheter (PIVC) without ultrasound to reduce the risk for damage or penetration through the posterior vein wall. For shallow veins and veins of older adults, consider a 5° to 15° angle; a steeper angle may be required when accessing deep veins.[5,21,40] (V, A/P)
4. Choose the median cubital vein or the cephalic vein for phlebotomy, as these veins are closer to the surface and in an area where nerve damage and brachial artery puncture are less likely.[5,6,8,14,19,21] (V, A/P)
    a. The medial and lateral portions of the antecubital fossa (eg, basilic and median basilic veins) are avoided due to proximity to the median nerve, as well as the brachial artery; injury to the median nerve can result in loss of extension, flexion, and sensation in the hand/forearm.
5. Avoid the cephalic vein in the first quarter of the forearm (ie, above the wrist).[4,10,12] (V, A/P)
6. Minimize the risk of needle movement during phlebotomy procedures while attaching and removing the blood collection tube(s).[5,21,41] (V)
7. Stop the VAD insertion procedure immediately and carefully remove the VAD or phlebotomy needle if the patient reports symptoms of a direct puncture nerve injury, including 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.[6,7,16,22] (V)
    a. Inform the provider of the patient's report of symptoms, as early recognition and early intervention for nerve injury produce a better prognosis. Consultation with an appropriate specialist (eg, hand specialist, neurologist) may be required; the majority of venipuncture-related nerve injuries resolve within 6 months.[16,17,20,22] (IV)
8. Reduce the risk for nerve compression and compartment syndrome:
    a. Limit the amount of solution that enters the tissue through early recognition of signs/symptoms of infiltration/extravasation (refer to Standard 44, *Infiltration and Extravasation*).
    b. Control bleeding at attempted and successful sites to reduce the risk of hematoma that can lead to nerve injury due to compression. Identify if the patient is on anticoagulant therapy, as this increases the risk for hematoma.[13,29,33,42] (V)
    c. Remove a VAD immediately when the patient reports any pain, neuropathy, or weakness in the extremity of the VAD during the dwell time. Nerve injury following peripherally inserted central catheter (PICC) insertion has been reported. Nerve compression injuries can originate from infiltrated intravenous (IV) solutions, hematoma, and edema associated with the inflammatory process of phlebitis and thrombophlebitis.[7,43-45] (IV)
    d. Identify and immediately report signs and symptoms of nerve compression, including pain, pallor, paresthesia, paralysis, and pulselessness. Pain progresses from paresthesia to paralysis. Pallor and loss of peripheral pulse indicate an advanced stage of compartment syndrome. Surgical fasciotomy to reduce pressure within the affected compartments is required within a few hours to prevent loss of the extremity. Notably, there are numerous compartments in the hand, as compared to the wrist or forearm.[42,46,47] (V, A/P)
    e. Consider risk factors associated with compartment syndrome from IV infiltration. While rare, risk factors identified in a literature review included contrast media, pressurized infusion delivery, and patients with barriers to effective communication (younger than 3 years old, impaired sensation, altered mentation).[45] (IV)
9. Recognize that complex regional pain syndrome (CRPS) is a chronic, debilitating condition characterized by ongoing neuropathic pain over a regional area; the pain is not proportional to the original injury and progresses to include sensory, motor, and autonomic changes. Venipuncture-induced CRPS is rare and often difficult to recognize as the cause of the pain, as this syndrome frequently spreads to nontraumatized extremities. Lifelong management may be required, including multiple pain medications, steroids, nerve blocks, physical therapy, and surgical procedures (eg, sympathectomy).[48,49] (V)

C. Observe for respiratory difficulties or dyspnea.[31,32] (V)
    1. Subclavian and jugular insertion sites can produce damage to the phrenic nerve, which is seen on a chest radiograph as an elevated right hemidiaphragm. Right shoulder and neck pain, distended neck veins, and hiccups may also be present. Phrenic nerve injury can come from direct trauma associated with multiple needle insertions, compression due to the presence of the catheter itself, intraventricular tip locations, hematoma, and infiltration/extravasation of infusing solutions. CVAD removal is indicated.

D. Observe for changes in the eye, such as pupil constriction and upper eyelid drooping in the presence of any CVAD.[28,29] (IV)
    1. PICCs and catheters inserted in the internal jugular vein have been reported to produce vision-related changes, suggestive of inflammation of cervical sympathetic nerves, known as Horner's Syndrome. Risk reduction strategies include ultrasound-guided insertion; avoiding excessive head rotation during skin puncture, repeated insertion attempts, and a steep angle between needle and skin during insertion; and attention to compression to avoid hematoma if carotid artery inadvertent injury.

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46. VASCULAR ACCESS DEVICE OCCLUSION

Standard

46.1 Vascular access device (VAD) patency is routinely assessed and defined by the ability to flush all catheter lumens without resistance after establishing blood return from each lumen.

46.2 Catheter salvage is preferred over catheter removal with the choice of clearing agents based on a thorough assessment of potential causes of occlusion.

46.3 When catheter patency cannot be confirmed and there is continued need for the device, alternative actions are implemented, such as evaluation by an infusion/vascular access specialist team (VAST), radiographic studies to identify catheter tip location or to evaluate catheter flow, and/or pharmacy consult to determine cause of occlusion.

Practice Recommendations

A. Reduce the risk for VAD occlusion.
   1. Use recommended flushing and locking procedures (refer to Standard 38, *Flushing and Locking*).
   2. Prevent catheter dislodgement (partial or complete) through appropriate catheter securement (refer to Standard 36, *Vascular Access Device Securement*; Standard 51, *Central Vascular Access Device Malposition*).
   3. Avoid incompatible mixing of intravenous (IV) solutions and/or medications.
      a. Check for incompatibility when 2 or more drugs/solutions are infused together (eg, combined in same container, administered as an intermittent solution for a short-term infusion or a manual injection, or administered concomitantly through the same VAD). Consult with a pharmacist or use an evidence-based compatibility reference when unsure of compatibility; if no compatibility information is found, consider the mixture as incompatible.[1-5] (IV)
      b. Identify medications/solutions at high risk for precipitation. These may include alkaline drugs such as phenytoin, diazepam, ganciclovir, acyclovir, ampicillin, imipenem, and heparin; acidic drugs such as vancomycin and parenteral nutrition (PN) solutions; ceftriaxone and calcium gluconate; and mineral precipitate in PN solutions with increased levels of calcium and phosphate.[1-5] (IV)
      c. Perform a gentle, pulsatile flush between infusions with 10 mL of preservative-free 0.9% sodium chloride (less in pediatric/neonatal, fluid restricted patients) or use separate catheter lumens, if available (refer to Standard 38, *Flushing and Locking*).
   4. Identify risk of lipid residue occlusion when administering lipid-containing infusions. Employ preventative strategies (eg, increased flushing) if lipid residue buildup is suspected.[1-5] (IV)

B. Assess for signs and symptoms of possible VAD occlusion:
   1. Inability to withdraw blood or sluggish blood return.[1,2,5] (IV)
   2. Sluggish flow; resistance or inability to flush lumen; inability to infuse fluid.[1,2,5] (IV)
   3. Frequent occlusion alarms on electronic infusion pump.[1,2] (V)
   4. Swelling/leaking at infusion site.[1,2,4] (V)
   5. No reflow or insufficient blood flow in hemodialysis central vascular access devices (CVADs).[3] (V)

C. Assess VAD patency by aspirating for a blood return and flushing each lumen with 0.9% preservative-free sodium chloride prior to administering any solution (see Standard 38, *Flushing and Locking*).[1-3,6] (IV)
   1. If no blood return on aspiration, conduct a thorough VAD site and clinical assessment and consider the safety and merit of alternating gentle aspiration with gentle instillation of small amounts of saline.[1-4,7] (V)
   2. Use a small-barrel syringe to aspirate blood if no blood return obtained and able to flush catheter. A small-barrel syringe exerts less negative pressure when withdrawing blood and may result in more success.[2] (V)
   3. When blood return remains sluggish/absent, or assessment of blood return is contraindicated due to the patient's condition (eg, hemodynamic instability dependent on vasopressor delivery), VAD patency should be evaluated through alternative signs, including ongoing clinical response to an infusing medication, lack of resistance to flushing, site evaluation, and patient symptom report. This assessment can assist in determining patency (see Standard 44, *Infiltration and Extravasation,* Standard 65, *Vasopressor Administration*). (Committee Consensus)
      a. Increase the frequency of site assessment for potential complications (eg, infiltration, extravasation).
      b. If using the peripheral intravenous catheter (PIVC) for vesicant administration, plan to transition the infusion to a more appropriate VAD or CVAD when clinically possible.
      c. Promptly evaluate and treat CVAD occlusion. If unable to restore patency, consult with provider to evaluate the need for VAD removal/replacement.

D. Assess the infusions, injections, flushing procedures, and other events with the VAD that led to the occlusion to determine the possible cause.
   1. Rule out/resolve external mechanical causes, assessing the entire infusion system from the administration set to the VAD insertion site under the dressing.[1,2,5,6] (IV)
      a. Assess securement device or tight suture for constriction of catheter, kinked/clamped catheter or administration set, obstructed/malfunctioning filter or needleless connector, change in external catheter length, or malposition of an implanted port access needle (refer to Standard 36, *Vascular Access Device Securement*; Standard 39, *Vascular Access Device Post-Insertion Care*).
      b. Remove add-on devices; assess catheter patency by attaching syringe at the hub and attach new add-on device. External kinks may be resolved by repositioning the catheter and reapplying a sterile dressing. Replace an implanted port access needle that is malpositioned or occluded.[1-6,8] (IV)
      c. Attempt short-term resolution of withdrawal occlusion (inability to obtain blood return) by changing the patient's position (eg, raise arm, cough, or breathe deeply) to alter catheter position. Further investigation should be initiated for recurrent/persistent withdrawal occlusion.[1,2,4,5,7,9] (IV)
      d. Assess for catheter damage (eg, catheter bulging, leaking, or swelling along CVAD pathway) and repair or replace VAD (refer to Standard 48, *Catheter Damage [Embolism, Repair, Exchange]*).
   2. For CVADs, assess for internal mechanical causes, such as pinch-off syndrome, secondary CVAD malposition, catheter-associated deep vein thrombosis (CA-DVT), implanted vascular access port failure, and kinks related to the tissue and vasculature (eg, head and neck movement causing kinking of catheters inserted in internal or external jugular vein) (refer to Standard 48, *Catheter Damage [Embolism, Repair, Exchange]*; Standard 50, *Catheter-Associated Thrombosis*; Standard 51, *Central Vascular Access Device Malposition*).
      a. Assess external catheter length, arm or shoulder discomfort, arrhythmias, and need to roll shoulder or raise the ipsilateral arm to allow flow or obtain blood return. If pinch-off syndrome is suspected, gently flush the CVAD with 10 mL of 0.9% preservative-free sodium chloride (less for pediatric or neonatal patient), while asking the patient to raise the ipsilateral arm and roll the shoulder backward. If the flow is dependent upon arm position, pinch-off syndrome should be investigated through informed radiographic studies.[10] (V)
      b. Collaborate with the provider to manage suspected CVAD malposition, pinch-off syndrome, or CVAD damage.[2] (V)
   3. Suspect thrombotic occlusions based on visible blood in catheter or add-on devices, inability to aspirate blood, or sluggish flow. A thrombotic occlusion may be intraluminal due to fibrin or clot formation or extraluminal, related to a fibrin tail, fibrin sheath or sleeve, or mural thrombus.[1-4] (V)
   4. Suspect chemical occlusion based on the type(s) of medications or solutions administered, duration of contact of drugs, and observation of the catheter or administration set for any visible precipitate, history of infusion rate, dilution properties and sequences, light exposure, and flushing frequency.[1-4,6] (IV)
      a. Suspect calcium phosphate precipitation if calcium or phosphate concentrations in PN solutions are elevated, in fluid restricted PN, or if the PN recipe's calculated calcium phosphate solubility is low (ie, when the solubility product is less than 75 $mmol^2/L^2$).[11] (II)
      b. Suspect lipid residue if infusing total nutrient admixture (TNA) with lipid concentration greater than 10%.[11] (II)
      c. Suspect chemical occlusion if thrombolytic agent is unsuccessful.[2] (V)

5. Consider a contrast study for persistent or recurring unresolved CVAD occlusion.[2,5] (IV)

E. Review the patient's medication record and collaborate with the pharmacist for the appropriate intervention/catheter clearance agent.[4] (V)

F. In multilumen CVADs, treat all catheter lumens with partial, withdrawal, or complete occlusion. Do not leave an occluded lumen untreated because another lumen is functional; prolonged fibrin formation is a risk factor for catheter-associated bloodstream infection (CABSI).[3,4] (V)
   1. Avoid applying excessive force when instilling a catheter clearance agent to reduce risk of catheter damage.[2] (V)
   2. Promptly resolve a suspected thrombotic occlusion or occlusion of unknown cause to increase the efficacy of thrombolysis use in CVADs and avoid or at least delay the need for catheter replacement.[2,3,9,12] (IV)
      a. Assess risks/benefits of thrombolysis. Determine if CVAD removal or replacement is warranted (eg, contraindications for thrombolytic agent, patients with CVAD-associated sepsis due to candidemia or *Staphylococcus aureus*).[1,2] (V)
      b. For CVADs, instill tissue plasminogen activator ([tPA] alteplase) in the catheter lumen in accordance with manufacturer directions for use and repeat one further time if first attempt is unsuccessful.[1,2,7,13,14] (IV)
         i. tPA for catheter occlusion may be administered in all health care settings, including community and long-term care settings.[1,2,4,15] (IV)
         ii. Stop all infusions prior to and during thrombolytic agent dwell time, if possible (particularly if treating a suspected fibrin tail/sheath), to optimize thrombolysis and to facilitate contact between the thrombolytic and thrombus/fibrin on the intraluminal and extraluminal surfaces of the catheter.[1,2] (V)
         iii. Lower doses of tPA (eg, 1 mg/mL) in lumens requiring less than or equal to 1-mL volume and cryopreserved aliquots have been demonstrated to be effective; however, randomized controlled trials (RCTs) are required to determine the efficacy of alternate dosing.[7,15-19] (III)
         iv. For neonatal and pediatric patients weighing 30 kg or less, use a volume equal to 110% of the catheter priming volume.[1,2,20] (IV)
         v. Alternative thrombolytic agents such as urokinase, reteplase, tenecteplase, and alfimeprase have been shown to be effective in smaller studies; further safety data are recommended to compare the efficacy, safety, and cost of different thrombolytic agents.[1,2,8,15,19,21-29] (III)
         vi. Consider alternative methods to deal with persistent/recurring CVAD occlusions not resolved by instillation of a thrombolytic agent:
            a) Push method over 30 minutes.[2,8,9] (IV)
            b) Low-dose infusion (relative to patient weight) over 30 minutes to 3 to 4 hours.[8,27] (IV)
            c) Dual syringes and implanted port access needles method.[2,29] (IV)
         vii. Let thrombolytic agent reside in the CVAD lumen for duration recommended in manufacturers' directions for use or as per organizational policies, procedures, and/or practice guidelines.[1-4,6,7] (IV)
         viii. Two retrospective studies have reported use of tPA in management of thrombotic occlusions in midline peripheral catheters. Use of tPA off-label to restore function to midline catheters should be used with caution and only after careful assessment of continued need for vascular access, and to rule out catheter malfunction. Consider use due to (a) thrombus in the vessel (eg, leaking at catheter insertion site), (b) infiltration/extravasation (assess for swelling, discoloration, subcutaneous fluid visualized on ultrasound, complaints of pain or assessment of pain validated for the patient), and/or (c) catheter malposition that can be resolved with catheter/patient reposition (eg, that has migrated catheter into the vein valve or lodged against the vein wall). Once satisfied that catheter malfunction is due to occlusion within or at the tip of the catheter, consider administration of tPA in accordance with provider order, if supported and appropriate to do so (see Standard 44, *Infiltration and Extravasation*).[30,31] (V)
   3. Consider resolving a suspected CVAD chemical occlusion (eg, medication precipitate or lipid residue), using a catheter-clearance agent based on the catheter lumen priming volume and allowing it to dwell for 20 to 60 minutes.[1-4] (V)
      a. L-cysteine 50 mg/mL or 0.1 N hydrochloric acid (HCl) have been used with acidic drug precipitates (pH 1-5).[1,2,4,7,11] (II)
      b. Sodium bicarbonate 8.4% or sodium hydroxide 0.1 mmol/L have been used with alkaline drug precipitates (pH 9-12).[4] (V)
      c. Sodium hydroxide 0.1 mmol/L (first attempt) or L-cysteine hydrochloride 50 mg/mL have been reported for PN and calcium phosphate.[1,2,4,7,11] (II)
      d. Sodium hydroxide (0.1 mmol/L) and 70% ethanol (with a systematic review finding the sodium hydroxide to be more effective and trial research and observational studies yielding mixed responses) have been used to treat lipid residue.[2,4,7,11,12,32-34] (II)
      e. Repeat instillation of catheter-clearance agent one further time, if necessary.[1,2] (V)
   4. After appropriate dwell time of catheter clearance agent, aspirate and discard degradation products prior to flushing the lumen to assess catheter patency.[1,2] (V)
      a. There is limited research on use of more than 2 doses of thrombolytic therapy. Additional assessment is recommended (see below) before

considering additional doses of thrombolysis. (Committee Consensus)

G. If catheter patency is not restored:
   1. Consider alternative actions, such as radiography, to rule out catheter tip malposition and/or a referral to interventional radiology for contrast study or removal of fibrin using procedures such as an internal snare, ablation of implanted CVAD, catheter exchange with fibrin sheath disruption, or angioplasty of central veins.[1,2,11,35] (IV)
   2. Collaborate with the health care team and infusion/VAST services (if available) regarding further investigation to rule out catheter-associated thrombosis, as venous thrombosis is a predictor for ineffective thrombolytic instillation procedures.[1,2,5,14] (IV)
   3. Catheter removal may be necessary, with an alternative plan for vascular access as indicated. (Committee Consensus)

H. Monitor the patient who has received a thrombolytic agent for signs of catheter-related infection or catheter-related thrombosis. Recognize that bacteria may adhere to thrombi in and around the CVAD, leading to potential infection.[1,2,5,14] (IV)

I. Monitor outcomes, including known/suspected causes of occlusions, treatment success or failure, and other measures required. Identify barriers to implementing VAD occlusion prevention and interventions, and implement appropriate strategies, including policies and procedures and clinician education and training (refer to Standard 6, *Quality Improvement*).

J. Improvements in catheter materials may reduce complications such as occlusion and thrombosis. Consider use of devices made of novel or alternative material as a preventative method if catheter occlusion/thrombosis incidence is high in the patient population. Definitive trial evidence is required to support routine and/or wider use (see Standard 50, *Catheter-Associated Thrombosis*).[36] (V)

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47. VASCULAR ACCESS DEVICE-RELATED INFECTION

KEY DEFINITIONS

Catheter-Associated Bloodstream Infection (CABSI): Given variability in international definitions, outcome reporting, and application of the terms catheter-related bloodstream infection (CR-BSI) and central line-associated bloodstream infection (CLABSI), the INS Standards of Practice Committee is using the terminology catheter-associated bloodstream infection (CABSI) to refer to bloodstream infections (BSIs) originating from either peripheral intravenous catheters (PIVCs) and/or central vascular access devices (CVADs). Both are equally injurious and can occur from 4 possible sources:

1. During catheter insertion through transfer of microbes down the catheter tract.
2. Via the catheter hub/lumen during routine administration and manipulation at the hub/lumen.
3. Due to endogenous microorganisms within the bloodstream.
4. From contaminated infusates.

When CABSI is used within a standard, refer to the respective references in that standard to understand the terminology and definitions used in the cited studies.

Catheter-Related Bloodstream Infection (CR-BSI): The recognized diagnostic criterion that more accurately confirms the catheter as the source of the infection. It is diagnosed if the same organism is isolated from a blood culture and the tip culture and the quantity of organisms isolated from the tip is greater than 15 colony forming units (CFUs). Alternatively, differential time to positivity (DTP) requires the same organism to be isolated from a peripheral vein and a catheter lumen blood culture, with growth detected 2 hours sooner (ie, 2 hours less incubation) in the sample drawn from the catheter.

Central Line-Associated Bloodstream Infection (CLABSI): This is most commonly reported as a surveillance term; however, it is not an established diagnostic criterion. CLABSI is a primary BSI in a patient who had a central line the day of or day before infection and had more than 2 days of central access. CLABSI surveillance definition may overestimate the true incidence of CR-BSI.

Standard

47.1 Infection prevention measures are implemented with the goal of preventing infusion- and vascular access device-(VAD) related infections.
47.2 The patient with a VAD is assessed for signs and/or symptoms of infection and is educated about infection, risks, interventions, and any required follow-up.

Practice Recommendations

A. Implement a care bundle in conjunction with a culture of safety and quality to reduce the risk of infection associated with VADs during insertion and during daily care and management.[1-13] (IV)
   1. Ensure that clinicians who insert VADs have sufficient training and documented competency (see Standard 5, *Competency and Competency Assessment*).
   2. Optimize VAD lumen utilization to avoid increased risk for infection. Consider working with the interdisciplinary team for scheduled dosing, as needed, to provide safe care with the minimum number of lumens needed.
   3. Ensure key aspects of insertion and postinsertion care are documented and readily retrievable to assist infection prevention efforts (see Standard 10, *Documentation in the Health Record*).
   4. Consider implementation of an infusion/vascular access specialist team (VAST) for reducing catheter-associated bloodstream infection (CABSI) when basic prevention measures have failed to control CABSI incidence (refer to Standard 4, *Infusion and Vascular Access Services*).
B. Consider collaborative rounds and audits as a strategy to enhance compliance with infection prevention efforts (refer to Standard 6, *Quality Improvement*).
C. Evaluate site selection for VAD placement as a strategy to reduce infection risks (refer to Standard 25, *Vascular Access Device Planning and Site Selection*).
D. Assess the VAD insertion and/or exit site for signs and symptoms of a VAD-related infection.[1,14-17] (IV)
   1. This includes, but is not limited to, erythema, edema, pain, tenderness or drainage, fluid in the subcutaneous pocket, and/or tunnel of a totally implanted intravascular device or tunneled catheter, induration at the exit site or over the pocket, drainage, or skin breakdown at the VAD insertion site, and/or body temperature elevation.
   2. When signs and symptoms of a VAD-related infection are present, immediately notify the provider and implement appropriate interventions.
   3. Not all microorganisms produce local site symptoms; absence of exit site complications does not rule out the possibility of infection.
E. Perform skin antisepsis at the VAD site prior to placement and as part of routine site care (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*; Standard 39, *Vascular Access Device Post-Insertion Care*).
F. Remove catheters that are inserted under emergent conditions and without full compliance with Aseptic Non Touch Technique (ANTT®) as soon as clinically practicable (refer to Standard 42, *Vascular Access Device Removal*).
G. Ensure needleless connectors are appropriately disinfected prior to use (refer to Standard 34, *Needleless Connectors*).
H. Consider use of an antimicrobial catheter to reduce the risk of CABSI.[1,5,18-22] (III)
I. Use chlorhexidine gluconate (CHG)-containing dressings to prevent CLABSIs in patients greater than 2 months of age with short-term CVADs, unless contraindicated (eg, sensitivity or allergy to CHG), including patients with oncohematological disease (see Standard 39, *Vascular Access Device Post-Insertion Care*).[1,20,23-31] (I)
   1. Weigh risks and benefits of the use of chlorhexidine-containing dressings in patients with complicated skin disorders (eg, Stevens-Johnson syndrome, graft-vs-host disease, burns, and anasarca) and highly exudative sites; immunocompromised patients, infants/young children, and as indicated by product directions for use (refer to Standard 52, *Catheter-Associated Skin Injury*).
   2. Guidelines for oncology patients suggest use of a chlorhexidine-containing dressing around the needle insertion site based on duration of infusions exceeding 4 to 6 hours.[32] (V)
   3. Catheter-related infection reduction has also been observed in both inpatient and outpatient hemodialysis patients with the addition of a CHG-containing dressing.[24,33] (III)
   4. One retrospective cohort study demonstrated a decrease in CLABSI with the use of silver-plated dressings for intensive care unit (ICU) patients.[33] (IV)
J. For patients receiving outpatient dialysis through a central venous catheter, consider the use of an antimicrobial barrier cap as a strategy to reduce bloodstream infection.[34-36] (II)
K. Consider the use of daily chlorhexidine bathing in patients with a CVAD in situ, including infants, as a strategy to reduce CABSI. Use with caution, particularly in low-birthweight and premature infants to reduce the risk of skin injury.[1,20,27,37-43] (I)
   1. Consult manufacturer instructions regarding application of a chlorhexidine-impregnated cloth over the transparent semipermeable membrane (TSM) and along the first 6 inches of the administration set daily. (Committee Consensus)
   2. Consider the additional impact of nasal decolonization combined with CHG bathing.[37,44] (IV)
L. Remove a PIVC if the patient develops symptoms of complication and failure, such as infection (eg,

erythema extending at least 1 cm from the insertion site, induration, exudate, fever with no other obvious source of infection), or the patient reports any pain or tenderness associated with the catheter (see Standard 42, *Vascular Access Device Removal*).[1,14,15,45,46] (II)

M. Do not remove a functioning CVAD solely on suspicion of infection when there is no other confirmatory evidence of catheter-related infection other than an elevation in core body temperature.[1,14,15] (II)

N. Assess the risk and benefit of CVAD removal or catheter salvage based on the type of CVAD (long-term vs short-term), infecting organism, and ability to insert replacement CVAD if necessary. Consider a consultation to an infectious disease medical service.[14,47-51] (II)

O. Remove the CVAD if there is clinical deterioration or persisting or relapsing bacteremia. The timing of insertion of a new CVAD at a new site should be a collaborative decision based on the specific risks, benefits, and need for central vascular access for each patient.[1,14,45,47] (II)

P. Evaluate the use of a prophylactic, antimicrobial catheter lock solution for high-risk patients and in a patient with a long-term CVAD who has a history of multiple CABSIs despite optimal maximal adherence to ANTT (refer to Standard 38, *Flushing and Locking*).

Q. Do not use a guidewire exchange to replace a nontunneled central venous catheter suspected of infection.[52] (V)

R. Assess risk versus benefit of a catheter exchange procedure when other vascular access sites are limited and/or bleeding disorders are present. Consider using an antimicrobial-impregnated catheter for catheter exchange.[14,15] (IV)

S. Collect and culture a specimen of purulent exudate from a peripheral or CVAD exit site to determine the presence of fungi or gram-negative or gram-positive bacteria, and initiate empirical antimicrobial therapy as ordered by the provider.[1,10,11] (IV)

T. Do not routinely culture the VAD tip upon removal unless the patient has a suspected CABSI. Catheter colonization may be detected, resulting in inappropriate use of anti-infective medications and increasing the risk of emergence of antimicrobial resistance. Recognize that the catheter tip culture will identify microorganisms on the extraluminal surface and not microorganisms located on the intraluminal surface.[1,14,15] (IV)

U. Culture the tip of short-term CVADs, PIVCs, and arterial catheters suspected of being the source of a CABSI using a semiquantitative (roll-plate) method or quantitative (sonication) method upon removal. Culture the introducer/sheath tip from a pulmonary artery catheter when a CABSI is suspected.[1,14,15] (IV)

V. Culture the reservoir contents of a port body of an implanted vascular access port and the catheter tip when it is removed for suspected CABSI.[1,14,15] (IV)

W. Consider contamination of the infusate (eg, parenteral solution, intravenous (IV) medications, or blood products) as a source of infection. This is a rare event, but an infusate can become contaminated during the manufacturing process (intrinsic contamination) or during its preparation or administration (eg, parenteral nutrition) in the patient care setting (extrinsic contamination).[52] (IV)

X. Consider the impact of specimen collection technique and blood culture contamination rates when assessing CABSI (see Standard 41, *Blood Sampling*).[53,54] (IV)

Y. Obtain paired blood samples for culture when CABSI is suspected to definitively diagnose CR-BSI. These should be drawn from the catheter and a peripheral vein before initiating antimicrobial therapy. CR-BSI is the likely diagnosis when clinical signs of sepsis are present in the absence of another obvious source with one of the following findings (see Standard 41, *Blood Sampling*)[1,14,15,53,55]: (IV)
   1. Positive semiquantitative ($>$15 colony forming units [CFUs]) or quantitative ($\geq 10^3$ CFUs) culture from a catheter segment with the same organisms isolated peripherally
   2. Simultaneous quantitative blood cultures with a ratio of $\geq$3:1 (CVAD vs peripheral)
   3. Time to culture positivity difference of more than 2 hours between CVAD cultures and peripheral cultures.
      a. Early PICC insertion in *Staphylococcus aureus* BSI appears safe in one retrospective audit. Further prospective studies are needed to validate these findings; however, early establishment of safe, reliable vascular access in patients with *Staphylococcus aureus* bacteremia should be considered.[56] (V)

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48. CATHETER DAMAGE (EMBOLISM, REPAIR, EXCHANGE)

Standard

48.1 Preventative strategies are implemented to maintain catheter integrity and reduce the risk for catheter damage.
48.2 Assessment of the patient's risk-to-benefit ratio and vascular access need is performed prior to undertaking catheter repair or exchange.

Practice Recommendations

I. General

A. Prevent catheter damage.[1-8] (IV)
   1. Use a 10-mL diameter barrel syringe to assess vascular access device (VAD) function; do not forcibly push against resistance (see Standard 38, *Flushing and Locking*).
   2. Limit contrast power injections to VAD and add-on devices with labeled indication for power injection.
   3. Do not withdraw the catheter or guidewire from the needle during insertion, as the needle bevel can damage the wire, and always maintain control of the guidewire to prevent inadvertent wire embolus.
   4. Avoid stretch force, frequent bending, or friction against the catheter (eg, rotate location of integrated clamp[s] on central vascular access devices [CVADs], if required).
   5. Consider ultrasound-guided internal jugular approach or, if necessary, subclavian approach for

implanted vascular access port placement to reduce the risk of pinch-off syndrome and avoid acute angle of catheters inserted into the internal jugular vein (see Standard 32, *Vascular Access Device Insertion*).

6. Consider an annual chest radiograph assessment of long-term CVADs, including implanted vascular access port position and integrity.
   a. Recognize that younger age, femoral placement, and longer dwell times may be associated with catheter fracture.
7. Avoid inadvertent catheter damage during insertion/removal, such as accidental puncture with needle/scalpel, overly tight sutures, placement of CVAD in the subclavian vein in a position prone to pinch-off syndrome, incorrect attachment of catheter to a port body, and pulling against resistance when removing CVAD.
8. Protect and secure catheter.
   a. Educate the health care provider and patient/caregiver on how to prevent catheter damage/embolism (eg, avoid flushing against resistance, use of sharp objects, pulling on the catheter; apply gauze to protect the catheter if a clamp is used, and rotate clamp area to avoid continuous pressure on a particular segment if a clamping sleeve is unavailable).
   b. Cover catheter with clothing and avoid friction of heavy items (eg, backpacks, straps, stiff collars, and jewelry) over external CVADs.
   c. Use clamps only at clamping sleeve, if present.
   d. Attach luer-lock connectors carefully to the catheter hub (see Standard 37, *Site Protection and Joint Stabilization*).[7,9-11] (IV)

B. Suspect catheter damage/embolism if assessment reveals signs and symptoms such as visible catheter or fractured hub, leaking at the site, catheter dysfunction (eg, inability to aspirate blood, frequent infusion pump alarms), localized pain and/or swelling along CVAD pathway during infusion, paresthesia in the arm, radiographic findings, respiratory distress, or arrhythmias (although patient may be asymptomatic). As many as 20% of catheter fragments are missed on radiographic studies.[5,8,9] (IV)
   1. Evaluate catheter integrity for the presence of signs and symptoms of catheter damage. Catheter separation may occur at the lumen–hub junction or other external connections, as well as at the internal junction of the septum and outflow tubing in implanted ports with resultant infiltration, bleeding, or exsanguination. Verify all connections are secure, and ensure all connections are visible during hemodialysis to enable assessment of connections.[5] (V)
   2. Assess the patient for signs or symptoms of catheter damage and catheter, air, or thrombotic embolism when VAD removal is difficult or in the presence of catheter dysfunction (see Standard 42, *Vascular Access Device Removal*).[2] (V)
   3. Recognize early signs and symptoms of pinch-off syndrome in patients with catheters inserted via the subclavian vein, such as resistance with flushing, infusion or blood return relieved by specific postural change (eg, rolling shoulder, raising arm, neck movement), frequent occlusion alarms, infraclavicular pain, pain during flushing or infusion, possible swelling at the insertion site, and a change in the clinical picture with arm or shoulder movement.[2,3,5,9] (V)
      a. Confirm the presence of pinch-off syndrome through radiographic examination, indicating on radiology requisition to "rule out pinch-off syndrome" to ensure proper arm positioning during radiographic examination.[2,3,9,11,12] (V)

C. Manage catheter damage (eg, ballooning, fracturing, rupturing, and cracking of the hub) in a timely manner to reduce the risk of catheter fracture and embolization, air emboli, bleeding, catheter-lumen occlusion, catheter-associated bloodstream infection (CABSI), and treatment interruption or failure, as well as to prolong catheter longevity.[7,10,12-14] (IV)
   1. Stop any infusions. Clamp or seal a damaged catheter (eg, close an existing clamp, add a clamp, cover the damaged area with adhesive dressing material, or fold the external segment and secure) between the catheter exit site and the damaged area to prevent air embolism or bleeding from the device immediately upon discovery of catheter damage. Label the damaged catheter, "Do Not Use," while waiting for the repair or exchange procedure to be performed.[15,16] (IV)
   2. Determine appropriate intervention, considering patient and health care team preference for the following options:
      a. Catheter repair may promote catheter longevity and limit loss of vascular access sites and reduce risk of infection compared to catheter exchanges.[13,15] (V)
      b. Catheter exchange:
         i. Associated with reduced risk for technical complications of new catheter insertion (eg, pneumothorax, hemothorax, arterial puncture) but may be associated with higher thrombosis rates.[10,17,18] (IV)
         ii. Should not be performed in the setting of suspected infection in patients with conditions where removal is warranted (eg, sepsis, hemodynamic instability, persistent bacteremia beyond 72 hours of appropriate antibiotics).[19] (V)
         iii. Peripherally inserted central catheter (PICC) exchanges have been associated with a 2-fold increased risk of thromboses compared to those without exchanges.[18] (IV)

c. Catheter removal and replacement.[5,10,11,14,15,18,20,21] (IV)

3. Assess risks versus benefits of the procedure.
   a. Consider factors such as the patient's age, venous integrity, and condition (eg, compromised immune systems, burns, transplants, confirmed or suspected infection); length of time remaining and characteristics (eg, osmolarity) of infusion therapy; availability of alternative vascular access options; and catheter status and history (eg, femoral catheterization, patency, external length, catheter material), possible exposure of catheter to microorganisms due to the catheter damage, resulting changes in appropriate tip position with repair, damage located near exit site (eg, within 3.0 cm of exit site or <2.5 to 5.0 cm of undamaged length proximal to bifurcation of catheter), persistent leakage postrepair attempts, and previous catheter repairs or exchanges.[7,10,13-15,18,21] (IV)
   b. Consider exceptions to catheter repair/exchange, such as sepsis, endocarditis, and suppurative thrombophlebitis.[18] (IV)
4. Confirm tip location radiographically or by other imaging technology prior to initiating or resuming prescribed therapies after catheter repair (if CVAD was withdrawn as a result of damage or repair) and after catheter exchange (see Standard 22, *Central Vascular Access Device Tip Location*).[9] (V)
5. If unable to repair/exchange catheter, collaborate with health care team for replacement or removal, as required.[9] (V)
6. Monitor for signs of postprocedural complications (eg, catheter-related infection, leakage, migration of metallic stent, occlusion, or thrombosis).[10,13,15,18] (IV)

II. Catheter and Guidewire Embolism

A. Suspect catheter/guidewire embolism when patient exhibits symptoms such as palpitations, arrhythmias, dyspnea, cough, or thoracic pain that are not associated with the patient's primary disease or comorbidities. In some cases, there are no signs or symptoms, but damage often occurs over time with lengthy usage.[2,8] (V)
B. Examine guidewire, 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 is required.[9] (V)
C. Promptly manage catheter or guidewire embolism.[3,9,11,13,18] (V)
   1. Place patient on left side in Trendelenburg position, unless contraindicated (eg, increased intracranial pressure, eye surgery, or severe cardiac or respiratory disease); minimize movement of patient and involved limb; reassure patient; call immediately for emergency medical assistance.
   2. Pressing the limb over the target vein may decrease the chance of migration of the fracture; consider immediate application of a tourniquet above site when catheter or guidewire embolization is observed.
   3. Notify health care team; percutaneous interventional/surgical procedures are likely required for fragment/catheter removal to prevent further complications.

III. Catheter Repair

A. Repair catheter with catheter-specific repair kit, according to the manufacturer's directions for use. If no device-specific repair kit is available, consider alternative strategies, such as catheter exchange or removal and replacement.[13-15] (IV)
B. Maintain Surgical-ANTT for catheter repair procedures (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*).
C. Do not use the catheter for the time indicated on the repair instructions to allow adhesive to bond catheter segments; inspect the catheter for patency and leakage before catheter use.[13-15] (IV)
D. Assess the catheter regularly after repair to confirm the integrity of the repair and identify potential problems. The repaired catheter may not have the same strength as the original catheter.[13] (V)
E. Consider a catheter exchange or replacement after performing a risk–benefit analysis if the catheter repair fails.[10] (IV)

IV. Catheter Exchange

A. Avoid routine exchanges for CVADs that are functioning and without evidence of local or systemic complications.[18] (IV)
B. Consider CVAD exchange, including tunneled, cuffed catheters and implanted vascular access ports if there is no evidence of infection.[22] (IV)
   1. Consider CVAD exchange in the setting of an actual or suspected infection (excluding septic shock or metastatic infection) when there is limited vascular access. Consider use of an antimicrobial impregnated, coated, or bonded catheter and prophylactic antimicrobials. Limited evidence suggests hemodialysis catheter revision with a new tunnel, new exit site, and the same venotomy site may result in a lower infection rate compared to catheter exchanges (see Standard 47, *Vascular Access Device-Related Infection*).[22] (IV)
C. Maintain Surgical-ANTT and use techniques to reduce the risk of air embolism during the catheter exchange (see Standard 19, *Aseptic Non Touch Technique [ANTT®]*; Standard 49, *Air Embolism*).[23] (IV)
D. Monitor postprocedure for complications such as bleeding or hematoma, infection, or recurrence of malfunction due to intact fibrin sheath.[12] (V)

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Note: All electronic references in this section were accessed between September 30, 2022, and August 19, 2023.

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49. AIR EMBOLISM

Standard

49.1 All infusion connections are of a luer-lock design to ensure a secure connection (eg, intravenous [IV] administration sets, syringes, needleless connectors, extension sets, and any add-on devices).

49.2 Air is always purged/removed from administration devices (eg, IV administration sets, syringes, needleless connectors, extension sets, and add-on devices) prior to connection or initiating an infusion.

49.3 Clinicians, patients, and/or caregivers initiating and managing infusion therapy are instructed in air embolism recognition, prevention, and implementation of critical actions in the event an air embolism is suspected.

Practice Recommendations

A. Instruct the patient and/or caregivers not to disconnect or reconnect any IV administration sets or connectors from the catheter hub unless they have been instructed in IV administration and evaluated as competent in the procedure.[1-3] (IV)

B. Never use sharp objects (eg, scissors, hemostats, or razors) near the catheter.[4] (V)

C. For all vascular access devices (VADs), use the following techniques to prevent air embolism:
   1. Prime and purge air from all administration sets and add-on devices.[1-3,5,6] (IV)
   2. Use patient positioning and air-occlusive techniques during insertion, use, replacement, and following VAD removal.[7-16] (IV)
   3. Use luer-lock connections and equipment with safety features designed to detect or prevent air

embolism, such as administration sets with air-eliminating filters and electronic infusion pumps with air sensor technology.[2,5,6] (IV)

4. Do not leave unprimed administration sets attached to solution containers.[1,2,6] (V)
5. Ensure the VAD is clamped before changing administration sets or needleless connectors.[3,5,6] (IV, A/P)

D. Implement special precautions to prevent air embolism during placement of central vascular access devices (CVADs) and other procedures involving entry into the vascular system, such as catheter exchange and extracorporeal membrane oxygenation.[5,10,11,15,17-25] (IV, A/P)
   1. Air embolic events have occurred related to contrast administration, endoscopy, guidewire-assisted procedures, sheath exchange, arterial catheterization, neurosurgery in an upright position, cardiopulmonary bypass, during extracorporeal membrane oxygenation, and unsecured connections.[1,3,5,11,17,26,27] (IV)

E. Implement precautions to prevent air embolism during removal of CVADs, including, but not limited to, the following:
   1. Place the patient in a supine position or Trendelenburg, if tolerated, during CVAD removal (contraindicated in premature neonates), so that the CVAD insertion site is at or below the level of the heart. While there are no published cases of air embolism associated with peripherally inserted central catheter (PICC) removal, there may be risk due to an intact skin-to-vein tract and fibrin sheath (see Standard 42, *Vascular Access Device Removal*).[24,28-37] (IV, A/P)
   2. Instruct the patient to perform a Valsalva maneuver during catheter withdrawal, unless contraindicated. The Valsalva maneuver may be contraindicated in patients including, but not limited to, those with supra-ventricular tachycardia (SVT), acute myocardial infarction, hemodynamic instability, aortic stenosis, carotid artery stenosis, glaucoma, or retinopathy because it increases intra-abdominal and intrathoracic pressure, which reduces cardiac output and affects blood pressure.[29,30,33-35,38,39] (IV)
      a. When the Valsalva maneuver is contraindicated, place the patient in Trendelenburg. If unable to tolerate Trendelenburg position, or for femoral lines, use the supine position. Time removal to exhalation (end expiration of the respiratory cycle) if the patient is on mechanical ventilation or unable to cooperate with instructions.[29,30,33,34] (IV, A/P)
   3. Apply digital pressure until hemostasis is achieved (by using manual compression with a sterile, dry gauze pad).[2,5,10,11,15,17-21] (IV)
   4. Apply petroleum ointment and an air-occlusive dressing (eg, petroleum, covered with gauze and transparent semipermeable membrane) to the access site for at least 24 hours for the purpose of occluding the skin-to-vein tract and decreasing the risk of retrograde air emboli.[2,29,33,34] (V)
   5. Encourage the patient to remain in a flat or reclining position for 30 minutes after removal, if able. While documentation of air embolism during removal of a PICC has not been reported, the exit site could be at the same level as the patient's heart, increasing the risk of air entering through an intact skin-to-vein tract and fibrin sheath (see Standard 42, *Vascular Access Device Removal*).[2,29,33,34,36] (V, A/P)

F. Suspect an air embolism with the sudden onset of dyspnea, gasping, continued coughing, breathlessness, chest pain, hypotension, tachyarrhythmias, wheezing, tachypnea, altered mental status, headache, seizures, altered speech, changes in facial appearance, numbness, or paralysis, as clinical events from air emboli produce cardiopulmonary and neurological signs and symptoms.[2,5,10,11,15,17-21,25,28-36,40] (IV)
   1. Implement immediate actions to prevent more air from entering the bloodstream. Close, fold, clamp, or cover the existing catheter or cover the puncture site with an air-occlusive dressing or pad if the catheter has been removed.[2,5,10,11,17-21,28-35] (IV)
   2. Position patient immediately 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.[2,5,10,11,17-21,28-35,37] (IV, A/P)
   3. For arterial air embolism, the recommendations are to position the patient in the supine position. The left lateral recumbent position is insufficient to prevent arterial air emboli from entering the systemic circulation. Head down positioning may exacerbate cerebral edema in patients who sustain cerebral air embolisms.[6] (V)

G. Implement additional actions once air embolism is suspected.
   1. Initiate resuscitation team if in acute care setting or call emergency medical services if in patient's home or alternative care setting.[2,6,10,11,17-20,28-35,41] (IV)
      a. Notify provider.
      b. Ensure adequate vascular access.
      c. Provide 100% oxygen, if available, and further support actions as needed.
   2. Alternative treatments, if available, that have shown effectiveness:
      a. Hyperbaric oxygen[29,30,41] (V)
      b. Manual removal of air through a catheter[5,28,33,41,42] (V)
      c. Forced expulsion of air through smaller segments of the pulmonary arteries via chest compression.[21,31,33,37,43] (V)

H. Anticipate diagnostic tests such as transesophageal echocardiography, precordial doppler ultrasonography, computed tomography, magnetic resonance imaging, electrocardiogram, or ultrasound.[2,5,10,11,17,20,21,28-31,33-35] (V)

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50. CATHETER-ASSOCIATED THROMBOSIS

KEY DEFINITIONS

Catheter-associated thrombosis is a global term (synonymous with catheter-related thrombosis [CRT]) that encompasses the spectrum of peripheral and central catheter-associated thrombosis. Recent research is heterogenous in the use of definitions and of methodologies to report catheter-associated thrombotic outcomes. The global term catheter-associated thrombosis (CAT) and definitions below will be used within the standard, with specific use of different terms when used by a particular study.

- **Catheter-associated thrombosis (CAT):** initiated as an inflammatory response to vessel wall injury and appears as an anechoic or hypoechoic image on ultrasonic evaluation, partially or fully occluding the vessel lumen. It is generally subdivided into deep versus superficial vein thrombosis (DVT, SVT) and symptomatic versus the larger percentage that are asymptomatic. Rates of CAT are generally low (but vary widely), and CAT rarely results in more serious complications, but may impact the function of the vascular access device (VAD), delay required treatment, require anticoagulant therapy, cause VAD failure/premature removal, increase costs, and may result in postthrombotic syndrome.
  - **Deep vein thrombosis (DVT):** thrombosis involving the deep veins of the arm (brachial, axillary), subclavian, or internal jugular veins, or the leg (iliac, femoral, popliteal) detected by compression and flow ultrasonography, venography, or computed tomography (CT) scan.
    - **Upper extremity DVT (UE-DVT):** often associated with VADs inserted in smaller upper arm veins with lower blood flow velocity.
  - **Superficial vein thrombosis (SVT):** thrombosis involving the superficial veins of the upper extremity (eg, basilic, and cephalic) or lower extremity (eg, saphenous veins).
  - **Venous thromboembolism (VTE):** a clinical episode of VTE includes deep vein thrombosis and pulmonary embolism (may include SVT in some studies).
- **Fibroblastic sleeve:** a sleeve of connective tissue that develops as an apparent adaptive process to a foreign body and may eventually surround a VAD. The sleeve does not originate from the vein wall; contains fibroblasts, smooth muscle cells, and collagen; is typically asymptomatic; but may potentiate catheter dysfunction if it obstructs the distal tip of the catheter.
- **Post-thrombotic syndrome (PTS):** a complication occurring after a venous thrombosis (typically a DVT) in either a lower or upper extremity characterized by pain, tenderness, swelling, and skin changes. Endothelial injury secondary to VAD insertion is a potential source.

Standard

50.1 The clinician identifies risk factors, implements preventative strategies, assesses the patient for signs/symptoms of suspected catheter-associated thrombosis (CAT), and assesses patient response to treatment, including optimal vascular access device (VAD) removal.

Practice Recommendations

A. Identify risk factors for CAT in patients who require a VAD to assist in VAD planning and to inform the need for increased monitoring and for potential prophylaxis.
   1. Malignancy (type of cancer, tumor size, and characteristics), diabetes mellitus, obesity, chemotherapy administration, thrombophilia (eg, Factor V Leiden, protein C deficiency, protein S deficiency), critical illness, and personal and family history of thrombosis.[1-13] (I)
      a. Routine investigation of thrombophilia is not recommended in pediatric patients with catheter-associated DVT (CA-DVT).[4,5] (I)
   2. Other risk factors include SARS-CoV 2 virus infection (COVID-19), patient age (but varies widely per study and population risks), pregnancy, elevated triglycerides, elevated low-density protein, ethnicity (higher risk reported in Black or African Americans), reduced functional capacity (as measured by Eastern Oncology Cooperative Group [ECOG] scoring), readmission to the hospital shortly after central vascular access

device (CVAD) insertion, inadequate hydration and nutrition, non-O blood types, and blood transfusions.[2,7-9,14-18] (I)

3. VAD-related risk factors include distal tip malposition, higher catheter-to-vessel ratio (venous, arterial), reduced blood velocity in the area of the VAD, VAD- and infusate-related endothelial injury, multiple insertion attempts, longer VAD dwell time, increased arm circumference, increased vein depth, and presence of concurrent VAD.[2,3,6,16,19-27] (I)
   a. In a prospective cohort study regarding peripherally inserted central catheter (PICC)-related thrombosis, it was noted that localized factors (in the area of the VAD) may contribute more to CAT risk than systemic factors within the first 2 weeks of VAD insertion.[28] (IV)
   b. Repetitive PICC insertions in the same arm were associated with an increased risk and speed of progression of symptomatic thrombosis in pediatric patients.[29] (IV)
4. CAT risk factors vary based on patient characteristics and VAD selection. Various methods have been studied to identify validated risk reduction measurement tools for CAT in specific populations (primarily with PICC insertion), but further research is needed in this area.[9,20,30,31] (IV)
   a. The Caprini Risk Assessment Model may have predictive value for PICC-related thrombosis, especially in high-risk patients. The Caprini score, however, was found to have moderate sensitivity and low specificity, possibly leading to overdiagnosis.[32-34] (IV)
   b. Machine learning predictive techniques using genotypes may assist in identifying patients at high risk for PICC-related thrombosis.[9] (IV)

B. Evaluate the risk of CAT during the process of VAD selection with careful consideration of patient vasculature, urgency and type of treatment required, and patient preference and functional needs (including laterality) (see Standard 25, *Vascular Access Device Planning and Site Selection*).[10,17,22,23,29,35-37] (I)
   1. Consider risk reduction recommendations for general patient populations.
      a. Use the smallest diameter, least number of lumens possible to deliver the required infusion therapy.[12,17,20,22,23,29,37-40] (I)
      b. Consider the risks of non-PICC central vascular access devices (CVADs).
         i. Nontunneled CVADs inserted via the subclavian site are associated with lower thrombotic risk compared to jugular or femoral in adult patients in intensive care units (ICUs) but should be avoided in patients with chronic kidney disease (CKD) due to increased risk of stenosis. The femoral insertion site is reported to have higher thrombotic risk.[24,41-43] (III)
      c. Employ risk reduction interventions when selecting where to insert a PICC. PICCs have been associated with higher rates of DVT than other CVADs due to reduced blood velocity in upper extremity vessels. Increased thrombotic risk has been noted with PICC insertion in critically ill patients.[3,16,22,23,35,41] (I)
         i. In a meta-analysis of PICC-related outcomes, optimal insertion techniques and use of single-lumen, smaller diameter PICCs reduced PICC-related DVT risk to a rate comparable to other CVADs.[23] (I)
         ii. Use a bundled approach for PICC insertion, including systematic ultrasound evaluation and identification of optimal area for placement, insertion methods that reduce vascular trauma, optimal tip placement verification, optimal catheter-to-vein ratio, and use of smallest diameter/fewest number of lumens.[23,35,44,45] (II)
         iii. Consider tunneling PICCs. A single-center, randomized, controlled, nonblinded, prospective trial demonstrated tunneled PICCs had a lower incidence of venous thrombosis and lower costs of catheter maintenance compared to nontunneled PICCs (See Standard 32, *Vascular Access Device Insertion*).[46] (III)
         iv. Further high-quality studies are needed to determine the optimal PICC characteristics and insertion technique for CAT risk reduction.[23,45] (I)
   2. Consider CAT risk reduction recommendations for cancer-related treatment.
      a. Consider insertion of an implanted vascular access port rather than a PICC for treatment of cancer due to a reported lower thrombotic risk.[10,47-50] (II)
      b. Balance known risks of location of insertion of implanted vascular access ports (chest versus the arm), with patient preference and treatment needs (eg, breast cancer).[51-53] (II)
         i. Total complications associated with arm ports (including thrombosis) were not significantly different between arm- and chest-placed implanted ports in patients with cancer, based upon a meta-analysis.[52] (II)
         ii. In a retrospective study, insertion of an implanted port in the arm was associated with a significant increase in symptomatic radiologically confirmed UE-DVT when compared to ports inserted in the chest in patients with breast cancer.[51] (V)
         iii. In a prospective study with adult cancer outpatients who were candidates for home parenteral nutrition and had a CVAD inserted, the rates of catheter-related

symptomatic thrombosis were low and similar for PICCs, tunneled-cuffed CVADs, and ports.[54] (IV)

3. Consider the potential benefits of thromboresistant or antithrombotic CVAD and midline catheter use. Confirmatory clinical evaluation of various catheter surface and composition modifications are needed, including hydrogel, drug coating, and hydrophilic, hydrophobic, and biologic characteristics.[55-57] (II)
   a. This is an evolving area of research with the potential for reduction in thrombotic risk. Further high-quality evidence with sufficient sample sizes is needed to optimize catheter characteristics to reduce thrombotic risk.[20,56,58-62] (II)
4. Consider CAT risk reduction recommendations for pediatric patients.
   a. Use implanted ports as the preferred VAD (compared to tunneled and nontunneled CVADs) to reduce VTE risk in children with cancer diagnosis.[5] (I)
   b. In a multicenter, prospective, observational cohort study with pediatric patients with a newly inserted PICC, implanted venous port, or tunneled cuffed CVAD, PICCs were associated with a significantly higher risk of catheter-related VTE than tunneled lines.[17] (IV)
5. Consider the risk for CAT with midline catheters. The utilization of midline catheters has increased rapidly, with an urgent need for high quality research to guide optimal use.[59,63,64] (II)
   a. In a systematic review and meta-analysis, including 40 871 adult patients, the prevalence of VTE (defined as DVT or PE) with midline catheters was significantly higher than with PICCs ($P < .00001$). Further research is needed to establish the thrombotic risk of midline catheters versus PICCs in the pediatric population.[64] (II)
6. Reduce thrombotic risk with arterial catheter insertion and management through use of ultrasound for accurate insertion, optimization of the catheter entry angle and length within the artery, catheter securement and stabilization, and frequent monitoring of circulatory status.[65,66] (V)

C. Implement preventative interventions for CAT during VAD insertion (see Standard 32, *Vascular Access Device Insertion*).
   1. Ensure that the selected VAD is inserted by staff with specific training, using vascular visualization (see Standard 21, *Vascular Visualization*).[6,22,35,39,67] (II)
   2. Position the tip of a CVAD in the lower third of the superior vena cava (SVC) or upper third of the right atrium (RA) at or near the cavoatrial junction (CAJ) for adults and children. For lower body insertion sites, position the CVAD tip in the inferior vena cava (IVC) above the level of the diaphragm (refer to Standard 22, *Central Vascular Access Device Tip Location*).
      a. The use of electrocardiography to confirm appropriate PICC tip positioning has been associated with reduced thrombotic risk.[22,39] (III)
      b. Ensure proper tip placement after umbilical venous catheter (UVC) insertion before use to prevent thrombotic complications such as UVC-related portal vein thrombosis (see Standard 28, *Umbilical Catheters*).[68] (IV)
   3. Measure the catheter-to-vessel ratio prior to insertion; ensure no more than 45% ratio (see Standard 32, *Vascular Access Device Insertion*).[2,22,28,35,45,69] (II)
   4. Evaluate the need and appropriateness of PICC exchange. PICC exchange was independently associated with a twofold greater risk of thrombosis in a retrospective study. However, this risk may have been influenced by the fact that patients who experienced exchanges were more likely to have had multilumen PICCs (see Standard 48, *Catheter Damage [Embolism, Repair, Exchange]*).[38] (IV)
   5. Consider upper extremity exercise to reduce venous stasis; handgrip exercise using an elastic ball 3 or 6 times per day for 3 weeks was associated with a lower incidence of ultrasound-confirmed CA-DVT in patients with cancer who had a PICC. Further research is needed to identify postinsertion nursing interventions that reduce thrombotic risk.[15,70,71] (III)
   6. Recommendations for prophylactic anticoagulation for CA-DVT prevention have not been established for all patient populations but should be guided by individual patient risk.[23,72] (I)
      a. VTE prophylaxis is recommended during cancer treatment requiring CVAD insertion and has not been associated with a risk of major bleeding.[10,72,73] (I)
      b. The role of pharmacologic VTE prophylaxis is unclear in pediatric patients but has been associated with decreased CAT risk without increased bleeding risk in specific pediatric populations.[17,74-76] (II)

D. Monitor for signs, symptoms, and potential consequences of CAT; recognize that CA-DVT often does not produce overt signs and symptoms. Clinical signs and symptoms are related to obstruction of venous blood flow and may include, but are not limited to, pain/edema/erythema in the extremity, shoulder, neck, or chest, and engorged peripheral veins of the extremity.[2,34] (IV)
   1. Measure baseline circumference of the extremity with a PICC or a midline catheter upon insertion, noting location for future measurements to ensure consistent measurement. Assess circumference when edema or signs and symptoms of DVT present, noting the location and characteristics of edema. A 3-cm increase in mid-arm circumference in adults with PICCs was associated with CA-DVT (see Standard 10, *Documentation in the Health Record*).[2,34,77] (IV)
   2. Reports of CAT-related pulmonary emboli are rare but may occur with CVADs and midline catheters.[3,59,78] (II)

3. Recognize post-thrombotic syndrome as a potential long-term consequence of CA-DVT characterized by chronic pain, swelling, and skin changes.[6,79,80] (II)

E. Diagnose and confirm CA-DVT using color-flow Doppler ultrasound by the presence of at least 2 of the following: an echogenic mass in the venous structure assessed; noncompressibility of the vein, abnormal color Doppler vein pattern, and/or vein filling defect. Venography with contrast injection may also be used to assess more proximal veins (eg, brachiocephalic) that are obscured by the clavicle or ribs.[2,3,9,17,50] (II)
   1. Do not remove a CVAD in the presence of CA-DVT when the catheter is correctly positioned, functional, and necessary for infusion therapy. The decision to remove a CVAD should be made based on the individual patient's characteristics, symptoms, and imaging.[10,19,81] (I)
   2. Treat CA-DVT with anticoagulant medication for at least 3 months after diagnosis. For CVADs with a longer dwell time, continue the treatment for as long as the CVAD is in situ; unfractionated heparin infusion or catheter-directed thrombolysis may be of benefit to patients with severe symptoms.[2,10,16] (IV)

F. Remove the VAD when no longer clinically needed to reduce the risk of thrombotic complications (refer to Standard 42, *Vascular Access Device Removal*).
   1. Carefully consider the need to retain or remove an implanted port at the conclusion of chemotherapy, evaluating the patient risks and need for further therapy.[51] (V)

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51. CENTRAL VASCULAR ACCESS DEVICE MALPOSITION

Standard

51.1 The clinician assesses for central vascular access device (CVAD) malposition and uses appropriate resources and interventions when malposition is suspected or confirmed.

Practice Recommendations

A. Correlate normal vascular anatomy and the acceptable CVAD tip location to aberrant locations in the thorax, abdomen, and neck on insertion (ie, primary malposition) and during dwell (ie, secondary malposition).
   1. Primary intravascular malposition of CVADs occurs during or immediately after the insertion procedure

and includes locations in the aorta, lower portion of the right atrium and right ventricle, ipsilateral and contralateral brachiocephalic (innominate) and subclavian veins, ipsilateral and contralateral internal jugular veins, azygous vein, internal mammary, and many other smaller tributary veins. Femoral insertion sites may produce malposition of the catheter in the lumbar, iliolumbar, and common iliac veins. Causes of malposition include the folllowing[1-13]: (IV)

a. Inadequate catheter length and insertion depth
b. Patient position changes (eg, from supine to upright)
c. Respiratory movement of the diaphragm and use of mechanical ventilation
d. Upper extremity and shoulder movement
e. Body habitus (eg, obesity, breast size)
f. Congenital venous abnormalities, including persistent left superior vena cava (PLSVC) and variations of the inferior vena cava (IVC), azygous vein, and pulmonary veins. Many of these anatomical variations are undiagnosed until CVAD insertion is required.
g. Trauma
h. Acquired venous changes, including thrombosis, stenosis, and malignant or benign lesions prohibiting advancement to appropriate tip position.

2. Secondary intravascular malposition of CVADs, also known as tip migration, occurs any time during the dwell and is related to sporadic changes in intrathoracic pressure (eg, coughing, vomiting); original tip located high in the superior vena cava (SVC); deep vein thrombosis (DVT); congestive heart failure; neck or arm movement; positive pressure ventilation; exercise; and dislodgement (partial or complete).[14,15] (V)
3. Primary and secondary extravascular CVAD malposition includes location in the following[2,9,11,12]: (IV)
   a. Mediastinum producing infiltration/extravasation
   b. Thoracic duct producing chylothorax
   c. Pleura producing hemothorax or pleural effusion
   d. Pericardium producing pericardial effusion and cardiac tamponade, especially in infants
   e. Peritoneum producing intra-abdominal bleeding and abdominal compartment syndrome
   f. Trachea and other structures due to fistula formation
   g. Epidural space in neonates.

B. Recognize and control the risk of malposition during insertion, if possible.[2,16-18] (IV)
   1. Insertions on a patient's left side are more prone to malposition due to a longer left brachiocephalic (innominate) vein and a more diagonal pathway to the heart. Left-sided insertions are more prone to abut the contralateral side of the SVC, leading to vessel erosion.
   2. Bevel orientation during guidewire insertion may reduce malposition. For internal jugular sites, medial bevel orientation, and for subclavian sites, caudal bevel orientation, facilitate guidewire advancement and subsequent tip location.
   3. Tip location in the lower right atrium is associated with infective endocarditis due to abrasion of the tricuspid valve or cardiac wall from the catheter tip and subsequent organism introduction into the bloodstream causing infection.
C. Use tip location technology to enhance awareness of primary CVAD malposition during the insertion procedure (see Standard 22, *Central Vascular Access Device Tip Location*).[3,19,20] (III)
D. Use real-time ultrasound during the insertion procedure to reduce the risk of inadvertent arterial insertion. Ultrasound is also useful to rule out cephalad tip orientation in the jugular vein prior to removal of the sterile field (see Standard 21, *Vascular Visualization*).[21-27] (IV)
E. Assume inadvertent arterial CVAD insertion as a possibility if the patient presents with a stroke or other neurological injury, hematoma, or hemothorax at insertion or during the dwell time.[2,8,16] (IV)
   1. Confirm arterial or venous placement by assessing waveforms using a pressure transducer, blood gas values from a sample taken from the CVAD, or computed tomography angiogram (CTA). Pulsatile flow and color of the blood are not always reliable indicators for arterial placement due to low blood pressure or the length of the catheter.
   2. For inadvertent arterial placement in axillo-subclavian or jugular insertion sites, consult with the provider, radiology, and/or vascular surgery teams to develop a plan for removal. Withdrawal of large catheters from an accessed artery (eg, carotid) with site compression increases the risk of brain ischemia from lack of blood flow, hematoma, or emboli. Endovascular techniques or open surgical repair may be needed.
   3. Consult with interventional radiology and/or surgeon to develop a plan for urgent removal. Delay can increase the risk of thrombosis.
F. Monitor the growth of infants and children with CVADs, as growth can produce suboptimal intravascular tip location when a CVAD is indwelling over extended periods of time. Correlate growth to tip location, and plan for CVAD changes as needed.[11,28] (IV)
G. Use only a CVAD labeled for power injection of contrast agents. Power injection is reported to produce mediastinal extravasation if the tip is malpositioned and may be the cause of malposition due to force of injection. Assess for clinical signs and symptoms and patency of the CVAD by manual flush, aspirate for a blood return, and confirm the correct tip location before and after power injection. Uncertainty about tip position or catheter patency should be assessed with a scout scan or topogram before power injection.[1,29] (IV)

H. Identify CVAD dislodgement, another cause of secondary malposition, by monitoring and measuring the external CVAD length with dressing changes and compare to the documented external length at insertion.[30] (V)
   1. Dislodgement alters tip location and is associated with arm movement, body habitus, patient manipulation (eg, Twiddler's syndrome), inadequate catheter securement and/or incorrect dressing, and securement device removal.
   2. Never advance any external portion of the CVAD that has been in contact with skin into the insertion site. No antiseptic agent or technique applied to skin or the external catheter will render skin or the catheter to be sterile, and no studies have established an acceptable length of time after insertion for such catheter manipulation.
   3. Management may require an exchange over a guidewire or removal and insertion at a new site.

I. Assess the patient and the CVAD for signs and symptoms of catheter dysfunction and associated complications before each CVAD infusion, as these factors will be the first indication of malposition[4,31-34]: (IV)
   1. Absence of blood return from any catheter lumen
   2. Changes in blood color and pulsatility of the blood return from any catheter lumen
   3. Difficulty or inability to flush the CVAD
   4. Arterial vs venous waveform from an attached pressure transducer
   5. Atrial and/or ventricular dysrhythmias
   6. Changes in blood pressure and/or heart rate
   7. Shoulder, chest, or back pain during insertion or dwell time
   8. Edema in the neck or shoulder
   9. Changes in respiration
   10. Complaints of hearing gurgling or flow stream sounds on the ipsilateral side
   11. Paresthesia and neurological effects due to retrograde infusion into the intracranial venous sinuses.

J. Withhold infusion through a malpositioned catheter until appropriate tip position has been established. Assess the prescribed infusion therapy and, if possible, insert a short peripheral intravenous catheter (PIVC) to continue therapy. If the infusion therapy is not possible through a peripheral vein, assess the potential risk for discontinuing therapy and consult with the provider regarding changing the infusion therapy until the appropriate CVAD tip location can be reestablished.[31] (V)

K. Obtain diagnostic tests, including chest radiograph with or without contrast injection, fluoroscopy, echocardiogram, computed tomography (CT) scan, and/or magnetic resonance imaging (MRI) to diagnose CVAD malposition based on clinical signs and symptoms and problems with catheter function.[2,3,8,21,35] (IV)
   1. Provide the radiology department with clinical information to enhance their ability to identify the problem.
   2. Chest radiographs at specific intervals may not identify tip migration because of the sporadic and unpredictable nature of malposition. Each acute care facility should assess the need for chest radiograph when patients with a CVAD are admitted.
   3. Collaborate with the radiology department to have chest radiographs or other diagnostic radiographic procedures include catheter tip location. Establish and follow organizational policy for reporting and management of malpositioned catheters found during these procedures.

L. Manage malposition depending upon the location of the CVAD, the continued need for infusion therapy, and the patient's acuity. Consult with the provider and/or radiology department as needed.[4,34,36] (V)
   1. Noninvasive or minimally invasive techniques are preferred as the initial step to reposition a CVAD. Bedside ultrasound may be useful in identifying catheter malposition in the internal jugular vein.[14,28,37-40] (IV)
   2. Intracardiac location in the lower two thirds of the right atrium or right ventricle should have the CVAD retracted based on electrocardiogram results or measurement of the specific distance on the chest radiograph.[17,39] (V)
   3. CVADs angling cephalad into the internal jugular vein, the contralateral subclavian or brachiocephalic (innominate) vein, or other tributary veins may be repositioned by a high-flow flush technique involving elevating the patient's head to a 60° to 90° angle (ie, high Fowler's position) and flushing the catheter. Instructing the patient to cough while flushing may also change intrathoracic pressures, allowing catheter movement. Repeat radiograph should be performed to determine tip location.[37,38,41] (V)
   4. Invasive techniques include catheter exchange over a guidewire and other radiological techniques under fluoroscopy.[14,38] (V)
   5. For a PICC inadvertently placed in an artery, remove the catheter and apply and maintain direct manual pressure on the arterial puncture site until hemostasis is achieved. Inform primary clinicians of arterial placement for continuing close observation.[31] (V)
   6. For PICC malposition in neonates, attempt noninvasive repositioning by elevating the head of the bed for internal jugular placement, lying on the opposite side with head elevated for brachiocephalic placement, or gentle flushing or fluid infusion. Secondary intravascular malposition may be corrected by abduction, adduction, flexion, or extension of the extremity.[40,42] (IV)
   7. Repositioning of long-term CVADs may require using a diagnostic catheter inserted via the femoral vein under fluoroscopy and manipulating the tip using a snaring technique.[38] (V)

8. Fluid aspiration from the CVAD before removal may be indicated if cardiac tamponade is suspected. Consult with the provider and/or radiology department.[7,31] (V)
9. Removal when an infiltration/extravasation has occurred will require a treatment plan for the specific medication involved (see Standard 44, *Infiltration and Extravasation*).[4,14,37-39] (IV)

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52. CATHETER-ASSOCIATED SKIN INJURY

KEY DEFINITIONS

- **Catheter-associated skin injury (CASI):** an abnormality including, but not limited to, erythema, vesicle, bulla, erosion or tear, at a peripheral or central vascular access device (VAD) site that is noted in the area of the device dressing and/or securement device and that is observable for 30 minutes or more after dressing/securement removal. CASI is associated with increased patient discomfort (eg, pain, pruritis), increased cost, delays in treatment, and a potential for VAD removal and replacement. Skin conditions from other sources (eg, eczema, autoimmune disorders, medication adverse events) are not included.
  - **Medical adhesive-related skin injury (MARSI):** erythema or cutaneous abnormality (including occurrence of, but not limited to, vesicle, bulla, erosion, skin tear or vesicle) that continues to be observable 30 minutes or more post adhesive removal. This definition will be used in the standard only if it was specifically mentioned in the reference.
- **Conditions related to adhesive and catheter-associated skin injury include the following:**
  - **Erythema:** Red discoloration to skin; may be painful, pruritic; may be difficult to detect with darker pigmented skin
  - **Allergic contact dermatitis (ACD):** Cell-mediated immune response in the area of the catheter; corresponds to the area of exposure; possible appearance: erythema, vesicles, pruritic dermatitis; typically, longer length of symptoms (eg, up to a week)
  - **Irritant contact dermatitis (ICD):** Nonimmunological skin injury; corresponds to area of exposure; possible appearance: erythema, edema, vesicles; typically, short in duration when exposure is eliminated
  - **Tension injury or blister:** Separation of epidermis from dermis, caused by tension, shear; can be potentiated by severe edema
  - **Skin stripping:** Removal of one or more layers of the stratum corneum, often due to removal of adhesive, excess friction with site cleansing
  - **Maceration:** Skin injury caused by prolonged exposure to moisture; area may appear pale, white, grey, wrinkled; increases permeability and susceptibility to injury
  - **Skin tear:** Separation of epidermis from dermis due to shear/friction forces; may be partial or full thickness
  - **Pressure injury:** Injury to superficial and potentially deeper structures due to prolonged pressure
  - **Folliculitis:** Small, inflamed, elevated skin pustules at hair follicles; often due to trapped microbes, damage from shaving.

Note: Within this standard, the acronym CASI will refer to the global term catheter-associated skin injury, inclusive of all vascular access device-related skin injury. The acronym CASI is also used in Appendix B. In those documents, CASI refers to the 2017 central vascular access device (CVAD)-associated skin impairment algorithm. This algorithm is included to provide guidance on assessment and treatment of CVAD-related skin impairment.

Standard

52.1 Preventative strategies are implemented to eliminate or minimize the risk of catheter-associated skin injury (CASI).

52.2 Vascular access device (VAD) site, dressing, and securement status are routinely assessed for signs and symptoms of skin injury.

52.3 Appropriate interventions are implemented to manage and prevent further risk of CASI.

Practice Recommendations

A. Use prevention strategies that incorporate individual patient risk factors to prevent skin injury related to VAD placement and management.[1-5] (II)
   1. Assess risk of skin injury based on patient characteristics, required VAD, and infusates.[1,2,5-13] (II)
      a. Consider patient population risks for CASI. Risks cited most frequently are shown in Table 1 below.
   2. Incorporate skin injury risk assessment into VAD device and site selection (see Standard 25, *Vascular Access Device Planning and Site Selection*; Standard 32, *Vascular Access Device Insertion*).[3,7,9,10,27,29,30] (IV)
      a. Reduce vascular trauma associated with VAD insertion using vascular visualization; bruising and hematoma formation may promote skin injury.[9,10] (IV)
      b. Administration of chemotherapy in an implanted port may have reduced risk of skin injury with chemotherapy that has a high risk of skin toxicity.[27] (V)
   3. Assess the patient's history of CASI and related allergies prior to VAD placement to mitigate risk of skin injury.[1,3-5,9,14,31] (III)
   4. Ensure that preventative strategies are incorporated as appropriate, based on identified patient risk factors:
      a. Avoid insertion into areas of pre-existing injury.[2,10,32] (II)
      b. Reduce site infection and folliculitis by clipping or trimming hair at the insertion site vs shaving.[5] (IV)
      c. Choose VAD-related products (eg, antiseptic, skin barrier, dressing, securement) based on a thorough risk assessment, and individualize strategies to the patient's clinical needs. Utilize them per manufacturer guidelines and patient population guidelines. The preferred skin antiseptic agent is alcohol-based chlorhexidine solution. Use chlorhexidine gluconate (CHG)-containing dressing unless contraindicated (eg, sensitivity or allergy to CHG) to prevent central line-associated bloodstream infections (CLABSIs) in patients greater than 2 months of age with short-term central vascular access devices (CVADs), including patients with onco-hematological disease (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis;* Standard 47, *Vascular Access Device-Related Infection*).[1,2,5,18,33,34] (II)
         i. Ensure the integrity of products prior to use; maintain single-patient use.[5,14] (IV)
         ii. Select antiseptic products that will provide effective antimicrobial action between applications and that minimize skin irritation and damage.
            a) Carefully review product information, especially for patients at high risk for infection, as some antiseptic products are provided in nonsterile form and may contain contaminants.[35] (V)
            b) Use lower concentrations of antiseptic or aqueous solutions, if needed, to reduce

TABLE 1

Population Risks for CASI

Population	CASI Risk Factors Include (But Are Not Limited To)
General	Extremes of age, decreased mobility, history of CASI, dwell time of VAD, obesity, low BMI, altered cognitive status, malnutrition, dehydration, comorbidities (eg, diabetes, infection, renal insufficiency, venous insufficiency, immune deficiency), smoking, history of chronic dermatological conditions (including allergies), ethnicity (eg, darker pigment), medications (eg, chemotherapy, long-term steroid use, anticoagulants), use of phototherapy.[1,2,4-6,9,10,13-17] (II) • Dry skin has been found to be an independent risk factor for MARSI, with one study noting that patients with dry skin had over 5-fold greater risk of MARSI.[2,13,14,18,19] (IV)
Neonates	Immature stratum corneum (not fully mature until at least 34 weeks' gestation), immature immunity, cardiovascular compromise.[5,20-22] (IV)
Pediatrics	Particularly critically ill, have high reported rates of contact dermatitis and skin injury due to impaired dressing integrity.[8,12,23] (III) • In an observational study in the pediatric intensive care unit, MARSI occurred in 58.3 per 100 cases.[12] (IV)
Older	Loss of dermal matrix and subcutaneous tissue, epidermal thinning, reduced cohesion between dermis and epidermis, suboptimal hydration, and reduced vasculature and tensile strength of skin.[5,14,18,24] (IV)
Critically Ill	Altered immunity, malnutrition, hemodynamic instability (reduced tissue perfusion), longer length of stay, low Braden scale.[2,10,14,18,25] (IV) • Edema was found to be predictive of MARSI risk.[10] (IV)
Oncology	Hormone use, chemotherapy-induced skin toxicity, female gender.[6,10,16,17,26-28] (IV)

BMI, body mass index; CASI, CVAD-associated skin impairment; MARSI, medical adhesive-related skin injury; VAD, vascular access device.

skin irritation. Sterile saline may be used in the presence of severe skin conditions (refer to Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).

c) Allow the product to fully dry to reduce risk of maceration and skin irritation.
   1) Allergy to chlorhexidine (CHG) is uncommon but has been reported. Note that a history of skin irritation may be listed in the patient history as an allergy, limiting antiseptic options. Consider performing patch tests to determine true allergy status.[5,7,9,31,34] (IV)
   2) In the neonatal population, risk of skin injury from chlorhexidine use has been well documented; however, chlorhexidine is reportedly used in many neonatal intensive care units (NICUs), often with weight and age criteria to determine respective safety. Tincture of iodine is avoided due to risk of absorption/thyroid toxicity. There is insufficient evidence to identify optimal skin antisepsis in neonates, especially in low- and extremely low-birthweight infants (LBW, ELBW). Recommendations to reduce skin injury are to use the lowest effective concentration (<1% CHG), and avoid alcohol in high-risk infants, with aqueous CHG preferred (see Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).[3,5,20-22,36,37] (III)
      (a) Sodium hypochlorite has been used with minimal skin irritation in neonates.[20,38] (IV)

iii. Aseptically, apply an alcohol-free skin barrier product that is compatible with the antiseptic solution, enhancing protection for the skin around the VAD insertion site. The barrier provides a physical barrier to protect the epidermis from irritants. A variety of products are available with variable effectiveness. Follow manufacturers' instructions for application. Allow to fully dry.[2,4,5,19,30-32,39-41] (II)

iv. Select the most appropriate dressing based on the intended purpose, the impact on the ability to assess the insertion site, area of application, patient status (eg, including positioning), and clinical setting. VAD dressings are generally composed of a polyurethane film with an acrylate adhesive backing that is pressure sensitive. Consider breathability, stretch, conformity, character of adhesive, and compatibility with other products in use.[1,4,5] (III)
   a) Use proper application technique: apply firm, gentle pressure; eliminate tension/stretch on the dressing. Limit or avoid use of substances that increase the adhesion of dressings/tape (eg, tackifier, bonding agents). Avoid use of circumferential coverage, as it may contribute to pressure injury.[2,4,5] (II)
   b) Weigh risks and benefits of allowing longer intervals between CVAD dressing changes due to increased risk of infection in some populations.[42,43] (IV)
   c) If a nontransparent dressing (eg, gauze) is required, apply the dressing per manufacturer's instructions and consider expert consult (eg, wound care, infusion/vascular access specialist team (VAST), infectious diseases) on frequency of site assessment/dressing change (refer to Standard 39, *Vascular Access Device Post-Insertion Care*). (Committee Consensus)

d. Monitor patients for symptoms of contact dermatitis and adjust product choice based on the individual patient tolerance. The incidence of contact dermatitis from use of CHG skin antisepsis and CHG-containing dressings is reportedly low but requires further high-quality research to evaluate the impact of single and multiple product regimens.[44,45] (IV)
   i. Weigh risks and benefits of the use of chlorhexidine-impregnated dressings in patients with complicated skin disorders (eg, Stevens-Johnson syndrome, graft-vs-host disease, burns, and anasarca) and highly exudative sites; immunocompromised patients, infants/young children, and as indicated by product directions for use.[32,42,46,47] (III)
   ii. Consider dressing options for challenging clinical situations with increased frequency of assessment: a dressing alternative that does not contain a patient-specific allergen, gauze only (eg, severe exfoliative dermatitis), silicone-based, silver ion alginate antibacterial (reduced risk of folliculitis), hydrocolloid (increased absorption), absorbent clear acrylic, hemostatic (bleeding at site).[1,14,26,28] (IV)

e. Change the VAD dressing promptly if soiled, not intact, or upon initial signs/symptoms of skin impairment. Follow manufacturers' instructions for use.

i. Consider use of hemostatic agent/dressing for patients at risk of bleeding post-VAD insertion; increase frequency of monitoring (refer to Standard 39, *Vascular Access Device Post-Insertion Care*).

f. Select the method of VAD dressing and securement to reduce frequency of dressing changes that may increase risk of skin injury, that incorporates patient characteristics, area of application, length of dwell, and delivered therapy.[4,5,33,39] (III)
   i. Consider use of gum mastic liquid adhesive that is compatible with antiseptic and dressing products when enhanced dressing adherence is needed.[23,39,48] (IV)
   ii. Cyanoacrylate tissue adhesive has been associated with improved hemostasis to reduce localized bleeding at the insertion site and a reduction in the need for early dressing changes (see Standard 36, *Vascular Access Device Securement*).[46,49] (II)
   iii. Consider use of skin barrier film prior to application of liquid adhesive and ensure correct technique in dressing removal to prevent catheter-associated skin injury due to increased bonding of adhesive to skin (see Standard 36*, Vascular Access Device Securement*).[4,5,14] (III)
   iv. Consider options for securement based on patient risks, with potential for reduction in CASI: subcutaneous anchor securement system (SASS), integrated securement dressing, silicone splinting for infants, central line vest (see Standard 37, *Site Protection and Joint Stabilization*).[50-52] (III)
   v. Evaluate the risks of skin stripping when evaluating use of medical adhesive tape as additional securement and when anchoring tubing. There are multiple products available with rubber-backed tape associated with increased risk of skin stripping.[18] (IV)
      a) Further research is needed to identify optimal properties that facilitate high adhesion yet safe removal of medical tapes. Recent research shows promise in development of temperature-sensitive and photo-thermal release prototypes.[53,54] (IV)

g. Use appropriate removal technique for dressing, securement, and tape removal: keep the product horizontal to the skin, as a vertical pull increases peel force. Support the skin at the peel line during removal.[3-6,55] (IV)
   i. Use medical adhesive remover per manufacturer instructions and adhering to Aseptic Non Touch Technique (ANTT®). Use additional precautions with dressing and securement removal for patients at high risk for skin injury. Sterile saline may be used to aid removal in high-risk patients.[1,3-5,15,18,39,48] (III)

h. Skin health is supported by proper hydration and nutrition.[5,7,31] (IV)

i. Educate staff and patients on VAD site care, as well as early recognition and prompt management of CASI. Educate clinicians/parents/caregivers on antiseptic solutions and atraumatic dressing application and removal.[1,2,4,5,7,21,31,33] (II)

j. Consider multi-disciplinary collaboration for high-risk patients, including dermatology and wound care consultations as needed.[1,5,7,9,26,28,48] (IV)

k. Remove the VAD as soon as clinically indicated to prevent skin injury (see Standard 42, *Vascular Access Device Removal*).[15,56] (V)

B. Assess the status of the VAD site (including integrity of the skin, dressing and securement, evidence of patient discomfort) to promptly recognize the development of skin injury.[2,5,6,10,12,18,27,31,57] (II)
   1. Assess the skin in the area of the VAD for texture, color, uniformity of appearance, and integrity using adequate lighting. Document skin condition and noted abnormalities (eg, vesicles, exudate, erythema, warmth, edema, pressure-related injury).[1,4-6,31,58] (II)
      a. If skin injury is noted, assess the severity to determine the impact on the VAD, the treatment regimen, and management.[5] (IV)
         i. For premature infants with signs of a chemical burn or irritation, take immediate action, removing the potential source of irritation. Treat, and if necessary, promptly consult with other specialists, including dermatology and surgery specialists.[20] (V)
      b. Assess for pain related to skin injury and treat, if needed, with analgesic, anti-inflammatory, and/or cool compress.[6,7,31,32] (II)
      c. Assess for VAD-related pruritis. Treatment with antihistamines or steroids may be indicated. Pruritis is common in some populations (eg, end-stage renal failure), which may mask CASI or other serious conditions.[31,56] (IV)
      d. Rule out the presence of infiltration, extravasation, thrombophlebitis, and skin conditions related to other body regions (eg, eczema, impetigo, cellulitis, erysipelas, or drug eruptions) and treat accordingly. Consider wound care and/or dermatology consultation as needed (see Standard 43, *Phlebitis*; Standard 44, *Infiltration and Extravasation*).[31] (IV)
      e. Assess for signs of localized or systemic infection, including fungal infection (eg, Candida; whitish or raised red areas unresponsive to other treatment).

Adhesives and resultant skin injury may promote bacterial overgrowth.[4,5,7,28,30,41,48] (III)

f. Rule out dressing, antiseptic, and securement-related factors if an abnormality is noted (eg, failure to allow product to fully dry, frequent dressing changes, improper removal technique).[5,14,31] (IV)

g. Monitor and intervene early if allergy or sensitivity to a product is suspected. Identify alternative products for cleansing and VAD dressing and securement use.[4,9,34] (IV)

2. Further validation of CASI resources is needed to establish a thorough CASI-related skin assessment resource.[6,31] (II)

C. Employ strategies to promote skin regeneration and protection in the presence of skin injury (see Appendix B for CASI algorithm; Standard 36, *Vascular Access Device Securement*; Standard 37, *Site Protection and Joint Stabilization;* Standard 51, *Central Vascular Access Device Malposition*).

1. There is wide variation in practice in the management of CASI. Further research is needed. Recommended interventions are listed.[1,5,7,9,14,18,29-31,57] (III)

a. Avoid subsequent exposure to products suspected of causing CASI.

b. Consider changing to a different antiseptic product and/or a reduced concentration.

c. Consider dressing alternatives, balancing adhesion/securement with prevention of further skin damage at removal.

i. Consider risks of insufficient adhesion for securement in loss of device.

d. Consider securement alternatives that reduce the use of adhesives.

i. Address catheter securement and site protection if using a dressing system with no securement properties; more frequent monitoring may be required.

e. Perform patch testing if new allergy is suspected. Refer for allergy testing, if indicated.

f. Use medical adhesive remover if not already in use.

2. For skin tears, if skin flap is present, realign skin flap edges prior to dressing application.[31,55] (IV)

a. Avoid use of transparent, semipermeable membrane (TSM) dressings, adhesive strips, and hydrocolloid dressings for the skin tear management due to risk of epidermal stripping if not removed properly.

b. If skin damage/drainage is not in the immediate VAD insertion area, isolate the wound and exudate from the exit site, apply absorbent dressing over the injury, and apply the transparent dressing over the insertion site. A recent published protocol indicates that silicone mesh and TSM dressing may be used, ensuring the dressing is applied over a healthy skin border.[55]

3. If no improvement with inflammation and pruritis at the site, consider short-term use of topical low-to-moderate potency corticosteroid (do not apply directly on VAD insertion site; agent is non-sterile) and consider obtaining culture of insertion site.[31] (IV)

4. If no improvement in skin within 3 to 7 days or skin condition deteriorates with above measures, seek expert consultation (eg, wound care, dermatology).[5,31,32] (IV)

5. Consider VAD removal, if required, and reassess plan for vascular access needs.[32] (V)

6. Ensure that the patient/caregiver understands strategies in place to mitigate further skin injury and products that should be avoided to prevent future recurrence.[4,31] (IV)

D. Employ quality improvement measures to monitor and address incidence of CASI. Monitor current evidence to explore options.[5,48] (IV)

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Infusion Therapy Standards of Practice 9th Edition

Section Eight: Other Infusion Devices

Section Standards

I. The clinician is competent in the management of epidural/intrathecal, intraosseous (IO), and subcutaneous devices, including knowledge of anatomy, physiology, infusion administration, and management techniques aimed at maintaining access and reducing risk of complications.
II. Insertion, care and management, and complication management for epidural/intrathecal, IO, and subcutaneous access are established in organizational policies, procedures, and/or practice guidelines.

53. EPIDURAL AND INTRATHECAL ACCESS DEVICES

Standard

53.1 Epidural and intrathecal (neuraxial) access devices and administration sets are identified and labeled as a specialized infusion administration system and differentiated from other infusion administration and access systems.
53.2 Medications administered via a neuraxial route are free of preservatives.
53.3 Infusion solutions administered via a neuraxial route are filtered using a 0.2-micron, surfactant-free, particulate-retentive, and air-eliminating filter.
53.4 Neuraxial (NRFit) connectors are used to prevent inadvertent neuraxial administration of non-neuraxial medications, solutions, or enteral feedings.
53.5 Neuraxial access device placement, removal, care and management, and medication administration are performed either by or upon the order of the provider in accordance with regulations established by regulatory and accrediting bodies and in accordance with organizational policies and procedures.

Practice Recommendations

A. Recognize indications for epidural/intrathecal medication infusions for patients across practice settings from acute care to outpatient and home care:
   1. Management of short-term acute pain associated with surgical procedures, trauma pain, and during labor in hospitalized patients; a temporary catheter is placed for analgesic/anesthetic medication administration (see Standard 60, *Patient-Controlled Analgesia*).[1-3] (V)
   2. Management of chronic cancer and non—cancer-related pain refractory to medical management and/or intolerable side effects associated with systemically administered analgesics. Infusions may include opioids alone, opioids in combination with ziconotide (first choice), local anesthetics, and opioids in combination with local anesthetics and clonidine. Access options for chronic pain include long-term tunneled catheters, implanted ports with epidural/intrathecal catheters, and implanted intrathecal drug delivery (ITDD) systems consisting of an intrathecal catheter attached to an implanted infusion pump.[3-12] (IV)
      a. Patient selection criteria include history of adherence to a treatment plan and ongoing appointments for pump maintenance, general medical/psychosocial status/social support and disease prognosis.[13,14] (V)
      b. The clinical site for trialing and dosing for patients with chronic pain generally requires hospital admission, which allows for flexibility in trialing different intrathecal medications and regimens. Low-dose opioid trialing may be considered in the outpatient setting with a shorter observation period before releasing the patient; however, an overnight hospital admission is recommended with high starting doses. Trialing may include a single bolus or catheter-based bolus or infusion via the epidural or intrathecal route. Medications are carefully titrated during medication initiation when converting from one route to another (eg, intravenous [IV] to epidural to intrathecal), one medication to another, and when adding adjuvant medications. Dosing and opioid conversion guidelines should be used, and dosing should start low when converting from one medication to another; opioid dosing for intrathecal drug infusion is about 1/10 the dosing for an epidural drug infusion.[3,12,14,15] (V)

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c. ITDD therapy was similarly efficacious with no significant difference in side effects when placed in younger patients (<65 years old) as compared to those 65 years and older in a small retrospective study representing approximately 11 years on ITDD. The researchers suggest that, in carefully selected patients, intrathecal opioids are helpful in avoiding unwanted side effects from oral pain management.[16] (V)

3. Spasticity treated with intrathecal baclofen.[7-9,17,18] (IV)
4. Treatment of primary central nervous system cancers and leptomeningeal metastases.[3,19,20] (IV)

B. Assess the patient's current coagulation status; anticoagulants must be withheld before epidural/intrathecal insertion and before removal due to risk for hematoma and paralysis.[1,2,14,21-23] (IV)
   1. Obtain dosage, route, date, and time of last anticoagulant administration.
   2. Review coagulation panel results.
   3. Consult guidance from American Society of Regional Anesthesia and Pain Medicine and the Polyanalgesic Consensus Conference guidelines for time frames to withhold each type of anticoagulant.
   4. Review platelet count; spinal epidural hematoma in thrombocytopenic patients with a platelet count of 75 000/microliter or above is rare. There is no current consensus about the minimum threshold platelet count; patients should be monitored carefully for any signs of bleeding (eg, petechiae, bruising) for the first 24 hours.

C. Implement specific practices to prevent medication errors; errors from inadvertent administration of IV medications administered via the intrathecal route (eg, vinca alkaloids, potassium chloride, antibiotics) and anesthetic solutions (eg, fentanyl and bupivacaine, ropivacaine) inadvertently administered by the IV route have resulted in profound toxicity and death.[19,20,24-28] (IV)
   1. Use neuraxial ([NRFit] International Organization for Standardization [ISO]–approved connector) to prevent misconnections among IV, enteral, and neuraxial infusions. Neuraxial medications are prepared in NRFit syringes and/or administered via NRFit administration sets; standard luer needleless connectors/infusion administration sets will not fit into NRFit connectors.
   2. Ensure clinicians involved in neuraxial procedures are educated about NRFit connectors and the importance/rationale for this change. Evaluate and update procedures, related order sets, and pharmacy preparation and dispensing processes to include NRFit connectors.
   3. 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 (refer to Standard 40, *Administration Set Management*).
   4. Recognize that antineoplastic medications administered via an intrathecal route are administered by physicians and advanced practice providers in conjunction with local and national regulations and organizational policy.
   5. Use different delivery devices and systems for medications to be administered via an epidural/intrathecal versus other parenteral routes. IV vinca alkaloid administration should be prepared in a small-volume infusion bag (ie, minibag) and administered as an infusion, not in a syringe; this is also advised for other antineoplastics such as anthracyclines.
   6. Prepare and store intrathecal medications separately. These should be clearly labeled "For Intrathecal Use" (refer to Standard 56, *Compounding and Preparation of Parenteral Solutions and Medications*).
   7. Limit access to epidural analgesia; require the clinician who will administer the neuraxial medication to bring the medication to the patient's bedside immediately before use.
   8. Perform an independent double check with another qualified nurse, pharmacist, or physician prior to administration (including when syringe/medication container, rate, and/or concentration is changed), including verification of the safety of intraventricular/intrathecal route and its mixture with preservative-free 0.9% sodium chloride or Elliotts B solution (used for methotrexate sodium and cytarabine).
   9. Use a time-out procedure prior to medication administration.

D. Maintain Surgical-Aseptic Non Touch Technique (ANTT®) during catheter insertion, implanted neuraxial port access, and access and filling of implantable intrathecal drug delivery systems. Wear a mask during all neuraxial medication injections to reduce the risk of droplet transmission of oropharyngeal flora (see Standard 19, *Aseptic Non Touch Technique [ANTT®]*).[1-3,29] (IV)

E. Confirm position of external epidural/intrathecal access devices before any infusion or medication administration.
   1. Aspirate epidural access devices prior to medication administration to ascertain the absence of spinal fluid and blood; if greater than 0.5 mL of serous fluid is aspirated, notify the provider, and do not administer the medication, as this finding is indicative of catheter migration into the intrathecal space.
   2. Aspirate intrathecal and ventricular access devices prior to medication administration to ascertain the presence of spinal fluid and the absence of blood.[2,3] (A/P)

F. Use an electronic infusion pump with anti–free-flow protection to administer continuous infusions. Patient-controlled analgesia may be used with epidural infusions; ITDD systems provide precise medication dosage at constant or variable rates with refilling of the pump reservoir based upon the individual patient requirements

(eg, every 1-6 months) (see Standard 23, *Flow-Control Devices*).[2,3,13] (V)

1. Use an administration set without any injection ports with external epidural/intrathecal infusions to reduce the risk of inadvertent epidural/intrathecal access.[2,3] (V)

G. Provide pain management when accessing an implanted intrathecal drug delivery system, as this is a needle-related procedure (see Standard 30, *Pain Management for Venipuncture and Vascular Access Procedures*).[30] (V)

H. Ensure safe management of patients with an implanted intrathecal drug delivery (ITDD) system.

1. Ensure that clinicians who perform the access procedure, medication filling, and pump programming are educated and competent. Skills required include infusion pump interrogation and programming, pump refill with attention to ANTT, ability to recognize a "pocket fill" (accidental injection into surrounding tissue), and identification of residual volume discrepancies and actions to take.
   a. Inadequate training is reported; pump refill errors and nerve damage, whether from intraoperative injury, infection, or intrathecal granuloma formation, were causes of patient injury in an analysis of malpractice claims. Inadvertent pocket fills and programming errors were often performed by clinicians who lacked adequate education and training. Guidelines recommend a minimum of 20 supervised pump refills for competency assessment prior to refills being performed independently.[7,13,14,31-34] (IV)
   b. In a hospital at-home pilot program, successful pump refills by a nurse/physician team were effective and safe, with high reported patient satisfaction. The program included a post-refill ultrasound to ensure that there was no subcutaneous drug injection.[35] (V)
2. Observe patients for 30-60 minutes after a pump refill; an appropriate method to confirm a pocket fill is to re-access the pump reservoir to check for a volume discrepancy.[31,33] (V)
3. Evaluate for potential catheter dysfunction when there is an inadequate response to therapy despite adjustments in pump rate.[7,13] (IV)
4. Consider ultrasound guidance with pump refills if port is difficult to locate/palpate, and consider ultrasound to identify pocket fills; notably, ultrasound is less effective than use of palpation to identify the septum with a raised septum ITDD.[6,36,37] (V)
5. Monitor patient in controlled setting. Transfer to emergency department (ED) in the event of a pocket fill. Signs/symptoms include site swelling, patient report of burning/stinging during procedure, and technical difficulty during the fill procedure.[33] (V)
6. Evaluate patients admitted to the ED or hospital who have an ITDD. Obtain information about level of catheter tip; medications/concentrations via continuous, patient-administered dosage; if applicable, pump reservoir volume and date and refill alarm date; signs/symptoms of under/overdose of infusion.[13,18]

I. Apply and maintain a sterile dressing that is clean, dry, and intact over the insertion site, and secure the access site.

1. Use a securement product or tape a tension loop of tubing to the patient's body to reduce the risk of accidental dislodgement; external catheter (eg, epidural) dislodgment is a recognized risk. There are limited data about the optimal securement technique (see Standard 36, *Vascular Access Device Securement*).[2-4,38,39] (V)
2. Perform site care and dressing changes over a tunneled and accessed implanted neuraxial device in accordance with organizational policy; there are no evidence-based recommendations for routine site care and dressing changes. (Committee Consensus)
3. Avoid use of alcohol with device access and when site care is performed; use aqueous chlorhexidine solution or povidone iodine solution; however, allow any skin antiseptic agent to fully dry, as all antiseptic agents have the potential to be neurotoxic.[2,3] (V)
4. Use a transparent semipermeable dressing to allow for site visualization; consider the use of chlorhexidine-impregnated dressings for patients with an epidural access device. A significant reduction in epidural skin colonization and catheter tip colonization has been demonstrated with their use.[3,40] (I)

J. Assess and monitor patients frequently for 24 hours after initiating or restarting a neuraxial infusion (eg, every 1 to 2 hours until stable, then every 4 hours). Include the following assessment parameters[1,2,13,41,42]: (IV)

1. Pain rating using a validated pain scale based on the patient's age and condition, 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 epidural infusion for the patient in labor.
6. Presence of any side/adverse effects, such as pruritus, nausea, urinary retention, orthostatic hypotension, motor block, ringing in the ears.
7. Changes in sensory or motor function such as new onset of pain, unexplained back pain, leg pain, bowel or bladder dysfunction, and motor block.
8. Catheter exit site for any signs/symptoms of infection such as erythema, swelling, or local pain; catheters should be removed when such signs are present. Other signs/symptoms of infection may include back pain, tenderness, erythema, swelling, drainage,

fever, malaise, neck stiffness, progressive numbness, or motor block.

9. Signs of catheter tip migration, such as a change in external catheter length, decrease in pain control, or increased side effects.
10. Dressing for intactness and absence of moisture/leakage.
11. Catheter and administration set connections.
12. Electronic infusion pump for history of analgesic use and correct administration parameters.
13. ITDD pump-related complications, which may be evident as loss of pain control, oversedation with opioid infusions, or increased/decreased spasticity with baclofen infusions.
14. Oxygen saturation levels via pulse oximeter and end-tidal carbon dioxide levels (capnography) in accordance with organizational policy. Use of capnography is more sensitive in identifying respiratory depression than oxygen saturation monitoring.

K. Address the following patient education topics[2,3,13,33]: (V)

1. Principles of neuraxial access device placement and what to expect during the insertion procedure.
2. The importance of reporting alcohol use and all medications used, including prescription, over-the-counter, and complementary medications.
3. Signs and symptoms to report, including changes in pain perception, new or worsening side effects, and fever and to seek immediate medical care in the event of such signs/symptoms.
4. Clinical signs of overdose, including dizziness, sedation, euphoria, anxiety, seizures, and respiratory depression or underdose, such as increased pain or spasticity.
5. Patients with ITDD systems: no bending/twisting at the waist for 6 weeks and overall caution with active repetitive bending or twisting of spine, as these may increase the risk for catheter damage or dislodgement. Increased pain and withdrawal symptoms may be indicative of problems.

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Note: All electronic references in this section were accessed between January 13, 2023, and June 19, 2023.

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54. INTRAOSSEOUS ACCESS DEVICES

Standard

54.1 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 Recommendations

A. Use the IO route in the event of a cardiac arrest if intravenous (IV) access is not available or cannot be obtained promptly.[1-5] (IV)
   1. Pediatric advanced life support guidelines recommend the use of the IO route as an initial vascular access route in case of cardiac arrest or if intravenous access cannot be obtained within 30 seconds.[6,7] (V)
   2. Neonatal guidelines recommend umbilical access for resuscitation, but IO may be considered if intravenous (IV) access is not feasible. Venous access is recommended for blood and fluid expansion in the neonate (see Standard 28, *Umbilical Catheters*).[8-11] (IV)
      a. There is a paucity of evidence to guide IO utilization in neonate resuscitation, resulting in low utilization. Further research is needed to improve vascular access options when umbilical access is delayed or not feasible. A recent animal study noted similar survival outcomes in epinephrine delivery IO versus IV.[9,11-14] (IV)
   3. IO access has a reported high rate of first-time insertion success with low complications and reduced vascular access insertion attempts.[1,5,10,15-20] (II)
   4. Escalate to a venous access option if the patient status does not improve with IO use; prompt escalation facilitates rapid delivery of resuscitation medications and solutions (see Standard 25, *Vascular Access Device Planning and Site Selection*).[21-23] (IV)
   5. The clinical impact on patient outcomes of IO delivery of medications and fluid resuscitation versus IV (eg, peripheral or central) delivery requires further investigation.[2,3,21,24-31] (II)
      a. Multiple factors impact patient outcomes (eg, return of spontaneous circulation, survival to discharge, length of stay), leading to indeterminate recommendations and a need for further investigation to determine optimal IO use:

i. Lack of quality research (eg, heterogenous and retrospective methodology) regarding the impact of IO versus venous delivery.[24,25,32] (II)
   a) High-quality research is needed to illustrate pharmacokinetic properties from various IO sites to measure the impact of "time to intervention" and to prospectively measure outcomes in the critically ill patient.[5,23,24,29,31-33] (II)
ii. Preferential use of IO in high-acuity patients with higher risk of negative outcomes.[15,33-36] (IV)
iii. Reported underutilization of the IO route due to lack of training and available equipment to insert.[11,20,37-39] (IV)
iv. Transition to the IO once attempts at IV access are unsuccessful, causing potential deterioration in patient condition during that delay.[22,27,28,32,40-43] (III)
v. Lack of documentation of IO site or IV attempts in many clinical settings.[3,34] (IV)
vi. Factors that may reduce flow rates with IO use: viscosity of infusate, add-on devices, anatomic resistance in the medullary space, needle malposition, distal IO sites (proximal tibia, distal tibia).[5,32,44,45] (IV)
vii. Factors that influence bone perfusion and absorption: hypoperfusion states, hypovolemia, impact of catecholamines on red marrow, and lipid binding in medullary space.[5,27,32,45] (IV)

B. Consider the IO route for emergent and nonemergent use in patients with limited or no vascular access or when the patient may be at risk of increased morbidity or mortality if access is not obtained.
   1. Clinical situations where the IO route has been utilized successfully include hemorrhagic and septic shock, life-threatening seizures/status epilepticus, extensive burns, traumatic injuries, transfusion, severe dehydration, administration of anesthesia, rapid sequence intubation, hypertonic saline administration in acute intracranial hypertension, palliative/end-of-life care, and radiologic imaging with radiologic confirmation of placement prior to contrast administration. Consult manufacturer instructions for use to verify appropriateness of IO use in a specific clinical situation.[11,13,19,20,34,46-57] (III)
      a. Use caution with IO delivery of injectable lipid emulsion, based on a case report of delayed improvement in patient outcome.[58] (V)
      b. In a prospective interventional randomized clinical trial, resuscitation of pediatric patients with septic shock with IO insertion was associated with a significantly shorter time to vascular access, shorter length of stay, and reduced mortality when compared to resuscitation with peripheral IV access.[54] (III)
      c. Recent studies have reported low incidence of complications with IO administration of blood products. Research indicates successful delivery of whole blood, freeze-dried plasma, warm fresh whole blood (WFWB) in trauma settings, with secondary IO insertion potentially required in polytrauma situations. Further research is needed.[17,18,55,59,60] (II)

C. Restrict IO access in the following sites/situations:
   1. Absolute contraindications (related to anatomic issues): compartment syndrome in target extremity, previously used IO site or recent failed IO attempt, fractures at or above the site, previous orthopedic surgery/hardware, presence of infection or severe burns near the insertion site, local vascular compromise, and history of sternotomy.[1,19,61,62] (IV)
   2. Avoid use of IO access in the presence of bone diseases, such as osteogenesis imperfecta and osteoporosis.[1] (IV)

D. Improve appropriate use of the IO route through education and competency programs; underuse of the IO route in multiple settings is reported.
   1. Include the following in competency programs: initial and ongoing validation of safe insertion knowledge and skills through demonstration; demonstration of appropriate device management; ability to recognize complications related to IO access and IO removal (see Standard 5, *Competency and Competency Assessment*.[1,4,20,34,37,38,63,64] (IV)
   2. Conduct training for IO insertion under simulated challenging clinical situations (eg, biohazardous exposure, nighttime), using appropriate personal protective equipment (PPE) and supplies.
      a. Research conducted during the COVID-19 pandemic to compare IO and peripheral intravenous catheter (PIVC) access with full PPE in place indicates that PPE impacts dexterity and time to procedure completion, with reduced time to successful IO insertion compared to PIVC insertion.[65-68] (I)
      b. Use of the tactical headlamp was found to be superior to use of night vision goggles during nighttime IO insertion.[69] (III)

E. Use an appropriate IO device for the patient's age and condition. Performance (success rates, time of placement, ease of use, user preference) of different IO devices is dependent on training and user preference. There is no clear evidence of superiority of one device over another. In a 3-arm randomized clinical simulation study in neonates, IO needles were found to have higher rates of successful insertion when compared to an IO drill.[70] (III)

F. Consider the use of a safety-engineered IO device (see Standard 16, *Medical Waste and Sharps Safety*).[1,18,40] (IV)

G. Select an appropriate IO insertion site and needle size based on the clinical situation and in accordance with

manufacturers' directions for use. Current needle size recommendations are based on weight and age.

1. Adjust needle length for the thickness of skin over the IO insertion site in the child and adult (eg, with higher body mass index [BMI]).[71-75] (IV)
    a. Pretibial subcutaneous skin thickness correlates most strongly with BMI.[74] (IV)
2. Consider sites most commonly reported in the literature for use in both adults and children, including the proximal and distal tibia, the proximal humerus, distal femur, and the sternum in adults.[1,5,7,19,53,61,76] (IV)
    a. Sites less commonly reported in the literature include the medial surface of the ankle, radius, ulna, iliac crest, and clavicle. Alternative sites may be required due to traumatic injury, amputations.[1,60] (IV)
        i. The sternal insertion site is U.S. Food and Drug Administration (FDA)-approved for ages 12 years and older due to risk to retrosternal structures in pediatric patients. The sternal IO insertion site has been used successfully during chest compressions and offers the following advantages in chosen clinical situations: increased flow rates with gravity flow possible, lower density bone and minimal overlying skin for easier insertion, readily visible location, direct access to central circulation, presence of red marrow to improve absorption.[17,34,55,61] (II)
        ii. In a radioanatomical study, the optimal adult proximal tibial IO insertion site was found to be 0.5 cm below the tibial tuberosity at the midline of the medial surface, with the standard needle length noted to be 17 mm.[71] (IV)
        iii. A cadaveric study of neonates suggests that the proximal humerus and distal femur can be considered IO insertion options.[77] (IV)
3. Ensure that proper landmarks are identified prior to insertion to avoid complications related to improper placement. Ultrasound visualization improves landmark identification.[73] (IV)
4. Ultrasound has been found to be reliable in identifying proximal humerus landmarks in patients of various BMIs.[39,72,73] (IV)
5. Obesity is identified as a common factor for insertion failure due to difficulty identifying landmarks.[5,72] (IV)

H. Consider the use of subcutaneous lidocaine as a local anesthetic prior to insertion at the intended site. For infusion-related pain, consider IO administration of 2% preservative-free and epinephrine-free lidocaine given slowly prior to infusion initiation.[1,7,19] (IV)

I. Adhere to Aseptic Non Touch Technique (ANTT®) during IO placement and infusion. Consider the complexity of placement of the IO access device, including consideration of use of sterile gloves when placing IO devices (refer to Standard 19, *Aseptic Non Touch Technique [ANTT]®*).
    1. Perform skin antisepsis using an appropriate solution (eg, alcohol-based chlorhexidine, povidone-iodine, 70% alcohol) based on organizational policies and procedures. There is no evidence addressing the optimal antiseptic solution for IO insertion.[1,78-80] (IV)

J. Confirm correct placement of the IO device by assessing the following: correct needle position, sensation of loss of resistance upon bone penetration, and absence of any signs of infiltration upon flushing with 5- to 10-mL (adult) or 2- to 5-mL (pediatric) preservative-free 0.9% sodium chloride. The ability to aspirate blood or bone marrow also assists in confirmation but may be difficult in certain patients (eg, severe dehydration) and, therefore, is not an indication of improper placement if other indications of placement confirmation are present.[1,19] (IV)
    1. Consider the use of color Doppler ultrasound to confirm initial and ongoing placement.[19] (V)

K. Consider reserving the initial IO aspirate for laboratory analysis when there are no other options. Use caution in interpretation of laboratory results of IO aspirate, as IO blood samples have been found to have inconsistent correlation with venous and arterial samples in the critically ill.[1,54,81] (II)
    1. IO aspirate point of care testing has been found to be accurate for glucose, calcium, sodium, pH, and bicarbonate. Potassium levels drawn from the IO may overestimate serum levels but may be helpful to rule out hyperkalemia.[82] (IV)
    2. IO blood sampling may be accurate for blood typing. IO aspirate should not be used for rotational thromboelastometry (ROTEM) in trauma care due to increased coagulation.[83,84] (IV)
    3. The majority of blood sampling research has been conducted on healthy subjects. Further research is needed to establish reference values for IO laboratory values and to improve the validity of laboratory analysis from IO aspirate in critically ill patients.[81] (II)

L. Apply a sterile dressing over the IO access site and secure the device.
    1. Ensure that securement is intact prior to transport to prevent dislodgement.[1,19,85] (III)

M. Use an external pressure device (300 mm Hg) or infusion pump for consistent solution/medication delivery. IO infusion may be successfully administered via gravity; however, significant variability in flow rates based on the device and site of insertion have been demonstrated.[1,17,19,44,55,85] (II)

N. Monitor for complications associated with IO access. While the rate of immediate complications is very low, data regarding long-term complications is lacking. Potential IO-related complications include infiltration and extravasation (into surrounding tissue and intra-articular), compartment syndrome, iatrogenic

bony fracture, site infection, osteomyelitis, fat and air embolism, and traumatic bullae.[1,19,79,80,85-92] (IV)

1. Reduce risk for infiltration/extravasation by avoiding multiple attempts at IO access at the same site; ensuring proper needle placement (straight path, perpendicular); properly securing IO device; monitoring flow and loss of flow, immobilizing the involved extremity if required, validating IO placement and patency with transport or repositioning of the patient and before infusing highly irritating solutions/known vesicants and large-volume infusions; ongoing assessment of the IO site and extremity, including palpation and calf circumference for tibial placement; and limiting infusion time to less than 24 hours (see Standard 44, *Infiltration and Extravasation*).[1,19,28,43,62,75,79,80,86,92] (IV)
    a. Infants and young children may be at greater risk for extravasation and subsequent compartment syndrome due to small bone size and inappropriate needle length.[9,40,75,93] (IV)
        i. In a postmortem study of infants after IO insertion, a 53% failure rate (nonmedullary placement) was noted in infants 6 months and younger.[37] (IV)
2. Observe and promptly treat patients for IO-related complications. Infectious complications are more likely to occur with prolonged infusion or if bacteremia was present during the time of insertion. Risk of IO-related fat emboli may be increased with rapidly repeated infusions or high flow rates.[1,79,87-91] (IV)
3. IO-related complications may be delayed in presentation. Accurate documentation of IO insertion (location, failed attempts), duration, and removal is critical to assure proper identification of IO-related complications, such as infection, fracture, or nerve injury.[19,62,94] (V)

O. Promptly remove the IO device within 24 hours, when therapy is complete, or if signs of dysfunction occur. Dwell time for specific devices may be extended (not to exceed 48 hours total) in instances where alternative vascular access is not successfully established. Follow manufacturers' directions for use and removal of IO device to reduce risk of complications.[1,4,19,85] (IV)

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55. SUBCUTANEOUS INFUSION AND ACCESS DEVICES

Standard

55.1 The subcutaneous route is considered as an alternative to intravenous (IV) access as part of a vessel health and preservation strategy.

55.2 The patient is assessed for appropriateness of the subcutaneous route in relation to the prescribed medication or solution, the patient's clinical condition, and the presence of adequate subcutaneous tissue.

Practice Recommendations

A. Consider subcutaneous administration of isotonic solutions (hypodermoclysis) for treatment of mild-to-moderate dehydration in both older adults and children as an alternative to the IV route when the oral route is not feasible; outcomes are favorable relative to effectiveness, safety, acceptability, and efficiency.[1-6] (I)
   1. Advantages include ease of access, simplicity of procedure, cost-effectiveness, and patient satisfaction. Home-based hypodermoclysis may be administered by caregivers with minimal burden, equipment, and technical support.[1,7] (I)
   2. Contraindications to hypodermoclysis include severe dehydration or malnutrition, severe electrolyte disturbances, decreased tissue perfusion, compromised skin integrity/evidence of skin infection, bleeding/coagulation disorders, and generalized edema.[1] (IV)
   3. Local site reactions include transient swelling, erythema, and pain with needle access; the risk for local reactions is reduced with attention to infusion rate and proper needle placement.[1,3] (I)
   4. Reported infusion rates vary widely among studies[1,3]: (I)
      a. Older adults: 5 to 167 mL/hour or boluses of 500 mL over 2 to 6 hours
      b. Pediatric patients: 15.4 mL/kg/hour
      c. Palliative care patients: 42 to 72 mL/hour.

B. Consider the subcutaneous infusion of medications:
   1. Ideal medications for subcutaneous administration are hydrosoluble, of neutral pH, have low viscosity, and have low molecular weight. Based upon outcomes evaluating effectiveness, safety, acceptability, and efficiency, evidence was strong for subcutaneous administration of the following 10 medications, including opioids (hydromorphone, morphine, ketamine), antimicrobials (ceftriaxone, ertapenem), hydrocortisone, trastuzumab, immunoglobulin, treprostinil, and deferoxamine.[3,8] (I)
   2. Antibiotics with longer half-lives that are well-absorbed and well-tolerated are appropriate for subcutaneous infusion, including ceftriaxone and ertapenem. Adverse events associated with antibiotics included local pain, hematoma, induration, and erythema.[9] (IV)
   3. Subcutaneous or IV administration of diuretics in the management of heart failure was associated with symptom relief and low risk of adverse effects based upon a systematic review. A new subcutaneous formulation of furosemide was made available for home treatment in 2022 (see Standard 66, *Home Infusion Therapy*).[10,11] (I)
   4. Avoid infusion rates greater than 5 mL/hour unless recommended by manufacturer (eg, subcutaneous immunoglobulin).[3,12,13] (I)

C. Consider the use of hyaluronidase in both adults and pediatric patients for initiation and maintenance of subcutaneous hydration and for some medications to facilitate dispersion and absorption of the infusate. Consult drug information references to determine stability and compatibility with hyaluronidase.[1,3,6,14,15] (V)

D. Recognize that continuous subcutaneous insulin infusion is a common therapy for patients with diabetes mellitus and requires safe management across care settings.[16,17] (IV)
   1. Establish policies and procedures to assess patient appropriateness for self-management of insulin therapy during hospitalization and to guide patients and nursing staff in the management of continuous subcutaneous insulin infusion. Patients who are familiar with treating their own glucose levels can often adjust insulin doses more knowledgably than inpatient staff who do not personally know the patient or their management style.
   2. Supervise patients to ensure their ability to adjust insulin doses in a hospitalized setting, where factors such as infection, certain medications, immobility, changes in diet, and other factors can impact insulin sensitivity and the response to insulin.

E. Select an appropriate subcutaneous site.[1,3,6,13] (I)

1. Consider patient's comfort, mobility, and site preference. Select areas with intact skin and adequate subcutaneous tissue (eg, 1.0-2.5 cm), abdomen (at least 4 fingers-width away from the umbilicus), upper chest, upper extremities, flank, hips, thighs, and/or as recommended by the drug manufacturer.
2. Avoid sites near bony prominences, joints, previous surgical incisions, radiotherapy, damaged skin, intercostal space in patients with cachexia (due to high risk of pneumothorax), mastectomy, tumors, ascites, lymphedema, inner thigh if urinary catheter present, or thigh if peripheral vascular insufficiency exists.

F. Adhere to Aseptic Non Touch Technique (ANTT®) during subcutaneous access device insertion and infusion; perform skin antisepsis prior to inserting the subcutaneous access device (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*; Standard 31, *Vascular Access Site Preparation and Skin Antisepsis*).

G. Use a small-gauge (eg, 24- to 27-gauge) and short-length nonmetal cannula with luer-lock design for infusions. A metal-winged needle is not recommended for infusions; however, use a subcutaneous needle labeled for high flow rates when indicated by the drug manufacturer.[1,3,6,8] (I)
   1. May use 2 or more sites, as required for high-volume hydration solutions (eg, up to 1 L/d per site).

H. Remove and insert new device at a new site if blood return is present during device placement.[6,13] (V)
   1. Due to a lack of data and the low likelihood of injecting subcutaneous immunoglobulin (SCIg) into a small blood vessel, assessment of blood return prior to SCIg varies by manufacturer.[8] (V)

I. Apply a transparent semipermeable membrane (TSM) dressing over the site to allow for continuous observation and assessment. Change the TSM dressing with each subcutaneous site rotation or immediately if the integrity of the dressing is compromised.[3,6,13] (I)

J. Assess the subcutaneous access site and rotate the site as follows:
   1. As clinically indicated, based on access site assessment findings (eg, erythema, swelling, leaking, local bleeding, bruising, burning, abscess, or pain).[6,12,13] (V)
   2. For hydration solutions, reported dwell times range from 24 to 48 hours or after 1.5 to 2.0 liters of solution have infused.[6,12] (IV)
   3. For continuous medication infusion, every 2 to 7 days; for intermittent infusions (eg, SCIg), the site is changed with each infusion. Site reactions from SCIg (eg, swelling and site erythema, pain, and pruritus) are common and tend to decrease over time, with persistent reactions possibly requiring a slower infusion rate or decreased volume per site, longer needle, or site change.[3,6,8,12,13] (I)

K. Regulate the flow rate of the infusion. The following devices have been reported for use with:
   1. Hypodermoclysis: gravity infusion set, electronic infusion pump; gravity infusion may reduce risk for local edema, as the infusion will naturally slow down with increased pressure in the subcutaneous tissue.[1,3,7,14] (I)
   2. Medications: mechanical infusion device; electronic infusion pump; newer "on body" delivery systems consist of a type of infusion pump that is adhered to the skin and delivers the subcutaneous dose.[3,8,9] (I)

L. Monitor patient and access site regularly (refer to Standard 39, *Vascular Access Device Post-Insertion Care*).

M. Address the following patient education topics:
   1. Signs/symptoms of access site complications and how/where to report.
   2. Activity limitations/protecting the subcutaneous access site (refer to Standard 8, *Patient Education*).

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Note: All electronic references in this section were accessed between October 20, 2022, and July 21, 2023.

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Section Nine: Infusion Therapies

Section Standards

I. Current references and resources on infusion medications and solutions are readily available to the clinician at the point of care.
II. At least 2 patient identifiers, including patient's full name (or distinct methods of identification for infants), are used to ensure accurate patient identification when administering medications.
III. Aseptic Non Touch Technique (ANTT®) is applied to all infusion-related procedures as a critical aspect of infection prevention.

56. COMPOUNDING AND PREPARATION OF PARENTERAL SOLUTIONS AND MEDICATIONS

Standard

56.1 Parenteral solutions and medications are compounded in accordance with laws, rules, and regulations established by regulatory and accrediting bodies in each jurisdiction (eg, countries, states, provinces).
56.2 Parenteral solutions and medications are compounded and/or prepared following processes to create a sterile product.

Practice Recommendations

A. Administer, whenever possible, medications that have been compounded (prepared, mixed, packaged, and labeled) in a pharmacy that complies with compounding standards and regulations.[1-6] (I)
   1. Do not compound, reconstitute, or otherwise manipulate hazardous medications outside the environmentally controlled hazardous drug preparation area (refer to Standard 15, *Hazardous Drugs and Waste*).
   2. Use infusions supplied by the manufacturer or pharmacy in a ready-to-administer form to minimize the need for manipulation outside the pharmacy sterile compounding area. Infusions prepared or manipulated outside the pharmacy are more likely to contain microbial contamination.
   3. Perform complex compounding preferentially in the pharmacy environment.
      a. Whenever possible, medications that require special attention during the compounding or preparation process should be supplied to the nurse in a ready-to-administer form. Such medications may include those requiring filtration during preparation, susceptible to microbial growth (eg, lipids or dextrose), involving a complex calculation, requiring dilution, or those with long dissolution times, multistep procedures, or specialized reconstitution instructions.
      b. Limit preparation to the pharmacy, whenever possible, when it is necessary to combine more than 1 medication in a single syringe for intravenous (IV) administration or more than 3 sterile products into a final product for administration.

B. Avoid unnecessary manipulation to decrease the risk of dosing errors and contamination.[4,6,7] (IV)
   1. Do not withdraw IV push medications from commercially available, cartridge-type syringes into another syringe for administration.
   2. After measuring the dose in an appropriately sized syringe, do not transfer the medication to another (eg, larger) syringe prior to administration.
   3. Avoid unnecessary dilution. Only dilute IV push medications when recommended by the manufacturer or in accordance with organizational policies, procedures, or practice guidelines.
   4. Use single-use, commercially prepared, prefilled syringes of appropriate solution to flush and lock vascular access devices (VADs) (refer to Standard 38, *Flushing and Locking*).
   5. Dedicate multidose vials (eg, multidose vial if used for IV flush) to a single patient.

C. Prepare medications and assemble needed supplies in a clean area using a General Aseptic Field/Micro Critical Aseptic Field in accordance with Aseptic Non Touch Technique (ANTT®) (see Standard 19, *Aseptic Non Touch Technique [ANTT®]*).[1-13] (III)
   1. Compound outside of the pharmacy only when performing in immediate-use situations with appropriate precautions to limit patient risk.

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2. Use a syringe small enough to accurately measure the dose. For improved accuracy, select a syringe close in volume to the desired dose, such that at least 20% of the syringe capacity is occupied by the dose. For hazardous drugs, to decrease the likelihood that the plunger separates from the syringe barrel, use a syringe sized such that no more than 75% of the capacity is occupied by the dose.
3. Remove contaminants physically and chemically by wiping the Key-Site (eg, vial stopper, bag septum, or ampoule neck) with 70% isopropyl alcohol prior to vial/bag access or breaking of an ampoule. Allow the disinfectant to dry prior to entry of the vial/bag or breaking of the ampoule.
4. Use a second clinician to check that the volumes and identities of all compounding ingredients are correct (including any diluents) prior to combining the ingredients.
    a. Whenever possible, the second clinician should be a pharmacist who remotely verifies the compounding process through video or still images.
5. Use vials (a closed system) instead of ampoules (an open system) to decrease microbial contamination risk.
    a. Use a filter every time medication is withdrawn from an ampoule.
        i. Use a 5-micron or smaller filter straw or blunt fill filter needle to withdraw medication from an ampoule and immediately discard any leftover medication along with the broken ampoule and the filter straw or filter needle. The use of a blunt fill needle or filter straw decreases the likelihood that the medication is inadvertently administered through the used filter. If a needle is required for administration, after discarding the filter needle or filter straw, place a new needle on the syringe prior to administration. Do not infuse or inject medication through a filter needle that was used to draw up medication.[14] (II)
6. Only use supplies intended for compounding.
    a. Do not use IV solutions in containers intended for infusion, including minibags, as common-source containers to dilute or reconstitute medications.
    b. 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.
7. Label any prepared medications (that are not immediately administered) at the location of preparation without any break in the procedure. Protect Key-Parts (eg, injection needle) from contact with nonsterile surfaces, biological fluids, or particulate matter (including aerosolized particles). If administration of the immediate-use sterile product has not begun within 4 hours of preparation, discard the product (refer to Standard 57, *Infusion Medication and Solution Administration*).
8. Never reuse compounding supplies either for the same patient or different patients.
    a. Use medications packaged as single-dose or single-use for only 1 patient.
    b. Use a new needle and syringe for every entry into a vial or bag and for every injection. Never use the same needle or syringe to administer medication to more than 1 patient.
9. Use a multidose vial for up to a maximum of 28 days after opening or first puncture unless there is a different beyond-use date (BUD) specified by the manufacturer. After the first use, label the multidose vial with the BUD. The BUD should never exceed the manufacturer's expiration date.
    a. Whenever possible, use multidose vials for only 1 patient. Multidose vials used for more than 1 patient should never enter the immediate patient care area. If a multidose vial has entered the immediate patient care area, it must become dedicated to that patient only and discarded after use.

D. Provide education and ongoing (at least annual) competency assessment. Nurse medication administration skills were found to need improvement, particularly in the areas of medication preparation and administration.[3,7,15] (II)

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Note: All electronic references in this section were accessed between August 4, 2022, and August 11, 2023.

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57. INFUSION MEDICATION AND SOLUTION ADMINISTRATION

Standard

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

57.2 The prescribed medication/solution, including indications, dosing/diluent, acceptable infusion routes/rates, compatibility data, and adverse/side effects is reviewed for appropriateness prior to administration.

57.3 Concerns about the appropriateness of orders are addressed with the pharmacist, provider, supervisor, and/or risk management, or as defined in organizational policy.

57.4 The infusion system is inspected for clarity of the solution and integrity of the system (ie, leakage, secure connections), accurate flow rate, and for expiration date and beyond-use date (BUD) of the infusate and administration set prior to infusion.

Practice Recommendations

A. Perform a medication reconciliation at each care transition and when a new medication is ordered (eg, admission, transfers to different levels of care, discharge to new health care setting). Include verification of discontinued medications to reduce the risk of medication errors, including omissions, duplications, dosing errors, and drug interactions.[1-6] (I)
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 (refer to Standard 2, *Special Patient Populations*).
C. Use a structured clinical reasoning guide or set of cues (eg, the "rights" of medication administration, WARRIORS acronym below) to support safe medication administration.
    1. Perform a cognitive review of all components of the medication assessment, including and beyond the medication rights (eg, appropriateness of drug, dose, route, compatibility of multiple drugs, monitoring test results, flow-control device settings, correct infusion is activated).[7,8] (V)
    2. Teach patients/caregivers who administer medications to consistently confirm the medication cues.[9,10] (V)
    3. The WARRIORS clinical guide for medication administration[8]: (V)
        a. Why: what is the reason this patient is receiving this medication?
        b. Allergies: Does the patient have allergies? If so, will I give or hold this medication?
        c. Right laboratory values and vital signs: What are the laboratory values or vital signs that are trending out of range for the patient or will be impacted if this medication is administered or withheld?
        d. Range: What is the correct range? Is this dose incorrect or correct?
        e. Implications or interactions: What are the implications and interactions of this medication for this patient?
        f. Only: Am I the only nurse giving this medication?
        g. Return: When should I return for reassessment?
        h. Safety: What should the patient be taught for safe use now or at discharge?
D. Avoid interruptions during all phases of medication administration, and educate staff, patients, and families, as there is a significant association between medication errors and interruptions.[11] (V)
    1. Set up multiple infusions one at a time. Set up each infusion as completely as possible before beginning preparation of the next infusion (ie, label set and pump, spike and hang solution container, connect set to pump, and program pump).[4,12-14] (V)

E. Implement safeguards to reduce the risk of medication errors with high-alert medications, as follows:
   1. Standardize storage, preparation, and administration (eg, standard order sets, standardized drug concentrations, and dosing units); improve access to drug information; limit access (eg, stored securely, limited quantities); use supplementary labels and automated alerts.[15-17] (V)
   2. Consider using centralized pharmaceutical reconstitution/admixture service to minimize errors and optimize delivery of medication.[2,13,18,19] (I)
   3. Perform an independent double-check by 2 clinicians for the organization's selected high-alert medications that pose the greatest risk of harm (eg, opioids, insulin, heparin, chemotherapy).
      a. Develop a standard process and educate staff in how to perform the double-check. Consider the use of a checklist.[17,20,21] (II)

F. Organize the infusion administration system to minimize errors related to multiple infusions and variations in infusion delivery methods (refer to *Table 1: Medication/Infusion Delivery: Dose Accuracy and Error Prevention*).

G. Use approved, standardized nomenclature for communication of medication information. Use a list of error-prone drug names, abbreviations, symbols, and dose designations (eg, sound-alike, look-alike drugs) to implement safeguards to reduce the risk for medication errors, such as using both generic and brand names; including reason for medication on label; and changing the appearance of look-alike names by using approved, bolded, tall man (mixed-case) lettering.[4,9,14,17,22,23] (V)

H. Use technology when available to verify medications prior to administration as one of multiple infusion safety strategies. Analyze effectiveness and limitations related to technology through organizational quality improvement (QI) processes.[12,23-31] (II)
   1. Use barcode scanning (preferred) or similar technology immediately prior to the administration of medication (unless its use would result in a clinically significant delay and potential patient harm, such as in cardiac arrest). Barcode scanning is associated with decreased risk of medication errors and is increasingly common among acute care organizations, and there is emerging research supporting its use in long-term care settings. Studies have reported that errors still occur, as staff may create "work-arounds" that bypass safety mechanisms with barcode technology.[17,32] (I)
   2. Use electronic infusion pumps that include dose error reduction systems ([DERS], ie, smart pumps) with current and relevant drug libraries, as these are associated with reduced risk for infusion-related medication errors, including error interceptions (eg, wrong rate) and reduced adverse drug events.[12,17,24-30,33] (II)
      a. Provide regular education and training, including usability issues and avoidance of work-arounds, and assessment of use for both routine users and new staff members; failure to comply with appropriate use, overriding of alerts, and use of the wrong drug library contribute to the risks associated with smart pumps and high-risk medications.[12,17,24-30,33] (II)
   3. Use medication labels consistent in format and content from the electronic infusion pump drug library to the infusion reservoir (eg, bag labels) to the health record documentation.[33-36] (IV)

I. Assess vascular access device (VAD) function and patency prior to administration of parenteral solutions and medications and during continuous infusions, as clinically indicated.
   1. Assess patency during a continuous infusion when the following are present: sluggish infusion (eg, gravity infusion), frequent infusion pump alarms, leakage of fluid from the insertion site, pain during infusion, and/or signs/symptoms of infiltration/extravasation (see Standard 38, *Flushing and Locking*).[10] (V)
   2. Assess patency during a continuous infusion by attaching a syringe to the lowest injection port on the administration set; do not disconnect administration set from the VAD hub. (Committee Consensus)
      a. When blood return is sluggish/absent or assessment of blood return is contraindicated due to the patient's condition (eg, hemodynamic instability dependent on vasopressor delivery), VAD patency should be evaluated through alternative signs, including ongoing clinical response to an infusing medication, lack of resistance to flushing, site evaluation, and patient symptom report. This assessment can assist in determining patency.
      b. For a peripheral VAD (eg, short/long peripheral intravenous catheter [PIVC], midline) that no longer has a positive blood return, increase the frequency of assessment of the insertion site and the venous pathway of the VAD to minimize the risk and severity of complications, such as infiltration, extravasation, and occlusion. If using the PIVC for vesicant administration, plan to transition the infusion to a new VAD when clinically possible. Peripheral administration of certain antineoplastic vesicants is contraindicated in the absence of blood return (refer to Standard 58, *Antineoplastic Therapy*).
      c. In situations with increased line/luminal volume and high-risk medications (eg, vasopressors, inotropics), aspirating for blood return might be contraindicated in patients where interruptions of the infusion or inadvertent bolus could cause a clinically relevant decline in the patient's

TABLE 1

Medication/Infusion Delivery: Dose Accuracy and Error Prevention

Clinical situation	Factors to consider	Practice recommendations

Intermittent secondary medication administration small-volume medications (50—100 mL)	• Potential for incompatibility of primary solution to subsequent intermittent medications.
	• Increased risk of contamination if intermittent set is disconnected from primary set, then reconnected later.
	• Risk of secondary medication infused at incorrect rate that primary solution is set for.
	• Incomplete delivery of dose if administered on a primary line. It is estimated that up to 33% dosage loss occurred when intermittent medications were delivered (via gravity and flow-controlled devices) without adequate flush after delivery, reducing therapeutic effect of medication, increasing time to minimum inhibitory concentration for antibiotics.[39]
		• Ensure a consistent process is used for delivery of all intermittent medications to promote accurate dose delivery and reduce infection risk.[40,41] (IV)
		  • Use a primary continuous administration set with a back-check valve to prevent retrograde flow of the medication into the primary solution container, and connect to a port above the electronic infusion pump.[14,42] (V)
		  • Consider the compatibilities of all infusions, volume of each intermittent medication, any overfill, the priming volume of the administration set, any shared volume, and the infusion pump function/variability.[40,41,43,44] (IV)
		  • Deliver small-volume intermittent medications on secondary tubing with a carrier fluid on the primary administration set; follow administration with a flush of adequate volume to ensure full dose delivery and prevent incompatibilities. Monitor fluid intake.[39,40,45-49] (IV)
		  • Consider adopting a uniform administration process, where all intermittent medications are given via secondary tubing, with primary fluid as carrier, and administration is followed with flush to assure full dose delivery to standardize the process. (Committee Consensus)
		  • Manage the height of each infusate per flow-control device and administration set manufacturer indications to ensure accurate dose delivery. Recent studies have found head height differential to be a persistent knowledge gap for clinicians, challenging to adhere to in many clinical settings, and a significant source of medication errors. Further education and technological advancement are needed to promote patient safety.[41,50-52] (IV)
		• Ensure that antimicrobial medications are infused with minimal loss of drug as a component of antimicrobial stewardship.[53] (IV)
		• Avoid disconnecting intermittent sets from primary administration set, when possible, by establishing compatibility of medications.
		  • If the intermittent medications that are to be connected to a primary set are compatible, use 1 secondary administration set and back prime from the primary infusion container.
		  • If intermittent medications given as secondary infusions are incompatible with each other, use a different secondary set with each medication and ensure an adequate flush of the primary set between medication administrations (see Standard 40, *Administration Set Management*). (Committee Consensus)
		• Avoid administration of continuous infusions (eg, rate-sensitive, narrow therapeutic window) as a secondary medication to avoid delay in delivery or inadvertent bolus.[41] (V)

IV push medications	• Risk of inadvertent bolus or delayed delivery of IV push medications.	• Administer IV push medications through an injection port closest to the patient, at the rate recommended by the drug manufacturer and/or per organizational policy/practice guidelines. Complete the administration by flushing the line at the same rate to ensure that the entire dose has reached the bloodstream (see Standard 38, *Flushing and Locking*).[54] (V)

(*continues*)

TABLE 1

Medication/Infusion Delivery: Dose Accuracy and Error Prevention (*continued*)

Clinical situation	Factors to consider	Practice recommendations
More than 1 infusion required for a patient and/or multiple routes in use (eg, peripheral, central, epidural, hemodynamic monitoring)	• Risk of dose error if pump is programmed for the wrong medication or concentration. • Risk of incompatibility, dose error if a medication is connected to a medication that is incompatible or should not be delivered at a faster than intended rate. • Risk of tension on lines, VAD malposition during repositioning/mobility. • Risk of misconnection/disconnection. • Risk of dose error if discontinued medication is left connected to a chain of administration sets.	• Limit use of add-on devices to only those clinically indicated to reduce risk for contamination and dosing errors (refer to Standard 35, *Other Add-On Devices*). • Trace all catheters/administration sets/add-on devices between the patient's VAD and the solution container before connecting or reconnecting an infusion/device and with transitions in caregivers. Label each tubing with the route and medication/solution near the connection to the solution container and near the patient's access site.[4,14,16,41,47,55] (V) • Align the solution container/bag with the corresponding infusion device(s)/channels.[41,47,55] (V) • Do not force connections; validate that the administration set is configured to be connected to a device/VAD prior to connection.[55] (V) • When preparing multiple infusions for administration, set up each infusion as completely as possible before beginning preparation of the next infusion (ie, label set and pump, spike and hang container, connect and program pump).[6] (V) • Promptly disconnect the administration set when discontinuing a medication. Patient harm has resulted from incorrectly infusing a discontinued medication when left connected to the patient.[56,57] (V)
Patient movement or mobility with 1 or more attachments (eg, ECG cable, administration sets)	• Risk of disconnection, misconnection to administration sets. • Risk of tension on administration sets and VAD insertion site. • Risk of patient injury/dose error if tubing is not connected properly.	• Train unlicensed staff not to disconnect or reconnect IV administration sets. In some instances (ie, home care), caregivers may be trained to aseptically disconnect and connect administration sets.[55,58] (V) • Use a process and/or device (ie, secondary securement) to stabilize administration sets and other lines during patient repositioning and mobilization (see Standard 37, *Site Protection and Joint Stabilization*).[59,60] (IV)
High-risk medication administration using large volume flow infusion pump (eg, medications that have a high risk of causing significant patient harm when the infusion is not delivered as indicated, such as vasopressors, anti-arrhythmic)	• Delays/inadvertent bolus if given as secondary.	• High-risk medications should be administered on a primary administration set, not as a secondary, to prevent inaccurate dose delivery.[41] (V)
Change in concentration of an infusion	• Potential of dosing error (ie, reduction or escalation) with change in rate if primary administration set retains previous concentration.	• Consider changing tubing with a change in concentration of a solution or medication.[41] (V)
Antineoplastic medication that requires rate changes during administration	• Potential for dosing error if primary administration set is not properly primed.	• For medications that require rate increases, prime the tubing with the antineoplastic medication. Utilize engineering controls (priming the line under a biosafety cabinet with a CSTD on the end of the tubing) to prevent HD exposure (see Standard 58, *Antineoplastic Therapy*).
Hemodynamic readings performed with continuous and/or intermittent medications given in same lumen	• Risk of interruption and/or bolus of medication.	• Avoid connection of a continuous IV medication to a lumen where central venous pressure monitoring and/or cardiac output measurements will be obtained.[41] (V)

(*continues*)

TABLE 1

Medication/Infusion Delivery: Dose Accuracy and Error Prevention (*continued*)

Clinical situation	Factors to consider	Practice recommendations

Multiple medications infused in a single VAD or single lumen of a multi-lumen VAD "shared volume"	• Risk of bolus or delay in delivery due to increased dead or shared volume.
	• Risk of incompatibility.
		• Limit "shared infusion volume/space" by administering primary continuous infusions as close to the patient VAD site as possible to reduce dose variability.[41,47,61] (V)
		  • Use parallel extension set (multiple lumen extension set with minimal inner luminal volume) rather than multiple stopcocks or manifold.
		  • Connect IV infusions as close as possible to the hub of the VAD. Do not sequentially connect more than 1 primary continuous administration set to the Y-sites of other sets connected to the same lumen (ie, daisy chain), to prevent dose inaccuracy.[62,63] (V)
		• Consider tubing compliance, presence of filters, compatibility, and variability of flowrates when multiple medications are delivered in the same VAD/lumen and adjust delivery as indicated.[41,63] (V)
		• Avoid sudden rate change to 1 medication where other infusates are being concurrently administered, as this may cause an inadvertent bolus of medication(s).[41,61,63] (V)

Syringe pump exchange of high-risk medications (eg, medications that have a high risk of causing significant patient harm when the infusion is not delivered as indicated, such as vasopressors, anti-arrhythmics)	• Risk of inadvertent bolus or delay in dose during syringe initiation, administration set, or syringe exchange when administering medications with narrow therapeutic window (ie, vasopressors), with elevated risk of error in infusions delivered at low rates (eg, 5 mL/hour or less)	• Optimize syringe delivery of high-risk medications through standardized concentrations and flow rates of high-risk medications, identification of optimal syringe sizes for required flow rates, and length and type of administration set size. Follow manufacturers' instructions. • Establish a protocol for syringe and administration set exchange of high-risk medications that accounts for patient variations and eliminates interruption or inadvertent bolus delivery. • Ensure proper height of syringe pump during delivery of high-risk medications to avoid delivery errors; follow manufacturers' recommendations based on pump function.[64-68] (IV)
Pumps outside of room during critical shortage of supplies (eg, COVID-19 pandemic)	• Increased infection risk with potential for tubing misconnections. • Increased risk of inaccurate dose delivery with increased length of tubing/varying tubing compliance. • Potential for decreased surveillance of patient. • Potential for decreased attention to pump alarms.	• Carefully consider the risks and benefits of adding extension tubing to enable moving pumps outside of the patient room. • Monitor the processes to ensure that pump alarms are being addressed. • Monitor therapeutic effect of medications being administered to ensure that the clinical outcomes are being achieved. • Assess VAD sites as indicated by patient risk. • Respond to pump alarms promptly with assessment of full system to determine source.[56,69,70] (V)
Increased risk of patient harm from strangulation or entanglement with administration set	• Patient risk factors (ie, extremes of age, risk of self-harm, fall risk) that may contribute to injury from presence of tubing.	• Consider risks/benefits of continuous versus intermittent medication delivery. • Provide increased supervision or video surveillance as indicated. • Avoid use of additional extension sets. • Consider use of a device (eg, medical tubing stabilizer, administration set safety release connector) to reduce risk. • Evaluate impact of nearby structures (eg, side rails) and reposition device/tubing as indicated. • Use accessories (eg, sleeve) over insertion site/tubing to provide secondary securement, central line vest (see Standard 37, *Site Protection and Joint Stabilization*).[71,72] (V)

Abbreviations: CSTD, closed system transfer device; ECG, electrocardiogram; HD, hazardous drug; IV, intravenous; VAD, vascular access device.

condition. In these patients, blood return could be evaluated when the infusion is paused for other reasons (eg, bag change, blood draw, tubing change). Increase the frequency of assessment of the insertion site and clinical response to the medications (refer to Standard 65, *Vasopressor Administration*). (Committee Consensus)

J. Administer the first dose of medications with an appreciable risk of a severe allergic/anaphylactic reaction or other unknown response (eg, antimicrobials, immunoglobulins [Igs]) in nonacute care settings (eg, home, skilled nursing facility) only if conditions for safe administration are evaluated and verified[10,14,22,37]: (V)
   1. Patient has no history of allergy to medications in the same class.
   2. Patient is alert, cooperative, and able to respond appropriately.
   3. There is reasonable geographic access to emergency services, should a severe reaction occur.
   4. The first dose is administered under clinician supervision with ability to respond to a life-threatening immediate hypersensitivity or anaphylactic reaction. The patient is observed for at least 30 minutes after infusion of the first dose is completed.
      a. Recognize that the first exposure may not result in or cause a reaction and that the risk exists with subsequent exposures. Educate the patient/caregiver in signs and symptoms of reactions and actions to take.
   5. Medications are available in the home and there are orders for their use (eg, epinephrine) and clinicians have completed a basic life-support provider course and are competent in managing an anaphylactic reaction (see Standard 59, *Biologic Therapy*; Standard 66, *Home Infusion Therapy*).[10,14] (V)

K. Administer solutions and medications prepared and dispensed from the pharmacy or as commercially prepared solutions and medications whenever possible; do not add medications to infusing solution containers (refer to Standard 56, *Compounding and Preparation of Parenteral Solutions and Medications*).

L. Prepare solutions and medications for administration as close as possible to the time of administration (eg, spiking infusion container, priming administration set).[5] (V)

M. Replace IV solution containers in accordance with organizational policy, procedures, and/or practice guidelines.
   1. There is insufficient evidence to recommend the frequency of routine replacement of IV solution containers, with the exceptions of parenteral nutrition (PN) solutions, which are replaced every 24 hours. One study found no relationship between length of time used and likelihood of colonization and suggests that routine replacement at regular time intervals may not be necessary. Further research is needed (see Standard 61, *Parenteral Nutrition*).[38] (IV)

N. Provide patient/caregiver education, including, but not limited to, infusion administration method and signs and symptoms to report, including those that may occur after the patient leaves the health care setting (refer to Standard 8, *Patient Education*).

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.[14] (V)

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

Q. Discontinue infusion medications/solutions as follows:
   1. Upon provider order.
   2. In the event of a severe reaction (eg, anaphylactic reaction, speed shock, circulatory overload); notify code or rapid response team, as available, and provider immediately.[14] (V)

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Note: All electronic references in this section were accessed between March 21, 2023, and August 18, 2023.

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58. ANTINEOPLASTIC THERAPY

Standard

58.1 Antineoplastic medications are administered only upon orders written or directly entered via computerized prescriber order entry (CPOE) by a physician or other

provider in accordance with laws, rules, and regulations established by regulatory and accrediting bodies in each jurisdiction (eg, countries, states, provinces). Verbal orders are acceptable only if antineoplastic medications are to be placed on hold or discontinued.

58.2 Antineoplastic medications are prepared and administered with attention to ensuring the safety of patients and health care workers and providing environmental protection.

58.3 Clinicians who prepare and administer antineoplastic medications are educated about potential hazards and special handling to reduce the risk of occupational exposure and risk for significant adverse health effects.

Practice Recommendations

A. Use personal protective equipment (PPE) and engineering controls when working with hazardous antineoplastic medications in all health care settings, including the home setting, as there is no known level of exposure that is considered to be safe.[1-3] (III)
   1. Provide access to PPE, safety data sheets, spill kits, containment bags, and designated waste disposal containers in all areas where hazardous drugs are prepared and administered. Provide PPE at the point of use to promote compliance.[1,4] (V)
   2. Use PPE that has been tested for use with hazardous drugs.[1-3,5] (IV)
      a. Wear gloves that meet American Society for Testing and Materials Standard D6978 (ASTM) (in the United States).
      b. Wear double gloving for all hazardous drug (HD) handling.
      c. Use single-use gowns meant for single use; must be disposable (nonsterile settings) and shown to resist permeability to hazardous drugs, with long sleeves, elastic or knit cuffs, closed in the back, and without seams or closures that could allow HDs to pass through.
      d. Use respirators (National Institute for Occupational Safety and Health [NIOSH]-approved filtering facepiece or powered air-purifying respirator) when inhalation exposure is possible.
      e. Apply eye and face protection when HD splashing is possible (refer to Standard 15, *Hazardous Drugs and Waste*).
   3. Use closed-system drug transfer devices for antineoplastic hazardous drugs when the dosage form allows.[1,5] (IV)
   4. For antineoplastic medications that require rate increases, prime the tubing with the antineoplastic medication. Utilize engineering controls (priming the line under a biosafety cabinet with a closed system transfer device [CSTD] on the end of the tubing) to prevent HD exposure.[2] (V)
   5. Employ safe precautions during transportation of hazardous drugs (refer to Standard 15, *Hazardous Drugs and Waste*).
   6. Discard hazardous drugs and contaminated disposable equipment in approved containers.[5] (V)
   7. Employ safety precautions when handling patient body fluids and during patient care activities where contact with body fluids (eg, sweat, saliva, emesis, urine, feces, blood) is anticipated or likely for at least 48 hours after receipt of an HD and until the known excretion time is exceeded, as some HDs may be present in body fluids for longer than 48 hours. Consult with pharmacy for questions regarding metabolism and excretion time for the drug in question (refer to Standard 15, *Hazardous Drugs and Waste*).

B. Ensure that only qualified clinicians administer antineoplastic therapy based on completion of a specialized education and competency program (see Standard 5, *Competency and Competency Assessment*).[2,6] (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*).[2,6,7] (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.[2,6,8] (IV)
   1. Educate the patient/caregivers in the home about safe disposal of all items in contact with antineoplastic medications, management of body waste and laundry, and skin and eye care if exposed (see Standard 8, *Patient Education*).[2,3] (V)

E. Assess patient prior to each treatment cycle, including the following[2,6,9]: (V)
   1. Accurately measured weight and height (at least weekly when present in health care setting)
   2. A review of current laboratory data, diagnostic tests pertinent to the specific agent, and current medications (including over-the-counter, supplements, complementary and alternative therapies)
   3. The patient's medical history, comorbidities, substance use, immunizations, pretreatment vital signs
   4. Risk factors for acute infusion-related reactions, expected side effects of therapy, presence of new signs or symptoms of toxicity, and allergies (medication, food, environmental)
   5. Psychosocial assessment, including patient and caregiver comprehension of the disease and planned cancer treatment, therapy goals, and planned frequency of future visits.

F. Implement safeguards to reduce the risk of medication errors with antineoplastic medications. Antineoplastics are high-alert medications.
   1. Review laboratory values prior to each treatment, which will be specific to the individual patient and treatment plan. Laboratory tests may be ordered to calculate doses, assess for toxicity from prior treatments, and ensure that the agent will be adequately metabolized and excreted. Examples of laboratory tests include complete blood count (CBC), serum creatinine and creatinine clearance, total bilirubin and liver function tests, electrolytes, hepatitis B antibodies, thyroid function tests, and serum cortisol tests.[2,9] (V)
   2. Use independent dual verification, standardized orders, standardized dosage calculation, established dosage limits, CPOE, barcode technology, and electronic infusion pumps with dose-error reduction systems ([DERS]; ie, smart pumps) (see Standard 23, *Flow-Control Devices*; Standard 57, *Infusion Medication and Solution Administration*).[10,11] (IV)
   3. Consult with the pharmacist to review drug interactions with any changes in the patient's medication list.[6] (V)
   4. Obtain orders for emergency treatment before drug administration.[9] (V)
   5. Verify accuracy of the treatment plan against published standards before administration (dose, route, schedule, rate).[10] (IV)
   6. Compare the medication and label with the treatment plan.
   7. Verify the patient (2 identifiers minimum), medication, and pump programming (as applicable). Involve the patient and family members in medication identification; patients often observe and report errors and adverse events. Strategies to involve patients in the process of medication verification should be considered a risk-reduction strategy.[2,9,10] (IV)
   8. Monitor cumulative chemotherapy dose, as appropriate, to ensure that the medication is discontinued if the maximum lifetime dose is reached.[6,10] (V)
   9. Administer vinca alkaloids only by infusion (eg, prepared in bags and not dispensed in a syringe, to avoid inadvertent intrathecal administration) (see Standard 53, *Epidural and Intrathecal Access Devices*).[6] (V)
   10. Assess appearance and physical integrity of drug prior to administration.[7] (V)

G. Administer antineoplastic vesicant medications safely via a short peripheral intravenous catheter (PIVC).[2,10,12-14] (IV)
   1. Limit to intravenous (IV) push or infusions lasting less than or equal to 30 minutes and remain with the patient during the entire infusion.
   2. Do not use an infusion pump for peripheral vesicant administration.
   3. Do not use scalp veins in the neonate and pediatric patient.
   4. Assess patient-related risk factors for extravasation: small/fragile veins, lymphedema, obesity, impaired level of consciousness, previous multiple venipunctures (see Standard 44, *Infiltration and Extravasation*).
   5. Choose a vein that is large, smooth, and palpable, or if vascular visualization technology is necessary, choose a vein with a straight venous pathway (refer to Standard 25, *Vascular Access Device Planning and Site Selection*). Use the smallest size of adequate cannula in the largest vein available.
   6. Avoid the following sites: dorsal surface of the hand, wrist; antecubital fossa; near a joint; lower extremities; areas distal to a recent venipuncture, including laboratory draws; and in the limb where there is impaired sensation, circulation, or lymphatic drainage, and/or history of lymph node dissection.
   7. Do not use an established IV site that is greater than 24 hours old. If a new IV site is initiated, use the smallest-gauge catheter possible. If the insertion attempt is unsuccessful, additional attempts should be proximal to the previous attempt or on the opposite arm.
   8. Verify the functional integrity of the vascular access device prior to administration.
   9. Inform patients of the risks of and signs/symptoms of extravasation. Instruct patient in the importance of immediately reporting any pain, burning, sensation changes, or feeling of fluid on skin during the infusion.
   10. Confirm and document a blood return prior to vesicant administration. Do not administer antineoplastic vesicants in the absence of a blood return or if other signs and symptoms of infiltration are present (see Standard 44, *Infiltration and Extravasation*).
   11. Provide dilution by administering through a free-flowing infusion of a compatible solution.
   12. Assess and verify blood return every 2 to 5 mL for IV push, every 5 minutes during an infusion, and upon completion. Remain with the patient during the entire short-term infusion.
   13. Discontinue infusion at first sign of extravasation (refer to Standard 44, *Infiltration and Extravasation*).

H. Do not use long peripheral IVs or midline catheters for continuous infusions of antineoplastic vesicants.[2] (V)

I. Do not aspirate air with a syringe from intravenous tubing with a solution containing hazardous drugs (see Standard 15, *Hazardous Drugs and Waste*).[15] (V)

J. Administer vesicant medications safely via a central vascular access device (CVAD).[2] (V)
   1. Confirm tip placement for newly placed central catheters and with suspicion for catheter malposition (refer to Standard 51, *Central Venous Access Device Malposition*).
   2. Confirm and document a blood return prior to vesicant administration. Do not administer in the absence of a blood return (see Standard 44, *Infiltration and Extravasation*).

3. Do not administer if signs of inflammation, swelling, or venous thrombosis are present (refer to Standard 50, *Catheter-Associated Thrombosis*).
4. Ensure proper placement and adequately secure and stabilize the noncoring needle within implanted vascular access ports.
5. Provide dilution by administering through a free-flowing infusion of a compatible solution.
6. Assess and verify blood return every 2 to 5 mL for IV push; for infusions, assess and verify blood return before infusion, during the infusion in accordance with organizational policy, and after the infusion.
7. Discontinue infusion at first sign of extravasation (refer to Standard 44, *Infiltration and Extravasation*).

K. Safely dispose of hazardous waste and materials contaminated with hazardous drugs (refer to Standard 15, *Hazardous Drugs and Waste*).

L. Contain, manage, and treat hazardous drug spills as soon as possible to reduce the risk of environmental contamination and exposure to health care workers (see Standard 15, *Hazardous Drugs and Waste*).[2] (V)

M. Monitor for and educate patients about adverse reactions, which can include hypersensitivity, anaphylaxis, and cytokine release syndrome (CRS).[2] (V)
1. Distinguishing between the types of reactions is challenging, as symptoms from each may overlap.
2. Common signs and symptoms of acute infusion reactions include fever, shaking, chills, flushing, itching, dyspnea, back or abdominal pain, nausea, vomiting, diarrhea, skin reactions, and fluctuations in heart rate and blood pressure.
3. Common signs and symptoms of hypersensitivity and/or anaphylaxis include flushing, pruritus, hives, angioedema, shortness of breath, wheezing, nausea, vomiting, diarrhea, hypotension, oxygen desaturation, and cardiovascular collapse.
4. Common signs and symptoms of cytokine release syndrome include fever, oxygen desaturation, hypotension, tachycardia, chills, nausea, anorexia, myalgia, headache, and rigors.
5. Instruct patient to report signs and symptoms immediately.

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59. BIOLOGIC THERAPY

Standard

59.1 Biologic therapies, such as colony-stimulating factors, gene therapy, monoclonal antibodies, fusion proteins, interleukin inhibitors, and immunoglobulins (Igs), are administered in a setting in which the clinician monitors the patient closely and is prepared to recognize and manage severe adverse reactions.

59.2 Patients are assessed for contraindications and risk factors before initiation of a biologic therapy and for adverse reactions prior to each subsequent administration.

Practice Recommendations

A. Implement safeguards to reduce the risk of adverse reactions and errors with biologic therapies.[1] (V)

1. Standardize prescribing, storage, dispensing, and medication administration (refer to Standard 57, *Infusion Medication and Solution Administration*).
2. Determine the most appropriate care setting for biologic therapy administration.[2,3] (V)
    a. Care settings include hospital inpatient, hospital outpatient, provider office, free-standing infusion suite, long-term care, and the patient's home (refer to Standard 66, *Home Infusion Therapy)*.
    b. Administer biologic therapy in the setting that best ensures safety and the ability to respond to adverse reactions.
        i. The risk for potential adverse reactions and the ability to manage/reduce risk are identified before administering biologic therapy in a home setting. First doses administered in the home are provided by educated clinicians and when there is availability of medications to treat an adverse reaction and rapid access to emergency medical services (refer to Standard 57, *Infusion Medication and Solution Administration*; Standard 66, *Home Infusion Therapy*).
3. Ensure clinician access to drug information.[1,3] (V)
4. Confirm indication for use when administering biosimilars.[4] (V)
    a. Recognize that biosimilars are biologic products that are highly similar to, with no clinically meaningful differences in, safety, purity, or an existing US Food and Drug Administration (FDA)-approved reference product. Biosimilars are not exact duplicates but must be chemically, functionally, and clinically similar to the reference product. Biosimilars are not the same as generic medications.
5. Collaborate with the health care team regarding serious risks associated with some biologic therapy; risk evaluation and mitigation strategies (REMS) may be required.[5] (V)
6. Identify agents at high risk for hypersensitivity reactions. Anticipate potential orders for premedications, such as acetaminophen, diphenhydramine, and corticosteroids. Ensure availability of medications for treatment of adverse reactions and anaphylaxis; consider patient safety as a primary factor when selecting the treatment setting.[3,6-8] (II)

B. Store, prepare, and administer biologic therapy according to the manufacturers' directions for use and dispose of biologic waste in accordance with regulations established by regulatory bodies in each jurisdiction (refer to Standard 16, *Medical Waste and Sharps Safety*).
    1. Adhere to Aseptic Non Touch Technique (ANTT®) during reconstitution/preparation of biologic therapy in a clean environment (refer to Standard 19, *Aseptic Non Touch Technique [ANTT®]*; Standard 56, *Compounding and Preparation of Parenteral Solutions and Medications*).
    2. Utilize personal protective equipment if biologic therapy is considered hazardous (refer to Standard 15, *Hazardous Drugs and Waste*).[9]
    3. Select the most appropriate flow-control device for the biologic infusion therapy, including the following: need for rate control, dosing considerations, volume, duration; age, acuity, and mobility of the patient; health care setting; and the potential for side effects or adverse effects of the therapy (refer to Standard 23, *Flow-Control Devices*).
    4. Filter infusion, if required, in accordance with manufacturer's instructions (refer to Standard 33, *Filtration*).
    5. Avoid switching Ig brands, as this puts the patient at greater risk for adverse reactions.[2] (V)

C. Assess patients before initiation of therapy and with subsequent administrations.[2,3,8,10-12] (V)
    1. Identify risk factors, including, but not limited to, the following: comorbidities; infections; allergy profile (food, medications, environment); history of any previous treatment with a reaction to biologic therapy; tuberculosis testing; history of malignancies; weight changes; and hepatitis B and C screenings.[13] (V)
    2. Evaluate vaccination status and requirements relative to the biologic agent in accordance with the manufacturer's directions for use; follow recommended intervals for vaccination administration.
    3. Identify any significant changes in health status prior to each administration, such as disease progression, changes in weight, presence of any acute illness, infection, or presence of diarrhea.
    4. Check vital signs prior to administration and as indicated during and after the dose.
    5. Review laboratory data specific to the biologic therapy prior to initiation and during subsequent administrations, as indicated.
    6. Monitor for adverse reactions, including hypersensitivity and anaphylaxis (refer to Standard 58, *Antineoplastic Therapy*).

D. Consider the option for self-administered subcutaneous immunoglobulin (SCIg) infused at various intervals, usually weekly or biweekly, using a subcutaneous pump and needle set, or daily as a subcutaneous push infusion; self-administered hyaluronidase-facilitated SCIg is infused at 3- or 4-week intervals using a subcutaneous infusion pump.[11,12,14-16] (II)
    1. Ensure that the first SCIg dose is administered in a setting where there is availability of medications to treat an adverse reaction and rapid access to emergency medical services.
    2. Limit infusion volume of standard SCIg to no more than a 30-mL volume per site.
        a. For hyaluronidase-facilitated SCIg, follow manufacturers' recommendations for site

volume limits (see Standard 55, *Subcutaneous Infusion and Access Devices*).

3. Keep needle insertion sites at least 2 inches (5 cm) apart if using multiple sites simultaneously.
4. Identify the best method for flow control. This is generally via a syringe pump; however, a manual push can be utilized for some patients. Consider product, patient preference, and interprofessional team recommendation.
5. Educate the patient/caregiver about infection prevention, drug preparation, equipment needed, common side effects, subcutaneous administration, the importance of site rotation, adherence to therapy, local site reactions, and what to monitor or report during and after the injection. Educate specifically on preparation, pump setup, administration, infusion techniques, and supply disposal (see Standard 66, *Home Infusion Therapy*).
6. Minimize risk for local site reactions: utilize a dry insertion technique to minimize dermatitis; start with a low volume and gradual escalation; use appropriate size needle based on patient's subcutaneous tissue and mobility; apply ice packs after administration to relieve symptoms.

E. Administer subcutaneous biologics in accordance with manufacturers' directions for use (refer to Standard 55, *Subcutaneous Infusion and Access Devices*).

F. Consider the option for nurse-administered home administration of intravenous immunoglobulin (IVIg) in long-term, stable patients who require extended therapy for primary immune deficiency diseases.[17] (IV)
   1. Data suggest that treatment outcomes were enhanced by home administration, as reflected by improved adherence to therapy, decreased rates of infection, and decreased cost per infusion (see Standard 66, *Home Infusion Therapy*).[14,18] (II)

G. Teach the patient and caregiver about all aspects of the biologic agent, including physical and psychological effects, adverse effects, timing of vaccines, potential toxicities, and delayed reactions. Address how to manage adverse effects and when to escalate concerns or notify the health care team for further assessment (see Standard 8, *Patient Education*).[2,3,8,12,15] (V)

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60. PATIENT-CONTROLLED ANALGESIA

Standard

60.1 The clinician is knowledgeable of the appropriate drugs used with patient-controlled analgesia (PCA), including pharmacokinetics and equianalgesic dosing, contraindications, side effects and their management, appropriate administration modalities, and anticipated outcomes.

60.2 The decision to initiate PCA occurs in collaboration with the patient and the health care team based on assessment of PCA risk factors and the patient's level of understanding and ability to use PCA.
60.3 Pain management is comprehensive and individualized and involves the patient and caregiver in developing a treatment plan and setting realistic and measurable goals.

Practice Recommendations

A. Assess the patient for the appropriateness of PCA therapy and the patient's comprehension of and ability to participate in the intended therapy.[1-4] (II)
   1. The goal of PCA utilization is adequate pain management, while minimizing analgesia-related side effects. Opioids are most commonly used for PCA delivery, but various medications and combinations are reported. Medications used include morphine, fentanyl, hydromorphone, oxycodone, sufentanil, remifentanil, dexmedetomidine, dezocine, ketamine, and tramadol/lornoxicam.[5-12] (I)
      a. Drug stability should be established for PCA delivery.[13-15] (IV)
      b. Based on a systematic review of meperidine use in postoperative and labor patients, meperidine is not recommended for use due to higher risk of side effects and lower analgesic efficacy.[16] (I)
   2. Reported benefits of PCA therapy include increased patient and caregiver/parent satisfaction and autonomy, reduced delay to pain treatment, reduction in breakthrough pain, increased mobility, improved quality of life, better utilization of nursing resources, and improved outcomes when compared to intravenous (IV) push narcotics in adults with pain related to cancer and surgical procedures and in pediatric patients.[8,17-20] (II)
      a. Intravenous and subcutaneous PCA has been found to be safe and effective when used for pain management outside of the acute care setting in children and adults (eg, palliative care, cancer-related pain, vaso-occlusive episodes), and when patient safety measures are appropriately addressed.[4,13,17,21] (IV)
         i. Further study is needed to optimize the pharmacokinetics and pharmacodynamics of PCA therapy for infants and pediatric patients.[17,21,22] (III)
      b. Epidural pain management remains the gold standard in the postoperative period for many abdominal, thoracic, and orthopedic surgical procedures due to reported lower pain scores, increased mobility, and improved long-term outcomes. However, epidural catheter placement may be contraindicated (eg, anticoagulation, infection, patient refusal, patient anatomic variants) and carries risks (eg, hypotension, neurovascular trauma, infection).
         i. Multiple research studies have investigated the efficacy of epidural versus IV PCA routes in various clinical settings. The IV PCA route has been found to be effective as an alternative to the epidural route when required by patient characteristics.[7,11,23-29] (III)
         ii. In the labor and delivery setting, the epidural route is associated with successful pain management during active labor and post-delivery, using combinations of continuous, intermittent bolus, and patient-controlled epidural analgesia (PCEA). Alternatives to epidural use have been studied due to epidural-related complications, such as maternal hypotension and fever.[5,30-32] (I)
            a) Remifentanil PCA has been successfully used in the labor and delivery setting as an alternative to the epidural route. It is a potent, short-acting opioid with increased risk of hypoxemia, bradycardia, and hypotension, requiring close monitoring of patient tolerance to ensure optimal maternal and neonatal outcomes.[5,32,33] (I)
   3. Risks associated with opioid pain management include hyperalgesia (hypersensitivity to pain), hypotension, bradycardia, respiratory depression, nausea and vomiting, pruritis, potentiation of cancer growth, pressure ulcer development, urinary retention, tolerance to opioids, addiction, constipation, ileus, and iatrogenic withdrawal syndrome (IWS) in infants and children (syndrome of tolerance and dependence). The extensive risks and related complications have the potential to increase length of stay, morbidity, and mortality.[9,17,22,25,28,34-44] (I)
      a. Because of the risks and complexity involved in PCA analgesia, multiple studies have investigated alternative pain management regimens to either reduce PCA-related opioid consumption or eliminate PCA use. This research has investigated several avenues to optimize pain management, minimize side effects, and improve functional capacity.
         i. Alternative modes of PCA delivery: oral-administered patient-controlled analgesia, time-scheduled decremental continuous infusion, variable-rate feedback infusion plus demand dosing, and dosing that adjusts to increasing or decreasing patient demand and vital signs.[20,33,44,45] (III)
         ii. Multimodal pain management strategies for high-risk patients (eg, total joint replacement, lumbar fusion, open and laparoscopic abdominal and thoracic surgical procedures):

enhanced recovery after surgery (ERAS) strategies, wound or intra-articular infiltration of local anesthetic, concomitant epidural or intrathecal dosing, intercostal block, and nonopioid analgesics.[10,24,35,36,39,46-48] (III)

iii. PCA medication combinations that have synergistic effect with opioids and/or reduce opioid-related side effects: dexmedetomidine, ropivacaine, ketamine, and low or ultra-low dose naloxone (may enhance antinociceptive effect of opioids and may reduce postoperative nausea and vomiting).[6,10,12,23,34,38,49] (III)

B. Assess the patient and caregiver for appropriateness of using authorized agent-controlled analgesia (AACA) if the patient is unable to actively participate in PCA or patient/nurse-controlled analgesia (PNCA) for infants, children, and critically ill adults. Further research is needed to determine the optimal use of AACA for specific populations.[1,6-8] (IV)
   1. Develop predefined protocols or algorithms for AACA or PCA by proxy with clear assessment parameters for dose delivery and adjustment. In the absence of a defined structure, PCA by proxy has been associated with negative patient outcomes.
   2. Provide caregiver education and evaluate competency prior to AACA, including patient assessment, what to report to the provider, operating instructions for electronic infusion pump, appropriate actions to take if therapy is not meeting patient needs, and contact information for support services.
   3. Provide oversight of outpatient-based AACA through a health care entity (eg, community-based nurses) to assure compliance, availability of supplies, and expertise to manage complications and device concerns.[2-4,17,21,22] (III)

C. Use standardized medication concentrations and standardized or preprinted provider order sets for PCA and AACA that allow for individualization of dose.[1,22,42,50-54] (III)
   1. Use dosing that is based on comprehensive patient assessment and not based solely on pain assessment score (numeric or behavioral).[6,17,18,22,36,39,41,51,55] (III)

D. Identify patient risk factors for opioid-induced respiratory depression (OIRD) that include, but are not limited to, prematurity, older age, male gender, morbid obesity, known/suspected sleep disorder breathing problems, pre-existing pulmonary and/or cardiac disease, renal insufficiency, impaired liver function, and continuous basal infusions.[1,42,51,53,56,57] (I)
   1. A combination of factors precipitates OIRD in all ages: decreased respiratory drive, decreased level of consciousness, and upper airway obstruction. OIRD has been associated with increased length of stay, increased readmissions, and increased mortality.[42,53] (IV)
   2. In the presence of risk factors, use continuous monitoring of capnography, pulse oximetry, and/or other clinically effective methods.[5,32,51,53,55,58] (I)
      a. Continuous capnography monitoring provides an earlier warning of respiratory depression as compared to continuous oximetry and is associated with significant reduction in the incidence of OIRD, duration in opioid treatment, and opioid-related serious adverse events.[1,42,57] (IV)
      b. Assess the efficacy of the chosen capnography device (ie, oral, nasal) and adjust, if needed, to improve accuracy.[59] (IV)
      c. Carefully evaluate patient safety in the setting of concomitant use of sedating medications with opioid delivery.[38,56,57] (IV)

E. Perform an independent double-check by 2 clinicians prior to initiation of the PCA and when the syringe, solution container, drug, or rate is changed. Provision of PCA therapy is a complex process, vulnerable to many points of error. The administration phase has the highest reported error rates. Globally, these errors have been associated with negative outcomes, such as increased pain through delays or interrupted treatment, cardiopulmonary compromise, and mortality.
   1. Give special attention to drug, concentration, dose, and rate of infusion according to the provider order and as programmed into the electronic infusion pump in order to reduce the risk of adverse outcomes and medication errors.
   2. Validate that the administration set is correctly connected for immediate delivery of analgesic and is configured to prevent retrograde flow of medication (see Standard 23, *Flow-Control Devices*; Standard 57, *Infusion Medication and Solution Administration*).[8,18,54,60] (IV)

F. Provide patient and caregiver education appropriate to duration of therapy and care setting, treatment options, the purpose of PCA therapy, frequency of monitoring, expected outcomes, precautions, potential side effects, symptoms to report, and how dose will be adjusted.[17,31,39,50-52,54] (III)

G. Evaluate the effectiveness of PCA/AACA/PNCA and potential adverse events, using valid and reliable monitoring and assessment methods and documentation tools.
   1. Monitor parameters, including pain score, breakthrough pain, ability to perform functional milestones, respiratory depression, nausea and vomiting, urinary retention, and parental and patient satisfaction with analgesia.[6-9,18,20,23,30,36,39,41,44,48] (I)
   2. Conduct regular assessment and reassessment of patient self-report of pain or objective measure of pain using a valid, reliable, developmentally appropriate pain assessment tool individualized to the patient. Assess and reassess pain at rest and with movement.[1-4,6,9,11,17,20,22-24,36,40,44,48,51,52] (I)

a. An area in need of further research is the development of pain assessment tools validated for palliative care and end-of-life. Pain scales in use are generally designed for acute pain and not reflective of quality of life/end-of-life patient needs.[4] (IV)

3. Use a validated sedation scale and direct assessment of quality and adequacy of cardiopulmonary status.[6,17,20,22,44] (I)
4. Individualize alarm settings for each patient to assure alarms are valid and to reduce alarm fatigue.[1,57] (IV)
5. Recognize the risk of supplementary oxygen delivery in masking-reduced respiratory drive.[42,53,57] (IV)
6. Assess for risk factors and treat opioid-related nausea and vomiting.[43] (IV)
7. Regularly evaluate PCA device function, number of injections and attempts, and the potential for patient/caregiver manipulation.[18,54] (IV)
8. Regularly assess the vascular access device (VAD) site, including patency, to assure correct analgesia delivery (refer to Standard 46, *Vascular Access Device Occlusion*; Standard 57, *Infusion Medication and Solution Administration*).
9. Evaluate the need to change treatment methods as necessary. Adjust the pain management plan based on pain relief and presence of adverse effect.[4,33,37,50-52] (IV)

H. Ensure clinicians receive education that addresses pain assessment, pharmacokinetics and pharmacodynamics of opioids and adjuvant medications, risk of concomitant use of sedating medications, operation of electronic infusion pump, and the need to individualize pain management based on individual needs of the patient.[1,15,18,38,50-52,54,57,60] (IV)

I. Assure adequacy of the pain management plan and patient stability during handoffs to different clinicians and/or settings.[1,53] (V)

J. Participate in selection and evaluation of PCA electronic infusion pump and monitoring equipment and in quality processes to promote patient safety, which includes review of administration of opioid reversal and opioid-related resuscitation, technology/decision support, evaluation of workflows, barcoding technology, root cause analysis, Healthcare Failure Mode and Effect Analysis (HFMEA), long-term outcomes from pain management strategies, and prescription drug monitoring programs to evaluate opioid utilization.[10-18,22,46,50-52,54,60] (IV)

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61. PARENTERAL NUTRITION

Standard

61.1 The decision to implement parenteral nutrition (PN) occurs in collaboration with the patient/caregiver and the health care team based on the projected treatment plan.

61.2 PN is administered using filtration and an electronic infusion pump with anti–free-flow control and appropriate alarms.

61.3 Medications are not added or co-infused with the PN solution before or during infusion without consultation with a pharmacist regarding compatibility and stability.

Practice Recommendations

A. Plan for safe and appropriate PN.
   1. Use the enteral route in preference to the parenteral route for nutrition support whenever feasible.[1-3] (IV)
   2. Recognize that PN is a complex and high-alert medication; reported incidents and errors that may lead to patient harm include microbial contamination, inappropriate prescriptions, and compounding and dispensing errors (see Standard 11, *Adverse and Serious Adverse Events*).[4-9] (IV)
   3. Ensure an interdisciplinary approach to promote safe use and encourage error reporting and error analysis to improve safety; nutritional support teams are associated with a reduction in catheter-related infection, inappropriate PN use, and reduced mortality.[5,7,10-12] (I)
   4. Use standardized order forms or templates and computerized order entry (COE) throughout the continuum of care whenever feasible, as they have been found to prevent errors related to PN prescriptions.[1,7,11,12] (V)
   5. Develop written protocols for PN component substitution or conservation methods in the event of drug/component shortage.[1,11,12] (V)
   6. Coordinate care using a patient-centered, interprofessional team approach for patients who will transition between health care settings (eg, acute care, skilled nursing facility, home, long-term acute care hospital).
      a. Address the following factors in the transition process: PN orders/formula, clinical status, appropriateness for patient setting, patient/caregiver education, available patient support, insurance coverage, appropriate vascular access device (VAD), and monitoring plan (eg, laboratory studies) (see Standard 66, *Home Infusion Therapy*).[1,12-14] (IV)

B. Administer PN safely.
   1. Plan for an appropriate VAD based upon expected duration of therapy, nutritional requirements, and the patient's vascular condition and preferences (see Standard 25, *Vascular Access Device Planning and Site Selection*).
      a. Consider a VAD with a minimal number of lumens.[3,11,15,16] (V)
      b. Consider peripherally inserted central catheters (PICCs) and tunneled, cuffed central vascular access devices (CVADs) for infants and

children who require prolonged PN during hospitalization.[15,17] (IV)

c. Consider tunneled, cuffed CVADs or PICCs for home parenteral nutrition (HPN) in both adults and children; implanted vascular access ports with the noncoring needle changed at least every 7 days may also be an option.[14-16,18-22] (V)

2. Administer peripheral PN (PPN) solutions/emulsions with a final concentration of 10% dextrose or lower through a PIVC as a bridge to central PN, when oral intake or enteral nutrition is suboptimal, or when the patient's clinical condition does not justify CVAD placement. Consider dextrose and other additives that affect osmolarity. The American Society for Enteral and Parenteral Nutrition (ASPEN) recommends not exceeding an osmolarity of 900 mOsm/L; studies show endothelial damage begins to occur at 600 mOsm/L. The osmolarity limit for PPN is an area of needed research.[1,3,11,23] (IV)
   a. Recognize the increased risk for phlebitis with PPN; weigh the risks vs benefits for PPN administration and limit duration of therapy to no more than 14 days. ASPEN recommendations do not address PPN administration via midline catheters.[1,3] (IV)
   b. Do not use midline catheters for continuous vesicant therapy, PN, or solutions with extremes of pH or osmolarity; the use of midline catheters for PPN is not established; the location of midline catheters in a deeper vein may mask early signs of phlebitis, extravasation, and thrombosis (refer to Standard 25, *Vascular Access Device Planning and Site Selection*).
3. Filter PN solutions and place the filter on the administration set as close to the patient as possible. Prime the filter in accordance with manufacturer's directions.[24,25] (IV)
   a. Use a 1.2-micron filter for all PN solutions, including dextrose-amino acid admixtures, lipid injectable emulsions (ILE), and PN solutions containing ILEs (also known as total nutrient admixture [TNA]).
4. Replace solution containers and administration sets used for PN (TNA and amino acid/dextrose formulations) and lipids every 24 hours; replace administration sets used for ILE with each new infusion. Hang time for PN should not exceed 24 hours.[1,11,14] (IV)
   a. In a laboratory study, TNA and ILE support *Candida albicans* growth after minimal initial contamination with microorganisms migrating from the fluid bag to the CVAD. Attention to Aseptic Non Touch Technique (ANTT®) during management of the administration set is imperative, and administration sets should be replaced daily (see Standard 40, *Administration Set Management*).[26] (IV)
   b. Limit separate ILE infusion to a 12-hour maximum time; if volume limitations require separate ILE administration for a period longer than 12 hours, ASPEN recommends strong consideration for a new ILE container and administration set for the second 12-hour portion. The hang time of a TNA can be extended to 24 hours because bacterial growth in these solutions is inhibited due to reduced pH and to increased total osmolarity compared to infusing ILE separately.[1,9] (V)
   c. Change the filter to coincide with initiation of a new PN mixture and administration set; change filters used for separately infused ILEs every 12 hours. Prime filters immediately before use.[24,25] (IV)
5. Use PN containers and administration sets free of Di[2-ethylhexyl]phthalate (DEHP) to administer lipid-based solutions, such as ILE or TNA. DEHP is a lipophilic toxin that can leach from commonly used polyvinyl chloride administration sets and containers into lipid-based solutions (see Standard 40, *Administration Set Management*).[1,8] (IV)
6. Protect PN admixtures from light for premature infants; degradation of PN components occurs with light exposure, resulting in oxidation; preterm infants are more susceptible than children and adults and face potential complications as a result of oxidative stress (eg, bronchopulmonary dysplasia, retinopathy, necrotizing enterocolitis).[1,27-30] (IV)
   a. ASPEN recommends complete PN light protection for preterm infants beginning during compounding and continuing until the entire PN/ILE infusion is complete (eg, during transport/delivery and administration). ASPEN acknowledges that full implementation may not be currently feasible, given product availability, but organizations should define what steps can be achieved and implement attainable strategies.
   b. While partial light protection does not offer clinical benefits, recommendations from ASPEN for non-preterm infants state to refrigerate and protect the PN solution from light exposure until just before infusion. There is a need for further studies about light protection for children and adults receiving long-term PN.
7. Use electronic infusion pumps with anti–free-flow protection and alarms for occlusion; consider the use of electronic infusion pumps with dose error reduction software (DERS) (ie, smart pumps), as they are associated with reduced risk for infusion-related medication errors, including error interceptions (eg, wrong rate), and reduced adverse drug events (refer to Standard 23, *Flow-Control Devices*).
8. Reduce the risk of catheter-associated bloodstream infection (CABSI) when administering PN.

a. Consider peripheral venipuncture for blood sampling instead of via the CVAD used for PN (see Standard 41, *Blood Sampling*).[1] (V)
   i. Adhere to ANTT if blood sampling via the CVAD is necessary; blood sampling via the CVAD is a quality-of-life issue for patients receiving long-term PN.[15] (IV)
b. Consider dedicating a single lumen to PN administration when a multilumen CVAD is in place.[3,14,15] (IV)
   i. Based upon a systematic review, data are insufficient to ascertain whether dedicating a lumen to PN results in a lower risk of infection; this remains an area of needed research.[31] (I)
c. Avoid attaching administration sets before the time of infusion; the risks of spiking containers and priming administration sets in advance has not been studied.[1,11] (V)
d. Consider antimicrobial lock therapy for patients receiving cyclic HPN as an infection-prevention strategy (see Standard 38, *Flushing and Locking*).
   i. Taurolidine was effective in prevention of catheter-related bloodstream infections (CR-BSIs) for patients on HPN and, while considered generally safe, rare allergic reactions and VAD-related problems, including pain, have been reported.[14,32-38] (I)
   ii. Other antimicrobials, including 4% tetrasodium, ethylenediaminetetraacetic acid (EDTA) and 70% ethanol (limited to patients with silicone CVADs) are also associated with reduced incidence of CR-BSI.[37-42] (I)
e. Consider CVAD repair for damaged subcutaneously tunneled, cuffed CVADs to extend CVAD survival and to reduce risk for future compromised vascular access. Retrospective studies have reported extension of CVAD survival without increased risk for central line-associated bloodstream infection (CLABSI) (see Standard 48, *Catheter Damage [Embolism, Repair, Exchange]*).[35,43-45] (IV)

C. Monitor the patient and provide patient education.
1. Monitor patient receiving PN for the following: body weight; fluid and electrolyte balance; metabolic tolerance, especially glucose control; VAD-related complications, including CABSI; organ function; nutrition therapy-related complications; functional performance; and psychological responses.[11,14,16,46-48] (IV)
2. Monitor blood glucose; when changing to a cyclic infusion, monitor on and off PN during initial cycling in the acute care or home setting; once stable, less frequent monitoring may be acceptable. Insulin may be used to control blood glucose levels and administered via the subcutaneous or intravenous (IV) route (may be added to PN solution).[1,47] (V)
3. Teach patients or family members of patients who receive home PN about importance of ANTT during all PN procedures, access device care, weight and hydration monitoring, blood/urine glucose monitoring, electronic infusion pump use and troubleshooting, and signs and symptoms to report; and assist patients on how to fit PN into their lifestyles (see Standard 8, *Patient Education*; Standard 19, *Aseptic Non Touch Technique [ANTT®]*; Standard 66, *Home Infusion Therapy*).[1,14,16,49,50] (IV)
4. Assess and address patient and family management and coping with HPN (refer to Standard 66, *Home Infusion Management*).

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62. BLOOD ADMINISTRATION

Standard

62.1 Administration of blood and blood components, including the use of infusion devices and ancillary equipment, and the identification, evaluation, and reporting of adverse events related to transfusion are established in organizational policies, procedures, and/or practice guidelines.
62.2 Verification of the correct patient and blood product is performed in the presence of the patient prior to transfusion.
62.3 Blood and blood components are transfused through a transfusion administration set that has a filter designed to retain potentially harmful particles.

Practice Recommendations

A. Recognize the risks versus the benefits of transfusion prior to administering human blood and blood components (whole blood, red blood cells [RBCs], plasma and plasma components, platelets, granulocytes, cryoprecipitate).
   1. Patient blood management (PBM) is an evidence-based, multidisciplinary approach aimed at optimizing the care of patients who might require a blood transfusion. PBM programs provide guidance and decision-making for the appropriate use of transfusions, eliminate unnecessary transfusions, and increase patient safety. Strategies include evidence-based indications for transfusion, maintaining hemoglobin (Hgb) concentration, optimizing coagulation/hemostasis, close post-operative monitoring to minimize oxygen consumption, and management/prevention of anemia (eg, reducing blood loss associated with blood sampling) (see Standard 41, *Blood Sampling*).[1-9] (II)
      a. Transfusion of red blood cells at a lower Hgb level (eg, 7.0-8.0 g/dL) compared to higher Hgb level is considered safe in both adults and stable, nonbleeding, critically ill children.[6,10] (I)
      b. Key elements for PBM specific to the neonatal population include management of anemia, blood conservation strategies, optimization of coagulation and hemostasis, as well as surgical and anesthetic techniques and patient and family-centered decision-making.[4,11] (IV)

B. Provide patient/caregiver education and ensure that informed consent is obtained.[2,12-17] (IV)
   1. Include a description of risks, benefits, and treatment alternatives, while providing the opportunity to ask questions and ensuring understanding of the right to accept or refuse the transfusion.
   2. Allow the opportunity for patients to discuss their religious/cultural beliefs regarding blood transfusion.
   3. Include the following in the educational process:
      a. Elements of the transfusion procedure (eg, compatibility testing, vascular access)
      b. Signs/symptoms associated with complications of transfusion therapy (eg, vague uneasy feeling, pain, breathing difficulties, hypotension, chills/flushing/fever, nausea, dizziness, rash/urticaria, hives, pruritus, localized angioedema, dark/red urine).

C. Perform a baseline physical assessment prior to obtaining blood for transfusion, including vital signs, respiratory assessment, skin (eg, evidence of rash), 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.[8,12,14,17] (V)
   1. Identify and report any symptoms to the health care team that may later be mistaken for a transfusion reaction; recognize that fever may be a cause for delay in transfusion, as it could mask a symptom of an acute transfusion reaction.
      a. Based upon a multicenter retrospective review, transfusions associated with febrile reactions had higher pretransfusion temperatures and pulse rates; transfusions associated with transfusion-associated circulatory overload (TACO) had higher pretransfusion respiratory rates.[18] (V)
   2. Administer premedications, if ordered. Oral medications should be administered 30 minutes before start of transfusion; intravenous (IV) medications can be given immediately before starting the transfusion.
      a. Routine premedication with acetaminophen and antihistamines did not prevent nonhemolytic transfusion reactions. The impact of premedication for patients with a history of transfusion reactions is unknown; further research is needed.[19] (I)

D. Choose an appropriate VAD based on patient condition and transfusion needs.
   1. Peripheral intravenous catheters (PIVCs):
      a. Adults: A 20- to 22-gauge is acceptable for routine transfusions; a 16- to 18-gauge may be used for rapid transfusions; red blood cells can be safely administered via smaller-gauge catheters/needles (eg, 24/25); however, the flow rate should be slower, as the pressure with rapid transfusion through a small catheter may cause hemolysis.[8,12,15,17,20] (V)
      b. Infants/children: Options include the umbilical vein (neonates) or a vein large enough to accommodate a 23- to 25-gauge needle or a 22- to 24-gauge catheter (see Standard 28, *Umbilical Catheters*).[12,17] (V)
   2. Central vascular access devices (CVADs) are acceptable for blood administration.[12,14,15,17,20] (V)
   3. Blood components may be administered by the intraosseous route (refer to Standard 54, *Intraosseous Access Devices*).

E. Perform patient and blood product identification and inspect blood component for abnormalities at the time the blood component is released from the transfusion service and in the presence of the patient before preparing the transfusion.[4,11-14,17,21] (IV)
   1. Verify the following: provider order for transfusion; patient's core independent identifiers, ABO group and Rh type, donation identification number, crossmatch test interpretation, if performed, expiration date/time, and date/time of issue, special transfusion requirements (eg, irradiated, cytomegalovirus [CMV]-negative, leukocyte reduced, hepatitis E negative, washed cells, platelet in additive solutions, hemoglobin S negative).
   2. Verify volume requirements for certain populations (eg, neonatal, pediatric, older adult).
   3. Use an independent double-check by 2 adults in the presence of the patient (eg, hospital/outpatient setting: 2 persons trained in the identification of the recipient and blood components; in home setting: nurse and responsible adult).
      a. Use of electronic patient identification technologies for blood draw and sample labeling, blood collection procedures, and blood administration were associated with a lower incidence of wrong component transfusions and near misses compared to a manual system.[22] (V)
   4. Inspect each blood component prior to transfusion and do not use if container is not intact or if the appearance is not normal (eg, abnormal color, presence of clots, leakage, excessive air/bubbles, unusual odor), and return it to the transfusion service.

F. Administer blood or blood components.[8,12,14,15,17] (IV)
   1. Never add or infuse any other solutions or medications through the same administration set with blood or blood components (do not piggyback blood administration sets into other infusion administration sets).
   2. The administration set used to administer the blood or blood component is primed only with 0.9% sodium chloride or the blood component itself.

G. Filter all blood components and follow the manufacturers' directions for filter use.[8,12,14,15,17] (IV)
   1. Use a filter designed to remove blood clots and harmful particles; standard blood administration sets include a 170- to 260-micron filter.
   2. Do not use microaggregate filters routinely; these may be used for reinfusion of blood shed during high-blood-loss surgical procedures.
   3. Leukocyte reduction filtration is preferred "prestorage" or shortly after blood collection. Bedside leukocyte reduction is a less efficient method and has been associated with dramatic hypotension in some patients. Use of leukocyte-reduced blood products (RBCs and platelets) decreases the risk of febrile transfusion reactions, risk of human leukocyte antigen (HLA) alloimmunization, allergic reactions, and transmission of CMV.
   4. Never use leukocyte filtration when transfusing granulocyte or hematopoietic progenitor cells.

H. Change the transfusion administration set in conjunction with manufacturers' directions for use.[8,12,17] (IV)
   1. Clinical studies establishing the maximum time for set use are lacking. In accordance with the Association for the Advancement of Blood & Biotherapies (AABB), if the first unit requires 4 hours for transfusion, the administration set and filter are not reused. National guidelines from some countries recommend changing the administration set every 12 hours.
   2. Note that most standard filters have a 4-unit maximum capacity; follow manufacturers' directions for use.

I. Administer and complete each unit of blood or blood component within 4 hours.[8,12,14,15,17] (IV)
   1. Ask the transfusion service to divide a unit of RBCs or whole blood into smaller aliquots when it is anticipated that the unit cannot be transfused within 4 hours (eg, pediatric patients or adult patients at risk for fluid overload).
   2. Usual duration of transfusion: red blood cells over 1-2 hours based upon hemodynamic stability; platelets over 1 to 2 hours; granulocytes over 2 hours; plasma as quickly as tolerated by the patient or over 15 to 60 minutes; cryoprecipitate as rapidly as tolerated.
   3. Only electronic infusion pumps that have a labeled indication for blood transfusion should be used. Electronic infusion pumps can be used to deliver blood or blood components without significant risk of hemolysis of RBCs or platelet damage. Syringe

infusion pumps can be used for small-volume transfusions in neonatal and pediatric patients. Follow the manufacturers' directions for use (see Standard 23, *Flow-Control Devices*).

4. Manual pressure cuffs can be used to increase RBC flow rate when rapid transfusion is required. Externally applied compression devices should be equipped with a pressure gauge, totally encase the blood bag, and apply uniform pressure against all parts of the blood container. Pressure should not exceed 300 mm Hg. A standard sphygmomanometer is never used for this purpose. For rapid infusion, a large-gauge catheter may be more effective than a pressure device.

J. Use blood and fluid warmers when warranted by patient history, clinical condition, and prescribed therapy, including, but not limited to, preventing or treating intraoperative hypothermia, during plasma exchange for therapeutic apheresis, for patients known to have clinically significant cold agglutinins, for neonate exchange transfusions, during replacement of large blood volumes, vaso-occlusive episodes, or when treating trauma, hypothermia, or cold exposure (refer to Standard 24, *Blood and Fluid Warming*).

K. Initiate transfusion and monitor for immediate adverse transfusion reactions.[8,12,14,17,23,24] (IV)

1. Check the patient's vital signs within 30 minutes prior to transfusion, 15 minutes after the blood enters the vein upon transfusion initiation, upon completion of the transfusion, and 1 hour post-transfusion. Visually check the patient for any adverse reactions at least every 30 minutes throughout the transfusion; check vital signs immediately upon identification of any change in the patient's condition.
2. Initiate nonemergent transfusions slowly and remain near the patient; major reactions usually appear before the first 50 mL have been transfused. Increase the transfusion rate after 15 minutes when there are no signs of a reaction and to ensure the completion of the unit within 4 hours.
   a. Recognize that the first 10-15 minutes of any transfusion are the most critical.
3. Stop the transfusion immediately if signs and symptoms of an acute transfusion reaction are present (eg, fever, chills, tachycardia, chest/flank/back pain, hypotension, bronchospasm, dyspnea); perform a clerical check of the blood component (ABO confirmation), notify the provider and transfusion service, and administer emergency medications as prescribed.
   a. Do not administer emergency medications through the blood administration set; prime a new administration set with 0.9% sodium chloride for infusion through the VAD.

L. Monitor patients for signs/symptoms of other acute transfusion reactions[12,15,17,23,25-27]: (IV)

1. Pruritis, urticaria, flushing, or wheezing associated with mild allergic reactions
2. Respiratory failure, hypoxemia, hypotension, and/or pulmonary edema associated with transfusion-related acute lung injury (TRALI)
3. Dyspnea, jugular venous distention, cough, increased blood pressure, cough associated with TACO. TACO is the leading cause of transfusion-related morbidity and mortality; patient risk factors include older adults and history of cardiac disease, acute/chronic renal failure. Signs/symptoms of circulatory overload (eg, respiratory distress, tachycardia, increased blood pressure) occur 6-12 hours after the transfusion.

M. Recognize age-related complications.

1. Adverse events of red blood cell transfusions are more frequent in older patients, and TACO is the most frequent complication in transfused older adults.[28] (IV)
2. Immature organ function in neonates is associated with increased risk for metabolic complications and for infectious and immunologic complications (see Standard 2, *Special Patient Populations*).[11,21] (IV)

N. Ensure safe transfusion practice if transfusing in an out-of-hospital setting (eg, dialysis, skilled nursing facilities, home, outpatient surgery).[12,17,29] (IV)

1. Develop well-planned programs that incorporate all relevant aspects for hospital transfusion, including educated clinicians trained in the management of transfusion, transfusion reaction, anaphylaxis, and emergency support.
   a. The most common adverse reactions occurring in out-of-hospital settings were febrile nonhemolytic reactions (28.6%), allergy (26.9%), and TACO (6.3%). The researchers emphasize the need for patient/caregiver education and the importance of having plans of action in place for adverse reactions.[29] (V)
   b. Provision of written instructions regarding signs/symptoms of transfusion reactions and contact information is essential due to lack of prolonged assessment by a clinician postinfusion.[12,13] (V)
2. Employ the following when transfusing in a home setting: documentation showing no identified adverse events during previous transfusions; immediate access to the provider by phone during the transfusion; presence of another competent adult in the home who is available to assist with patient identification and summon for medical assistance if needed; a telephone to contact emergency personnel; ability to transport blood product in appropriate containers; and the ability to appropriately dispose of medical waste.[17] (V)

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63. MODERATE SEDATION/ANALGESIA USING INTRAVENOUS INFUSION

Standard

63.1 Intravenous infusion of moderate sedation/analgesia is provided in accordance with laws, rules, and regulations established by regulatory and accrediting bodies in each jurisdiction and in accordance with organizational policy.
63.2 Target sedation level and optimal sedation and/or analgesic agents are selected based on a thorough assessment of the specific characteristics of the patient (eg, age, pain, anxiety, sedation history, medical condition) and the procedure (eg, potential for pain, positioning, duration).
63.3 An emergency cart and reversal agents are immediately accessible, and clinicians with expertise in patient age and size-appropriate airway management, emergency intubation, advanced cardiopulmonary life support, and management of potential complications are immediately available.

Practice Recommendations

A. Implement a comprehensive educational and competency program for clinicians providing moderate sedation, including age-specific interventions, levels of sedation, medications (onset, peak, duration, synergistic action), effective use of monitoring equipment, airway management, positioning requirements, and postrecovery care.[1-5] (IV)
B. Identify a list of medications that may be administered in specific clinical settings based on patient needs and existing clinician competencies and monitoring capabilities.
   1. Select sedation/analgesic medications with the lowest effective dose and widest therapeutic index for patient and procedural characteristics, using a multimodal approach as indicated.

a. Medications that may be administered for moderate sedation include sedative/hypnotics (eg, midazolam, diazepam, dexmedetomidine), narcotics (eg, fentanyl), anesthetic agents (eg, propofol, ketamine), neuroleptic tranquilizers (droperidol), and combination agents (eg, ketamine/fentanyl, ketamine/propofol).[1,6-14] (IV)
    i. In a prospective, observational evaluation of a pediatric population receiving sedation for painful procedures, preprocedural opioids administered close to sedation were significantly associated with increased risk of oxygen desaturation and vomiting.[15] (IV)
b. Slower titration and use of target-controlled infusions are recommended in elderly and obese populations due to variability in pharmacokinetics.[8,16] (IV)
c. Select initial dosing as fixed dosing or dosing based on actual, adjusted, or ideal body weight depending on the medication and the patient's weight, body mass index (BMI), and sedation goals. Then titrate dose to achieve sedation goal.[11,16] (V)

2. Ensure that the administration of moderate sedation medications (eg, anesthetic agents) is within the scope of practice for the clinician performing this role.
    a. Registered nurse-administered moderate sedation is appropriate when performed under the supervision of a physician.[1,8,11] (IV)
        i. In a retrospective study, patients diagnosed with obstructive sleep apnea (OSA) received nurse-administered moderate sedation under the guidance of an algorithm and use of continuous positive airway pressure (CPAP) during the procedure with no adverse events noted.[17] (IV)
    b. Propofol may safely be administered for moderate sedation by nonanesthesia clinicians with proper training, competency, and when propofol in the moderate sedation setting falls within the jurisdiction of their governing body, generally in patients with American Society of Anesthesiology (ASA) Physical Status Classification System scoring of I to III.[6,8,18-20] (III)

C. Ensure that informed consent was obtained according to organizational policy and procedure (see Standard 9, *Informed Consent*).[6,7,9,11] (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 after the procedure.[1,7,11] (IV)
E. Perform a comprehensive preprocedural assessment to include medical history/current condition, airway assessment, body mass index (BMI), current prescribed and over-the-counter medications that may impact tolerance of moderate sedation medications (such as sedatives, long-acting opioids, cannabis), allergies, previous sedation experience, opioid history, current pain assessment, risk of respiratory depression, drug/alcohol/tobacco use, and fasting status/risk of vomiting and aspiration.[1,6-8,11-13,21-26] (IV)
    1. Consider preprocedural assessment of sleep apnea risk with a validated tool, such as the STOP BANG tool.[1,7,16,27,28] (IV)
F. Consult with an anesthesia provider for issues identified during the assessment that may increase risk of adverse events, such as complex procedure (eg, duration, positioning, painful), anatomic airway abnormalities, ASA score greater than III/IV, infants, children with special needs, significant opioid use, history of intolerance to moderate sedation, airway issues, allergies, sleep apnea, morbid obesity, gastric outlet obstruction, and gastroparesis.[7,8,11,21,29,30] (IV)
G. Establish a process for the procedural timeout to assess and address potential patient and procedure-related risks. Moderate sedation may convert to deep sedation and loss of consciousness due to multiple factors, such as the types of agents used, the patient's physical status, and drug sensitivities.
    1. Ensure that all required equipment is appropriate for the procedure/environment (eg, magnetic resonance imaging [MRI] suite, operating room) and the patient age and body habitus (eg, size of blood pressure cuff, monitoring devices).
    2. Initiate and maintain vascular access throughout the procedure and recovery for administration of medications and for potential need for emergency resuscitative medications and/or reversal agents.[1,7-9,11,13,16,19,21] (III)
H. Monitor the patient continuously throughout the procedure, including blood pressure, respiratory rate, ventilatory status, oxygen saturation, cardiac rate and rhythm, and level of consciousness.[1,7,8,11,13,21] (IV)
    1. Assign a dedicated, trained assistant for sedation monitoring during procedure.[1,6-8,11,13,21] (IV)
    2. Supplementary oxygen is often utilized in procedural sedation but may result in a delay in recognition of respiratory depression.[7,25,31,32] (IV)
        a. In a prospective, observation evaluation of the effects of sedation on arterial blood gas results during cardiac catheterization, significant hypercarbia and respiratory acidosis was noted in patients receiving supplemental oxygen, indicating that oximetry alone may lead to delay in recognition of respiratory acidosis.[33] (IV)
    3. Select a validated method to monitor the patient's level of sedation periodically through the procedure (eg, Richmond Agitation and Sedation Scale, American Society of Anesthesia Society Depth of Sedation Levels).
        a. No single scale has been shown to be superior due to diversity of settings/sedation used.[7,9,13,19] (III)

b. Document assessment parameters at regular intervals (eg, every 5 minutes) throughout the procedure, as indicated by type of medication, patient status, and type of procedure.[7,21,23,24] (IV)
c. Use of advanced monitoring techniques such as acoustic respiratory monitoring, transtracheal auscultation, respiratory volume monitoring, and processed electroencephalography (eg, bispectral indexing [BIS]) may be useful in early detection of level of sedation, hypoxia, and respiratory depression.[9,21,25,34-37] (IV)
    i. Further evaluation is needed to establish the role of BIS monitoring in moderate sedation. This monitoring tool is frequently used in general anesthesia to assess depth of sedation; however, use of BIS is challenging in moderate sedation due to more frequent artifact, lack of consistent signal with some medications, other factors influencing the signal (eg, critically ill patient), and lack of evidence to support, especially in the pediatric population.[8,9,11,38,39] (III)
d. Consider the use of capnography to measure adequacy of ventilation, unless contraindicated by patient, procedure, or equipment characteristics.[1,7,24,40-46] (II)
    i. Use capnography in the following clinical settings: ASA score of III or greater, BMI greater than 30, elderly patients, patients with significant cardiopulmonary risk, high risk gastrointestinal procedures (eg, percutaneous endoscopic gastronomy [PEG] insertion), patient at high risk for respiratory compromise, sedation target is deep sedation.[11,47-49] (II)
        a) In a secondary analysis from a prospective observation study, an increased risk of apnea was associated with a change of greater than 10% from the baseline capnography reading in bolus doses of midazolam and fentanyl.[50] (IV)
    ii. Recent research continues to indicate concerns with a mandate for universal use of capnography use in procedural sedation, indicating that further research is needed. These concerns include the following:
        a) A lack of high-quality evidence associated with early recognition of adverse events and cost-effectiveness in healthy adults undergoing procedural sedation.[8,9,21,31,47,49,51-55] (II)
        b) Continued underutilization and lack of availability of capnography in rural and low-to-moderate income countries.[52,54,56,57] (II)
I. Provide postprocedure recovery monitoring and care appropriate to the patient and procedure characteristics.
    1. Design discharge criteria and facility guidelines for postrecovery monitoring and discharge, using a validated scoring tool (eg, Modified Aldrete, Post-Anesthesia Discharge Scoring System/PADSS).
    2. Monitor the patient until they are at or near baseline status, as assessed preprocedure, with no risk of hypoxia or cardiorespiratory compromise.[1,6,7,9,21] (IV)
        a. One prospective cohort study of pediatric patients undergoing sedation for fracture reduction noted a greater than 50% higher frequency of hypoxia during the recovery period than during the procedure.[58] (IV)
J. Address the following patient/caregiver education topics prior to, and reinforce teaching after, the procedure[6,11,59]: (III)
    1. Sedation/analgesia infusion and procedure and what to expect during the procedure
    2. Postprocedural restrictions
    3. Signs and symptoms to report that may indicate an adverse reaction to medications, the vascular access device, or procedure
        a. A prospective cohort study of children who had received ketamine procedural sedation in the emergency department for fracture reduction noted that high presedation anxiety and ethnicity were associated with significant negative behaviors within 1 to 2 weeks after discharge.[60] (IV)
    4. Emergency instructions and 24-hour contact phone number.
K. Monitor moderate sedation patient outcomes (eg, reversal requirement, transfer to higher level of care, airway intervention) and implement process improvement and improve standardization of moderate sedation care as indicated by quality data.[1,7,9-11,23,29,54,61,62] (IV)

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64. THERAPEUTIC PHLEBOTOMY

Standard

64.1 Selection of the most appropriate type of vascular access device (VAD) for therapeutic phlebotomy occurs in collaboration with the patient/caregiver and the health care team based on the projected treatment plan.
64.2 Interventions to reduce the risk for side effects and/or adverse reactions associated with therapeutic phlebotomy are implemented.
64.3 All medical waste, including the blood from the therapeutic phlebotomy, is disposed of in accordance with organizational policies, procedures, and/or practice guidelines.

Practice Recommendations

A. Establish parameters for therapeutic phlebotomy: laboratory values to be assessed specific to the patient's diagnosis, including, but not limited to, hemoglobin, hematocrit and/or ferritin levels; parameters for laboratory values guiding the indication and continuation of phlebotomy, frequency of phlebotomy, type of VAD, and volume of blood to be withdrawn.[1-15] (V)
    1. Erythrocytapheresis (an apheresis procedure where red cells are extracted, with the remaining blood returned to the patient) may be an alternative to therapeutic phlebotomy when rapid attainment of treatment goals becomes necessary to reduce blood viscosity and risk of thrombosis or when therapeutic phlebotomy fails to accomplish treatment goals. However, apheresis has higher rates of adverse reactions and is more costly.[16] (V)

B. Prevent, manage, and recognize common side effects (eg, hypovolemia, nausea/vomiting) by using a reclining chair or exam table/bed for the procedure; monitor vital signs before and after the procedure; encourage oral hydration before and after the procedure; ask about fear of needles or blood; and administer parenteral solution replacement if prescribed, indicating the type of solution, amount, and rate of infusion. Oral hydration is preferred over parenteral.[1,10,14,17-19] (IV)
C. Assess for history of self-harm prior to initiating phlebotomy. Therapeutic phlebotomy can become a substitute for usual self-harm practices. Be aware that cessation of therapeutic phlebotomy in these patients may result in an increase in self-harm behaviors.[20] (V)
D. Select the most appropriate VAD based on patient condition, anticipated duration of treatment, and other infusion therapies:
    1. Short peripheral intravenous catheter (PIVC) using a 16- to 18-gauge device and inserted before phlebotomy and removed upon completion.[4] (V)
    2. Central vascular access device (CVAD) (including implanted vascular access port), if already placed and therapeutic phlebotomy will not compromise other infusion therapies.[21] (V)
E. Blood collection receptacles may include collection bags used for volunteer blood donation or bags specifically designed for therapeutic phlebotomy; syringes may also be used based on the VAD. Do not use vacuum bottles to facilitate blood flow due to risk of air embolism. (Committee Consensus)
F. Instruct the patient to remain in a reclining position for several minutes after the procedure, then to rise slowly.[22] (V)
G. Address the following topics in patient education: cost; potential impacts to quality of life; potential side effects, such as a hematoma, dizziness, syncope, headache, nausea/vomiting, and fatigue; and consequences of missing treatments, as well as activity restrictions before and after the procedure.[23] (V)
H. Therapeutic phlebotomy may be used alone or in combination with other therapies to achieve treatment goals.[5,7,24,25] (IV)
I. It may be safe to use blood collected from therapeutic phlebotomy for blood transfusion.[26,27] (IV)

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65. VASOPRESSOR ADMINISTRATION

KEY DEFINITION

Vasopressor Therapy: includes medications that promote vasoconstriction with potential for positive inotropic activity. Examples include, but are not limited to, norepinephrine, epinephrine, dopamine, dobutamine, vasopressin, terlipressin, phenylephrine, angiotensin II.

Standard

65.1 The most appropriate vascular access device (VAD) is selected when initiating vasopressor administration to ensure prompt and effective medication delivery, accommodate patient-specific characteristics, minimize the potential for infusion-related complications, and support vascular health and preservation.

65.2 Patency of the selected VAD is validated prior to initiation and during the vasopressor infusion.

65.3 VAD planning and assessment occurs on a regular basis as the condition of the patient requiring vasopressor therapy evolves.

Practice Recommendations

A. Initiate the required vasopressor infusion in a VAD that is patent (eg, positive blood return) with site assessed to be within normal limits to assure prompt, safe and effective delivery of time-sensitive treatment. This is accomplished with consideration of the risks and benefits of peripheral administration of a vesicant, patient-specific risks with central vascular access device (CVAD) insertion, trajectory of patient condition, and potential delays in medication delivery (eg, including low resource settings).[1-8] (IV)
   1. An evolving area of research is the role of supportive therapy to reduce vasopressor requirements and associated mortality; this will impact VAD selection due to potential for additional vesicant administration. Examples include early use of a second vasopressor (eg, vasopressin), methylene blue to reduce excess nitric oxide production, and amiodarone to control shock-related tachycardia.[9-14] (IV)

B. Balance fluid resuscitation and vasopressor administration based on the individual patient clinical needs to improve tissue perfusion.[15,16] (II)
   1. Assess the patient's responsiveness to fluid resuscitation and medication delivery using the most accurate blood pressure measurement and monitoring clinical signs, including dynamic measures to optimize/improve tissue perfusion (eg, passive leg raise test, mottling score, peripheral or central arterial monitoring) as appropriate to the patient's clinical condition.[1,6,8,13,15,17-22] (II)
      a. There is insufficient evidence to inform the optimal timing and titration of vasopressor administration in the hypoperfused adult or pediatric patient (eg, hypotension, mottled, increased capillary refill, elevated lactic acid) due to the wide spectrum of pathophysiology. Early vasopressor delivery has been associated with more rapid achievement of clinical targets (eg, mean arterial pressure of 65 mm Hg), reduction of fluid volume required, and reduction of end organ damage. However, vasopressor delivery may lead to tissue ischemia, increased afterload, and a reduction in needed fluid delivery. Multiple studies illustrate significant heterogeneity in management of hypotension in hypoperfused states. There is a need for high-quality, controlled trials in various clinical settings.[5,16,17,21,23-32] (IV)

C. Use a CVAD as the preferred route for continuous vasopressor infusions to reduce the risk of complications (eg, extravasation, phlebitis/thrombophlebitis) when CVAD insertion will not delay life-saving treatment or when a properly functioning CVAD is already present.[6,21,33,34] (IV)
   1. Insert a CVAD to reduce the risk of VAD-related complications when rapid escalation of vasopressor infusions and/or infusion of more than 1 vasopressor is required.[35,36] (IV)
      a. In a retrospective, cohort study, the time to central line insertion and time to vasopressor initiation were found to be reduced in those who received a peripherally inserted central catheter (PICC) placed by a dedicated team versus nontunneled CVAD at intensive care unit (ICU) admission.[37] (IV)

D. Evaluate potential complications associated with each VAD option (eg, venous depletion, extravasation, bloodstream infection, and thrombotic risks).[38-40] (IV)
   1. Do not insert a peripheral intravenous catheter (PIVC) or midline catheter as a central line-associated bloodstream infection (CLABSI) prevention strategy (refer to Standard 25, *Vascular Access Device Planning and Site Selection*; Standard 44, *Infiltration and Extravasation*; Standard 47, *Vascular Access*

Device-Related Infection; Standard 50, *Catheter-Associated Thrombosis*). (Committee Consensus)

2. Initiate vasopressor administration via a short PIVC for short-duration vasopressor infusion (24 hours or less in the adult) if CVAD insertion is not immediately available (eg, limited resources for insertion, patient characteristics) or if the vasopressor requirement is likely of short duration (eg, hypotension related to epidural anesthesia, high probability of successfully weaning off within 24 hours).[2,4-6,8,29,36,41-53] (II)
   a. Numerous studies have reported low prevalence of adverse events in adults and children associated with peripheral administration of vasopressors, with reduction in CVAD utilization and limited long-term sequelae.[7,42,47-55] (II)
      i. The risk of extravasation appears to increase with duration of the infusion.[2,36,42,47] (IV)
         a) In 3 systematic reviews of peripheral administration of vasopressors in adults and children, the mean duration of peripheral infusion ranged from 12 to 25 hours.[49-51] (II)
         b) There is insufficient evidence to draw conclusions on the safety of peripheral vasopressor infusions longer than 24 hours.[50] (III)
      ii. Optimal duration for peripheral vasopressor administration is unknown for the pediatric population. Research has indicated durations of 9.5 to 21 hours, with the majority progressing to a central line as soon as clinically possible.[47,56] (IV)
         a) In a retrospective cohort study in the pediatric population, the PIVC option was found to be an adequate option for pediatric patients with lower illness severity and older age (mean age 10.3 years). PIVC locations were listed as hand, arm, lower extremity.[42] (IV)
3. Consider an intraosseous VAD for vasopressor administration, placed by a trained and competent clinician, if unable to establish a short PIVC or a CVAD in all ages (see Standard 54, *Intraosseous Access Devices*).[2,34,57-59] (IV)
4. Do not use the midline peripheral catheter or long peripheral intravenous (IV) catheter placed in deep peripheral vessels for continuous vesicant therapy, as there is insufficient evidence to support this practice and there is an increased risk of extensive tissue damage due to the depth of the catheter (refer to Standard 25, *Vascular Access Device Planning and Site Selection*).
   a. Further high-quality, prospective research is needed to establish the safety of the use of the midline PIVC for vasopressor administration.[60-62] (IV)
      i. In a secondary analysis of a randomized controlled trial comparing 2 midline catheters, administration of norepinephrine was associated with an increased risk of midline catheter failure.[62] (IV)
   b. Initial and ongoing assessment of VAD patency is required for continuous administration of vesicants. Midline catheter failure due to thrombotic and occlusive events (eg, nonpatent, occlusion, leaking) are among the most frequently reported outcomes, with causative factors yet unclear.[61-65] (II)
5. There is an urgent need for high-quality, prospective research trials due to limitations in current research regarding peripherally administered vasopressors: variation in definitions of PIVC complications, a preponderance of retrospective methodology, well-documented inconsistency in documentation of PIVC status, high heterogeneity in population base, risk of bias, and inconsistent reporting of study characteristic (eg, location of PIVC, concentration and dose of vasopressor).[6,33,49-51,66-68] (II)

E. Monitor the patient and VAD for expected and unexpected outcomes related to vasopressor administration, according to patient and infusate risk (refer to Standard 39, *Vascular Access Device Post-Insertion Care*).
   1. Validate VAD patency regularly during the infusion of a vasopressor by obtaining positive blood return.
      a. In situations with increased line/luminal volume and vasopressor administration, aspirating for blood return might be contraindicated in patients where interruption of the infusion or inadvertent bolus would cause a clinically relevant decline in the patient's condition. In these patients, blood return could be evaluated when the infusion is stopped or paused for other reasons (eg, bag/tubing change). Increase the frequency of assessment of the insertion site and clinical response to the medication. (Committee Consensus)
   2. Plan to transition the vasopressor to an alternate VAD when blood return is not obtainable (eg, inability to obtain blood return from a central or peripheral VAD that previously had positive blood return, PIVC site that is difficult to assess due to dressings, patient position, or generalized edema). During this transition, other methods of patency assessment may be used when blood return cannot be obtained (eg, assessment of the insertion site and surrounding area, expected clinical effect of the medication).
      a. Further high-quality research is needed to validate a definition of PIVC occlusion and to establish effective PIVC occlusion prevention and treatment strategies as an important precursor to long-term peripheral administration of

vasopressor therapy (see Standard 46, *Vascular Access Device Occlusion*). (Committee Consensus)

F. Consider the following criteria for initiation and assessment of peripheral vasopressor administration. There is insufficient evidence to construct a bundle of interventions regarding peripheral administration of vasopressors; however, consistent utilization of a pre-established safety protocol has been associated with improved outcomes.[47-51,54,55,66,67] (II)
   1. Restrict use of the PIVC to clinical situations in which there is an anticipated short duration of vasopressor use (eg, lower severity of illness, epidural-related hypotension).[36,42,54,69] (III)
   2. Limit to 1 vasopressor infusion per PIVC site.[43] (IV)
   3. Limit concentration and/or dose of the vasopressor to the lowest possible. Severity of tissue damage from extravasation is associated with higher concentration of the medication.[8,47,48,52,54,55,69] (IV)
   4. Place the PIVC in a vessel of sufficient diameter to promote adequate hemodilution (eg, >4 mm, at least 2/3 of catheter within the vessel); preferably placed by infusion/vascular access specialists with use of visualization technology.[49,70] (IV)
   5. Avoid areas of flexion for PIVC insertion. In emergent treatment, the antecubital (AC) fossa is often utilized due to ease of insertion. If the AC is used for peripheral vasopressor administration emergently, it should be monitored closely and transitioned to a site with a lower risk of complication as soon as clinically possible (see Standard 25, *Vascular Access Device Planning and Site Selection*).[69] (V)
      a. Several publications indicate that peripheral vasopressor administration should be accomplished in a site in or proximal to the AC or in the external jugular. The more proximal insertion site recommendation is based on the potential for improved hemodilution with a PIVC placement in a larger diameter vessel and the increased risk of extravasation distally in the severely hypoperfused patient.[6,35,36,43,54,69,70] (IV)
         i. This recommendation, however, does not address the risk of delay in the recognition of an extravasation and the potential for more extensive tissue damage in PIVCs placed in deeper vessels.[61] (V)

G. Assure staff competency in recognition and treatment of VAD-related complications, such as phlebitis and extravasation.[47,49,66,70,71] (IV)
   1. Monitor the VAD status closely (eg, every hour) for potential adverse events, with close monitoring required during transport of the patient.[2,47,49,55,66,70,71] (IV)
      a. In a cross-sectional observation study in adults, patients with a vasopressor or inotropic infusion had 9-times higher odds of adverse events during transport between departments within a facility.[72] (IV)

H. Assess the complete medication regimen to assure safe delivery of all required treatment (eg, incompatibilities, timing, shared volume in administration sets) (see Standard 57, *Infusion Medication and Solution Administration, Table 1: Medication/Infusion Delivery: Dose Accuracy and Error Prevention*).[70,73] (IV)
   1. Use electronic infusion pumps that include dose error reduction systems ([DERS], ie, smart pumps) with current and relevant drug libraries, as these are associated with reduced risk for infusion-related medication errors, including error interceptions (eg, wrong rate) and reduced adverse drug events (refer to Standard 23, *Flow-Control Devices*; Standard 57, *Infusion Medication and Solution Administration*).
      a. In a small observational study, implementation of a protocol for a peripherally administered norepinephrine infusion for management of septic shock in a low resource setting (eg, unavailability of DERS infusion system, of CVAD placement, or of ICU placement) was associated with improved mortality rates and no localized adverse events.[41] (IV)

I. Develop an extravasation policy and protocol that guides prompt notification of the provider and evidence-based treatment (see Standard 44, *Infiltration and Extravasation*).[49,54,71,74] (IV)

J. Monitor outcomes related to vasopressor administrations to inform quality improvement (refer to Standard 6, *Quality Improvement*).
   1. A new area of research is the creation of prediction models to better inform the optimal VAD for the hypotensive patient. Further study is needed to inform device selection in a rapidly evolving patient situation.[75,76] (IV)

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66. HOME INFUSION THERAPY

Standard

66.1 Home infusion therapy is provided with attention to appropriate patient selection and in collaboration with the patient/caregiver and the interprofessional team.
66.2 The risks of infusion-related complications, appropriateness of the infusion access device/infusion delivery method, patient and clinician safety are evaluated and considered by the home care organization and provider prior to accepting a patient for home infusion administration.
66.3 Home care organizations provide a comprehensive program that includes clinician education and competency assessment, evidence-based policies and procedures, and attention to quality improvement, including infection surveillance and reporting.

Practice Recommendations

A. Confirm that home infusion therapy is appropriate for the patient as part of a comprehensive planning/transition process and based upon multiple factors, including the following[1-13]: (IV)
   1. Home care organization ability to provide home infusions (eg, specialized clinician education and competency assessment, evidence-based policies/procedures, quality improvement program, infection surveillance).
   2. Infusion therapy that is appropriate for home care. General categories of home infusion therapy include antimicrobials, hydration solutions, parenteral nutrition (PN), antineoplastics, analgesics, biologics, and inotropes; when considering medications/solutions outside of these categories, rationale and safety issues for home infusion should be carefully investigated by the health care team.
   3. Patient stability relative to clinical condition and need for home infusion therapy (eg, no adverse reactions to prescribed infusion, metabolic stability for home parenteral nutrition [HPN], hemodynamically stable for inotropic infusions).
   4. The risk for potential adverse reactions and the ability to manage/reduce risk are identified before considering home infusion therapy and when initiating infusion therapy at home without a prior hospitalization or outpatient administration (eg, first dose) (see Standard 57, *Infusion Medication and Solution Administration*).
   5. Patient/caregiver preference for home infusion; motivation, ability, and willingness to participate in care; provision of patient education about home infusion therapy and home care expectations.
   6. Availability of services in the patient's geographic area (eg, 24-hour pharmacy/nursing support, drug/supply delivery, telehealth/telemonitoring, laboratory services).
   7. Consideration for telehealth for reinforcing patient education and monitoring patients in distant/isolated areas.
   8. Reimbursement for infusion medications/solutions and services at home or for other options (eg, outpatient); the patient is informed of any financial responsibility and availability of financial assistance programs.
   9. Appropriate vascular access device (VAD) for the prescribed home infusion therapy (refer to Standard 25, *Vascular Access Device Planning and Site Selection*).
   10. Appropriate infusion administration method; factors include drug/solution stability, frequency/duration of infusions. Patient preference should be considered whenever possible to improve success and satisfaction with home infusion; methods include intravenous (IV) push, elastomeric pumps, gravity infusions, and electronic infusion pumps (see Standard 23, *Flow-Control Devices*).[14] (V)

B. Evaluate patient/caregiver and clinician home environmental safety and risk factors; develop alternative infusion plans with the patient and health care team if home care is not a safe option.
   1. Identify that the home is reasonably safe and clean for medication/supply storage and infusion administration with running water, electricity, refrigeration, and telephone access.[2,9,15] (V)
   2. Assist patients/caregivers to mitigate potential home hazards by establishing a clean, uncluttered area for supply storage/infusion administration, and educate about how to protect the VAD and manage household tasks.[2,3,15] (V)
   3. Consider drug stability, which is a potential concern with continuous infusions, especially in very warm climates. Suggestions include discussion about home conditions before accepting patients for continuous home infusion and patient education that includes spending time in the most temperate area of home/air conditioning if possible; also ensuring that deliveries of drugs/supplies are promptly brought into the home.[15-18] (IV)
   4. Evaluate potential/actual clinician safety issues, such as abusive patient/caregiver behaviors, illegal

drug use, presence of weapons, or aggressive pets; mitigate any risks, if possible, or develop alternative plan of care (eg, outpatient services).[1,15] (V)

5. Ensure presence of emergency medications and supportive care measures in the event of adverse reactions, as appropriate, based upon the type of home infusion therapy (eg, antineoplastics, biologics, inotropics) (see Standard 58, *Antineoplastic Therapy*; Standard 59, *Biologic Therapy*).[19-21] (V)
6. Ensure availability and clinician competency in use of supplies needed for safe handling when administering hazardous drugs (eg, personal protective equipment [PPE], protective devices, disposal containers, spill kits) (see Standard 15, *Hazardous Drugs and Waste*).[21,22] (IV)

C. Provide home-based outpatient antimicrobial therapy (OPAT) based upon above criteria; OPAT is a well-accepted and common home infusion therapy for both adults and pediatric patients.[23-32] (IV)
   1. Favorable outcomes, including treatment success, are reported when there is attention to careful patient selection (eg, clinically stable, presence of caregiver support, no cognitive impairment).
   2. An infectious disease (ID) expert review prior to the initiation of OPAT is recommended. ID follow-up during OPAT is recommended, especially for immunosuppressed patients, as readmission for worsening or complication of infection is a common cause for hospital readmission. OPAT-related adverse drug events were highest in the first 2 weeks of home OPAT.[33,34] (IV)

D. Consider home-based OPAT for persons who inject drugs (PWID) on a case-by-case basis when defined patient selection criteria are in place.[31,35-39] (IV)
   1. Home-based OPAT can be safe and effective for PWID when there is care coordination between infectious disease and addiction specialists and case management; when patients are engaged in treatment and used no illicit substances during hospitalization; have a safe home and family/caregiver support; are counseled about risks with an indwelling VAD (eg, peripherally inserted central catheter [PICC]); have safe housing; agree to the plan for home care and close follow-up by home care agencies/video visits.
   2. Misuse of VADs is low, despite perceptions; however, some programs use a tamper-evident procedure/product at the catheter hub. A characteristic associated with adverse outcomes included lack of family involvement in discharge planning.

E. Consider HPN for patients transitioning from an inpatient setting who are clinically stable, with attention to safe transition planning, patient/caregiver education, and attention to an appropriate VAD and administration schedule (refer to Standard 61 *Parenteral Nutrition*).
   1. PN is initiated in the home only when benefits outweigh the risks and when there are organizational policies in place, including clear admission/eligibility criteria; a comprehensive patient assessment, including medical, clinical, and psychosocial parameters; strict protocols for initiation and monitoring PN.[13] (V)

F. Evaluate the safety profile and potential risks of biologic and antineoplastic infusion therapies when considering either the initiation of infusions in the home or when transitioning patients from acute care or outpatient administration (see Standard 58, *Antineoplastic Therapy*; Standard 59, *Biologic Therapy*).
   1. Home-based immunoglobulin (Ig) therapy may be appropriate for carefully selected patients. Ig-naïve patients and/or those with a prior history of adverse drug reactions should receive Ig therapy in a setting that ensures safety and the ability to respond to severe, adverse reactions (eg, acute care, outpatient) to ensure their safety because adverse drug reactions (ADRs) can occur more frequently in these patients.[40] (IV)
      a. Overall safe administration of home intravenous immunoglobulin (IVIg) infusions was reported in a large retrospective study; an increased risk for adverse events was associated with first course of treatment, younger age, female gender, and higher doses. In another report, patients were successfully transitioned from outpatient therapy during the pandemic to decrease exposure to COVID-19, with no impact on patient satisfaction, adherence, or efficacy.[41,42] (V)
   2. Successful home administration of biologic infusions, including natalizumab, infliximab, blinatumomab, and ocrelizumab are reported. Characteristics of programs included specific infusion protocols, clinically competent clinicians, attention to patient safety, consideration of patient preferences, attention to careful evaluation of potential adverse events. Any home administration of a biologic is carefully evaluated based upon the adverse event profile.[43-48] (IV)
   3. Home infusion for cancer treatment should be done with caution and consideration of the risk of harm for nurses, patients, and other household members. First doses should be completed without incident prior to converting to home infusion. Home care nurses should be competent in administration of chemotherapy/immune therapy. Infusion of investigational antineoplastic drugs is not recommended for home administration.[21] (V)
      a. In a single study, 140 children received cytosine arabinoside (ARA-C) by parents trained in administration, with no medication errors and reported benefits of reduced cost, decreased time spent in the hospital, less disruption to routines, less travel time, and less stress to the child. Another study reported home administration of a variety of

antineoplastic agents, hydration fluids, and antimicrobials (136 pediatric patients receiving 1701 home visits) as part of a hospital-at-home program, with no reports of adverse events.[49,50] (V)

G. Evaluate risks versus benefits when considering home cardiac infusion therapies for patients with heart failure.
   1. Inotropic infusions (most commonly dobutamine or milrinone) include a palliative approach for patients with end-stage heart failure (HF) or a bridge to transplant in both adult and pediatric patients and may be administered as continuous or intermittent infusions.[19,20,51,52] (I)
   2. Evidence suggests that inotropic infusions for patients with advanced HF are associated with an improvement in functional class and do not increase the risk of death.[52] (I)
   3. Other cited benefits include improved quality of life and reduced complications, while risks include central vascular access device (CVAD)-related complications, burden of infusion-related care, and need for caregiver support. There is a need for well-designed studies to address implications relative to survival, harm, and benefits.[19,20,51-53] (IV)
   4. Discharge planning should address the following elements relative to the plan for home care: frequency of vital signs monitoring and acceptable parameters; maximum time off in the event of a CVAD malfunction; evaluation for need of devices, including a back-up infusion pump, weight scale, and defibrillator.[19,20] (IV)
   5. Subcutaneous or IV administration of diuretics in the management of HF was associated with symptom relief and low risk of adverse effects based upon a systematic review. Cited benefits included reduction in edema/weight and high patient satisfaction, while challenges included difficult venous access in a primarily older patient population. A new subcutaneous formulation of furosemide was made available for home treatment in 2022 (see Standard 55, *Subcutaneous Infusion and Access Devices*).[54-57] (IV)

H. Provide effective patient/caregiver education.
   1. Identify the required level of procedural education based upon the type of infusion therapy; for example, biologic and antineoplastic drugs are more commonly administered by the home care nurse, while patients/caregivers will most often learn to self-infuse therapies, such as OPAT, PN, and cardiac infusion therapies. Safe home management of the VAD is always addressed.[1,2] (V)
   2. Select teaching methods based upon an assessment of age, culture, developmental and cognitive level, health literacy, preferred language, and learning style. Identify factors impacting readiness to learn, such as weakness, fatigue, anxiety, functional/cognitive limitations (see Standard 8, *Patient Education*).[1,2] (IV)
   3. Address basic infusion administration with attention to preventing complications, including all necessary tasks: flushing/locking all lumens, needleless connector disinfection, priming infusion system of air, clamping sequence, frequency of administration set change, VAD care and protection (eg, bathing, risk for inadvertent VAD dislodgement), infusion pump management, supply management, troubleshooting, and when/how to notify home care organization.[1,2,58] (V)
      a. Emphasize and observe adherence to basic infection prevention strategies, including hand hygiene and Aseptic Non Touch Technique (ANTT®); address self-monitoring of site; provide a list of complications, symptoms, and actions to take; use interactive/videotaped educational material.[59] (V)
      b. Evaluate learning outcomes with methods that directly measure knowledge, such as demonstration/return demonstration for psychomotor skills, verbal feedback for cognitive knowledge (teach-back) (refer to Standard 8, *Patient Education*).
      c. Consider telehealth visits; areas of focus during telemedicine visits may include CVAD methods materials, clinical concerns, and equipment management (see Standard 19, *Aseptic Non Touch Technique [ANTT®]*).[6,8] (IV)
   4. Re-evaluate and periodically review infusion-related skills, including adherence to ANTT; identify need for re-education.[1] (V)
      a. In a qualitative study involving interviews and observations of patients receiving OPAT, hazards to learning included misleading information from the hospital, rushed instructions, different instructions by different nurses, confusing/inaccurate written instructions, unfamiliar terminology. Six goals were identified: understanding and developing skills, receiving supplies, infusion medication administration and VAD maintenance, preventing VAD harm during activities of daily living, managing when hazards lead to failures, and monitoring.[58] (V)
   5. Provide easy access to technical support when medical devices are used in the home. In a retrospective study, safety risks relative to home infusion pumps were identified, resulting in device malfunction and medication underdosing; delays in recognizing and reporting problems were identified. Greater monitoring and oversight of medical devices used in the home are recommended, with easy access to technical support.[60] (V)

I. Evaluate and monitor response to and effectiveness of the home infusion therapy, including patient response, side effects/adverse drug events, laboratory study results as appropriate, and VAD-related complications (refer to Standard 39, *Vascular Access Device*

Post-Insertion Care; Section Seven: *Vascular Access Device Complications*).

1. In a systematic review of observational studies of hospital-at-home and OPAT episodes, more than 88% of the studies reported a cure or treatment success rate of greater than 80%; adverse events with drugs ranged from 0% to 30.2%; VAD-related adverse events ranged from 0% to 29%; readmission rates varied from 1% to 26%, and mortality rates from 0% to 27.5%. Methodologies used to measure these parameters were inconsistent, and some demographic groups had only a small number of studies.[28] (IV)
2. In a systematic review of studies (varied designs) comparing home infusion to inpatient/outpatient settings, patients receiving home infusion were no more likely to experience ADRs or side effects.[61] (IV)
3. Risk factors associated with VAD-related complications included younger patients, female gender, more than 1 CVAD lumen, and patients receiving PN. The most common CVAD-related complications were catheter occlusion and mechanical complication (accidental breakage, inadvertent outward migration). Adverse VAD-related events, including extravasation, blockage, and displacement were significantly more common with midline catheters in a retrospective study including over 500 OPAT episodes.[62-64] (IV)

J. Assess and address patient and family management and coping with home infusion therapy.

1. Ensure clear delineation of roles. Role ambiguity is common (eg, which health care provider to contact if problems, different information provided by different providers); there should be clear delineation of the roles of the patient, caregiver, and health care team.[5] (V)
2. Consider and address patient quality-of-life (QOL) issues relative to the infusion therapy.
   a. Factors known to negatively impact the QOL of patients receiving HPN include sleep disturbance, frequent urination, fear of therapy-related complications, inability to eat, and increased occurrence of depression. Consider supportive interventions; the Oley Foundation is a national support group that provides education, advocacy, and networking for patients requiring both enteral and HPN.[65] (V)
   b. Reduction in frequency of HPN infusions (eg, 5-6 infusions per week versus 7) was associated with improved QOL; when clinically appropriate and without sacrificing nutritional status, reducing infusion frequency should be considered (see Standard 61, *Parenteral Nutrition*).[66] (IV)
3. Assess for caregiver stress and need for support in providing care, and identify appropriate services or resources. Caregiver stress may be apparent, especially with more complex therapies such as PN, antineoplastic, and inotropic infusions, as caregivers are also coping with the diagnosis, treatment, and implications of treatment (eg, side effects, inability to eat) and dealing with their own social restrictions, depression, difficulty watching a loved one suffer.[49,50,67-71] (IV)

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Note: All electronic references in this section were accessed between September 13, 2022, and August 16, 2023.

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Appendix A

Aseptic Non Touch Technique (ANTT®) Clinical Practice Framework

INS recognizes the historical and contemporary problems with aseptic technique and the consequential risks to patient safety. It is widely noted that variable and ambiguous terminology for this critical clinical practice has inhibited effective education, standardized practice, and ultimately patient safety.[1-4]

In consideration of these problems and challenges, this edition of the *Infusion Therapy Standards of Practice* (the *Standards*) has introduced a new dedicated standard for aseptic technique. It features the original and explicitly defined ANTT Clinical Practice Framework that is used widely as a de facto international standard. All reference to aseptic technique throughout the *Standards* is therefore articulated using unique practice terms and principles of ANTT as outlined below.

WHY HAS INS ADOPTED ANTT AS A SPECIFIC STANDARD FOR ASEPTIC TECHNIQUE?

Although recognizing problems with practice, stakeholder organizations over recent years have typically only "prescribed aseptic technique" with virtually no meaningful description. Such "prescription without description" of aseptic technique, and the lack of consistent education and competency assessment, does not provide the level of clinical oversight and attention to quality improvement that this critical clinical competency demands.

INS provides global leadership for infusion practice and ultimately patient advocacy by developing and disseminating standards of practice. Establishing standards of aseptic technique is a global concern, and standardizing practice internationally with ANTT as a universal approach will help improve patient safety. The best example of a standardized approach to an important clinical competency is basic life support. Internationally, the health care community shares common clinical guidelines, recommendations, and practice terminology for resuscitation, thus supporting consistent practice across the globe.[5]

INS seeks to promote research inquiry for practice advancement, and aseptic technique is integral to a wide range of research in infusion practices. It is clear from an increasing number of international publications that the common and standardized language in the ANTT Clinical Practice Framework is being used to support more meaningful and generalizable research.[6-9]

Some clinicians may find ANTT terminology a change. Therefore, it is useful to remember it reflects a rationalization of the inaccurate, interchangeable, and variable practice terms that exist, and a step forward to a more universal approach for the ultimate benefit of consistent patient care.

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THE ANTT FRAMEWORK EXPLAINED

Originated by Rowley[10] and defined by the National Institute for Health and Care Excellence (NICE),[11] *ANTT* is a specific type of aseptic technique with a unique theory and Clinical Practice Framework. The Framework is designed for use with all invasive clinical procedures and management of indwelling medical devices in all patients. As well as robustly defining the different elements of aseptic practice, it better explains the necessary integration of these elements for different clinical situations. To this end, maintaining asepsis during infusion therapy is a diverse and challenging practice, and applying ANTT principles supports clinical decision-making.

The Aim Is Always Asepsis

ANTT is fundamentally based on the practice aim of asepsis for all invasive clinical procedures. This is because:

- The practice aim of ***clean*** technique is not appropriate for invasive procedures, as it is a visual standard of hygiene applied to invisible microorganisms.
- The practice aim of ***sterile*** technique, free of ALL microorganisms, is not achievable in typical health care settings due to the ever presence of microorganisms in the air environment.
- The practice aim of ***asepsis*** or ***aseptic*** technique, the absence of pathogenic organisms, in sufficient quantity to cause infection, is achievable. ANTT includes the words 'non-touch' to be descriptive, as non-touch technique is a critical component of this practice.

How Asepsis Is Achieved

To achieve asepsis in practice and support education and research, ANTT uses a novel approach termed ***Key-Part and Key-Site Protection***.[3,11] This model educates the clinician to always identify and protect the most important parts of the equipment and the vulnerable sites on the patient during any clinical procedure.

- **Key-Parts**
  Key-Parts are the parts of equipment that if touched or contaminated are most likely to contaminate and potentially infect the patient. Examples include the syringe tip, male luer end/spike of administration set, needleless connector, injection needle, or the open lumen of a central vascular access device (CVAD).
- **Key-Sites**
  Key-Sites are any portal of entry for microorganisms into the patient. Examples include any vascular access device (VAD) site, injection site, or open wound.

The Key-Part and Key-Site Rule

Safe practice is assured when clinicians always adhere to this rule: *Key-Parts must only come into contact with other aseptic Key-Parts and Key-Sites.*

ANTT Needs to Be Efficient as Well as Safe

The ANTT Clinical Practice Framework establishes two ANTT approaches to efficiently accommodate simple and complex procedures:

- **Standard-ANTT**

  Key-Parts are protected individually. It is used for procedures where it is simple to achieve and maintain asepsis. Such procedures, for example intravenous (IV) medication administration, will typically have few small Key-Parts, be minimally invasive, have a short duration of less than 20 minutes, and require low levels of personal protective equipment (PPE). Two types of aseptic fields are used in Standard-ANTT to protect Key-Parts independently.
  - **General Aseptic Field:** A decontaminated and disinfected surface or single-use procedure kit/barrier. Used to provide a controlled work space, promoting, but not ensuring asepsis.
  - **Micro Critical Aseptic Field:** A small protective sterile surface/housing (eg, sterile caps, covers, or the inside of recently opened sterile equipment packaging). Used to protect Key-Parts individually and placed/transported within a General Aseptic Field.

- **Surgical-ANTT**

  Key-Parts are protected together. It is used for procedures that are technically complex to achieve and maintain asepsis. Such procedures, for example peripherally inserted central catheter (PICC) insertion, will typically involve many and/or large Key-Parts, a relatively large open Key-Site, have a long duration of more than 20 minutes, be significantly invasive, and require high levels of PPE. One type of aseptic field is used in Surgical-ANTT to protect Key-Parts together as a group.
  - Critical Aseptic Field: A large sterile drape/barrier. Used to ensure asepsis; all procedure equipment is placed upon the drape and protects multiple and often large Key-Parts collectively.

ANTT RISK ASSESSMENT

Infusion therapy is a diverse specialty ranging from relatively simple to very complex clinical procedures. Often, the most suitable type of ANTT for any particular procedure is defined in organizational policy. In other situations, the ANTT Risk Assessment should be used to determine the type of ANTT approach to use. The decision is guided by asking the question:

Is it technically easy to protect and maintain the asepsis of the Key-Parts and Key-Sites during this procedure?

If yes, then Standard-ANTT is used. If no, then Surgical-ANTT would be selected. To help make this clinical judgment the clinician will consider a number of practice variables, including:

- The number and size of Key-Parts and Key-Sites.
- The invasiveness of the procedure.
- The duration of the procedure.
- The environment within which the procedure will take place.
- The level of PPE required.

APPLYING ANTT TO PRACTICE

Example 1: IV Drug Preparation and Administration

By applying the ANTT Risk Assessment above, the clinician would likely determine the use of Standard-ANTT due to asepsis being relatively easy to establish and maintain. This is due to the following factors:

- Few and small Key-Parts are used.
- The Key-Parts are relatively easy to protect individually with a combination of Micro Critical Aseptic Fields (eg, sterile caps and the inside of recently opened sterile packaging) and use of a non-touch technique within a General Aseptic Field (eg, a procedure tray).
- The procedure is short in duration (typically $<$20 minutes) and minimally invasive.

Preparation

The clinician performs hand hygiene and selects the appropriate PPE. The procedure tray is disinfected, providing a clean work space, or a barrier is used (General Aseptic Field). While the work space dries, all required equipment is gathered and placed around the procedure tray. Immediately prior to equipment assembly, hand hygiene is repeated and nonsterile gloves donned according to organizational policy. Once opened and assembled, immediately protect individu-

al Key-Parts with Micro Critical Aseptic Fields and place onto the work space. Waste and sharps are safely disposed, PPE removed, and hand hygiene performed.

Administration

With clean hands and fresh nonsterile gloves (as required), the clinician will disinfect the injection port/needleless connector and allow to dry fully. Syringes are removed from the procedure tray/barrier (General Aseptic Field). The protective syringe cap is removed or the syringe is removed from its packaging (both Micro Critical Aseptic Fields) and connected immediately and directly to the injection port/needleless connector (ie, aseptic Key-Part to aseptic Key-Part).

Example 2: PICC Placement

By applying the ANTT Risk Assessment, the provider would determine the use of Surgical-ANTT due to asepsis being more difficult to achieve and maintain. This is due to the following factors:

- Many, and some large, Key-Parts and one small but invasive Key-Site are used.
- The Key-Parts are not easily managed and all Key-Parts need to be protected.
- The procedure is typically 30 to 60 minutes or more in duration, relatively invasive, and is associated with a risk for infection.

Preparation

The clinician performs hand hygiene and selects appropriate PPE. The procedural area is disinfected providing a clean work space. While the work space dries, all required equipment is gathered. Immediately prior to opening sterile drapes/procedure pack, hand hygiene is repeated, creating a Critical Aseptic Field. The equipment and sterile supplies are placed onto the Critical Aseptic Field using a non-touch technique.

Procedure

After a surgical hand scrub is performed, the clinician dons a sterile gown and sterile gloves. Using a non-touch technique, equipment is assembled and local anesthesia is prepared. Although wearing sterile gloves, Key-Parts, such as syringe tips and the PICC, are not touched where practical not to do so. At all times, all equipment must stay on and within the Critical Aseptic Field(s).

ANTT QUALITY IMPROVEMENT

Like any critical clinical competency that is integral to patient safety, ANTT must be supported as part of a comprehensive quality improvement program. Namely, effective clinician education, training, competency assessment, and the ongoing monitoring of standards of practice through periodic audit.

ANTT is overseen and disseminated internationally by the Association for Safe Aseptic Practice (ASAP), providing free support, advice, and resources to help with ANTT implementation and maintenance at ANTT.org. Although ANTT® is trademarked and is copyrighted material, this is to protect the integrity of ANTT and not inhibit its free utilization for educational noncommercial activities.

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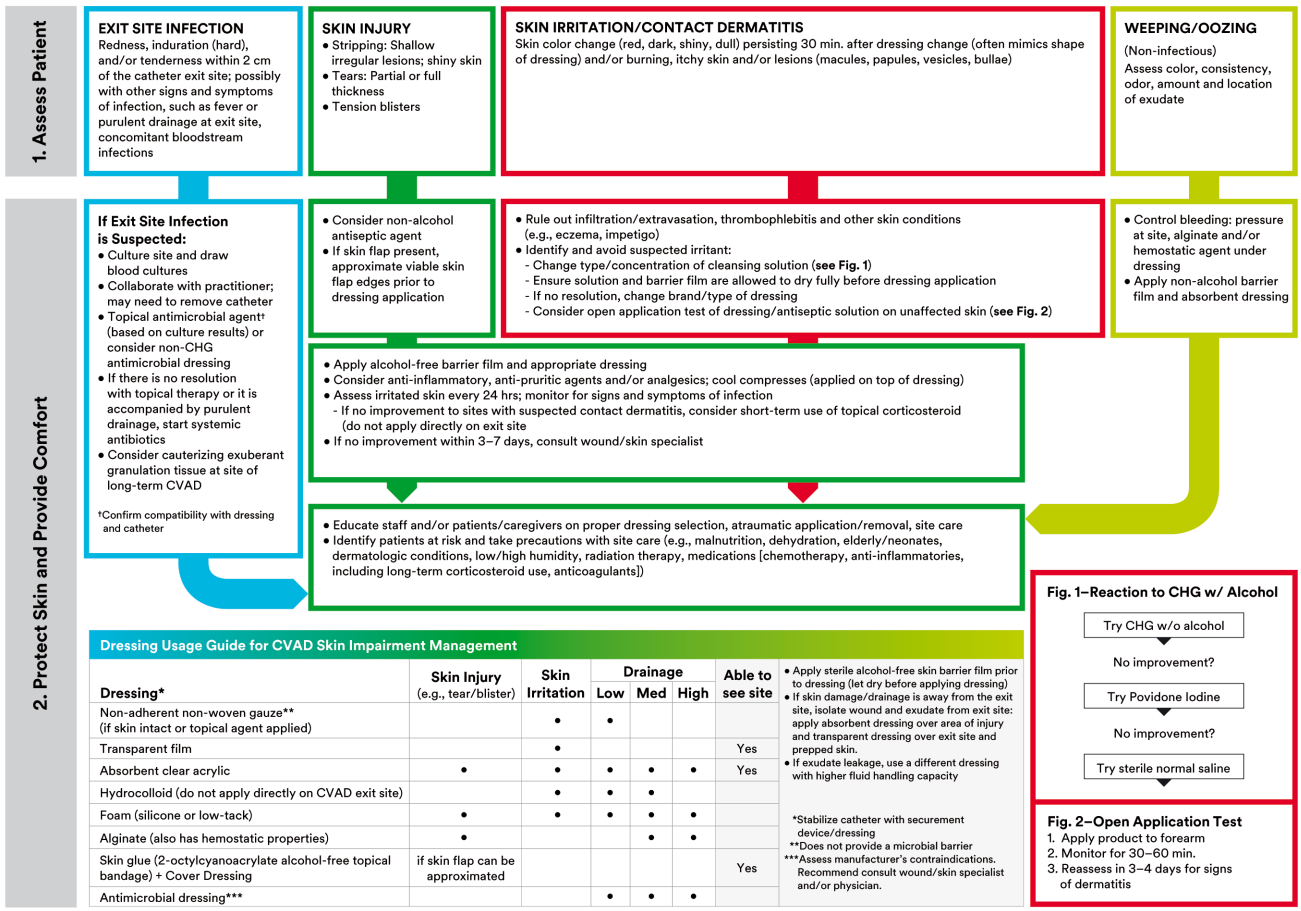
CATHETER-ASSOCIATED SKIN INJURY

CVAD– Associated Skin Impairment (CASI) Algorithm

(Broadhurst, Moureau, Ullman. *J Wound Ostomy Continence Nurs. 2017;* 44(3)1-10)



Dressing Usage Guide for CVAD Skin Impairment Management

Dressing*	Skin Injury (e.g., tear/blister)	Skin Irritation	Drainage			Able to see site
			Low	Med	High	
Non-adherent non-woven gauze** (if skin intact or topical agent applied)		•	•			
Transparent film		•				Yes
Absorbent clear acrylic	•	•	•	•	•	Yes
Hydrocolloid (do not apply directly on CVAD exit site)		•	•	•		
Foam (silicone or low-tack)	•	•	•	•	•	
Alginate (also has hemostatic properties)	•			•	•	
Skin glue (2-octylcyanoacrylate alcohol-free topical bandage) + Cover Dressing	if skin flap can be approximated					Yes
Antimicrobial dressing***			•	•	•	

- Apply sterile alcohol-free skin barrier film prior to dressing (let dry before applying dressing)
- If skin damage/drainage is away from the exit site, isolate wound and exudate from exit site: apply absorbent dressing over area of injury and transparent dressing over exit site and prepped skin.
- If exudate leakage, use a different dressing with higher fluid handling capacity

*Stabilize catheter with securement device/dressing
**Does not provide a microbial barrier
***Assess manufacturer's contraindications. Recommend consult wound/skin specialist and/or physician.

Appendix B. *Abbreviations: CASI, CVAD-associated skin impairment; CHG, chlorhexidine gluconate; CVAD, central vascular access device; w, with; w/o, without*. Reprinted with permission from Broadhurst D, Moureau N, Ullman AJ; The World Congress of Vascular Access (WoCoVA) Skin Impairment Management Advisory Panel. Management of central venous access device-associated skin impairment: an evidence-based algorithm. *J Wound Ostomy Continence Nurs*. 2017;44(3):211-220. doi:10.1097/WON.0000000000000322

Appendix C

Assessment Scales – Infiltration Scale, Phlebitis Scale, Visual Infusion Phlebitis Scale, and Extravasation Staging

Use a standardized tool/scale to accurately perform and document vascular access device (VAD) assessment for infiltration, extravasation, and phlebitis. Consistent use of one assessment and documentation method within an organization is essential. The population for which the tool/scale is appropriate should be identified as adult or pediatric.

The INS Infiltration Scale (Table 1) was last published in *The Infusion Nursing Standards of Practice* in 2006 and is republished here for archival purposes. Further study is recommended for validation of this specific tool.

The tool, Extravasation Staging (Table 2), was designed by Ong and Van Gerpen,[2] who utilized published literature to identify extravasation staging, assessment of symptoms, and treatment options.

The two phlebitis scales, the INS Phlebitis Scale (Table 3) and the Visual Infusion Phlebitis (VIP) Scale (Table 4), and a set of signs/symptoms have been evaluated for validity and interrater reliability in different populations with insufficient definitions and mixed results. There is often a lack of direction for interventions with a specific clinical finding. Further study is recommended for valid and reliable assessment tools.

TABLE 1

INS Infiltration Scale

Grade	Clinical Criteria
0	No symptoms
1	Skin blanched Edema < 1 inch in any direction Cool to touch With or without pain
2	Skin blanched Edema 1–6 inches in any direction Cool to touch With or without pain
3	Skin blanched, translucent Gross edema > 6 inches in any direction Cool to touch Mild–moderate pain Possible numbness
4	Skin blanched, translucent Skin tight, leaking Skin discolored, bruised, swollen Gross edema > 6 inches in any direction Deep pitting tissue edema Circulatory impairment Moderate–severe pain Infiltration of any amount of blood product, irritant, or vesicant

TABLE 2
Extravasation Staging

Stage	Assessment	Treatment Options
1	• Painful infusion site • No erythema • Localized swelling (1%-10% of extremity above or below site)	• Remove cannula • Elevate extremity • Warm/cold compresses
2	• Painful infusion site • Slight swelling at site (up to 25% of extremity above or below site) • Slight erythema (localized to the central area of extravasation) • Good pulse below site • Brisk (1-2 seconds) capillary refill below site	• Remove cannula • Elevate extremity • Warm/cold compresses • Consider antidote
3	• Painful infusion site • Moderate swelling at site (25%-50% of extremity above or below site) • Marked erythema (extends beyond central area of extravasation) • Blanching (for vasopressor extravasation only) • Good pulse below site • Brisk (1-2 seconds) capillary refill below site • Skin cool to touch	• Leave cannula in place; using a 1 mL syringe, aspirate as much fluid as possible • Remove cannula unless it is needed for antidote administration • Elevate extremity • Warm/cold compresses • Consider antidote
4	• Painful infusion site • Severe swelling at site (more than 50% of extremity above or below site) • Very marked erythema (extends beyond borders of swelling) • Blanching (non-vasopressor extravasation) • Decreased or absent pulse • Prolonged capillary refill > 4 seconds • Skin cool to touch • Skin breakdown including blistering or necrosis	• Leave cannula in place; using a 1 mL syringe, aspirate as much fluid as possible • Remove cannula unless it is needed for antidote administration • Elevate extremity • Warm/cold compresses • Consider antidote • If swelling of the site is tense and skin is blanched, obtain surgical consult

*Ong J, Van Gerpen R. Reprinted with permission. Recommendations for management of noncytotoxic vesicant extravasations. **J Infus Nurs.** 2020;43(6):319-343. doi:10.1097/NAN.0000000000000392*

TABLE 3
INS 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 4
Visual 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.
*Data from Jackson A. Infection control–a battle in vein: infusion phlebitis. **Nurs Times**. 1998;94(4):68-71. Reprinted with permission.*

GLOSSARY

A

Accreditation. A quality assurance process under which health care services and operations are evaluated and verified by an external body to determine if recognized standards are met.

Active disinfection. Use of a disinfectant to physically scrub the injection site/port before each access; often referred to as "scrub the hub."

Add-on device. Additional components, such as an in-line filter, stopcock (3-way tap), Y-site, extension set, manifold set, needleless connector, and/or dead end cap that is added to the administration set or vascular access device.

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

Adjuvant medication. Additional medications given to facilitate or enhance a primary drug or medical treatment.

Administration set. A tubing set composed of plastic components that is used to deliver infusions and typically includes a spike, a drip chamber, injection ports, and a male luer end. Variations may include a Y-set, integrated filter, and microbore tubing.

- **Primary administration set.** The tubing set connecting the infusate container directly to the vascular access device (VAD) or to a lower access point (eg, Y-site) of another primary set; may be used for gravity delivery or designed to be used with a flow-control device; may be continuous or intermittent.
- **Secondary administration set (eg, piggyback).** Additional, shorter tubing set that is connected to an access point on the primary set; may be used to administer infusates concurrently or intermittently with the primary infusate; may be used for gravity delivery or designed to be used with a flow-control device; commonly used for intermittent infusions, but may be used for secondary continuous infusions.
- **Intermittent administration set.** A primary or secondary administration set that has been disconnected from the initial access point (eg, needleless connector, VAD hub) and left disconnected due to completion or a pause in an infusion. It must be disconnected aseptically, with the distal tip protected by a new sterile end cap.
- **Continuous administration set.** A primary or secondary administration set that remains connected to the vascular access device (VAD) for the duration of an infusion or until the scheduled administration set change occurs. This set may be disconnected and reconnected to a VAD for a brief period (eg, blood sampling, transition to a new VAD lumen) with adherence to Aseptic Non Touch Technique (ANTT®) and needleless connector cleansing.
- **Continuous infusion.** A controlled method of intravenous administration given over at least several hours or longer without interruption.
- **Intermittent infusion.** A small volume given by manual push or short infusion (eg, 30 or 60 minutes); an infusion technique that would easily allow for patency assessment before, during, and after the medication infuses.

Admixture. A combination of 2 or more medications.

Advanced practice registered nurse (APRN). US state boards of nursing recognize 4 types of APRNs, including certified registered nurse anesthetist, certified nurse midwife, certified nurse practitioner, and clinical nurse specialist, with practice occurring in all health care settings with patients of all ages.

Adverse event. Any unintended or untoward event that occurs with a patient receiving medical treatment that is related to a medication, product, equipment, procedure, etc.

Air embolism. The presence of air in the vascular system that obstructs blood flow primarily to the lungs or brain.

Airborne precautions. A type of isolation precaution to reduce the risk of infection from airborne transmission of airborne droplet nuclei that may remain suspended in the air.

Alarm/alert fatigue. Exposure to frequent alarms (alerts) from multiple sources can result in sensory overload and desensitization. Desensitization can lead to delayed response times, which could potentiate missed critical early warning signs.

Allen test. A test performed on the radial and ulnar artery of the hand prior to arterial puncture to ascertain adequate arterial perfusion.

Alternative site. A health care setting outside of the acute care hospital that includes, but is not limited to, the home, long-term care/assisted living facility, outpatient center/clinic, and physician office.

Alternative to discipline program (for drug diversion). Generally administered by third party through contractual agreements with a state board of nursing; the nurse refrains from practice for a designated time while undergoing treatment, establishing sobriety and a program of recovery.

Ambulatory infusion pump. A portable electronic infusion pump designed to be worn on the body to promote patient mobility and independence. See *Electronic Infusion Pump.*

Amino acids. Organic components of protein.

Ampoule. Hermetically sealed glass medication container that must be broken at the neck to access the medication.

Anaphylaxis. A severe, potentially life-threatening allergic reaction with immunologic and nonimmunologic causes.

Ante area. A buffer zone of laminar or displacement airflow near a clean work area, such as a pharmaceutical compounding space.

Antimicrobial stewardship. The effort to improve antibiotic prescribing by clinicians and use by patients so that antibiotics are only prescribed and used when needed; to minimize misdiagnoses or delayed diagnoses leading to underuse of antibiotics; and to ensure that the right drug, dose, and duration are selected when an antibiotic is needed. Goals include improving safe and appropriate use of antimicrobials, reducing patient harm, and reducing antimicrobial resistance.

Anti–free-flow protection. Administration set technology that prevents free flow of intravenous solutions into the patient when the administration set is removed from the flow-control device.

Anti-infective vascular access device. A vascular access device whereby an antiseptic or antimicrobial agent is coated, impregnated, or incorporated; or the base catheter material has been engineered to inhibit bacterial attachment and biofilm formation.

Antimicrobial locking solutions. Solutions of supratherapeutic concentrations of antibiotic, or a variety of antiseptic agents, to lock the central vascular access device lumen for a prescribed period to prevent or treat catheter-associated bloodstream infection.

Antineoplastic therapy. Includes chemotherapy (chemical agents used to treat cancer), targeted therapy (agents that selectively target molecular pathways to block the growth and spread of cancer), and immunotherapy (a broad category of agents that harness the body's immune system to eradicate cancer cells).

Antiseptic. A substance used to reduce the risk of infection by killing or inhibiting the growth of microorganisms.

Apheresis. Process of separating blood into 4 components: plasma, platelets, red blood cells, and white blood cells, removing 1 of the components, and then reinfusing the remaining components.

Arterial pressure monitoring. Use of an indwelling arterial catheter connected to an electronic monitor that displays continuous information about arterial pressure.

Arteriovenous fistula (AVF). Surgical anastomosis between an artery and vein to provide vascular access for long-term dialysis.

Arteriovenous graft (AVG). Surgical structure created between an artery and a vein to provide vascular access for long-term dialysis, usually of a manufactured synthetic material.

Asepsis. The absence of pathogenic organisms in sufficient quantity to cause infection, achievable through aseptic technique.

Aseptic technique. A set of infection prevention actions with the aim of protection of patients from infection during invasive clinical procedures and management of indwelling medical devices; notably, it is a generic term that is variously defined, interpreted, and used interchangeably with other practice terms, such as clean, sterile, and nontouch technique.

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.

Automated dispensing cabinet (ADC). A computerized medicine cabinet for hospitals and health care settings. ADCs allow medications to be stored and dispensed near the point of care while controlling and tracking drug distribution.

B

Backcheck valve. A feature incorporated within an intravenous administration set that functions to prevent retrograde solution flow.

Bacteria. Microorganisms that may be nonpathogenic (normal flora) or pathogenic (disease-causing).

Barcode scan. Barcode medication administration (BCMA); the barcode is scanned on the patient's wristband and on the medication to be administered as a safeguard to reduce the risk of medication errors.

Beyond-use date (BUD). The date added to a product label during the compounding process after which a product may not be used because the manufacturer's original container has been opened, exposed to ambient atmospheric conditions, and may not have the integrity of the original packaging.

Biofilm. A community of microorganisms that form on and coat the surfaces of an implanted or indwelling device.

Biologic therapy. Biologics are large, complex molecules made from living sources such as bacteria, yeast, and animal cells. Examples of biologic therapies include immunoglobulins, monoclonal antibodies, interferons, interleukins, and vaccines.

Biological safety cabinet (BSC). A ventilated cabinet used for preparation of hazardous drugs for the purpose of controlling airflow to protect personnel and the product being prepared; environmental protection is provided by exhaust air passing through a high-efficiency particulate air (HEPA)/ultra-low particulate air (ULPA) filter.

Biosimilars. A biologic product that is highly similar to, and has no clinically meaningful differences in safety, purity, and potency from, an existing FDA-approved reference product. Biosimilars are produced from living systems that may cause minor structural and chemical

differences; however, none of these changes result in any differences in efficacy. Biosimilars are not exact duplicates but must be chemically, functionally, and clinically similar to the reference product. Biosimilars are not the same as generic medications.

Blood return. A component of vascular access device patency assessment; blood that is the color and consistency of whole blood flows readily into the syringe upon aspiration.

Blood/fluid warmer. An electronic device with adequate temperature controls that raises refrigerated blood or parenteral solutions to a desired temperature during administration.

Body surface area. Surface area of the body expressed in square meters. Used in calculating pediatric dosages, managing burn patients, and determining radiation and other classes of drug dosages.

Bolus. Concentrated medication and/or solution given over a short period of time.

C

Caregiver. Refers to person(s) who assist with a patient's care needs, eg, family members, friends, neighbors, church members; includes paid caregivers.

Catheter. A hollow, flexible tube made of a biocompatible material such as thermoplastic polyurethane or silicone elastomer, or newer materials, which may reduce the risk of complications such as occlusion and thrombosis; inserted into the body and used for injecting or evacuating fluids.

Catheter-associated bloodstream infection (CABSI). Given variability in international definitions, outcome reporting, and application of the terms catheter-related bloodstream infection (CR-BSI) and central line-associated bloodstream infection (CLABSI), the INS Standards of Practice Committee is using the terminology "Catheter-Associated Bloodstream Infection" (CABSI) to refer to bloodstream infections originating from either peripheral intravenous catheters and/or central vascular access devices. See *Catheter-Related Bloodstream Infection (CR-BSI)* and *Central Line-Associated Bloodstream Infection (CLABSI).*

Catheter-associated skin injury (CASI). An abnormality including, but not limited to, erythema, vesicle, bulla, erosion, or tear at a peripheral or central vascular access device (VAD) site that is noted in the area of the device dressing and/or securement device and that is observable for 30 minutes or more after dressing/securement removal. CASI is associated with increased patient discomfort (eg, pain, pruritis), increased cost, delays in treatment, and a potential for VAD removal and replacement. Skin conditions from other sources (eg, eczema, autoimmune disorders, medication adverse events) are not included.

Catheter-associated thrombosis (CAT). Initiated as an inflammatory response to vessel wall injury and appears as an anechoic or hypoechoic image on ultrasonic evaluation, partially or fully occluding the vessel lumen. It is generally subdivided into deep versus superficial vein thrombosis (DVT, SVT) and symptomatic versus the larger percentage that are asymptomatic. Rates of CAT are generally low (but vary widely), and CAT rarely results in more serious complications but may impact the function of the vascular access device (VAD), delay required treatment, require anticoagulant therapy, cause VAD failure/premature removal, increase costs, and may result in postthrombotic syndrome.

- **Deep vein thrombosis (DVT).** Thrombosis involving the deep veins of the arm (brachial, axillary), subclavian, or internal jugular veins, or the leg (iliac, femoral, popliteal) detected by compression and flow ultrasonography, venography, or computed tomography (CT) scan.
- **Upper extremity DVT (UE-DVT).** Often associated with VADs inserted in smaller upper arm veins with lower blood flow velocity.
- **Superficial vein thrombosis (SVT).** Thrombosis involving the superficial veins of the upper extremity (eg, basilic, cephalic) or lower extremity (eg, saphenous veins).
- **Venous thromboembolism (VTE).** A clinical episode of VTE includes deep vein thrombosis and pulmonary embolism (may include superficial in some studies).

Catheter clearance. The process to re-establish catheter lumen patency using medications or chemicals instilled into the lumen for a specified time.

Catheter dislodgement. Catheter movement into or out of the insertion site indicating tip movement to a suboptimal position; may be partial (catheter tip still remains within the venous system but is in a suboptimal location) or total (catheter tip is removed completely from the venous system).

Catheter exchange. Replacement of existing central vascular access device (CVAD) with a new CVAD using the same catheter tract.

Catheter-related bloodstream infection (CR-BSI). The recognized diagnostic criterion that more accurately confirms the catheter as the source of the infection. It is diagnosed if the same organism is isolated from a blood culture and the tip culture and the quantity of organisms isolated from the tip is greater than 15 colony forming units (CFUs). Alternatively, differential time to positivity (DTP) requires the same organism to be isolated from a peripheral vein and a catheter lumen blood culture, with growth detected 2 hours sooner (ie, 2 hours less incubation) in the sample drawn from the catheter.

Central line-associated bloodstream infection (CLABSI). This is most commonly reported as a surveillance term; however, it is not an established diagnostic criterion. CLABSI is a primary BSI in a patient who had a central

line the day of or day before infection and had more than 2 days of central access. CLABSI surveillance definition may overestimate the true incidence of CR-BSI.

Central vascular access device (CVAD). A catheter that is inserted via a peripheral vein of the upper or lower limbs or large vein of the chest or groin with the tip advanced to a central position, either the superior vena cava (upper body insertion) or inferior vena cava (lower body insertion).

Central vascular access device (CVAD) malposition. CVAD tip located in an aberrant position that differs from the original position on insertion within the vena cava or cavoatrial junction.

- **Extravascular malposition.** CVAD tip located outside the vein in subcutaneous tissue or nearby anatomical structures, such as mediastinum, pleura, pericardium, or peritoneum.
- **Intravascular malposition.** CVAD tip located in a suboptimal or aberrant position inside a vein; occurs as primary or secondary malposition.
- **Primary malposition.** CVAD tip positioned in a suboptimal or unacceptable location during the insertion procedure.
- **Secondary malposition.** CVAD tip found to be in a suboptimal or unacceptable location at any time during the catheter dwell time; commonly referred to as tip migration.

Certification/board certification. A voluntarily earned credential that demonstrates the holder's specialized knowledge, skills, and experience within a given specialty; awarded by a third-party, nongovernmental entity or association, such as the Infusion Nurses Certification Corporation (INCC), after the individual has met predetermined and standardized criteria.

Chelator-based lock solution. Solutions such as citrate and ethylenediaminetetraacetic (EDTA) that bind with metallic cations (eg, calcium, magnesium, iron) to produce an antithrombotic effect and/or disrupt biofilm formation.

Chemical incompatibility. Change in the molecular structure or pharmacological properties of a substance that may or may not be visually observed when a solution or medication contacts an incompatible solution or medication within the vascular access device lumen, administration set, or solution container.

Cleaning. The removal of visible soil (eg, organic and inorganic material) from objects and surfaces. Thorough cleaning is essential before performing disinfection and sterilization procedures because inorganic and organic materials that remain on the surfaces interfere with the effectiveness of these processes.

Clinical bag. The container carried by home care clinicians when traveling from home to home; contains equipment (eg, blood pressure cuff, stethoscope, pulse oximeter) and necessary supplies (eg, dressings).

Clinician. Refers to the nurse, physician, or other appropriately trained and educated health care individual involved with infusion administration or vascular access device insertion, care, and management.

Close call. An event or situation that could have resulted in an accident, injury, or illness, but did not, either by chance or through timely intervention. Such events have also been referred to as a *near miss* or *good catch*.

Closed system transfer. The movement of sterile products from one container to another, in which the containers, closure system, and transfer devices remain intact through the entire transfer process, compromised only by the penetration of a sterile, pyrogen-free needle or cannula through a designated closure or port to effect transfer, withdrawal, or delivery.

Closed system transfer device. A transfer device that mechanically prohibits the transfer of environmental contaminants into the system and the escape of hazardous drugs or vapor concentrations outside the system; used in compounding and administering sterile doses of chemotherapy and other hazardous drugs.

Color coding. System that identifies products and medications by use of a color system.

Compartment. Muscles, nerves, and blood vessels are in compartments, which are inflexible spaces bound by skin, fascia, and bone.

Compartment syndrome. Excessive fluid within a compartment that leads to increased pressure on capillaries, nerves, and muscles. The increased hydrostatic pressure leads to vascular spasm, pain, and muscle necrosis inside the compartment, which can result in functional loss. Signs and symptoms include pain, pallor, paresthesia, pulselessness, and paralysis.

Compatibility. Capable of being mixed and administered without undergoing undesirable chemical and/or physical changes or loss of therapeutic action.

Competency. A required level of effective performance in the work environment defined by adherence to professional standards, including knowledge, skills, abilities, and judgment based on established science.

Competency assessment. A dynamic process used to verify an individual's performance; designed to empower the individual and support positive behavior in patient care activities.

Compounding. The act of preparing, mixing, assembling, packaging, and labeling a drug, drug delivery device, or device according to a prescription for an individual patient or based on a professional agreement between the practitioner, patient, and pharmacist.

Computerized prescriber order entry (CPOE). A system in which clinicians directly enter medication, test, or procedure orders into an electronic system; medication orders are transmitted directly to the pharmacy.

Contact Precautions. Strategies implemented to prevent the transmission of infectious agents, such as wound drainage, which are spread by direct or indirect contact between the patient and environment.

Containment primary engineering control (C-PEC). A ventilated device designed to minimize microbial contamination and worker and environmental exposure by controlling emissions of airborne contaminants by using enclosure, airflow, air pressure, and high-efficiency particulate air (HEPA) filtration. Two main types of C-PECs are biological safety cabinets and compounding aseptic containment isolators.

Contamination. Introduction or transfer of pathogens or infectious material from one source to another.

Contrast media. Intravenous administration of iodinated or gadolinium-based pharmaceutical agents to improve imaging of internal structures. They have a wide range of osmolarity and viscosity compared to normal serum values and may be associated with tissue injury if extravasation occurs.

Controlled substance: Drugs and other substances are divided into 5 schedules under the Controlled Substances Act (CSA) based on whether they have a currently accepted medical use in treatment in the United States, their relative abuse potential, and the likelihood of causing dependence when abused. (www.deadiversion.usdoj.gov)

Crisis standards of care. Guidelines designed to help organizations and health care professionals deliver the best possible care in circumstances in which resources are severely limited and health care standards are compromised.

Cross contamination. The indirect movement of pathogens or other harmful substances from one patient to another patient.

Cultural competency. Care delivery that is respectful of and responsive to the beliefs, culture, practices, and linguistic needs of patients and their families served by the health care organization.

D

Dead end cap. Nonvented sterile cap used to cover the vascular access device (VAD) hub.

Dead space. The internal space outside the intended fluid pathway into which fluid can move, as applied to needleless connectors.

Decontamination. The removal of pathogenic microorganisms from objects so they are safe to handle, use, or discard.

Delegation. The process for a clinician (eg, registered nurse) to direct another person (eg, unlicensed assistive personnel) to perform a task or activity not commonly performed by that person; however, that person has the knowledge and skill to perform the task. The delegating clinician retains accountability for the outcome of the delegated task.

Di(2-ethylhexyl)phthalate (DEHP). A plasticizer that is added to polyvinyl chloride to make solution containers and administration set tubing soft and pliable. It is a known toxin that can seep from the plastic into the bloodstream. Risk of exposure is greatest in infants.

Difficult intravenous access (DIVA). Refers to multiple unsuccessful attempts to insert a catheter. This can be acute due to sudden illness or chronic, resulting from complex medical intervention. Characteristics of DIVA include, but are not limited to, patient characteristics (overweight/underweight), extremes of age (history of prematurity and older adult), gender (female), and vein characteristics (limited visibility and palpability).

Dilution. To add a diluent (eg, 0.9% sodium chloride, sterile water) to a solution of medication in order to make it less concentrated, to provide additional solution for ease of administration and titration, or to decrease the risk of tissue damage by bringing the final osmolarity closer to an isotonic solution.

Disclosure. The process of revealing all the facts necessary to ensure that the patient/caregiver or a surrogate understands what occurred when a patient experiences a significant complication from a medical error or mistake; information that is necessary for the patient's well-being or relevant to future treatment.

Disinfectant. Agent that eliminates most microorganisms except bacterial spores.

Disinfection. A process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects.

Disinfection Cap. Disinfectant-impregnated protective cap containing an antiseptic solution placed on top of the connection surface of a needleless connector/male luer end of administration set to disinfect the surface and provide protection between intermittent use. There are also disinfection caps that attach directly to the catheter hub.

Distal. Farthest from the center or midline of the body or trunk or from the point of attachment; opposite of proximal.

Doppler flow study. A form of ultrasound technology that produces audible sounds to determine characteristics of circulating blood.

Dose error reduction systems (DERS). Electronic infusion pumps manufactured with drug libraries containing drug name and soft and hard infusion limits; designed to prevent errors in solution and medication delivery, often called smart pumps.

Droplet Precautions. A type of isolation precaution to reduce the risk of infection from pathogens spread through close respiratory or mucous membrane contact with respiratory secretions.

Drug diversion. Removal of Drug Enforcement Administration (DEA)–scheduled medication from and within the lawful process of a hospital or health care system to an unlawful channel of distribution or use.

E

Elastomeric pump. A portable, single-use device with an elastomeric reservoir (ie, balloon). Used to deliver a variety of infusion therapies.

Electronic infusion pump. Device that is powered by electricity or battery to regulate infusion rate.

Electronic infusion rate monitor/drop counter. Used as an adjunct to gravity infusions by providing an electronically monitored infusion; placed around the administration set drip chamber; does not "pump" the fluid, rather monitors the drip rate.

Electronic medical record (EMR)/electronic health record (EHR). EMR is the same collection of documents as in the health record but manages the documents using electronic clinical information systems (specialized software) that protect and secure patient data. The EMR can track patient data, schedule visits and reminders, and is a source for quality monitoring and improvement. The EMR is used in a single clinic, hospital, or practice. The EHR often offers more functionality than an EMR and is used across many clinics, hospitals, or practices.

Elliotts B® Solution. A sterile, nonpyrogenic, isotonic solution containing no bacteriostatic preservatives. Elliotts B® Solution is a diluent for intrathecal administration of methotrexate sodium and cytarabine.

Embolus. Mass of undissolved matter present in blood or lymphatic vessel; an embolus may be solid, liquid, or gaseous.

End-tidal capnography. The measurement of the partial pressure of carbon dioxide during expiration (end-tidal carbon dioxide); used with general anesthesia, moderate/deep procedural sedation, and mechanical ventilation; a more sensitive indicator of respiratory depression than oxygen saturation monitoring with patient-controlled analgesia.

EnFit® connector. Designed to reduce the risk of inadvertent misconnections by ensuring that feeding tube connectors are incompatible with the connectors for unrelated delivery systems, such as intravenous catheters, tracheostomy tubes, and other catheters.

Engineering controls. Devices that isolate or remove the bloodborne pathogens hazard from the workplace, such as sharps disposal containers, self-sheathing needles, needleless systems, and sharps with engineered protections.

Enhanced barrier precautions. A recommendation from the Centers for Disease Control and Prevention (CDC) for long-term care facilities. Enhanced barrier precautions should be used in a location (eg, wing, floor, unit) when a resident of that location is colonized or infected with a novel or targeted multidrug resistant organism (MDRO). The use of personal protective equipment is expanded for high-risk residents in these locations (eg, those with wounds, vascular access devices), including the use of gowns and gloves during high-contact care activities that provide opportunities for transfer of MDROs to staff hands and clothing (eg, during dressing, bathing/showering, transferring, device care, or use: central line, urinary catheter, feeding tube, tracheostomy/ventilator, any skin opening requiring a dressing).

Enrolled nurse (EN). A designation used in Australia; an enrolled nurse works under the direct supervision of a registered nurse.

Epidural space. Space surrounding the spinal cord and its meninges; contains fatty tissue, veins, spinal arteries, and nerves; considered a potential space that is not created until medication or air is injected.

Erythema. Redness of skin in a specific area or more generalized.

Evidence-based practice. Application of the best available synthesis of research results in conjunction with clinical expertise and with attention to and inclusion of patient preferences.

Expiration date. The date and time, when applicable, beyond which a product should not be used; the product should be discarded beyond this date and time.

Extravasation. Inadvertent infiltration of vesicant solution or medication into surrounding tissue; rated by a standard tool or definition.

Extrinsic contamination. Contamination that occurs after the manufacturing process of a product.

F

Fat emulsion. See *Lipid Injectable Emulsion (ILE)*.

Fibroblastic sleeve. A sleeve of connective tissue that develops as an apparent adaptive process to a foreign body and may eventually surround a vascular access device (VAD). The sleeve does not originate from the vein wall; contains fibroblasts, smooth muscle cells, and collagen; is typically asymptomatic; but may potentiate catheter dysfunction if it obstructs the distal tip of the catheter.

Filter. A special porous device used to prevent the passage of air, particulate matter, and microorganisms; product design determines size of substances retained.

Flow-control device. Device used to regulate infusion flow rate; includes categories of manual devices (eg, slide, roller clamp, screw), non-electronic flow-control devices, and electronic infusion pumps. See *Non-Electronic Flow-Control Device* and *Electronic Infusion Pump*.

Flushing. The act of moving fluids, medications, blood, and blood products out of the vascular access device into the bloodstream; used to assess and maintain patency

and prevent precipitation due to solution/medication incompatibility.

G

Gamma scintillation sensors. Can be used for extravasation sensing: when the injected medium is radioactive, the flow of the medium can be detected via gamma scintillation sensors.

Guidewire. A long, flexible, metal structure, composed of tightly wound coiled wire in a variety of designs. Only guidewires specifically designed for vascular access (eg, atraumatic tip at one end) should be used for this purpose. Only the atraumatic (floppy, nonstiff) end of the guidewire should be advanced into the vein.

H

Hazardous drug. Drug exhibiting 1 or more of the following 6 characteristics in humans or animals: carcinogenicity, teratogenicity or other developmental toxicity, reproductive toxicity, organ toxicity at low doses, genotoxicity, and structure and toxicity profiles of new drugs that mimic existing drugs, determined hazardous by the above criteria.

Hazardous drug spill. Any fluid containing hazardous drugs escaping from its container in a quantity more than a few drops.

Hazardous waste. In the context of this document, hazardous waste is differentiated from medical waste and refers to that generated from administration of hazardous drugs (eg, intravenous containers, equipment, and supplies used to administer hazardous drugs).

Health literacy. The degree to which individuals have the capacity to obtain, process, and understand basic health care information and services needed to make appropriate decisions.

Health record/medical record/patient record. A patient-specific chronological and legal collection of health care documents that describe services/care provided, facilitate communication among health care team members, and support payment practices. Documents include, but are not limited to, assessments, observations, problem lists, intervention/procedure descriptions, instructions, orders, progress notes, medications administered, summaries, laboratory and radiologic reports, exams, and/or pictures. This collection may be in paper form, digitized, or stored as an electronic medical record or electronic health record.

Healthcare failure mode and effect analysis (HFMEA). A systematic, proactive method used to evaluate a process or device for the purposes of identifying where and how a process might fail; results are used to identify and prioritize the most needed process changes.

Hemodynamic pressure monitoring. A general term that describes the functional status of the cardiovascular system as it responds to acute stress, such as myocardial infarction and cardiogenic or septic shock. A pulmonary artery catheter is used to directly measure intracardiac pressure changes, cardiac output, blood pressure, and heart rate.

Hemolysis. Destruction of the membrane of the red blood cells resulting in the liberation of hemoglobin, which diffuses into the surrounding fluid.

Hemostasis. An arrest of bleeding or of circulation.

Heparin-induced thrombocytopenia (HIT). An acute, transient prothrombotic disorder caused by heparin-dependent, platelet-activating antibodies; a hypercoagulable state with a strong association to venous and arterial thrombosis.

High-alert medication. Medications that possess a heightened risk of causing significant patient harm when used in error.

Hypertonic. Solution of higher osmotic concentration than that of a reference solution or of an isotonic solution; having a concentration greater than the normal tonicity of plasma.

Hypodermoclysis. The subcutaneous administration of isotonic hydration solutions; used to treat mild-to-moderate dehydration.

Hypotonic. Solution of lower osmotic concentration than that of a reference solution or of an isotonic solution; having a concentration less than the normal tonicity of plasma.

I

Immunocompromised. Having an immune system with reduced capability to react to pathogens or tissue damage.

Impaired practice. Functioning poorly or with diminished competence, as evident in changes in work habits, job performance, appearance or other behaviors in any setting.

Implanted pump. A catheter inserted into a vessel, body cavity, or organ attached to a subcutaneous reservoir that contains a pumping mechanism for continuous medication administration.

Implanted vascular access port. A catheter inserted into a vein, attached to a reservoir located under the skin.

Incompatible. Incapable of being mixed or used simultaneously without undergoing chemical or physical changes or producing undesirable effects.

Independent double check. A process whereby 2 people working separately and apart from each other verify each component of a work process (eg, the prescribed dose, calculated rate of infusion) for select high-risk tasks, vulnerable patients, or high-alert medications.

Infection. The presence and growth of a pathogenic microorganism(s) having a local or systemic effect.

Infiltration. Inadvertent administration of a nonvesicant solution or medication into surrounding tissue; rated by a standard tool or definition.

Informed consent. A person's voluntary agreement to participate in research or to undergo a diagnostic, therapeutic, or preventive procedure, based upon adequate knowledge and understanding of relevant information.

Infusate. Parenteral solution administered into the vascular or nonvascular systems; infusion.

Infusion team/vascular access specialty team (VAST). A group of clinicians centrally structured within the facility charged with the goal of accurate, efficient, and consistent delivery of infusion and vascular access services. Staff mix varies; however, this team should be led by a registered nurse specializing in this practice. Scope of service, team name, and roles of team members vary greatly.

Instill/instillation. Administration of a solution or medication into a vascular access device (VAD) intended to fill the VAD rather than systemic infusion; examples include locking solutions to maintain catheter patency, thrombolytic medications, and medications/solutions used to dissolve precipitate.

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

Interprofessional/interprofessional collaboration. A cooperative approach to patient care acknowledging and respecting the unique knowledge, skills, and abilities of each professional health team member.

Intraosseous (IO). The spongy, cancellous bone of the epiphysis and the medullary cavity of the diaphysis, which are connected; the vessels of the IO space connect to the central circulation by a series of longitudinal canals that contain an artery and a vein. The Volkmann's canals connect the IO vasculature with the major arteries and veins of the central circulation.

Intrathecal. The subarachnoid space between the arachnoid and pia mater; contains cerebrospinal fluid.

Intrinsic contamination. Contamination that occurs during the manufacturing process of a product.

Irritant. An agent capable of producing discomfort (eg, burning, stinging) or pain as a result of irritation in the internal lumen of the vein with or without immediate external signs of vein inflammation.

Isotonic. Having the same osmotic concentration as the solution with which it is compared (eg, plasma).

J

Joint stabilization. Use of a device to support and stabilize a joint (eg, arm board, splint) when veins or arteries used for vascular access device (VAD) insertion are located in an area of flexion.

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.

Leaching. Process of a solute becoming detached or extracted from its carrier substance.

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.

Lipid injectable emulsion (ILE). Combination of liquid, lipid, and an emulsifying system formulated for intravenous use.

Locking. The instillation of a solution into a vascular access device (VAD) used to maintain patency in between VAD use and/or reduce risk of catheter-associated bloodstream infection.

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

Long-term. Referring to vascular access devices placed for anticipated need of greater than 1 month.

Luer. A standardized system of small-scale fluid fittings used for making leak-free connections between a male-taper fitting and its mating female fitting on all global intravenous (IV) medical devices and laboratory devices; includes, but is not limited to, syringe tips, IV administration sets, extension sets, manifolds, and stopcocks.

Lumen. The interior space of a tubular structure, such as a blood vessel or catheter.

M

Manifold. An accessory to an intravenous administration set that provides multiple stopcocks and regulates the directional flow of fluids for simultaneous/alternate infusion therapy.

Maximal sterile barrier protection. Equipment and clothing used to avoid exposure to pathogens, including sterile coverings for the clinicians and patient: mask,

gown, protective eyewear, cap, gloves, large or full body drapes, and towels.

Medical adhesive-related skin injury (MARSI). Erythema or cutaneous abnormality (including occurrence of, but not limited to, vesicle, bulla, erosion, skin tear) that continues to be observable 30 minutes or more post adhesive removal. This definition is only used if it was specifically mentioned in the reference.

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 capable of releasing these materials during handling; and microbiological wastes containing blood or other potentially infectious materials.

Medication reconciliation. The process of collecting and documenting complete and accurate medication information for each patient, including all medications—prescribed, over-the-counter, and herbals/nutritional supplements—that the patient is currently taking.

Microaggregate blood filter. Filter that removes microaggregates (includes platelets, leukocytes, and fibrin that are present in stored blood) and reduces the occurrence of nonhemolytic febrile reactions.

Microorganism. Extremely small living body not perceptible to the naked eye.

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

Milliosmoles (mOsm). One thousandth of an osmole; osmotic pressure equal to 1 thousandth of the molecular weight of a substance divided by the number of ions that the substance forms in a liter of solution.

Minimum inhibitory concentration (MIC). The lowest concentration of a drug that will inhibit bacterial growth.

Moderate/conscious sedation. Drug-induced depression of consciousness in which a patient is able to persistently respond to verbal commands or light tactile stimulation; interventions are not needed to maintain a patent airway, and the cardiorespiratory functions are sufficient and usually preserved.

Mottling score. Mottling score is estimated from 0–5 according to mottling over the knee and described as clinical evaluation of tissue perfusion.

Multidrug-resistant organism (MDRO). A microorganism, predominantly bacteria, resistant to 1 or more classes of antimicrobial agents. MDROs include, but are not limited to, methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and certain gram-negative bacilli that have important infection control implications.

N

Narcotic count. Process for periodically validating inventory of narcotics; may be blinded if those performing the count are unable to see the system automatic count totals but enter the number of actual products into the system for comparison and potential discrepancy recognition.

Near infrared (nIR) light technology. A device using near infrared light, a range of 700 to 1000 nanometers on the electromagnetic spectrum; works by either transilluminating the extremity and projecting the vessel image to a screen or by capturing an image of the superficial veins and reflecting it to the skin surface.

Needleless connector. A device that allows the connection of the male luer tip of a syringe or administration set directly to the hub of a vascular access device (VAD) or other injection sites on the infusion system without the use of needles; bidirectional fluid flow occurs within the device. Includes a variety of mechanisms (eg, mechanical valve, internal blunt cannula, pressure sensitive valve) categorized by how they function, although there are no established criteria for which devices fall into each group. All needleless connectors allow some fluid movement and blood reflux upon connection, disconnection, or both.

- **Anti-reflux.** Contains a 3-position pressure-activated silicone valve that opens and closes based on infusion pressure; a specific clamping sequence is not required.
- **Negative displacement.** Allows blood reflux into the VAD lumen upon disconnection due to movement of valve mechanism or withdrawal of the luer tip of a syringe or administration set. Use of the specific sequence of flush and clamp prior to disconnecting the syringe will minimize fluid movement.
- **Neutral.** Contains an internal mechanism designed to reduce blood reflux into the VAD lumen upon connection or disconnection. The sequence of flush then clamp prior to disconnecting the syringe may improve patency.
- **Positive displacement.** Allows blood reflux on connection and disconnection; a small amount of fluid is held inside the device that displaces intraluminal blood upon disconnection of the set or syringe. Use of the specific sequence of flush, disconnect, syringe, and then clamp the catheter will minimize this.

Needleless system. A device that does not use needles for (1) the collection of bodily fluids or withdrawal of body fluids after initial venous or arterial access is established; (2) the administration of medication or solutions; or (3) any other procedure involving the potential for

occupational exposure to bloodborne pathogens due to percutaneous injuries from contaminated sharps.

Neonate. Birth to 28 days of life; pertaining to the first 4 weeks of life.

Neuraxial anesthesia. Administration of medications into the intrathecal or epidural space to produce anesthesia or analgesia.

Noncritical equipment. Items that can come in contact with intact skin but not mucous membranes.

Nonelectronic flow-control device. Refers to both gravity infusions and use of mechanical pumps such as elastomeric/spring-based pumps. Gravity infusions control fluid flow rate by manual adjustment of components such as a roller clamp or flow regulator and require reliance on counting drops. It is affected by factors such as dislodgement of the components or distance between the solution container and the device and, therefore, is the least accurate.

Nonpermeable. Prevents passage of fluid or gases.

Nontunneled central vascular access device (CVAD). A type of CVAD for short-term use that is inserted percutaneously, usually via the axillary-subclavian, internal jugular, or femoral vein.

Nonvesicant. Solutions and medications that do not produce tissue damage when inadvertently delivered into subcutaneous tissue; a large volume of a nonvesicant can produce tissue damage through compartment syndrome but would not cause tissue destruction that leads to blistering and necrotic ulcer.

NRFit® connectors. Designed to reduce the risk of inadvertent misconnections by ensuring that neuraxial (ie, intraspinal) connections are incompatible with the connectors for unrelated delivery systems such as intravenous (IV) catheters, tracheostomy tubes, and catheters. NRFit connectors are 20% smaller in diameter, preventing medical devices meant for neuraxial administration from connecting to devices used for IV, enteral, and other therapies.

Nurse-controlled analgesia. Used for infants and children if they are too young, physically unable, or cognitively impaired and unable to use patient-controlled analgesia.

Nurse practice act. A law enacted by a jurisdiction (eg, state, province, country) that establishes the board of nursing and defines the qualifications of and scope of practice for registered nurses and licensed practical or vocational nurses.

O

Occlusion. Obstruction of a vascular access device lumen, preventing or limiting the ability to flush and/or administer solutions through a lumen or withdraw blood.

- **Complete occlusion.** Inability to administer solutions or withdraw blood from the central vascular access device (CVAD) lumen.
- **Partial occlusion.** Decreased ability to administer solutions and/or withdraw blood from the CVAD lumen.
- **Withdrawal occlusion.** Ability to infuse solutions with decreased ability or inability to obtain blood return.

Off-label use (extra-label use). The use of a marketed drug or device in a manner that is not included in the written directions for use and other written material that accompany the product as approved by the US Food and Drug Administration.

Older adult. Greater than 65 years of age, as defined by the American Geriatric Society.

Opioid-induced respiratory depression (OIRD). A combination of opioid-induced central respiratory depression (ie, decreased respiratory drive), sedation, and upper airway obstruction due to decreased supraglottic airway tone.

Osmolality. The characteristic of a solution determined by the ionic concentration of the dissolved substances per unit of solvent; measured in milliosmoles per liter.

Osmolarity. The number of osmotically active particles in a solution.

P

Palpable cord. A vein that is rigid and hard to the touch.

Palpation. Examination by application of the hands or fingers to the surface of the body to detect evidence of disease or abnormalities in the various organs; also used to assess location and quality of superficial peripheral veins.

Parenteral. Administered by any route other than the alimentary canal, such as the intravenous, subcutaneous, intramuscular, or mucosal route.

Parenteral nutrition (PN). The intravenous provision of nutritional needs for a patient who is unable to take appropriate amounts of food enterally; typical components include carbohydrates, proteins, and/or fats, as well as additives such as electrolytes, vitamins, and trace elements.

Paresthesia. Pain associated with nerve injury, including tingling, prickling, or shock-like sensations.

Particulate matter. Mobile undissolved particles, excluding gas bubbles unintentionally present in solutions. Sources include the environment (eg, dust, fibers), packaging material (eg, rubber, silicone), product-package interactions (eg, rubber, plastic), processes for manufacturing and dilution (eg, metal, glass), and the drug formulations and components (eg, drug precipitate, protein aggregation, undissolved material).

Passive disinfection. Use of a disinfectant-impregnated protective cap or covering to provide a constant physical barrier against contamination of the needleless connector septum between accesses; may also be used with the male luer end of the administration set when the set is disconnected between intermittent uses.

Passive leg raise test. The passive leg raising (PLR) test increases cardiac preload and allows the assessment of preload responsiveness of both ventricles.

Passive safety-engineered device. A device (eg, needle, catheter) that does not require additional steps to initiate the safety mechanism since it activates automatically during device use.

Pathogen. A microorganism or substance capable of producing disease.

Patient care setting. Where patient care is provided; may include hospital, outpatient or physician office setting, skilled nursing facility, assisted living facility, and the home.

Patient-controlled analgesia (PCA). A drug delivery system that dispenses a preset dose of a narcotic analgesia upon activation by the patient; most often used with intravenous infusion but may also be used with subcutaneous and epidural infusions.

Pediatric. Newborn to 21 years of age. (Note: the American Academy of Pediatrics states that pediatrics is actually the fetal period to 21 years of age; upper age limit may vary across countries); neonate refers to the first 28 days of life. See *Neonate*.

Percutaneous. Technique performed through the skin.

Peripheral. Pertaining to or situated at or near the periphery; situated away from a center or central structure.

Peripheral intravenous catheter (PIVC). A catheter that is inserted into and resides in veins of the periphery that includes all extremities, the external jugular vein, and scalp veins in neonates. PIVCs are inserted into superficial veins located just under the skin in the superficial tissue, as well as deep veins located under the muscle tissue. See *Short Peripheral Intravenous Catheter (Short PIVC), Long Peripheral Intravenous Catheter (Long PIVC),* and *Midline Catheter.*

Peripherally inserted central catheter (PICC). A catheter inserted through veins of the upper extremities in adults and children; for infants, may be inserted through veins of the scalp or lower extremity. The catheter tip is advanced to the superior vena cava, preferably at the cavoatrial junction (upper limb insertion), or inferior vena cava, above the diaphragm (lower limb insertion).

Personal protective equipment (PPE). The equipment worn to minimize exposure to a variety of hazards, including bloodborne pathogens; examples of PPE include items such as gloves, eye protection, gown, and face mask.

pH. The degree of acidity or alkalinity of a substance.

Phlebitis. Inflammation of a vein; may be accompanied by pain/tenderness, erythema, edema, purulence, and/or palpable venous cord; rated by a standard scale or definition.

Phlebotomy. Withdrawal of blood from a vein by direct venipuncture or via a vascular access device.

Physical Restraint. Physical, mechanical, or manual device that immobilizes or decreases the ability of the patient to move arms, legs, body, or head freely.

Pinch-off syndrome. A relatively rare but significant and often unrecognized complication; occurs when the central vascular access device enters the costoclavicular space medial to the subclavian vein and is positioned outside the lumen of the subclavian vein in the narrow area bounded by the clavicle, first rib, and costoclavicular ligament. Catheter compression causes intermittent or permanent catheter occlusion and, because of the "scissoring" effect of catheter compression between the bones, can result in catheter tearing, transection, and catheter embolism.

Policy. Written, nonnegotiable statement(s) that establish rules guiding the organization in the delivery of patient care.

Postthrombotic syndrome (PTS). A complication occurring after a venous thrombosis (typically a deep vein thrombosis [DVT]) in either lower or upper extremity characterized by pain, tenderness, swelling, and skin changes. Endothelial injury secondary to vascular access device (VAD) insertion is a potential source.

Pounds per square inch (psi). A measurement of pressure; 1 psi equals 50 mm Hg or 68 cm H2O.

Power injectable. A device (eg, vascular access device, extension set) capable of withstanding injection pressure used for radiology procedures; an upper limit is usually 300 to 325 psi.

Practice guidelines. Provide direction in clinical care decisions based on the current state of knowledge about a disease state or therapy.

Preanalytic phase. The period of time before a body fluid specimen reaches the laboratory; includes obtaining, labeling, and transporting the specimen to the laboratory.

Precipitation. The act or process of a substance or drug in solution to settle in solid particles; most commonly caused by a change in pH.

Preservative-free. Contains no added substance capable of inhibiting bacterial growth. Free of any additive intended to extend the content, stability, or sterility of active ingredients, such as antioxidants, emulsifiers, or bacteriocides.

Priming volume. Amount of fluid required to fill the fluid pathway of the vascular access device, any add-on devices, and administration set.

Procedure. Written statement of a series of steps required to complete an action.

Product integrity. The condition of an intact, uncompromised product suitable for intended use.

Provider. A practitioner permitted by law and by the organization to provide care and services within the scope

of the practitioner license and consistent with individually assigned clinical responsibilities. These titles may include, but are not exclusive to, physician, nurse practitioner, clinical nurse specialist, and physician assistant.

Proximal. Closest to the center or midline of the body or trunk, nearer to the point of attachment; the opposite of distal.

Psychomotor. Characterizing behaviors that place primary emphasis on the various degrees of physical skills and dexterity as they relate to the preceding thought process.

Pulsatile flushing technique. Repetitive injection of short (eg, 1 mL) pushes followed by a brief pause for the purpose of creating turbulence within the vascular access device (VAD) lumen.

Purulent. Containing or producing pus.

Q

Quality improvement (QI). An ongoing, systematic approach that uses problem solving to improve quality outcomes or health care processes. This usually involves a cycle of planning, implementation, audit, and evaluation.

R

Radiofrequency sensing. Can be used for extravasation sensing; technologies base their operating principle on changes in electrical permittivity when the extravasation event occurs.

Radiopaque. Impenetrable to x-rays or other forms of radiation; detectable by radiographic examination.

Ready-to-administer. An injectable product containing the active drug in solution at the required concentration and volume, presented in the final container (syringe, infusion bag, or elastomeric device), and ready to be administered to the patient.

Reconstitute. The act of adding diluent to a powder to create a solution.

Refractory. When multiple evidence-based therapies have been used appropriately but have failed to reach treatment goals.

Restraint, physical. A manually applied method that immobilizes or reduces the ability of a patient to move arms, legs, or body.

Risk evaluation and mitigation strategies (REMS). A US Food and Drug Administration program for monitoring medications with a high potential for serious adverse effects. REMS applies only to specific prescription drugs but can apply to brand name or generic drugs. REMS focus on preventing, monitoring, and/or managing a specific serious risk by informing, educating, and/or reinforcing actions to reduce the frequency and/or severity of the event.

Risk management. Process that centers on identification, analysis, treatment, and evaluation of real and potential hazards.

Root cause analysis (RCA). The process for identifying basic or causal factors that underlie variation in performance, including the occurrence or possible occurrence of a sentinel event; focuses primarily on systems and processes, not individual performance; identifies potential improvements in processes or systems that would tend to decrease the likelihood of such events in the future or determines, after analysis, that no such improvement opportunities exist.

S

Safety-engineered device. Also known as Sharps with Engineered Sharps Injury Protections. A needle-free sharp or a needle device used for withdrawing body fluids, accessing a vein or artery, or administering medications or other solutions, with a built-in safety feature or mechanism that effectively reduces the risk of an exposure incident. Used to prevent percutaneous injuries and blood exposure before, during, or after use.

Scope of practice. The roles, responsibilities, and functions that a qualified health professional is deemed competent to perform and allowed to undertake, in keeping with the terms of their professional license.

Sentinel event. See *Serious Adverse Event*.

Sepsis. The systemic response caused by the presence of infectious microorganisms or their toxins in the bloodstream.

Serious adverse event. Any unexpected, undesirable event, often resulting in death or serious physical injury that may or may not prolong hospitalization or require intervention to prevent permanent damage. When this is associated with the use of a medical product/medication in a patient, it should be reported to the US Food and Drug Administration.

Sharps. Objects in the health care setting that can be reasonably anticipated to penetrate the skin and to result in an exposure incident; including, but not limited to, needle devices, scalpels, lancets, broken glass, or broken capillary tubes.

Shedding. Particle release (solids) from an infusate container, administration set, or filter.

Short peripheral intravenous catheter (short PIVC). An over-the-needle catheter with a hollow metal stylet (needle) positioned inside the catheter; generally inserted in superficial veins. See *Peripheral Intravenous Catheter (PIVC).*

Short-term. When used in reference to a vascular access device, a time frame of less than 1 month.

Simulation. A technique that produces a scenario, environment, or experiment meant to allow a learner to experience a clinical event as close to real as possible for purposes of learning or to acquire or refine a skill.

Site protection. Strategies used in addition to vascular access device (VAD) insertion site securement (may also be called secondary securement), including:

- Interventions/products used to reduce the risk of VAD dislodgement due to the pulling/tugging of the administration set
- Interventions/products (eg, VAD covers, mitts, vests) to protect/disguise the VAD from patient manipulation, such as with pediatric patients, those with cognitive impairment/confusion, and/or other risk factors for VAD misuse
- Strategies to prevent exposure of the VAD site to water or other contaminants.

Smart pump. Electronic infusion pump with imbedded computer software aimed at reducing drug dosing errors through the presence and use of a drug library.

Sorption. A complex process including both adsorption and absorption that varies greatly with components within the infusion container, the administration set, type of infusate, the flow rate of infusates, and the contact duration and conditions during storage, preparation, and administration.

- **Absorption.** Drug penetration inside of the infusion system.
- **Adsorption.** Interaction of the drug with the surface of the infusion container and/or administration set; results in patient receiving a smaller amount of the drug.

Standard. Authoritative statement enunciated and promulgated by the profession by which the quality of practice, service, or education can be judged.

Standard Precautions. The minimum infection prevention practices that apply to all patient care, regardless of suspected or confirmed infection status of the patient, in any setting where health care is delivered. These practices are designed to both protect health care providers from infection and prevent the spread of infection from patient to patient; includes hand hygiene; environmental cleaning and disinfection; injection and medication safety; use of appropriate personal protective equipment; minimizing potential exposures (eg, respiratory hygiene and cough etiquette); reprocessing of reusable medical equipment between each patient and when soiled.

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

Sterile. Free from living organisms; this is not achievable in a general health care setting, due to the ever presence of microorganisms in the air environment.

Stylet. A sharp rigid metal hollow-bore object within a peripheral catheter designed to facilitate venipuncture and catheter insertion.

Stylet wire. A long stiffening wire within the catheter lumen that provides assistance advancing a vascular access device along the vein; may be multiple pieces welded together and is not intended for advancement into the vein alone, as it does not have an atraumatic tip.

Subcutaneous. Refers to the tissue located beneath the dermal layer of the skin.

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

Subcutaneous infusion. Administration of a medication into the subcutaneous layer of the skin (below the epidermis and dermal layers).

Substance use disorder. Can be diagnosed by criteria that specify a pattern of pathological behavior on a continuum: impaired control, social impairment, risky use, and pharmacological criteria.

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

Surrogate. Also referred to as legally authorized representative; someone who acts on behalf of the patient when the patient cannot participate in the decision-making process. Surrogates may be designated by the patient and know the patient's preferences or may be court appointed with or without this knowledge; without such knowledge, a surrogate is required to make decisions that are in the patient's best interest.

Surveillance. Active, systematic, ongoing observation of the occurrence and distribution of disease within a population and of the events or conditions that increase or decrease the risk of such disease occurrence.

T

Tackifier. A liquid adhesive used to increase the tack or the stickiness of a product.

Therapeutic phlebotomy. Removal of blood from the circulatory system via venipuncture or vascular access device to reduce a fraction of the patient's whole blood volume.

Thrombolytic agent. A pharmacological agent capable of lysing blood clots.

Thrombophlebitis. Inflammation of the vein in conjunction with formation of a blood clot (thrombus).

Thrombosis. The formation, development, or existence of a blood clot within the vascular system.

Tissue adhesive (TA). A medical-grade cyanoacrylate glue that can seal the insertion site and temporarily bond the catheter to the skin at the point of insertion and under the catheter hub. Depending on the chemical makeup, TA may be reapplied at each dressing change. Various formulations of TA for wound closure are commercially available, including first generation *N*-Butyl-2-cyanoacrylate (quick drying, rigid/brittle), second generation 2-octyl-cyanoacrylate (longer dry time, more flexible) and *N*-Butyl-2octyl cyanoacrylate formation (increased tensile strength and flexibility) with an additional indication for vascular access securement. Each TA formulation has varied properties, and the clinical decision to use should be based on research outcomes relative to the chosen product.

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.

Transient mechanical phlebitis. Phlebitis associated with the insertion of a midline or a peripherally inserted central catheter (PICC); may be due to rapid catheter insertion. Symptoms occur soon after insertion and often resolve. Catheter removal is indicated if symptoms do not resolve 24 hours postinsertion.

Transillumination. Shining a light at a specific body part (ie, extremity) to identify structures beneath the skin.

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

Transparent semipermeable membrane (TSM). A sterile air-permeable dressing that allows visual inspection of the skin surface beneath it; water resistant.

Tunneled, cuffed catheter. A central vascular access device with a segment of the catheter lying in a subcutaneous tunnel with the presence of a cuff into which the subcutaneous tissue grows to offer security for the catheter; indicates that the skin exit site and vein entry site are separated by the subcutaneous tunnel.

Tunneled, noncuffed central venous catheter. A non-cuffed catheter that is inserted into a large vein of the neck or groin. The catheter is traditionally tunneled through the subcutaneous tissue to an exit point on the anterior chest wall or mid-thigh. In comparison to a tunneled cuffed catheter, this catheter is reliant on external securement for anchorage.

U

Ultrasound. A device using sound waves at frequencies greater than the limit of human hearing; sound waves directed into human tissue to identify and display physical structures on a screen.

Umbilical catheter. A catheter that is inserted into the umbilical artery or vein at the umbilicus.

Unlicensed assistive personnel (UAP). A category of health care individuals who work as assistants to and under the direction of licensed health care professionals, including both nursing and medical assistants.

V

Vascular access device (VAD). Catheter, tube, or device inserted into the vascular system, including veins, arteries, and bone marrow.

Vascular access specialty team (VAST). See Infusion Team/Vascular Access Specialty Team (VAST).

Vascular visualization technology. Device that employs the use of sound or light waves to allow for the location and identification of blood vessels and guide device insertion.

Vasopressor therapy. Medications that promote vasoconstriction with potential for positive inotropic activity. Examples include, but are not limited to, norepinephrine, epinephrine, dopamine, dobutamine, vasopressin, terlipressin, phenylephrine, angiotensin II.

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.

AFTERWORD

The *Infusion Therapy Standards of Practice* (the *Standards*) is a significant work impacting clinical practice across the globe, with the goal of safe, high-quality patient care. The influence of the *Standards* on infusion practice is unparalleled. The *Standards* have been published in several languages over the years, are widely cited in clinical articles and books, and are used to develop and support clinical procedures in many published manuals. With the 2024 edition, the process evolved from an every 5-year to an every 3-year cycle. Due to the growing research base, a more frequent update was clearly needed.

In this edition, three new standards, Vasopressor Administration, Drug Diversion in Infusion Therapy, and Home Infusion Therapy, were added. With a trend toward an increase in peripheral vesicant infusions and the recognized risk for extravasation, it became important to include recommendations for vascular access for vasopressor administration. Similarly, it seemed prudent to address drug diversion in infusion therapy and to provide practice recommendations to optimize patient safety during procurement, dispensing, handling, and administration of controlled substances. Home infusion therapy continues to grow, with more studies to guide practice. With home infusion therapy, patients or their caregivers must be educated to safely live with a vascular access device and, in many cases, learn how to self-administer their infusions and minimize or completely avoid hospitalization. The new standard provides guidance for safe transitioning of patients to home infusion, to safe practices for a variety of home infusion therapies, patient education, and ongoing monitoring.

As I reflect on my involvement with the Infusion Nurses Society (INS), and as I finish my work with the Standards of Practice Committee, I am honored to write this *Afterword* after a 20-year journey participating in the development of the *Standards* and to share a bit of my personal journey. I began as a committee member for the 2006 *Standards*, as the chair for the 2011, 2016, and 2021 editions, and finally, as the co-chair for the 2024 edition.

I am fortunate to have an amazing career as a nurse working in post-surgical care, a critical care nurse and educator, and for the majority of my years, as a home care clinical nurse specialist (CNS), primarily focusing on home infusion therapy. As I transitioned from critical care to home care, literally "trying" out home care while I still worked in the hospital, I ultimately fell in love with home care. It was during that time of transition in the mid-to-late 1980s that great growth in home health care occurred due to a number of factors, including changes in United States (US) hospital reimbursement regulations. It was also the time of the acquired immunodeficiency syndrome (AIDS) epidemic, and complex home infusions were not uncommon in my practice. Based upon my acute care background and desire to provide care for those home care patients requiring a variety of infusions, I was given a position to develop a home infusion therapy program and have never looked back!

So, here began my history with INS and the *Standards*. As a CNS working with our small home infusion pharmacy, I reviewed the literature, spending time in the hospital library (no online searches then!), and looked for resources to help me. The *Standards* became an essential reference. Notably, in 1984, INS (then the National Intravenous Therapy Association [NITA]) published *Home IV Therapy Standards*, a one-page document. As I wrote policies and procedures and developed competency assessment tools for my home care organization, the *Standards* was my essential tool and reference. I published my first book in 1994 (*High Tech Home Care*), using the *Standards* as an important reference.

As a CNS focused on best practice, I wanted to become more involved beyond my local work; specifically, I wanted to be part of the *Standards* work! Expressing this desire to Mary Alexander, INS' CEO at the time, she invited me to become a member of the 2006 Standards development committee and, ultimately, to chair the committee starting in 2011.

After publication of the 2006 *Standards*, I was provided the opportunity to develop a column for the *Journal of Infusion Nursing,* entitled "Speaking of Standards," providing a focused discussion of some of the standards that generated the most questions. As this feature ended after 2 years, the work of the next committee began. With the 2006 edition, our committee reviewed the literature and added references to support the practice criteria. However, it did not qualify as an "evidence-based" document. As I transitioned to the chairperson for the 2011 *Standards*, my personal goal with our committee was to develop the *Standards* as an evidence-based document. Mary Hagle, a nurse researcher, was a central figure in helping our committee develop the content found in the "Strength of the Body of Evidence" and to be our leader in evaluating research identified in our literature reviews. From that point forward, instead of just listing our references, we have appraised the types and quality of the cited literature and rated the body of evidence for each practice criterion. As the work continued through development of the 2016 *Standards*, the level of global interest in the work afforded me and others increased opportunities to present our work beyond the United States. My opportunity to share the *Standards*, have dialogues with many clinicians, and understand local practices and resources was invaluable. Traveling to China and countries in Latin America, the Middle East, Africa, and Europe was a highlight of my career.

So, as I began the planning process with Mary Alexander for the 2021 *Standards*, it was clearly important to grow our committee to include more members beyond nurses from the United States. Members representing Canada, the United Kingdom, and Australia joined us. We continued in

2024 with global membership and added new non-nurse members from disciplines representing infection prevention and pharmacy.

When I served as INS president from 2007 to 2008, my presidential theme was "Advancing the Science of Infusion Therapy." I am honored that I have played a role in continuing this theme beyond my time as president, with the help of the committee members and the work of the incredible researchers who ask the important questions and do the research. I congratulate Barb Nickel, who could not be a better choice in continuing the leadership of the *Standards*. I offer my sincere thanks to Mary Alexander for giving me the opportunity to chair the *Standards*, to all the committee members over the years for the dedication of their time and expertise, to all of the peer reviewers, the INS membership, and all clinicians who have used this work to enhance their practice and deliver safe infusion care.

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