Access Device Standards of Practice
FOR ONCOLOGY NURSING

Edited by
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Oncology Nursing Society
Pittsburgh, Pennsylvania
To our mothers, who brought us together in so many ways.

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<td>AANA</td>
<td>American Association of Nurse Anesthetists</td>
</tr>
<tr>
<td>ANTT</td>
<td>aseptic no-touch technique</td>
</tr>
<tr>
<td>APN</td>
<td>advanced practice nurse</td>
</tr>
<tr>
<td>APRN</td>
<td>advanced practice registered nurse</td>
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<tr>
<td>BSI</td>
<td>bloodstream infection</td>
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<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
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<tr>
<td>CHG</td>
<td>chlorhexidine gluconate</td>
</tr>
<tr>
<td>CLABSI</td>
<td>central line-associated bloodstream infection</td>
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<tr>
<td>CNS</td>
<td>central nervous system</td>
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<tr>
<td>CRBSI</td>
<td>catheter-related bloodstream infection</td>
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<tr>
<td>CSF</td>
<td>cerebrospinal fluid</td>
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<tr>
<td>CT</td>
<td>computed tomography</td>
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<tr>
<td>CVAD</td>
<td>central venous access device</td>
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<tr>
<td>CVC</td>
<td>central venous catheter</td>
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<tr>
<td>DERS</td>
<td>dose error reduction system</td>
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<tr>
<td>DVT</td>
<td>deep vein thrombosis</td>
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<td>EMR</td>
<td>electronic medical record</td>
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<tr>
<td>EtOH</td>
<td>ethanol</td>
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<tr>
<td>HCI</td>
<td>hydrochloric acid</td>
</tr>
<tr>
<td>ICU</td>
<td>intensive care unit</td>
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<tr>
<td>IJ</td>
<td>internal jugular</td>
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<tr>
<td>INR</td>
<td>international normalized ratio</td>
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<td>INS</td>
<td>Infusion Nurses Society</td>
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<td>IP</td>
<td>intraperitoneal</td>
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<td>IR</td>
<td>interventional radiology</td>
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<td>IV</td>
<td>intravenous</td>
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<tr>
<td>LMWH</td>
<td>low-molecular-weight heparin</td>
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<td>MPE</td>
<td>malignant pleural effusion</td>
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<td>MRI</td>
<td>magnetic resonance imaging</td>
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<tr>
<td>NCCN</td>
<td>National Comprehensive Cancer Network</td>
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<tr>
<td>NS</td>
<td>0.9% normal saline</td>
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<td>ONS</td>
<td>Oncology Nursing Society</td>
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<tr>
<td>OR</td>
<td>operating room</td>
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<tr>
<td>PASV</td>
<td>pressure-activated safety valve</td>
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<tr>
<td>PICC</td>
<td>peripherally inserted central catheter</td>
</tr>
<tr>
<td>PIV</td>
<td>peripheral intravenous</td>
</tr>
<tr>
<td>RN</td>
<td>registered nurse</td>
</tr>
<tr>
<td>SC</td>
<td>subcutaneous</td>
</tr>
<tr>
<td>SVC</td>
<td>superior vena cava</td>
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<tr>
<td>TENS</td>
<td>transcutaneous electrical nerve stimulation</td>
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<tr>
<td>tPA</td>
<td>tissue plasminogen activator</td>
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<tr>
<td>TPN</td>
<td>total parenteral nutrition</td>
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<tr>
<td>VAD</td>
<td>venous access device</td>
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<td>WHO</td>
<td>World Health Organization</td>
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For decades, access devices have been used to deliver complex and diverse treatments to patients with cancer. IV therapy is an integral part of modern medicine and nursing, as it is practiced in every healthcare setting, from the hospital to the home. A new generation of access devices is quickly being adapted to provide a safe means to administer therapies into body systems, such as the peritoneal, arterial, epidural, pleural, or intraventricular spaces. The daily use of access devices is central to the care that oncology nurses provide to patients with cancer. With this increased complexity, nurses have an increased responsibility in maintaining access devices and a key role in preventing device-related complications.

Evolving technology continuously leads to newer devices and products used concurrently with access devices. This technology continues to improve existing access devices to decrease the occurrence of the most frequent complications: infection and occlusion. Increased safety features, for both patient and provider, help to decrease accidental exposures or catheter malposition. As new products emerge, nurses must advance their knowledge to provide competent and safe care.

Little empirical evidence and research are available to support evidence-based nursing care related to venous access devices (VADs). Few randomized controlled trials have been conducted to definitively support nursing practices. Practice continues to be dictated by manufacturer recommendations or manufacturer in vitro clinical trials performed for U.S. Food and Drug Administration device or product approval. Government regulations also dictate care from the standpoint of insurance reimbursement, but without clear evidence to support specific practices; in the absence of evidence but in the face of reimbursement losses, practices may be adopted without clear evidence to support them. Expert opinion and institution-specific historical data often are used to develop policies.

Oncology nurses must base practice on evidence-based research when available, but lack of evidence is a professional challenge. Given this challenge, the Oncology Nursing Society (ONS) recognizes that both the unique complexities of patients with cancer and the extensive use of access devices in this population warrants standards and recommendations that meet the specific needs of nurses who specialize in oncology nursing. ONS is well positioned to define the standards of excellence for access device management in the specialty of oncology nursing and has continually updated its access device recommendations since 1989. Terminology used in Access Device Standards of Practice for Oncology Nursing is deliberately chosen to distinguish between evidence-based practices and those for which no definitive evidence is available.

Access Device Standards of Practice for Oncology Nursing was developed through a multiphasic process, beginning with an exhaustive analysis of empirical research, meta-analytical summaries, case reports, and review articles. PubMed, Cumulative Index to Nursing and Allied Health Literature, Cochrane Library, Database of Abstracts of Reviews of Effects, National Guideline Clearinghouse, U.S. Preventive Services Task Force, and Turning Research Into Practice databases were queried to ensure complete data inclusion. Although the main focus of these standards is the adult population, research conducted with pediatric populations is included when available and when appropriate to extrapolate findings to adults. Following this synthesis of evidence, clinical experts working in the field of oncology nursing developed each chapter. Several editorial review cycles followed to ensure accuracy and inclusion of all relevant data. Field reviewers, including the Infusion Nurses Society, were invited to provide in-depth analysis and feedback. An open public comment period was offered to ensure a rigorous and transparent review process. Appendix 1 provides evidence demonstrating the strength on which standard statements are made.

The ONS Board of Directors defines the characteristics of a standard as “an authoritative document that provides requirements, specifications, and/or characteristics that shall be used consistently across practice settings to ensure that nursing actions, processes, and services are used to achieve desired optimal results” (www.ons.org/practice-resources/standards-reports). Practice statements in this publication are identified as standards, recommendations, or as practice for which no evidence can support a definitive statement in introduction
the case of lacking evidence. The following language is used to identify these statements:

- Practice standard: Evidence is sufficient to conclude the acceptance of this practice.
- Practice recommendation: Evidence is less robust; expert opinion, generally accepted practice, and sound nursing judgment warrant consideration of this practice.
- No definitive recommendation can be made: Evidence is lacking to support a definitive practice.

The Standards have been developed from this synthesis of evidence, critical review, and analysis, focusing on those aspects of VAD management for which nursing is accountable and directly associated with VAD care. Historical evidence, when provided, is offered when recent evidence is lacking or to underscore the strength of a standard statement.

Ongoing surveillance of infection and occlusion rates and daily evaluation of access device use will help any institution evaluate policies to determine if revisions in practice are needed. Access device manufacturer websites should be consulted for recommendations on specific brands and device types. With limited research to guide practice, ongoing controversies remain concerning optimal management. Developing the expertise needed to successfully manage access devices is a continual challenge to nursing professionals. The intent of these standards is to provide the foundation for evidence-based practice to guide individual oncology nursing practice.

Access Device Standards of Practice for Oncology Nursing is arranged in chapters for ease of use. Chapter 1 critically reviews controversies in access device care. Standard statements and recommendations made are based on the evidence presented. The remaining chapters detail each venous and specialty device. Patient selection criteria and advantage/disadvantage tables within each chapter can be used to select the best device based on the patient’s needs. Chapter 17 explores recommended documentation and key legal ramifications concerning access devices and their management. Examples of competency practicums are provided as appendices.

It is clear that, despite the lack of evidence-based practice for care of access devices, patient quality of life has greatly improved over the past decades with the advances in access device technology. Access Device Standards of Practice for Oncology Nursing explores the latest technologies, management procedures, and the controversies that remain.

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Chapter 1

Access Device Standards, Recommendations, and Controversies

Diane G. Cope, PhD, ARNP-BC, AOCNP®, and Laurl Matey, MSN, RN, CHPN

- **Practice standard**: Evidence is sufficient to conclude the acceptance of this practice.
- **Practice recommendation**: Evidence is less robust; expert opinion, generally accepted practice, and sound nursing judgment warrant consideration of this practice.
- No definitive recommendation can be made: Evidence is lacking to support a definitive practice.
- Recent evidence: Evidence is used to support standard or recommendation or to demonstrate insufficient evidence to recommend practice.
- Historical evidence: Evidence is provided as a historical reference; may or may not support current standards or recommendation statements.

(See Appendix 1 for a summary of studies related to access devices.)

I. Placement imaging

*What is the best evidence regarding imaging studies to ensure proper placement of a central venous access device (CVAD) during or postprocedure?*

A. **Practice recommendation**: Consider the use of ultrasound guidance to place central venous catheters (if this technology is available) to reduce the number of cannulation attempts and mechanical complications. Ultrasound guidance should be used only by those fully trained in its technique (Lamperti et al., 2012; O’Grady et al., 2011).

B. No definitive recommendation can be made regarding the use of intracavitary electrocardiography for central venous catheter placement based on the available evidence.

C. Recent evidence

1. Chest imaging, such as x-rays or fluoroscopic images, traditionally has been used to guide and to verify catheter positioning (Roldan & Paniagua, 2015; Zadeh & Shirvani, 2014).
2. Multiple studies and review articles assert that ultrasound-guided insertion by skilled practitioners should be used to decrease the number of cannulation attempts, reduce complications, and guide correct catheter tip placement by those trained and skilled in this technique (Ahn et al., 2012; Bowen, Mone, Nelson, & Scaife, 2014; Brass, Hellmich, Kolodziej, Schick, & Smith, 2015; Gibson & Bodenham, 2013; Lamperti et al., 2012; O’Grady et al., 2011; Teichgräber, Kausche, Nagel, & Gebauer, 2011; Thomopoulos et al., 2014).

3. A retrospective analysis concluded that if a port is placed with ultrasound or fluoroscopy, a postoperative chest x-ray is not needed to confirm placement (Bowen et al., 2014). Additional studies found accurate catheter tip placement with intracavitary electrocardiogram- and fluoroscopy-guided catheter placement. The studies concluded that the requirement of post-procedural chest x-ray to assess catheter tip placement potentially could be eliminated (Thomopoulos et al., 2014; Walker et al., 2015).

4. Multicenter research reveals that an intracavitary electrocardiography is a safe and accurate alternative method of positioning the catheter tip in the pediatric population (Rossetti et al., 2015). Similar findings have been shown in adult patient populations (Walker, Alexandrou, Rickard, Chan, & Webster, 2015; Wang et al., 2015).

5. Ultrasound or electrocardiogram guidance often may be unavailable where CVADs are needed, such as in urgent situations in the emergency department or operating suite. Skillful insertion of CVADs with subsequent radiographic confirmation of tip placement has proven to be safe and
effective in ensuring proper tip placement (Gan & Lanigan, 2013; see also Historical References).

II. Dressing types

What is the best evidence regarding type of dressing (transparent versus gauze and tape) for venous access devices (VADs)?

A. No definitive recommendation can be made based on the available evidence. Until prospective, multisite, randomized studies are conducted using standardized cleansing protocols, frequency of dressing changes, differences in transparent dressing brands, patient characteristics (e.g., patient disease, comorbidities, treatment, age), and outcome variables, determining which type of dressing and maintenance care protocol will result in the least number of complications will remain inconclusive.

B. Recent evidence

1. The Centers for Disease Control and Prevention (CDC) practice guidelines suggest that dressing choice could be a matter of patient preference (O’Grady et al., 2011).

2. A recent Cochrane systematic review of randomized controlled trials evaluated CVAD–related bloodstream infections with available CVAD dressing and securement devices (Ullman et al., 2015). Twenty-two studies involving 7,436 participants were evaluated, analyzing a variety of different interventions and comparisons involving sterile gauze, standard polyurethane, chlorhexidine gluconate (CHG)–impregnated dressings, silver-impregnated dressings, hydrocolloid dressings, second-generation gas-permeable standard polyurethane, and sutureless securement devices. Results indicated that medication-impregnated dressing products, defined as only CHG-impregnated dressings in a patch or a whole dressing, reduced the incidence of CVAD-related bloodstream infection relative to all other dressing types. Most studies were conducted in the intensive care unit, and the authors cautioned that the effectiveness of CHG-impregnated dressings may not be generalizable beyond these settings.

3. In a clinical trial comparing the safety (phlebitis, pain, and leakage) and costs of transparent versus gauze dressings in patients with peripherally inserted central catheters (PICCs), no significant differences in complication rates were found (Chico-Padrón et al., 2011). The authors concluded that increased costs were associated with gauze dressings compared to transparent dressings, as the gauze dressing required frequent replacement.

4. A randomized controlled clinical trial was conducted to compare the effectiveness of gauze and tape dressing and transparent polyurethane film dressing in a sample of 21 catheters (Pedrolo, Danski, & Vayego, 2014). No significant differences were found in catheter-related infections, dressing stability, or exudate absorption. A significant difference in local reaction was found in the gauze and tape group compared to the transparent film dressing group.

C. Historical evidence

1. Past studies, using both retrospective and prospective designs, support and refute the use of gauze and transparent dressings (see Historical References).

a) Many of these studies had methodologic flaws and insufficient power to detect significant differences in infection rates; therefore, drawing conclusions regarding differences in infection remains inconclusive.

b) Multiple operational definitions exist of concepts such as catheter-related infections, varying measures of outcomes, different patient populations, cleansing protocols, frequency of dressing changes, catheter dwell times, and types of catheters.

c) Studies in which prospective designs were used revealed an increase in catheter tip and exit-site infections with transparent occlusive dressings compared to dry gauze dressings; however, the majority of these studies were conducted over 20 years ago.

2. Investigators who conducted studies in which infection rates were higher with transparent dressings concluded that the transparent dressings did not allow for adequate evaporation of perspiration, leading to increased colonization of bacteria at the catheter exit site. Most studies were done with older dressing designs (over 25 years ago, beginning in the 1980s). Current dressing designs are available that may reduce the rate of organism colonization; however, further randomized controlled trials are needed.

3. Newer designs of transparent dressings with semipermeable and highly permeable membranes that allow for increased mois-
ture vapor transmission rates can remove up to eight times more moisture from the exit site than previous types of transparent dressings.

4. Cost: Historical research concluded that the cost of transparent dressings, even when the frequency of dressing changes is considered, remained higher than the cost of dry gauze dressings (see Historical References). More recent data contradict these findings (Chico-Padrón et al., 2011).

5. No dressing versus gauze dressing: One study investigated catheter-related sepsis, comparing no dressing or gauze dressing for newly inserted tunneled catheters in bone marrow transplant recipients (Olson et al., 2004). Findings suggested that no significant difference existed in catheter-related sepsis between the no dressing and gauze dressing groups; however, the gauze dressing group had a significantly shorter time interval to the development of sepsis.

III. Cleansing agents (see Appendix 2)
What is the best evidence regarding type of cleansing procedure for VADs?
A. Before insertion or implantation
1. Practice standard: Scrub the skin at the insertion site with 2% CHG and use vigorous friction for 30 seconds. Allow to air-dry for at least 30 seconds (Schiffer et al., 2013).
2. Recent evidence: CHG solution and povidone-iodine use, patient age and gender, presence of malignancy and coexisting diseases, catheter duration, and use of total parenteral nutrition solution or use of blood products were evaluated for the effects on the development of catheter colonization and catheter-related bloodstream infections in patients with CVAD (Atahan et al., 2012). Patients were randomly assigned for insertion site disinfection prior to CVAD insertion, with a povidone-iodine–based or a 1.5% CHG-based solution. A statistically significant reduction in catheter-related bloodstream infection and catheter colonization was only found with the use of CHG in comparison to the povidone-iodine antiseptic solution.
3. Historical evidence: Past studies using various research procedures for the investigation of cleansing agents before catheter insertion and for catheter site care and dressing changes have found diverse results in the reduction of catheter-related infections (see Historical References).

B. Before accessing port
1. Practice recommendation: Use > 0.5% CHG as a cleansing agent.
2. Few studies have been conducted to investigate cleansing agents and protocols for skin cleansing prior to implanted port access. Further research is needed (O’Grady et al., 2011; Schiffer et al., 2013).

C. Before access of a needleless connector or hub
1. Practice standard: Routinely clean the needleless connector or hub with an appropriate antiseptic prior to use (Flynn, Keogh, & Gavin, 2015; Moureau & Flynn, 2015; Wright et al., 2013).
2. Practice standard: Vigorously apply mechanical friction with a cleansing agent before accessing catheter hubs, needleless connectors, or injection ports. Apply mechanical friction for five seconds or more to reduce contamination (Marschall et al., 2014; O’Grady et al., 2011; Shekelle et al., 2013) (see Appendix 2). Needleless connectors have not been well studied, and it is unclear if duration of disinfection can be generalized.
3. Recent evidence
   a) In an experimental study, Hong, Morrow, Sandora, and Priebe (2013) evaluated different scrub times (e.g., swipe, 5 seconds, 15 seconds, 30 seconds) using CHG alcohol compared to alcohol on needleless connectors for residual disinfectant activity. The swipe with alcohol method did not adequately disinfect needleless connectors, especially with Staphylococcus aureus or Pseudomonas aeruginosa contamination. CHG alcohol and alcohol performed similarly with scrubs that last at least five seconds; however, CHG alcohol resulted in residual disinfectant activity for up to 24 hours.
A systematic review was conducted to evaluate literature from 1977 to December 2014 regarding disinfection of needleless connectors to develop recommendations for aseptic access (Moureau & Flynn, 2015). The review included 140 publications pertaining to disinfection and catheter hub and needleless connector contamination, with a combined 34 abstracts and posters. The authors cautioned that the evidence for the effectiveness of the disinfection strategies was low level. Recommendations for practice regarding infection prevention and aseptic access included the following:

1. Use an appropriate antiseptic agent (e.g., CHG alcohol, povidone-iodine, iodophor, 70% alcohol) on the surfaces of needleless connectors, stopcocks, and other intravascular access ports immediately prior to any connection, infusion, or aspiration.
2. Passive continuous hub disinfection on needleless connections may be achieved with antimicrobial caps or port protectors with frictional antiseptic wiping between applications and access (Sweet, Cumpston, Briggs, Craig, & Hamadani, 2012).
3. Hand hygiene, gloving, and aseptic practices should be maintained prior to any contact with IV devices and add-on equipment.
4. Clinical staff should be educated to disinfect catheter hubs, needleless connectors, and ports prior to and after each access. Moureau and Flynn (2015) concluded that large, randomized controlled trials are needed to establish quality evidence for disinfection practices, including efficacy of antiseptic type, to disinfect needleless connectors.

An in vitro study was conducted to evaluate the effect of alcohol disinfection duration on bacterial load on catheter hubs (Simmons, Bryson, & Porter, 2011). Catheter hubs were contaminated with bacterial solution and allowed to dry for 24 hours. Then the hubs were disinfected with alcohol for 3, 10, or 15 seconds. No significant difference was found in the duration of disinfection and reduction in bacterial load.

4. Historical evidence
   a) Past studies for the investigation of disinfection practices of catheter protective caps prior to puncture with a needle or access of a needleless connector hub found diverse results in the reduction of catheter-related infections (see Historical References).
   b) Several studies have suggested that the use of a novel antiseptic barrier or connector cap significantly decreased the risk of microorganisms (see Historical References). Further research is needed. No conclusion can be drawn to affect practice.

D. Skin cleansing with dressing changes

1. **Practice standard:** Clean skin with >0.5% CHG alcohol preparation during dressing changes. If a contraindication or allergy to CHG exists, a tincture of iodine, an iodophor, or 70% alcohol can be used (O’Grady et al., 2011). Large, prospective, randomized clinical trials investigating different cleansing agents and different cleansing duration with controlled dressing types are needed to determine the most appropriate cleansing agent.
2. No definitive recommendation can be made for the use of CHG in infants younger than two months of age (O’Grady et al., 2011).
3. Recent evidence
   a) The effects of CHG and povidone-iodine were compared for the prevention of bloodstream infection associated with access of venous ports (Kao et al., 2014). No significant difference was found in preventing the occurrence of port-associated bloodstream infections. The most common pathogens were gram-negative bacteria followed by gram-positive bacteria and fungi. CHG was associated with a significant improvement in time to first bloodstream infection caused by gram-positive bacteria; however, no significant preventive effects of CHG on time to first bloodstream infection caused by gram-negative bacteria or fungi were found.
b) CHG, octenidine, and povidone-iodine were compared for effects in preventing catheter-related infections by cleansing the skin with the designated antisepsis before insertion of the catheter and using the same antisepsis in the following days (Bilir, Yelken, & Erkan, 2013). Catheter-related sepsis was 10.5% in the povidone-iodine and octenidine hydrochlorodine groups, and catheter-related colonization was 26.3% in the povidone-iodine group and 21.5% in the octenidine hydrochlorodine group. There was no catheter-related sepsis or colonization in the CHG group.

c) Alcohol povidone-iodine was compared with a CHG antiseptic solution for the prevention of CVAD-related infections (Girard, Comby, & Jacques, 2012). When users switched from povidone-iodine to CHG, a significant reduction in colonization was noted; however, no significant difference in CVAD-related infection or bacteremia was found. Povidone-iodine was associated with a higher risk of colonization and infection.

E. Before epidural catheter placement

1. No definitive recommendation can be made based on the available evidence. The American Association of Nurse Anesthetists (AANA) supports CHG as the preferred skin preparation agent; however, povidone-iodine is a suitable alternative when CHG is contraindicated. Parachloroxylenol may be used as a cleansing agent, but it is less effective than CHG and povidone-iodine at eliminating microorganisms. Iodine base with alcohol also may be used (AANA, 2015).

2. Recent evidence

   a) A prospective study was conducted to compare the efficacy of 10% povidone-iodine and 2% CHG for skin disinfection prior to the placement of an epidural and CVADs (Kulkarni & Awode, 2013). The sample included a total of 60 patients, with 50 having epidural placement. Study findings suggested no difference in cost, efficacy, or side effects between 2% CHG and 10% povidone-iodine for skin disinfection.

   b) Alcohol-based CHG was compared to povidone-iodine for skin disinfection prior to a neuraxial blockade procedure (Kroobuaban, Diregpoke, Prasan, Thannomsat, & Kumkeaw, 2011). Results showed that the incidence of positive skin culture was significantly lower in the CHG group compared to the povidone-iodine group.

3. Historical evidence: Past studies for the investigation of cleansing agents prior to epidural placement have found diverse results in the reduction of catheter-related infections (see Historical References).

IV. Flushing agents

What is the best evidence regarding the type of flushing protocol for VADs?

A. No definitive recommendation can be made regarding a specific flushing protocol based on the available evidence (Bradford, Edwards, & Chan, 2015; Conway, McCollom, & Bannon, 2014; Ferroni et al., 2014; Goossens, 2015; Goossens et al., 2013; Gorji, Rezaei, Jafari, & Cherati, 2015; Guiffant, Durussel, Merckx, Flaud, Vigier, & Mousset, 2012; Murray, Precious, & Ali Khan, 2013; Odabas et al., 2014). Variability in studies involving heparin and saline flushing frequency, volume, concentration, and varying outcome measures prevent a definitive recommendation for a flushing solution protocol.

B. Practice standard: Flush all VADs with 0.9% normal saline (NS) following all blood sampling and medication administration.

C. Practice recommendation: Based on hydrodynamic flow studies and evidence of intraluminal fibrin buildup, use of pulsatile (push-pause) flushing techniques should be considered.

D. Recent evidence

1. Gorji et al. (2015) conducted a randomized, double-blind study to compare the effects of heparin saline solution and NS solution in maintenance of CVAD patency. The sample, which included 84 patients with non-tunneled CVADs in an intensive care unit, was randomized to a heparin saline flush (3 ml) or an NS flush (10 ml) following medication administration. No significant difference was found in catheter patency between both solutions.

2. A systematic review was conducted to evaluate heparin versus 0.9% sodium chloride, with intermittent flushing for the prevention of occlusion in CVADs in adults (López-Briz et al., 2014). The review included six studies with heparin concentrations varying from 10–5,000 IU/ml and follow-up varying from 20–180 days for use
in tunneled and nontunneled CVADs. No conclusive evidence of differences between heparin intermittent flushing and NS for efficacy and safety was found. Further, no differences were noted in rates of thrombosis, infection, bleeding, heparin-induced thrombocytopenia, mortality, or catheter survival.

3. In a randomized trial to evaluate blood withdrawal occlusion, catheter-related bacteremia, and occurrence of functional problems, heparin lock (300 IU/3 ml) was compared to 10 ml NS lock in a sample of 802 patients with cancer who had newly inserted nonvalved implanted venous ports (Goossens et al., 2013). No significant difference was found between heparin lock and NS lock. The authors concluded that NS is an effective solution if combined with a consistent pulsatile flushing technique followed by a positive pressure locking technique.

4. To evaluate maintenance of CVAD patency, Schallom, Prentice, Sona, Micek, and Skrupky (2012) conducted a randomized controlled trial of 341 patients with multi-lumen CVADs. The study compared 10 ml NS every eight hours with 10 ml NS followed by 3 ml heparin lock flush (10 IU/ml) every eight hours. No significant difference in catheter occlusion was found between heparin and NS lock.

5. A prospective, randomized, one-way, single-blinded post–test with a control group study of 90 noncancer homecare patients with PICCs was conducted to investigate three flushing protocols for the development of patency–related complications and issues, such as sluggishness, occlusion, missed medication doses, catheter replacement, additional nursing visits, and the use of alteplase (Lyons & Phalen, 2014). Results indicated that the saline flush group had the highest incidence of PICC occlusion requiring alteplase use. The higher concentration of heparin flush group and the saline flush group had similar number episodes of PICC sluggishness, and the lower concentration of heparin flush group had the lowest number of episodes of occlusions and use of alteplase. The three flushing protocols were as follows:

a) Study group I: Saline flush with 10 ml, followed by administration of IV medication, then by a saline flush with 10 ml

b) Study group II: Saline flush with 10 ml, followed by administration of IV medication, then by a saline flush with 10 ml, and finally by a heparinized saline solution with concentration of 100 IU/ml (3 ml or 300 IU)

c) Study group III: Same sequence as study group II but with heparin concentration of 10 IU/ml (5 ml or 50 IU)

6. The efficacy of pulsatile flushing to prevent bacterial colonization of VADs was compared with continuous flushing and no flushing in 576 *Staphylococcus aureus*–contaminated polyurethane short-term venous access catheters (Ferroni et al., 2014). *Staphylococcus aureus* endoluminal contamination was significantly higher with continuous flushing than with pulsatile flushing.

E. Historical evidence: Past studies of flushing protocols have found diverse results in the reduction of catheter-related occlusions and complications (see Historical References).

What is the best evidence regarding flushing protocols in patients with heparin-induced thrombocytopenia?

F. No definitive recommendation can be made based on the available evidence. Consideration should be given to insert devices with distal tip valve design and to use NS flush.

What is the best evidence regarding flushing protocols for short-term arterial pressure lines?

G. No definitive recommendation can be made based on the available evidence. Evidence comparing the use of heparin solution and NS solution for flushing and maintaining the patency of arterial pressure lines is inconclusive. Inconsistency in study variables involving heparin and saline flushing frequency, volume, concentration, and varying outcome measures prevent the establishment of a recommendation for a flushing solution protocol.

H. Recent evidence: A systematic review was conducted to compare NS and heparin in varying...
dosages in maintaining the patency of arterial intravascular catheters in adult patients without a hematologic disorder (Robertson-Malt, Malt, Farquhar, & Greer, 2014). As a result of the clinical and statistical heterogeneity of the seven included studies, no meta-analysis was completed and no conclusion could be drawn. The authors concluded that further research was needed with well-defined primary and secondary outcomes and the use of various heparin doses.

I. Historical evidence: Past studies for the investigation of flushing protocols of arterial pressure lines have found diverse results in the reduction of catheter-related occlusions and complications (see Historical References).

**What is the best evidence regarding the volume and flushing frequency needed for VADs?**

J. No definitive recommendation can be made based on the available evidence.

1. The issues of volume and frequency of flushing continue to be controversial among institutions across the United States. Multi-site, randomized prospective studies examining the relationship of these variables with factors such as patency, type of device, patient characteristics, infection, and cost are needed to standardize protocols used in multiple institutions.

2. Little evidence exists regarding the current state of flushing practice. Mechanisms to reduce complications in VADs have included evaluation of optimizing patency through flush volumes, types of flush preparations (prefilled syringes versus manually filled syringes), and flushing. Volume and frequency variations typically are not evaluated independently of other variables.

V. VAD without blood return

**What is the best evidence regarding the use of a VAD without a blood return?**

A. No definitive recommendation can be made based on the available evidence. No studies to date have provided a research-based answer as to when to administer medication through a VAD without a blood return. No definitive evidence exists to guide surveillance intervals to determine ongoing accuracy of VAD placement.

B. **Practice standard:** It is expert opinion and generally accepted practice in various clinical settings that prior to administering medications through VADs in which no blood return exists, verification of catheter placement and function should be established through imaging studies (Polovich, Olsen, & LeFebvre, 2014).

C. **Practice standard:** Do not administer antineoplastic agents in the absence of a blood return.

D. **Interventions (Polovich et al., 2014)**
   1. Attempt to flush with NS using gentle pulsatile (push-pause) technique.
   2. Reposition the patient.
   3. Ask the patient to cough and deep breathe.
   4. Obtain a provider order for declotting procedure, as appropriate.
   5. Obtain a provider order for possible imaging study.

E. **Practice standard:** Remove peripheral and midline catheters and reinset if no blood return (Gonzalez, 2013; Polovich et al., 2014; Schulmeister, 2011).

F. **Practice standard:** If no other options exist after verification of VAD intactness, position, and patency and confirmation by imaging study of the lack of backflow, obtain a provider order to use a VAD when there is no blood return (Polovich et al., 2014).

**What is the best evidence regarding type or frequency of imaging study to perform to evaluate a VAD with no blood return?**

G. No definitive recommendation can be made based on the available evidence. No studies to date have provided a research-based answer regarding the best imaging or study to determine safe use of a VAD with no blood return.

1. Management of a catheter without blood return requires evaluation of the location of the catheter’s tip. Imaging is ordered and may include injection of contrast (i.e., venogram) or cross-sectional computed tomography (CT) scan.

2. Expert opinion suggests that it is better to leave a questionable device in situ and to consult a vascular surgeon or interventional radiologist rather than to immediately remove the device (Gibson & Bodenham, 2013).

3. A chest x-ray will visualize catheter tip positioning and is best for evaluating malposition, migration, kinking, and pinch-off syndrome.

4. An ultrasound will visualize the vein where the catheter is located and the tip location and is superior in evaluating for clots in the catheter tip. If the VAD is completely occluded, an ultrasound is beneficial in evaluating the VAD.

5. CT imaging will visualize catheter intactness or the portal body and is useful in detecting malposition of the catheter or port.

6. A catheterogram (dye study) will visualize the intactness of the catheter and the flow.
VI. Catheter occlusion

**What is the best evidence regarding the treatment of a VAD occlusion due to suspected thrombosis?**

A. Additional large multicenter trials are needed with direct comparisons of fibrinolytic agents, drug concentrations, the effect on mineral precipitants or lipids, the type of device, and dwelling times in order to establish optimal treatment for catheter occlusion.

B. **Practice standard:** Use 2 mg alteplase (tissue plasminogen activator [tPA]) to restore patency and maintain catheter function (Schiffer et al., 2013).

C. Recent evidence: The successful use of tPA for restoration of catheter patency has been confirmed in numerous studies, among various patient populations and settings, and in catheters placed for various indications (Ernst, Chen, Lipkin, Tayama, & Amin, 2014; Ponce, Mendes, Silva, & Oliveira, 2015; Ragsdale, Oliver, Thompson, & Evans, 2014; Tebbi et al., 2011).

D. Historical evidence: The use of alteplase for catheter occlusion has been found to be safe and effective (see Historical References).

**What is the best evidence regarding use of tPA locks or infusions as maintenance therapy for occlusion prevention for VADs?**

E. No definitive recommendation can be made regarding use of tPA locks, infusions, or overnight dwells.

F. Recent evidence

1. Most studies evaluating tPA for locking catheters, specific dwells, or continuous infusions (during hemodialysis) have been conducted in the dialysis population, utilizing arteriovenous fistulas. Low-dose tPA directly infused continuously into the fistula during dialysis has been shown to decrease clot burden in a small sample of patients (van der Merwe, Luscombe, & Kii, 2015).

2. A twice-weekly recombinant tPA/heparin lock protocol used in each lumen of hemodialysis catheters demonstrated a mean overall cost and efficacy similar to that of a three times per week heparin lock protocol (Manns et al., 2014).

3. The efficacy of an alteplase 30-minute dwell protocol versus an alteplase push protocol (< 30 minutes) in hemodialysis patients with central VADs proved no statistical difference in the resultant blood flow rates from either group (Vercaigne, Zacharias, & Bernstein, 2012).

G. Historical evidence

1. Although dosing and administration recommendations outlined in drug package inserts for alteplase do not include protocols for overnight drug dwells, research in a homecare population used a three-dose protocol comparing partially and completely occluded devices. Alteplase was administered in partially and fully occluded CVADs up to three repeated doses as needed, with the third instillation dwelling overnight. Approximately 66.7% of all catheters were successfully cleared using this protocol (Moureau, Mlodzik, Pharm, & Pool, 2005).

2. Various protocols for VADs have been recommended, including allowing alteplase to dwell overnight depending on institutional practice and policy (see Historical References).

VII. Catheter occlusion prophylaxis

**What is the best evidence regarding effective anticoagulant prophylaxis for the prevention of catheter-related thrombosis?**

A. **Practice standard:** Do not use prophylactic, low-dose warfarin or low-molecular-weight heparin as prevention for thrombosis related to VADs in patients with cancer. This, along with the use of oral anticoagulants, is not recommended (D’Ambrosio, Aglietta, & Grignani, 2014; Kahn et al., 2012; Schiffer et al., 2013).

B. Recent evidence

1. A systematic review found that heparin (low molecular or unfractionated) or vitamin K antagonists compared to no therapy did reduce the incidence of symptomatic deep vein thrombosis in patients with cancer who also had a VAD. Heparin was associated with a higher risk of thrombocytopenia and asymptomatic deep vein thrombosis when compared to vitamin K antagonists; benefits must outweigh harms (Akl et al., 2014).

2. Studies investigating the use of low-molecular-weight heparin and vitamin K antagonists for the prevention of catheter-related thrombosis have shown a significant reduction in the rate of catheter-related thrombosis (Lavau-Denes et al., 2013; see also Historical References).

C. Historical evidence: Past randomized trials investigating low-molecular-weight heparin have not found efficacy in prevention of catheter-related thrombosis (see Historical References).
D. No definitive recommendation can be made regarding the use of heparin-bonded catheters for prolonging patency.  
1. Recent evidence: Shah and Shah (2014) conducted a systematic review of heparin-bonded and central venous catheter patency in children. Two studies were included in the review. Results found no difference in catheter-related thrombosis with the use of heparin-bonded catheters compared to non-heparin-bonded catheters.  
2. Historical evidence: Additional historical studies investigating heparin-bonded catheters and flushing protocols for prevention of catheter-related thrombosis have found conflicting results (see Historical References).  

VIII. Infection and infection control  
What is the best evidence regarding effective prophylaxis for the prevention of catheter-related infections?  

A. The presence of bacterial biofilms or deposits on the surfaces of VAD catheters is of clinical importance. However, their presence has the potential to serve as a nidus (focus) for infection and bacteremia (Miglietta et al., 2015; Mirijello et al., 2015; Pérez-Granda, Guembe, Cruces, Barrio, & Bouza, 2016; Zhang, Gowdaman, Morrison, Runnegar, & Rickard, 2016; see also Historical References). Several recommendations exist to prevent catheter-related infections.  

B. Practice standard: Do not routinely replace peripheral IV catheters unless clinically indicated (Helm, Klausner, Klemperer, Flint, & Huang, 2015; Rickard et al., 2012; Webster, Osborne, Rickard, & New, 2015). Recent studies in various settings have shown no difference in rates of phlebitis, occlusion, infiltration, infection, or mortality when peripheral catheters are changed as clinically indicated versus every 72–96 hours (Paşalioğlu & Kaya, 2014).  

C. Practice standard: Do not routinely replace central venous catheters (O’Grady et al., 2011; Schiffer et al., 2013).  

D. Practice standard: For short-term, nontunneled VADs, use a catheter coated with chlorhexidine and silver sulfadiazine or minocycline and rifampin prior to insertion to decrease the risk of catheter-related infections, especially in high-risk bone marrow transplant recipients and patients with leukemia (Lai et al., 2013; O’Grady et al., 2011; Schiffer et al., 2013).  

E. Practice standard: Due to the increased risk for fungal infections and antimicrobial resistance, antimicrobial ointment should not be used at the insertion site (Schiffer et al., 2013).  

F. Practice standard: Use povidone-iodine antiseptic ointment or bacitracin/gramicidin/polymyxin-B ointment at the exit site of hemodialysis catheters after insertion and at the end of each dialysis session (O’Grady et al., 2011).  

G. Practice standard: Use a CHG-impregnated sponge dressing for all catheters, including specialty catheters in patients older than two months of age, unless sensitive to CHG (Karpanen et al., 2016; Kerwat et al., 2015; Safdar et al., 2014; Timsit et al., 2012; Ullman et al., 2015; Wibaux et al., 2015).  
1. Following CHG skin preparation, it is recommended to use a CHG-impregnated sponge dressing for any long-term infusion (defined as exceeding 4–6 hours) or if the port remains accessed for intermittent long-term infusions.  
2. Recent evidence  
   a) Research demonstrated benefit from the use of CHG-impregnated sponge dressings in preventing catheter colonization and bloodstream infection in patients with VADs. The authors recommended routine use in patients at high risk for catheter-related bloodstream infections in VADs or short-term arterial catheters (Safdar et al., 2014). Additional research suggested that the use of CHG-impregnated sponge dressings significantly reduced the rate of central venous and epidural catheter-related infections (Kerwat et al., 2015; Wibaux et al., 2015).  
   b) CHG antimicrobial dressing was compared to gauze and tape dressing in a sample of 85 patients with nontunneled CVADs (Pedrolo et al., 2014). No statistically significant differences were found in bloodstream infections, local reactions, and dressing adherence between the dressings.  
3. Historical evidence: Past reviews suggested utility in the use of CHG-impregnated dressings (see Historical References).  

H. Practice standard: Monitor all device exit sites visually or by palpation through an intact dressing on a regular basis, depending on the clinical situation of individual patients (O’Grady et al., 2011).  

I. Practice standard: Use maximum sterile barrier precautions for insertion of all access devices except peripheral venous catheters. Sterile gloves are not necessarily required for insertion of
Peripheral catheters if an aseptic no-touch technique is used (Institute for Healthcare Improvement, 2015; Schiffer et al., 2013).

J. **Practice standard:** Use clean or sterile gloves when changing the dressing on VADs (O’Grady et al., 2011).

1. **Historical evidence:** One retrospective descriptive study investigated infection rate in 62 patients. An aseptic technique was used for accessing and deaccessing implantable ports. Nonsterile gloves were worn. Results indicated only two of the six infections that occurred could be attributed to the aseptic nonsterile glove technique for accessing and deaccessing implantable ports (Camp–Sorrell, 2009).

2. The Wound, Ostomy and Continence Nurses Society (2011) and the Association for Professionals in Infection Control and Epidemiology updated their guidelines to reflect the most recent evidence regarding clean versus sterile dressing technique for chronic wounds. They concluded that no definitive evidence exists that sterile technique is superior to clean technique or that it improves outcomes. They also noted a lack of agreement among expert opinion as to what constitutes sterile versus nonsterile technique.

3. The National Institute for Health and Care Excellence guidelines (2012) state that aseptic technique must be used for all VAD catheter care and when accessing the system.

K. **Practice standard:** Maintain aseptic technique for the care of intravascular catheters (O’Grady et al., 2011).

L. **Practice standard:** Avoid the use of the femoral vein for VAD insertion (O’Grady et al., 2011; Schiffer et al., 2013).

M. **Practice recommendation:** Although evidence does not exist to support sterile maintenance procedures for specialty access devices (e.g., access to cerebrospinal fluid), expert opinion and sound nursing judgment supports the use of sterile technique when accessing or maintaining these devices, as life-threatening infection could occur.

N. No definitive recommendation can be made regarding a preferred vein for insertion of a tunneled VAD (O’Grady et al., 2011; Schiffer et al., 2013). Ge et al. (2012) found that subclavian and internal jugular central venous access routes had similar risks for catheter-related complications in long-term catheterization in patients with cancer. Additional results suggested that subclavian central venous access was preferable to femoral sites in short-term catheterization, and femoral and internal jugular central venous access had similar risks in short-term hemodialysis catheterization, except for higher risks of mechanical complications in internal jugular central venous access.

O. No definitive recommendation can be made regarding coating a catheter with platinum/silver, as studies have shown conflicting results; recommendation for or against the use of these catheters cannot be made (O’Grady et al., 2011).

P. No definitive recommendation can be made regarding the routine use of antibiotic lock techniques for the prevention of catheter-associated infections because of the potential of an increased risk of microbial antibiotic resistance (van de Wetering, van Woensel, & Lawrie, 2013).

Q. **Practice standard:** Consider the use of antibiotic lock therapy if patient is diagnosed with catheter-related infection or is at high risk of infection; however, the frequency, length of dwell time, and whether or not to discard or flush antibiotic dwell has not been determined. Sensitivities of the organism dictate antibiotic use (Cheshyre, Goff, Bowen, & Carapetis, 2015; Fernández–Hidalgo & Almirante, 2014; Justo & Bookstaver, 2014; Mirijello et al., 2015; Raad & Chaftari, 2014; van de Wetering et al., 2013; Zhang et al., 2016).

R. **Practice standard:** Use of a combined antibiotic and heparin flushing or locking solution may increase microbial antibiotic resistance; therefore, it should be reserved for patients at high risk or where baseline VAD infection rates are high (>15%) (CDC, 2016; Justo & Bookstaver, 2014; Raad & Chaftari, 2014; van de Wetering et al., 2013).

1. **Recent evidence**
   a) The value of using an antibiotic lock technique in the port reservoir to prevent catheter-related sepsis is controversial. After investigation of numerous compounds, patient population heterogeneity, and limitations in sample size or study design, a recommendation for or against use cannot be made (O’Grady et al., 2011; Schiffer et al., 2013; Schoot, van Dalen, van Ommen, & van de Wetering, 2013).
   b) A retrospective study was conducted to investigate the efficacy of 70% adjunctive ethanol-lock therapy in combination with systemic antimicrobial treatment for central line–associated bloodstream infections (CLABSIs) and cath-
eter salvage (Kubiak et al., 2014). Findings suggested a trend toward CVAD salvage with the addition of 70% ethanol-lock therapy. The authors concluded that ethanol-lock was a well-tolerated, potentially effective therapy that warranted further large, randomized controlled trials.

c) Flushing or locking long-term VADs with a combined antibiotic and heparin solution appears to reduce gram-positive catheter-related sepsis in people at risk for neutropenia from chemotherapy or bone marrow disease (van de Wetering et al., 2013).

2. Historical evidence: Past reviews suggested some utility in the prevention of VAD removal associated with catheter-related sepsis with the use of antibiotic lock technique (see Historical References).

S. Practice recommendation: Change needleless connector after each use, with catheter change, or more frequently if damaged or signs of blood or precipitate. Use strict aseptic technique at all times (Flynn et al., 2015; Martinez et al., 2015; Moureaux & Flynn, 2015; Sherertz, Karchmer, Palavecino, & Bischoff, 2011; Tabak, Jarvis, Sun, Crosby, & Johannes, 2014; Wright et al., 2013).

T. Practice recommendation: Consider the use of connectors with design features such as those with a visible fluid path to assess efficacy of flush technique and a solid, flat, and smooth access surface that easily is disinfected.

U. No definitive recommendation can be made to support time intervals for changing needleless connectors. Additional evidence-based research is needed. Studies support vigorous cleaning of needleless connectors but do not provide clear evidence for changing protocols or whether one type of connector is superior to another. Data support development of biofilm within connectors. The presence of blood in connectors contributes to biofilm foundation. Given that the standard of practice is to verify blood return prior to determining use, it follows that residual blood will remain within the connector, contributing to biofilm development and ultimately increasing risk for bloodstream infection (Martinez et al., 2015; Sherertz et al., 2011).

1. Recent evidence: Martinez et al. (2015) used a nonrandomized, prospective sample of neutropenic hematology patients with long-term tunneled Hickman®-type catheters to study the effect of a bundle of interventions to reduce bloodstream infections.

During a five-month period, a study group was compared to a control group from the previous six months prior to implementation of the bundle, which consisted of the use of a neutral pressure mechanical valve connector, more frequent changes of the connector (twice weekly and after each blood sample for a new fever episode), and a more efficient 2% CHG solution to clean the connectors. Researchers concluded that the bundle quickly resulted in a significant reduction in bloodstream infections and catheter-related bloodstream infection rates.

2. During a 21-month period, Sherertz et al. (2011) evaluated for the presence of pathogens from samples drawn from three different needleless connector designs. Researchers found pathogens in samples from the Clearlink® connectors to meet CDC criteria for bloodstream infections; however, these patients were asymptomatic. Researchers concluded that pathogens may reside in the needleless connectors alone, causing false positive results.

3. In a retrospective analysis of 150 patients with Hickman catheters, results implied that needleless connector care using an aseptic no-touch technique coupled with hand hygiene, when compared to sterile technique, was not associated with an increase in catheter-associated bloodstream infections. The authors cautioned that the sample size was small (Flynn et al., 2015).

4. A systematic review of 140 studies and 34 abstracts on needleless connector disinfection, hub disinfection, and measure of education and compliance in use of strict aseptic technique concluded that the greatest risk for contamination for the catheter after insertion is the needleless connector. Disinfection compliance was found to be generally as low as 10%. Researchers cautioned that the optimal timing and tech-
nique for connector maintenance is not yet identified; vigorous scrubbing and use of passive alcohol disinfection caps positively affect catheter infection rates. Researchers stressed the importance of strict aseptic compliance (Moureau & Flynn, 2015).

5. Sandora et al. (2014) evaluated the association between needleless connector change frequency and CLABSI rates using an in vitro experimental model of pediatric stem cell transplant connector use. Three data collection periods included a baseline sampling, during which the connector was changed every 96 hours regardless of the infusate to which it was exposed. The connector was changed every 24 hours with blood or lipid infusions. The third sampling mirrored the first study group. Researchers concluded that changing the connectors in a simulated pediatric population increased CLABSI rates but that national recommendations regarding connector change frequency require clarification.

6. Tabak et al. (2014) reviewed studies reporting CLABSI in patients using a newer design of a positive-displacement needleless connector compared to negative- or neutral-displacement needleless connector design. Four out of seven studies occurred in the intensive care setting. Results demonstrated that newer design, positive-displacement connectors (a connection with visible fluid path to assess efficacy of flush technique; a solid, flat, smooth access surface that is easily disinfected; an open fluid pathway that facilitates high flow and avoids hemolysis; a tight septum seal; and a single-part activation of the fluid path) was associated with lower CLABSI risk.

V. No definitive recommendation can be made regarding preferential use of one type of VAD over any other to decrease the risk of bloodstream infection. This risk is unknown, with no recently published evidence (Schiffer et al., 2013).

1. Historical evidence: One previous study found higher rates of bloodstream infections with short-term noncuffed CVADs and non-medication-coated CVADs compared to IV catheters and midline catheters, while short-term arterial catheters and PICCs had bloodstream infection rates similar to CVADs (Maki, Kluger, & Crnich, 2006).

2. Ports usually are inserted in patients with solid tumors receiving less aggressive regimens; therefore, the patients do not have as prolonged nadirs as those with hematologic cancers or those who are undergoing stem cell transplant. However, tunneled catheters, usually multilumen, are placed in patients with hematologic cancers who receive aggressive regimens that result in prolonged nadirs.

3. Further research is needed that includes the type of device, therapy, maintenance protocols, and diagnosis, comorbidities, age, and manual dexterity.

IX. Removal of VADs in the presence of bacteremia

What is the best evidence regarding VAD removal for infection?

A. No definitive recommendation can be made based on the available evidence. Deciding when to remove VADs in the presence of catheter-related bacteremia is controversial and dependent on individual patient status. Immunosuppressed and thrombocytopenic patients are placed at higher risk for infections and bleeding if the existing catheter is removed and a new one is placed.

B. Recent evidence

1. In a prospective observational study, Lorente et al. (2014) evaluated central venous management of suspected catheter-related infection and its influence on patient mortality. Findings showed no significant difference in mortality in patients with confirmed catheter-related bloodstream infections related to catheter removal at the moment of suspicion versus removal of the catheter at any later point. The authors concluded that immediate removal of CVADs with suspected infection may not be necessary in all patients.

2. Catheter removal may be considered when VAD-related septicemia is confirmed; tunnel infection exists; signs and symptoms of septicemia persist despite antibiotics; or the causative organism is fungi, bacilli, or pseudomonas (Schiffer et al., 2013; see also Historical References).

3. In 2008, the Centers for Medicare and Medicaid Services implemented a payment system, which stipulated that preventable conditions, including vascular catheter-associated infections, would not be reimbursed to Medicare- and Medicaid-certified hospitals unless conditions were present on admission. Measures to prevent catheter-related infections in hospitalized patients are critical. Medicare has not given guidelines regarding prevention of infections (Centers for Medicare and Medicaid Services, 2008).
C. No definitive recommendation can be made on when to insert a new VAD after removal of a VAD for infection.

X. Blood sampling from VADs

**What is the best evidence regarding obtaining blood cultures from VADs?**

A. **Practice standard:** When fever or suspicion of an infected VAD is present, obtain blood cultures from the CVAD and from another peripheral site (Schiffer et al., 2013).

B. **Practice standard:** Accessing and obtaining blood cultures from an implantable port with clinical signs of an infection is recommended before the initiation of antibiotic therapy (Schiffer et al., 2013).

C. No definitive recommendation can be made regarding the frequency of blood culture sampling, blood discard volumes, methods of collection, or use of discarded blood for culture samples.

1. No specific professional or regulatory recommendations exist regarding the frequency in obtaining, discarding, or reusing blood drawn from CVADs for culture.

2. Blood culture collections of 10–20 cc for adults and 1–3 cc for children for each blood culture set; drawing one set through the vascular device and one set from a separate venipuncture is supported (O'Grady et al., 2011; Septimus, 2015).

D. Recent evidence

1. A study of 62 pediatric patients with cancer with CVADs and blood culture orders had blood drawn aseptically, with the normally discarded first 5 ml of blood injected into the second specimen culture bottle. In all cases where both culture bottles from a single source were positive for pathogens, the normally discarded specimen contained the same pathogen as the usual care specimen. In four cases, the normally discarded specimen demonstrated earlier time to positivity compared to the usual care specimen, allowing for earlier identification and treatment (Winokur et al., 2014).

2. A study compared individual blood cultures taken from each catheter lumen versus a pooled blood culture bottle containing samples from all catheter lumens to diagnose catheter-related bloodstream infection. The study demonstrated that the sampling of multiple lumens from a central line and incubating them in the same culture bottle is as effective as individual culture bottles in the diagnosis of either colonization or of catheter-related bloodstream infection. The researchers concluded that sampling multiple lumens using one culture bottle is a better choice than sampling only one lumen when sending three different culture bottles (Herrera-Guerra, Garza-González, Martínez-Resendez, Llaca-Díaz, & Camacho-Ortiz, 2015).

**What is the best evidence regarding blood sampling techniques to use when drawing from VADs?**

E. **Practice standard:** Blood-sparing techniques should be considered as best practice when drawing blood samples (Berg, Ahee, & Berg, 2011; McEvoy & Shander, 2013; Parco, Visconti, & Vascotto, 2014; World Health Organization [WHO], 2010).

F. **Practice standard:** Organize work to minimize the number of accesses of a device; if possible, time blood sampling to coincide with other indications for accessing a device, such as the administration of another medication (e.g., antibiotic) (WHO, 2010).

**What is the best evidence regarding blood sampling from VADs for coagulation studies?**

G. No definitive recommendation can be made regarding coagulation test sampling technique and blood discard volume from heparinized VADs. Further research is needed in investigating blood sampling, amount of discard, type of blood specimen, and blood collection methods in different types of VADs.

H. Recent evidence

1. A 2015 systematic review of the literature concluded that the only reliable method for obtaining coagulation test results from CVADs is to flush then waste or discard prior to obtaining a sample; however, this has been studied only in PICCs. The review noted significant variability in sampling technique and in discard volume practices (Dalton, Aucoin, & Meyer, 2015).

2. Blood specimens drawn from PICCs using a 10 ml saline flush, followed by a 6 ml blood waste, then by blood collection for evaluation of partial thromboplastin time and prothrombin time/international normalized ratio (INR) were compared to specimens drawn from peripheral venipunctures. After specimens were collected from the PICCs, the lines were flushed with another 10 ml NS and 2 ml of heparinized saline. Although the sample size was small, high correlation was found between all of the values obtained from both types of samples, except for the INR samples (Humphries, Baldwin, Clark, Tenuta, & Brumley, 2012). These findings
support earlier findings, although CVAD type was not specified in the study (see Historical References).

3. In a prospective comparison study, coagulation tests consisting of prothrombin time, activated partial thromboplastin time, and INR were obtained from a peripheral venipuncture and a VAD after discarding 6 ml, 9 ml, and 12 ml of blood (Zu-Kei Lin, Fowler, Dise, & Bustami, 2009). Results indicated a high correlation between peripheral venipuncture and all VAD blood samples. No differences were found between the three VAD samples, indicating that 6 ml was an adequate discard volume.

I. Historical evidence
1. Past research has reported mixed conclusions. INR specimens from heparinized CVADs and activated partial thromboplastin time specimens obtained from PICCs have shown no significant difference compared to samples obtained from peripheral venipuncture (see Historical References); however, past research found that coagulation testing from heparinized tunneled VADs was significantly different compared to peripheral samples.
2. One study found similar laboratory results with the push–pull method and the discard method of obtaining blood samples from CVADs; however, previous research suggested not reinfusing the discard blood collection because of the presence of clots and because the push–pull method can increase the risk of hemolysis with the agitation of blood (see Historical References).

XI. Power injection of contrast media
A. Practice standard: Power-injectable VADs are safe when used by skilled personnel using appropriate administration technique.
B. Power-injectable VADs have become increasingly popular to use in oncology clinical practice.

C. Recent evidence
1. Studies investigating the safety and efficacy of power-injectable VADs are limited.
2. In a small retrospective study, implantable venous power ports placed in the femoral vein were evaluated for indication, technical success, and complications (Goltz, Jansen, Petritsch, & Kickuth, 2014). Findings suggested that femoral placement is safe and that ports perform with high technical success when used.
3. The benefit of power-injectable ports was evaluated for safety, use for contrast media injections, and tip location (Teichgräber, Nagel, Kausche, & Enzweiler, 2012). Results indicated that the power-injectable port complication rate was similar to standard port systems.

D. Historical evidence: Past studies have focused on different catheter types and sizes and the power injection of contrast media (see Historical References).
E. Although studies evaluating power ports, tunneled catheters, or PICCs and the use of power injections are limited, numerous radiographic suites will use only VADs specifically designed for power injection of contrast material.

XII. Controversial issues related to nursing practice
A. Suturing of PICCs by RNs
1. No definitive recommendation can be made based on the available evidence.
2. Suturing of PICCs by RNs is defined by each state board of nursing’s scope of practice. Several states permit trained RNs to stabilize a PICC with sutures. No research has been conducted investigating RN suturing of PICCs. Opinions on training requirements for insertion of PICCs vary from state to state and from institution to institution, and a lack of uniformity exists regarding certification criteria for inserting these catheters. Training received in one state is not necessarily transferable to another. Further research is needed to investigate the RN scope of practice in suturing PICCs.
3. As universal IV securement devices are used more frequently, suturing PICCs for stabilization is becoming less common.

B. Removal of tunneled catheters by RNs
1. No definitive recommendation can be made based on the available evidence.
2. Several, but not all, state boards of nursing allow trained RNs to remove tunneled catheters.
References


Historical References


infection among patients with a needleless, mechanical valve–based intravenous connector in an Australian hematology-oncology unit. *Journal of Infusion Nursing*, 21, 301–305.


Laura, R., Degl’Innocenti, M., Moccali, M., Alberani, F., Boschi, S., Giraudo, A., ... Peron, G. (2000). Comparison of two different time interval protocols for central venous catheter dressing in bone
marrow transplant patients: Results of a randomized, multicenter study. The Italian Nurse Bone Marrow Transplant Group (GITMO).


stream infections in pediatric hematology-oncology patients without catheter removal. *Clinical Infectious Diseases, 29*, 102–105. doi:10.1086/520135


I. History (Dychter, Gold, Carson, & Haller, 2012)
   A. The use of cannulas or catheters to deliver IV therapies has origins in the 17th century, when a quill and pig’s bladder were first used by Christopher Wren to instill a mixture of ale, opium, liver, and wine into a dog’s vein. This method later was replaced by metal needles and plastic tubing, which were reused following cleaning and sterilization.
   B. Through extensive advances in technology, the plastic peripheral intravenous (PIV) catheter was introduced in 1950 by Dr. Davis Massa, an anesthesia resident who took a 16-gauge needle, shortened it, and inserted another steel needle within to act as an inner stylet. A polyvinyl chloride catheter was fitted over the top, and the tip of the catheter hardened, which then was shrunk to fit the needle. This “Rochester plastic needle” could be threaded directly into a blood vessel following venipuncture, revolutionizing IV therapy (Rivera, Strauss, van Zundert, & Mortier, 2005).
   C. Up to 70% of hospital inpatients require a PIV at some point during their admission (Bernat chez, 2014).

II. Device characteristics
   A. A PIV catheter is a small, hollow catheter inserted into a peripheral vein and used for the delivery of IV therapy (McCallum & Higgins, 2012).
   B. PIVs are used for short durations (Chopra et al., 2015; O’Grady et al., 2011). In children, PIVs can be inserted into the scalp (neonates) and foot (toddlers).
   C. Three main types of PIV administration exist: IV push, intermittent infusion, and continuous infusion.

III. Device features (Helm, Klausner, Klemperer, Flint, & Huang, 2015)
   A. Catheters are further defined by their gauge and length.

1. Gauges range from 14–28 with single-lumen designs.
2. Lengths range from ½–2 inches.

B. Catheter material is made of polymers, including polyurethane and polyvinyl chloride. Latex-free catheters are available (see Appendix 3).
   1. Teflon® (DuPont): Stiff material that can damage the vein intima (inner lining) during insertion. It is associated with fewer infectious complications than catheters made of polyvinyl chloride (O’Grady et al., 2011).
   2. Polyurethane: Firm, not stiff, material that softens and becomes more pliable in the vein in response to the body’s core temperature
      a) Provides exceptional tensile (physical) strength and flexible endurance, which permits the catheter to be constructed with a thinner wall and greater internal diameter for high flow rates
      b) Associated with less trauma for easier percutaneous insertion and decreased risk of phlebitis and other infectious complications

C. Specific peripheral infusion devices
   1. Steel-tipped, winged infusion (butterfly) needles
   2. Over-the-needle: Catheter sheath externally located over the needle stylet

D. Safety devices are available for PIVs to reduce the potential for needlesticks, exposure to blood-borne pathogens, and catheter-related complications, and also to comply with regulatory guidelines.
   1. Needle encapsulation/protection: Shielded butterfly needles, stylet protective devices, and needleless IV access systems
   2. Closed IV catheter systems: Integrate catheter, extension set, and securement device. The use of closed IV catheter systems has shown increased dwell times with lower
rates of phlebitis and infiltration (González-López et al., 2014).
3. Passive safety catheters: A protective shield that automatically covers the needle point during its withdrawal from the catheter top without any physical intervention by the nurse. This design differs from active safety devices, which require pressing a button to trigger the withdrawal of the needle into a plastic sleeve using a spring. Use of passive safety catheters for PIV catheter insertion has been shown to reduce the number of needle-stick injuries in the hospital setting (Hoffmann, Buchholz, & Schnitzler, 2013) (see Figure 2-1).

E. Available in radiopaque design

IV. Device advantages and disadvantages (see Figure 2-2)

V. Patient selection criteria (Dychter et al., 2012; Polovich, Olsen, & LeFebvre, 2014)

A. A patient's age, in general, does not restrict the use of PIVs.

B. Indications for PIVs
   1. Short duration for nonirritating infusions and for fewer than seven days
   2. Best used for simple, onetime-use IV therapies such as IV push administration of a vesicant or nonvesicant chemotherapy. Sclerosing of veins can occur over time.
   3. Infusions such as antimicrobials, analgesics, blood components, fluid and electrolyte replacement, nonvesicant chemotherapy, and drugs that cannot be given orally because the molecules are too large to be absorbed or are destroyed by digestion
   4. Patients with a short life expectancy

C. Contraindicated for continuous vesicant therapy or solutions with a pH less than 5 or greater than 9, glucose greater than 10%, protein greater than 5%, or osmolality greater than 900 mOsm/L (Boullata et al., 2014; Chopra et al., 2015; Cotogni & Pittiruti, 2014)

D. No definitive recommendation can be made regarding blood specimen collection from PIVs. A meta-analysis demonstrated a significantly higher risk of hemolysis of blood samples drawn via PIVs (Danielis, 2014).

VI. Insertion techniques (Boyd, Aggarwal, Davey, Logan, & Nathwani, 2011; Helm et al., 2015; Infusion Nurses Society [INS], 2016; Institute for Healthcare Improvement, 2015; O’Grady et al., 2011; Polovich et al., 2014; Sabri, Szalas, Holmes, Labib, & Musшиванд, 2013)

A. Implement care bundles similar to those used with central venous access devices (VADs) to reduce risk of infection (see Appendices 3, 4, and 5).

B. Perform patient assessment and preparation before insertion procedure.

Figure 2-2. Advantages and Disadvantages of Peripheral Intravenous Catheters

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• May be inserted by an RN</td>
<td>• Have a shorter life span than other types of venous access devices</td>
</tr>
<tr>
<td>• Can be easy to insert and maintain</td>
<td>• May involve discomfort with insertion</td>
</tr>
<tr>
<td>• Provide quick, simple access to vascular system</td>
<td>• Can be difficult to insert and maintain in young children, older adults, and those with fragile or sclerotic veins</td>
</tr>
<tr>
<td>• May be used in all patient care settings</td>
<td>• Can be cumbersome and restrictive, especially when inserted near a joint or in a dominant limb</td>
</tr>
<tr>
<td>• Involve minimal insertion costs compared to other venous access procedures</td>
<td>• Require daily care and maintenance</td>
</tr>
<tr>
<td>• Rarely associated with catheter-related bloodstream infections</td>
<td>• Can lead to peripheral vessels quickly becoming irritated from infusions of blood components, concentrated dextrose solutions, chemotherapy, and parenteral medications, including antimicrobial agents and electrolyte infusions</td>
</tr>
<tr>
<td></td>
<td>• Less desirable access for infusions of vesicant agents (e.g., certain chemotherapy, calcium gluconate), electrolytes, and vasoconstrictors</td>
</tr>
<tr>
<td></td>
<td>• Could be more costly if used long term and with repeated access, especially in the home environment</td>
</tr>
<tr>
<td></td>
<td>• Can lead to exhaustion of all suitable peripheral veins because of frequent site changes</td>
</tr>
</tbody>
</table>
1. Consider any special needs regarding age, physical condition, or type of fluid being infused. Explain the insertion procedure to the patient, and answer any questions the patient and caregiver may have.

2. Older adult patients have fragile veins and less subcutaneous (SC) support tissue because of fragile skin.

3. Use minimal tourniquet pressure over clothing or no tourniquet with older adults; venous distention may take longer because of slower venous return.

4. Children's veins are smaller in diameter and may be covered by a layer of SC fat, which can make veins difficult to access.

5. Access sites for infants and toddlers include scalp and feet. Access in older children usually is achieved through hands or arms. Use of the antecubital fossa in the pediatric population is highly correlated with device failure (Malyon et al., 2014).

6. Studies have shown that it may be reasonable to use a lower extremity vein in older adults with poor venous access in the upper extremity. Incidence of phlebitis was 6% in the upper extremity compared to 9.4% in the lower extremity (Benaya, Schwartz, Kory, Yinnon, & Ben-Chetrit, 2015).

C. Implement interventions to reduce the pain of IV insertion, especially if interventions increase the chance of success (Burke, Vercler, Bye, Desmond, & Rees, 2011; Fink et al., 2009; Kiger et al., 2014) (see Appendices 6 and 7).

D. Vein selection (see Figures 2-3 and 2-4)

1. Select vein based on type of fluid to be infused and the rate and duration of infusion. Ideally, it should not interfere with the patient’s comfort or mobility.

2. Preferred sites (Dychter et al., 2012; Helm et al., 2015; O’Grady et al., 2011)
   a) Upper extremity veins in adults include superficial dorsal and metacarpal veins on the dorsum of the hand and cephalic, basilic, and median veins on the upper arm.
   b) Upper or lower extremities in pediatric patients: The scalp can be used in neonates or young infants.
   c) Select the most distal site possible but proximal to previous venipuncture.

3. Sites to avoid (Benaya et al., 2015; Helm et al., 2015; McCallum & Higgins, 2012; O’Grady et al., 2011)
   a) Avoid extremities or sites with impaired circulation or injury.

   (1) Lymphedema or axillary lymph node dissection
   (2) Postoperative swelling
   (3) Recent trauma or hematoma
   (4) Local infection, phlebitis, or open wounds
   (5) Decreased sensation or paresthesia

   b) Avoid extremities where venipuncture has been performed within the past 24 hours, if possible.
   c) Prior to selecting a lower extremity vein, consult with the provider regarding VAD placement or other alternatives. Lower extremities are associated with a higher risk of thrombophlebitis. Obtain an order to use a lower extremity vein and replace as soon as possible.
   d) Avoid antecubital veins because of the difficulty in detecting infiltration and location in an area of flexion. In an
emergency situation, the use of these veins may be appropriate.  
e) Avoid placing the cannula over a joint, such as the wrist or elbow, as joint movement may produce mechanical phlebitis and increase the risk of catheter kinking.  
f) If possible, avoid venipuncture or IV insertion on the ipsilateral extremity of a mastectomy site (Fu, Deng, & Armer, 2014).  

E. Device selection (Dychter et al., 2012; Hadaway, 2012; Helm et al., 2015; O’Grady et al., 2011)  
1. Use the smallest gauge device and shortest length that will successfully deliver the prescribed therapy at the desired rate.  
2. Select catheter based on intended purpose, expected length of therapy, viscosity of fluid, fluid components, presence of infection, condition of vein, and experience of the individual inserting the device.  
3. Avoid the use of steel needles for administration of fluids and medications that may cause tissue necrosis if extravasation occurs; limit the use of steel needles to short-term or single-dose administration or onetime infusion and IV push.  
4. A short length and small gauge is less traumatizing, reduces irritation, and permits better blood flow; 24 gauge can infuse up to 250 ml of fluid per hour. Considerations for gauge selection include  
a) 16–18 gauge for major surgery  
b) 18–20 gauge for rapid infusion of IV fluids, blood components, or viscous medications  
c) 20 gauge for most IV applications and for blood products  
d) 22–24 gauge with ¼-inch catheter for older adult and pediatric patients  
5. Adequate gauge and length of needle decreases the risk of chemical phlebitis (irritation of the vein wall by medications) by providing good blood flow through the cannula, dispersing the medication into the bloodstream (Washington & Barrett, 2012).  
6. Special consideration: Obese patients with deep veins in the SC tissue may need slightly longer PIV catheters; consider use of alternative VADs.  

F. Procedure  
1. Wash hands: Good hand hygiene and standard precautions are used for PIV insertion and maintenance; a new pair of disposable, nonsterile gloves is used in conjunction with an aseptic no-touch technique (ANTT) for PIV insertion.  
a) ANTT: The planned insertion site is not palpated after skin cleansing unless
sterile gloves were worn during cleansing. No definitive recommendations can be made regarding sterile versus nonsterile gloves (see Chapter 1).

b) ANTT is used to prevent microorganisms from hands, surfaces, and equipment from being introduced to the insertion site.

2. Organize equipment (see Appendix 6 for PIV clinical practicum).
   a) Prepare IV fluid, attach administration set, and prime if PIV is to be connected to continuous fluids.
   b) If administering medication for PIV push, prepare IV medication and connect short extension tubing, if needed.
   c) If using PIV as a saline lock, prepare needleless connector and 0.9% normal saline (NS) flush.

3. Examine veins on both extremities by visual inspection and palpation, keeping in mind the purpose of IV therapy and any physical limitations of the patient (e.g., stroke limiting mobility on one side, axillary node dissection). Assess distal veins, and then move proximally.
   a) Technology such as guidance with near-infrared light can assist in the location and insertion of PIVs and has been shown to facilitate first-attempt success rates with an associated decrease in patient perception of pain; however, this requires specialized training and equipment (Hadayaw, 2012; Helm et al., 2015; Ismailoglu, Zaybak, Akarca, & Kiyan, 2015; Maiocco & Coole, 2012; Sabri et al., 2013).
   b) Feasibility testing of near-infrared spectroscopy using standard mobile device prototypes demonstrates superiority of vein visualization over simple visual inspection and palpation (Juric & Zalik, 2014).
   c) Meta-analyses support use of ultrasound guidance for difficult peripheral access and in patients who have failed venous cannulation by standard methods; however, they do not strongly support use for routine PIV placement (Egan et al., 2013; Liu, Alsawwi, & Bjornsson, 2014).

4. Rewash hands and apply gloves.

5. Select appropriate IV needle or catheter. Administer local anesthetic, as needed (see Appendix 7).

6. Place tourniquet 5–6 inches above insertion site. Tourniquet should obstruct venous but not arterial flow. Check presence of distal pulse, and, if not felt, loosen tourniquet.
   a) Select site: To assist in vein location, tap the vein, apply local warming, or have the patient place arm in dependent position (Helm et al., 2015; Kiger et al., 2014; Sabri et al., 2013; Washington & Barrett, 2012).
   b) Remove tourniquet for the patient’s comfort.
   c) If a large amount of body hair is present at insertion site, clip the area. Avoid shaving, which can increase irritation and risk of infection.

7. Cleanse site and allow to air-dry before inserting catheter (see Appendix 2). Chlorhexidine gluconate is recommended for skin cleansing prior to insertion. If the patient has a known allergy to chlorhexidine, 70% alcohol or povidone-iodine can be used. Once skin is cleaned, do not palpate planned IV insertion site.

8. Reapply tourniquet.

9. Perform venipuncture: Insert needle at a 15°–30° angle with bevel up distal to actual site of venipuncture.

10. Observe blood return through tubing of butterfly needle or catheter, indicating successful venous access. A butterfly needle may be taped in place at this time or threaded into the vein. Thread the catheter in its entirety into the vein and simultaneously remove the stylet. Occlude tip of the catheter by pressing fingers of nondominant hand over vein to prevent retrograde bleeding.

11. Release tourniquet, then attach the catheter to the infusion set or syringe.

12. Flush the catheter with NS while holding the catheter or needle in place to remove retrograde blood. Watch the insertion site during initial flush to assess integrity of the
vein. Edema or pain and discomfort at site indicates an infiltration or ruptured vein. If this occurs, remove the device and restart in another location.

a) If a second attempt is required, use the other extremity or select a site proximal to the previous venipuncture.

b) When administering a vesicant chemotherapy agent, select a site proximal to the previous venipuncture or select a vein on the opposite extremity, if possible.

c) To avoid unnecessary trauma to the patient, no more than two attempts at cannulation per nurse per patient should be performed. If unsuccessful after two nurses attempt, contact the provider to discuss alternative access device options.

13. Secure catheter or needle with a securement device, then apply occlusive dressing over insertion site. Do not put tape directly over insertion site.

a) Catheter securement devices help to reduce dislodgment episodes and infection risk and increase dwell times of PIVs (Bausone-Gazda, Lafaiver, & Walters, 2010; Helm et al., 2015).

b) For extremely short dwell times (e.g., less than 30 minutes, during a procedure), clean Micropore™ tape and gauze may be used; do not tape over the insertion site.

14. Discard used supplies; remove gloves.

15. Wash hands.

16. Label dressing with time, date of dressing change, and initials.

17. Document the number of attempts, location, type and gauge of catheter, dressing type, securement device, and the patient’s response to the procedure.

VII. Unique maintenance and care: No definitive recommendations can be made regarding frequency of dressing changes or blood sampling techniques (Hadaway, 2012; Helm et al., 2015; INS, 2016; O’Grady et al., 2011; Stauss et al., 2012; Washington & Barrett, 2012) (see Appendices 2, 4, 5, 6, and 7).

A. Inspect catheter insertion site and palpate for tenderness daily through the intact dressing. Do not remove opaque (including gauze) dressings in the absence of clinical signs of infection. If signs of potential infection are present, remove opaque dressings and inspect site visually. Minimize manipulation of the catheter to prevent mechanical phlebitis.

B. When adherence to aseptic technique cannot be ensured, replace all PIVs inserted under emergency conditions as soon as possible.

C. Routine replacement of catheters (Abolfotouh, Salam, Bani-Mustafa, White, & Balkhy, 2014; Dychter et al., 2012; Ho & Cheung, 2012)

1. Studies from a variety of settings support the practice of changing PIVs only as clinically indicated. Studies show no difference in rates of phlebitis, occlusion, infiltration, infection, or mortality when PIVs are changed as clinically indicated versus every 72–96 hours (Helm et al., 2015; Paslioglu & Kaya, 2014; Rickard et al., 2012; Webster, Osborne, Rickard, & New, 2015). This practice already is the standard of care in children (O’Grady et al., 2011).

2. Insert a new PIV when administering a vesicant, especially if more than 24 hours old (Polovich et al., 2014).

D. Dressing changes: Change dressing if wet, soiled, or nonocclusive. Dressing changes require ANTT.

E. Flushing: Use NS 1–3 ml every 8, 12, or 24 hours when the device is not in use to maintain patency in adults and in children aged one year or older (American Society of Health-System Pharmacists, 2012; Wang, Luo, He, Li, & Zhang, 2012).

F. Ensure all devices added onto catheter are Luer lock, including needleless connectors, stopcocks, short extensions, filters, and multisite connectors.

1. Needleless connectors allow for IV administration without use of a needle, thereby reducing the risk of needlestick. These devices also ensure that the IV system remains closed and can be left in place until the catheter is changed (if not contaminated or damaged).

2. Change administration sets when the PIV is replaced or when no longer intact.

3. Label all IVs and equipment with date, time, and initials.

G. Blood specimens: No definitive recommendation can be made regarding specific volume of blood discard or flush. Prior to policy development, the dead space volume of products used must be known (Danielis, 2014; Stauss et al., 2012).

1. In general, within certain limitations of infusates, PIVs flushed with NS are simple and safe for collecting blood samples for most laboratory tests (Baker et al., 2013; Orteils-Abuye, Busquets-Puigdevall, Díaz-Bergara, Paguina-Marcos, & Sánchez-Pérez, 2014).
2. Specimens collected from PIVs have an increased risk for hemolysis (Danielis, 2014; Lippi, Cervellin, & Mattiuzzi, 2013).

3. Discard 1 ml of waste to promote accurate laboratory testing results (Baker et al., 2013).

4. No definitive recommendation can be made on blood sampling from PIVs; more research is needed. Weighing the benefits and risks of safety, costs, and comfort may aid decision making (Danielis, 2014).

H. Administration types (Dychter et al., 2012)

1. IV push: Following flushing procedure, cleanse needleless connector, allow to air-dry, attach syringe containing medication, infuse over a short period of time (usually three to five minutes), and flush with 1–3 ml of NS following infusion.

2. Intermittent infusions: Used for drugs that require dilution or slow administration. Following flushing procedure, cleanse needleless connector, allow to air-dry, attach administration set of infusion to be administered, infuse over specified time, and flush with 1–3 ml of NS following completion of infusion.

3. Continuous infusion: Most common method of administering IV fluids and peripheral total parenteral nutrition. Follow flushing procedure, cleanse hub of catheter, allow to air-dry, attach administration set of infusion to be administered, and infuse at specified rate.

VIII. Removal technique (Hadaway, 2012; Helm et al., 2015; INS, 2016; O’Grady et al., 2011)

A. Indications: Remove catheter when signs and symptoms of infection, infiltration, or phlebitis are present, or when no longer required for therapy.

B. Procedure

1. Verify order and indication for removal.
2. Explain procedure to the patient.
3. Place the patient in chair or bed to stabilize extremity.
4. Inspect the general condition of the catheter pathway.
5. Discontinue all infusions into the device.
6. Apply gloves; remove dressing and observe site for edema, erythema, or discharge.
7. Change gloves; grasp device by the hub and, while stabilizing the skin and vein with sterile gauze in the nondominant hand, slowly and steadily pull out at the same angle of insertion.
8. If removal is due to infection, send catheter tip for culture, if ordered.

9. Apply constant, firm pressure to exit site until bleeding stops (longer in patients with coagulopathies, thrombocytopenia, or on anticoagulants).
10. Apply dressing or adhesive bandage; monitor as necessary.
11. Instruct the patient or caregiver to report any discomfort or signs of bleeding, bruising, redness, swelling, or drainage.
12. Inspect the device for defects: Report any defects to the manufacturer and regulatory agencies. Examine distal tip for signs of jagged, uneven edges suggestive of breakage.

IX. Complications (Abolfotouh et al., 2014; Dychter et al., 2012; Hadaway, 2012; O’Grady et al., 2011; Polovich et al., 2014; Sabri et al., 2013; Vallecocca et al., 2015; Washington & Barrett, 2012)

A. Insertion complications include bleeding, vein injury, nerve injury, infiltration, phlebitis, and thrombosis.

B. Vein injury from catheters can result in pain, tenderness, edema, erythema (vasodilation), thrombosis, sclerosis, and infiltration.

C. Phlebitis: most common complication, resulting in inflammation of the vein

1. Etiology: Insufficient vessel size to accommodate the catheter to allow hemodilution, traumatic insertion, or mechanical or chemical irritation

2. Risk factors
   a) Prolonged dwell time
   b) Mechanical irritation: Movement of the catheter, multiple IV attempts, catheter too large for vein, location of the catheter (hand, antecubital fossa, and wrist areas), or catheter material
   c) Chemical irritation: Tonicity of infusate, number and dosage of medications, pH of medication, or skin not allowed to fully dry after cleansing prior to insertion (Cotogni & Pittiruti, 2014)
   d) Increases with age of device or advanced age of the patient

4. Signs and symptoms: Pain, erythema, streak formation, palpable cord, and edema
   a) Older adult patients may not experience pain from phlebitis or infiltration because of a decrease in sensory perception; monitoring for complications through observation is important.
b) Children, older adults, or those with communication limitations may not be able to voice pain.

5. Diagnostic tests: Not indicated
6. Management: Remove device, apply heat, and give analgesic, as needed.

D. Infiltration: Second most common complication (Dychter et al., 2012; Helm et al., 2015; Sabri et al., 2013)

1. Etiology: Mechanical (e.g., injury during insertion, catheter malposition following insertion) or physiologic (e.g., preexisting or developing vein problems such as sclerosis). Because of penetration of the catheter into or through the venous wall, infiltration leads to infusion of fluids or medications into the surrounding soft tissue.

2. Risk factors: Placement in joint regions (e.g., wrist, antecubital fossa), inadequate catheter securement, traumatic injury to vessel wall on insertion, older or younger age, dehydration, and obesity

3. Prevention: Assess for infiltration. Occlude the vessel at the tip of the catheter with digital pressure. If the infusion continues, the fluid is probably infiltrating.
   a) Use of appropriately sized syringes to prevent vein rupture
   b) The larger the syringe, the less pressure is generated when force is applied and the more force is required to create a vacuum. Less force is generated in either infusion or aspiration with larger syringes, thereby reducing or preventing complications.
   c) Do not use a 1 ml syringe with PIVs. Use at least a 3 ml syringe or larger for all flushing and administration of medications.

4. Signs and symptoms: Leaking fluid around insertion site; cool, pale skin; possible decreased infusion rate; edema at insertion site; tenderness; and skin tightness or discomfort

5. Diagnostic tests: Not indicated
6. Management: Remove device, apply heat or cold (depending on the agent infiltrated), elevate extremity, and give analgesic, as needed.

E. Infection

1. Etiology: Microorganisms enter through a PIV by the external catheter upon insertion, the interior of the catheter, the contamination of connectors, the palpation of a proposed puncture site prior to insertion, excessive catheter manipulation, or by contaminated infusion.
   a) PIVs historically have been rarely associated with bloodstream infections. The reported rate of colonized peripheral catheters at the time of removal is 5%–25% (Abolfotouh et al., 2014; Dychter et al., 2012; Hadaway, 2012; Helm et al., 2015).
   b) Emerging data suggest that the rate of catheter-related bloodstream infections from peripheral catheters may be higher than once thought (Trinh et al., 2011); more research is needed to fully evaluate.
   c) The most common organism is Staphylococcus aureus.

2. Risk factors: Inadequate cleansing technique, poor skills of the nurse, an immunocompromised patient, older or younger age, comorbidities (e.g., diabetes, cancer, heart disease), or a malnourished patient


4. Signs and symptoms: Depend on type of infection
   a) Local: Erythema, purulent drainage, warmth, induration, or palpable cord
   b) Phlebitis: Pain, erythema, streak formation, palpable cord, or edema
   c) Bloodstream: Pain, erythema, streak formation, palpable cord, edema, or fever

5. Diagnostic tests: Wound and blood cultures, as ordered
6. Management: Remove device, apply heat, and administer antibiotics systemically per culture result.

F. Extravasation: The leaking or escape of infusate from the vessel into the surrounding tissue (Coyle, Griffie, & Czaplewski, 2014; Dychter
1. Etiology: Peripheral vein wall puncture, administration of a vesicant in a vein below a recent venipuncture, or an inadequately secured IV catheter causes leaking of vesicant agent into the surrounding tissue. Damage is dependent on specific factors:
   a) Mechanism of action and properties of drug
   b) Amount of drug extravasated

2. Risk factors: Inadequate IV insertion technique, small fragile veins, history of multiple venipunctures, limited extremity vein selection, decreased sensation or circulatory impairments, patient with altered mental status

3. Prevention
   a) Use aseptic technique when accessing peripheral vein.
   b) Avoid multiple attempts in establishing access.
   c) Avoid areas of impairment, previous IV sites, and inserting above previous venipuncture sites.
   d) Use transparent dressing over IV to visualize the site throughout vesicant administration.
   e) Verify blood return prior to, during, and after administration. Do not give vesicant through PIV without a blood return.
   f) Instruct the patient to promptly report symptoms of extravasation.

4. Signs and symptoms: Burning/stinging at site; pain; erythema; difficulty infusing solution; leaking around the insertion site; absence of blood return during or following infusion, followed by blistering, tissue necrosis, and ulceration; decreased IV flow

5. Diagnostic tests: Not indicated

6. Management
   a) Stop infusion and aspirate residual drug from the catheter using a 3 ml syringe.
   b) Assess the site and estimate amount of vesicant extravasated.
   c) Administer antidote through IV catheter, as indicated; remove peripheral catheter.
   d) Apply cold or heat, as indicated.
   e) Determine the cause of extravasation, notify the provider, measure and photograph the site, document actions, and provide patient education and follow-up.

References


Based on information from Hadaway et al., 2013; Harpel, 2013; O’Grady et al., 2011; Sabri et al., 2013.


puncture and peripheral venous catheter. *BMJ Open, 4, e004250.*
doi:10.1136/bmjopen-2013-004250
Pasalioglu, K.B., & Kaya, H. (2014). Catheter indwell time and phlebitis
development during peripheral intravenous catheter administration.
*Pakistan Journal of Medical Sciences, 30,* 725–730. doi:10.12669/ pjmns.304.5067
Rickard, C.M., Webster, J., Wallis, M.C., Marsh, N., McGrail, M.R.,
Stauss, M., Sherman, B., Pugh, L., Parone, D., Loopy-Rodriguez, K.,
Trinh, T.T., Chan, P.A., Edwards, O., Hollenbeck, B., Huang, B.,
Vallecoccia, M.S., De Pascale, G., Taraschi, C., De Angelis Durante, R.,
Wang, R., Luo, O., He, L., Li, J.-X., & Zhang, M.-G. (2012). Preservative-free 0.9% sodium chloride for flushing and locking peripheral intravenous access device: A prospective controlled trial. *Journal of Evidence-Based Medicine, 5,* 205–208. doi:10.1111/jebm.12004
Chapter 3

Midline Catheters

Diane G. Cope, PhD, ARNP-BC, AOCNP®

I. History (Dawson & Moureau, 2013)
   A. Midline catheters were first introduced in the 1950s for surgical patients and intended for subclavian access. In the 1980s, the split-away plastic introducer was developed to facilitate midline catheter placement.
   B. Extensive use of midline catheters has been controversial, with little evidence-based research supporting risks and benefits.
   C. Limited prospective research has recently supported midline catheters as a safe alternative to central devices, with complication rates comparable to those of other short- and long-term devices (Dumont, Getz, & Miller, 2014).

II. Device characteristics (Cotogni & Pittiruti, 2014; Dawson & Moureau, 2013; Giuliani et al., 2013) (see Figure 3-1)
   A. Short-term peripheral device: Research suggests replacing short-term central catheters, when feasible, with midline catheters to reduce the incidence of central line–associated bloodstream infections.
   B. A prospective randomized trial comparing short-term low pH vancomycin infusions through a novel midline device versus peripherally inserted central catheters (PICCs) demonstrated no significant difference in complications or safety; midline insertions proved more cost-effective compared to PICCs (Caparas & Hu, 2014).
   C. Considered a peripheral line because the tip is not located in the central circulation. The midline catheter tip terminates in the axillary vein in the upper arm (Bortolussi et al., 2015; Infusion Nurses Society [INS], 2013).

III. Device features (Cotogni & Pittiruti, 2014; Deutsch, Sathyanarayana, Singh, & Nicastro, 2014; Pathak et al., 2015; Scoppettuolo et al., 2016)
   A. Catheter material: Silicone, polyurethane, and available with latex-free design
   B. Available as radiopaque
   C. Available in single and double lumens with open- or closed-valve tip
   D. Range from 2 Fr (23 gauge) to 6 Fr (18 gauge)
   E. Range from 8–25 cm in length
   F. Prime volume of 0.5–1.5 ml
   G. Available in power-injectable design

IV. Device advantages and disadvantages (see Figure 3-2)

V. Patient selection criteria (Chopra et al., 2015; Cotogni & Pittiruti, 2014)
   A. Patients with limited peripheral veins for venous access
   B. Patients with need for venous access for a limited length of time (at least six weeks and potentially for months) (Scoppettuolo et al., 2016)
   C. Patients or caregivers who are willing and able to follow instructions to properly care for a midline device in the home setting

Figure 3-1. Midline Venous Catheter With Guidewire

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Figure 3-2. Advantages and Disadvantages of Midline Catheters

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Considered peripheral lines; chest x-ray not required for tip placement verification</td>
<td>• Cannot be used for continuous infusion of vesicants</td>
</tr>
<tr>
<td>• Can be placed at the bedside by a specially trained nurse</td>
<td>• May limit a patient’s overall mobility or comfort if necessary to insert into contralateral limb</td>
</tr>
<tr>
<td>• Ideal for those with limited peripheral access but who require prolonged IV therapy</td>
<td>(e.g., lymphedema, axillary dissection)</td>
</tr>
<tr>
<td>• Available in single and double lumens, radiopaque, and power-injectable versions</td>
<td>• May decrease ability to draw blood because of size and flexible nature</td>
</tr>
<tr>
<td>• Can be used for most IV solutions</td>
<td>• Contraindicated for continuous infusions of vesicants, infusates with pH &lt; 5 or &gt; 9, parenteral</td>
</tr>
<tr>
<td>• Possible reduction in central line–associated bloodstream infections when used to replace central</td>
<td>nutrition, infusates with glucose concentrations &gt; 10%, solutions with protein concentrations &gt; 5%,</td>
</tr>
<tr>
<td>catheters when feasible</td>
<td>or hyperosmolar solutions &gt; 900 mOsm/L</td>
</tr>
<tr>
<td>• Do not require routine replacement (only replaced as is indicated)</td>
<td>• Require a patient to have adequate peripheral veins</td>
</tr>
<tr>
<td>• Associated with lower rates of phlebitis than peripheral IVs and lower rates of infection than</td>
<td>• Require adequate patient support to maintain catheter in homecare setting</td>
</tr>
<tr>
<td>central venous access devices</td>
<td>• Not available as a triple lumen</td>
</tr>
<tr>
<td>• Can be removed at the bedside</td>
<td></td>
</tr>
<tr>
<td>• Relatively economical compared to more permanent lines</td>
<td></td>
</tr>
</tbody>
</table>

D. Patients receiving IV therapy that is appropriate for a midline catheter. Contraindications include the following (Boullata et al., 2014; Chopra et al., 2015; Cotogni & Pittiruti, 2014; INS, 2016):
1. Continuous infusion of vesicants
2. Infusates with pH less than 5 or greater than 9
3. Parenteral nutrition
4. Solutions with glucose concentration greater than 10%
5. Solutions with protein concentration greater than 5%
6. Solutions with osmolarity greater than 900 mOsm/L

E. Patient preference for this type of device over more permanent devices

F. Patients with limited life expectancy

G. For patients scheduled to receive IV therapy for more than a week, a plan should be followed to maximize comfort and preserve the integrity of the veins.

H. Contraindicated in an extremity affected by a mastectomy, lymph node dissection, or lymphedema. Contraindicated in patients with severe renal dysfunction who may require an arteriovenous fistula formation. Avoid use in patients with a history of thrombosis or hypercoagulability.

VI. Insertion techniques (Bortolussi et al., 2015; Scopettuolo et al., 2016)
A. Implement care bundles to reduce the chance of infection. Care bundles are a group of evidence-based interventions aimed at improving the processes of care and patient outcomes (Institute for Healthcare Improvement, n.d.) (see Appendices 3 and 4).
B. Before the insertion procedure, verify scope of practice with the individual state board of nursing and institutional guidelines.
C. Perform a patient assessment and preparation before the procedure.
1. Consider any special needs regarding age, physical condition, or type of fluid being infused. Explain the insertion procedure to the patient, and answer any questions the patient and significant others may have.
2. Older adult patients have fragile veins and less subcutaneous (SC) support tissue because of thinning of the skin.
3. Use minimal tourniquet pressure over clothing or no tourniquet with older adults. Venous distention may take longer because of slower venous return.
4. Children’s veins are smaller in diameter and may be covered by a layer of SC fat, which can make veins difficult to access.

D. Implement interventions to reduce the pain of IV insertion, especially if they increase the chance of success (see Appendix 7).
E. Vein selection: Insert in an antecubital vein, terminating in the upper arm or axilla (see Figure 2-4 in Chapter 2). Appropriate veins include
1. Basilic
2. Cephalic
3. Median cubital
F. Insertion procedure
1. Organize equipment and wash hands.
2. Examine veins on both extremities, taking into account the purpose of the IV therapy, the most comfortable exit site for the patient, and any physical issues the patient may have that may limit the use of one arm (INS, 2016).
3. Use local anesthetic, as ordered. Be aware that anesthetic may obscure the vein second- 
yary to vasoconstriction and vasospasm 
or may prevent the patient from sensing 
infusion (see Appendix 7).
4. Place the midline catheter per the man-
ufacturer’s guidelines; the nurse inserting 
should be skilled regarding the specifics of 
the individual product.
5. Can use ultrasound guidance at the bedside 
to facilitate effective placement (Bortolussi 
et al., 2015; Deutsch et al., 2014).
6. Anticipate the insertion site to be 1–1.5 
length above or below antecubital fossa. 
Extend the patient’s arm, and abduct the 
arm at a 45° angle.
7. Place a tourniquet 5–6 inches above the 
insertion site at the mid-upper arm area. 
The tourniquet should obstruct venous but 
not arterial flow. Check for the presence of 
a distal pulse. Remove the tourniquet for 
the patient’s comfort.
8. Clip the area if a large amount of body hair 
is present at insertion site. Avoid shaving, 
which can cause increased irritation and 
risk of infection.
9. Cleanse the site, and allow to air-dry without 
manipulation with sterile drapes for sterile field. 
Flush the catheter with 0.9% normal saline (NS) solution.
10. Stabilize the vein below the access site with 
nondominant hand. Perform venipunc-
ture by inserting the needle at a 15°–30° 
angle with bevel up distal to actual veni-
puncture site.
11. Observe blood return through tubing of the 
catheter, indicating the needle has entered 
the vein. Advance to the length of the nee-
dle, and remove the tourniquet.
12. Once venipuncture is complete, retract the 
needle into the needle safety tube on the 
 external end of the catheter. The tip of the 
catheter is advanced slowly for several inches 
to the desired initial length through the 
introducer. Remove the guidewire slowly 
while stabilizing the midline catheter at the 
insertion site. Remove the introducer, and 
break away or peel away from the catheter 
by pulling apart at the wings. Flush with 
NS to verify patency.
13. Secure catheter with securement device, 
and apply dressing over insertion site. 
X-ray verification of tip placement is not indicated.
14. Document insertion, including type of 
line used, length of catheter, and patient 
tolerance.
15. Change the dressing 24 hours after inser-
tion to assess for complications and then 
per protocol for transparent film or gauze 
dressing (see Appendices 2, 4, and 5).

VII. Unique maintenance and care (Boullata et al., 2014; 
Chopra et al., 2015; Cotogni & Pittiruti, 2014; 
O’Grady et al., 2011) (see Appendices 2, 4, 5, and 6): 
No definitive recommendations can be made regard-
ing flushing solution, volume, and frequency; fre-
quency of dressing and needleless connector changes; 
or blood sampling technique. 
A. Inspect the catheter insertion site and palpate for 
tenderness daily through the intact dressing. If 
signs of potential infection are present, remove 
dressing and inspect the site visually. Minimize 
manipulation of the catheter to prevent mecha-
nical phlebitis.
B. Replace midline catheters only when there is a 
specific indication (Abolfotouh, Salam, Bani-
Mustafa, White, & Balkhy, 2014; Dychter, 
Gold, Carson, & Haller, 2012; Ho & Cheung, 
2012). Midline catheters are associated with 
lower rates of phlebitis than peripheral IVs and 
lower rates of infection than central venous 
catheters (O’Grady et al., 2011).
C. Dressing changes: Change dressing if it becomes 
black; fit, or nonocclusive.
1. Dressing changes require an aseptic no-
touch technique.
2. Remove existing dressing and securement 
device while stabilizing midline catheter 
with nondominant hand.
D. Flushing: Flush catheter prior to use with 3 ml 
NS. Use NS 1–3 ml every 8, 12, or 24 hours when 
device is not in use to maintain patency in adults 
and children aged one year or older (American 
Society of Health-System Pharmacists, 2012; 
Wang, Luo, He, Li, & Zhang, 2012).
E. Blood specimens: No definitive recommendation 
can be made regarding specific volume of blood
discard or flush. Prior to policy development, the dead space volume of the products used must be known. Using midline catheters for blood specimens continues to be debated (Scoppettuolo et al., 2016; Stauss et al., 2012).

1. In general, within certain limitations of infusate, midlines flushed with NS are simple and safe for collecting blood samples for most laboratory tests (Baker et al., 2013; Ortells-Abuye et al., 2014).

2. Discard 1–3 ml or more of waste to promote accurate laboratory testing results (Baker et al., 2013).

F. Administration practices (Dychter et al., 2012)

1. IV push: Following the flushing procedure, cleanse the needleless connector, allow the solution to dry, attach the syringe containing the medication, infuse over a short period of time, and flush with 1–3 ml NS following completion of infusion.

2. Intermittent infusions: Used for drugs that require dilution or slow administration. Following the flushing procedure, cleanse needleless connector, allow solution to dry, attach administration set of infusion to be administered, infuse over specified time, and flush with 1–3 ml NS following completion of infusion.

3. Continuous infusions: Most common method of administering IV fluids, drugs, and peripheral nutrition. Following the flushing procedure, cleanse needleless connector, allow solution to dry, attach administration set of infusion to be administered, infuse over specified time, and flush with 1–3 ml NS following completion of infusion.

4. If used for intermittent vesicant administration, exercise caution and carefully monitor, as a risk of extravasation exists, which may go undetected because the line may be misidentified as a central line. The midline catheter is a peripheral venous device.

VIII. Removal technique (Hadaway, Dalton, & Mercanti-Erieg, 2013; Helm, Klausner, Klempner, Flint, & Huang, 2015; INS, 2016; O’Grady et al., 2011; Scoppettuolo et al., 2016)

A. Prior to removal, verify scope of practice with the individual state board of nursing and institutional guidelines. Credentialing and ongoing competency validation are required.

B. Indications: Remove the catheter when signs and symptoms of infection, infiltration, or phlebitis exist, or when no longer required for therapy.

C. Procedure

1. Verify order and indication for removal when IV therapy is discontinued.

2. Explain procedure to the patient.

3. Place the patient in a chair or bed to stabilize the extremity.

4. Inspect the general condition of the catheter pathway.

5. Discontinue all infusions into the device.

6. Put on gloves; remove dressing; remove securement device; and observe site for any pain, edema, redness, or discharge.

7. Change gloves; grasp device by the hub; and while stabilizing the skin and vein with sterile gauze in the nondominant hand, slowly and steadily pull until device is completely removed.

8. If removal of the catheter is indicated for infection, send the catheter tip for culture, if ordered.

9. Apply constant, firm pressure to the exit site until bleeding stops (longer in patients with coagulopathies or thrombocytopenia and those on anticoagulants). Apply dressing or adhesive bandage; monitor as necessary.

10. Instruct the patient or caregiver to report any discomfort or signs of bleeding, bruising, redness, swelling, or drainage.

11. Measure the catheter for appropriate length and catheter integrity. Inspect the device for defects, and report any to the manufacturer and regulatory agencies. Examine distal tip for signs of jagged, uneven edges suggestive of breakage.

12. Document observations and actions.

IX. Complications (Coyle, Griffie, & Czaplowski, 2014; O’Grady et al., 2011; Polovich, Olsen, & LeFebvre, 2014; Sabri, Szalas, Holmes, Labib, & Mussivand, 2013; Scoppettuolo et al., 2016)

A. Insertion complications: Bleeding, vein injury, nerve injury, infiltration, phlebitis, or thrombosis

B. Vein injury: Pain, tenderness, edema, redness (vasodilation), thrombosis, sclerosis, or infiltration

C. Phlebitis: Most common complication, resulting in inflammation of the vein

1. Etiology: Insufficient vessel size to accommodate the catheter and allow hemodilution, traumatic insertion, or mechanical or chemical irritation

2. Risk factors

a) Prolonged dwell time

b) Mechanical irritation: Movement of the catheter, multiple cannulation attempts, catheter too large for vein, location of the catheter, or catheter material
Chapter 3. Midline Catheters

3. Signs and symptoms: Pain, erythema, streak formation, or palpable cord edema
   a) Older adult patients may not experience pain from phlebitis or infiltration because of a decrease in sensory perception; monitoring for complications through observation is important.
   b) Children, older adults, or those with communication limitations may not be able to verbalize pain.

4. Diagnostic tests: Not indicated

5. Management: Remove device, apply heat, and give analgesic, as needed.

D. Infiltration: Second most common complication

1. Etiology: Mechanical (e.g., injury during insertion, catheter malposition following insertion) or physiologic (e.g., preexisting or developing vein problems such as sclerosis). From the penetration of the catheter into or through the venous wall, infiltration leads to infusion of fluids or medications into the surrounding soft tissue.

2. Risk factors: Insertion into antecubital fossa, inadequate catheter securement, traumatic injury to vessel wall on insertion, older or younger age, dehydration, and obesity

3. Prevention: Asses for infiltration by occluding the vessel at the tip of the catheter with digital pressure. If infusion continues, the fluid is likely infiltrating.
   a) Use of appropriately sized syringes will prevent vein rupture or infiltration with IV push administration or a vacuum on blood aspiration.
   b) The larger the syringe, the less pressure is generated when force is applied and the more force is required to create a vacuum. Less force is generated in either infusion or aspiration with larger syringes, thereby reducing or preventing complications.
   c) Do not use a 1 ml syringe with midline catheters. Use a syringe 3 ml or greater for all flushing and administration of medications.

4. Signs and symptoms: Leaking fluid around insertion site, cool and pale skin, possibly decreased infusion rate, edema at insertion site, tenderness, or skin tightness or discomfort

5. Diagnostic tests: Not indicated

6. Management: Remove device, apply heat, and give analgesic, as needed.

E. Infection

1. Etiology: Microorganisms enter by migration at insertion site, the interior of the catheter, contamination of connectors, excessive catheter manipulation, repalpation of a proposed puncture site prior to insertion, or by contaminated infusion. The most common organism is *Staphylococcus aureus*.

2. Risk factors: Inadequate cleansing technique, contamination of insertion site or supplies, immunocompromised patient, older or younger age, comorbidities (e.g., diabetes, cancer, heart disease), or malnourishment


4. Signs and symptoms: Depend on type of infection
   a) Local: Erythema, purulent drainage, warmth, induration, or palpable cord
   b) Phlebitis: Pain, erythema, streak formation, palpable cord, or edema
   c) Bloodstream: Pain, erythema, streak formation, palpable cord, edema, fever, or chills

5. Diagnostic tests: Wound and blood cultures, as ordered

6. Management: Remove device, apply heat or cold (depending on agent infiltrated), and administer antibiotics systemically, per culture result.

F. Extravasation: The leaking or escape of infusate from the vessel into the surrounding tissue (Coyle et al., 2014; Le & Patel, 2014; Molas-Ferrer et al., 2015; Polovich et al., 2014)

1. Etiology: Peripheral vein wall puncture; administration of a vesicant in a vein below a recent venipuncture; or inadequately secured IV catheter, which results in leaking of vesicant agent into surrounding tissue. Damage is dependent on specific factors.
   a) Mechanism of action or properties of drug
   b) Amount of drug extravasated

2. Risk factors: Inadequate insertion technique, small fragile veins, history of multiple venipunctures, limited extremity vein selection, decreased sensation or circulatory impairments, and patient with altered mental status
3. Prevention

a) Use clean technique in accessing peripheral vein, and avoid multiple attempts in establishing access.

b) Avoid areas of impairment, previous IV sites, and insertion above previous venipuncture sites.

c) Use transparent dressing over IV to visualize the site throughout vesicant administration.

d) Verify blood return prior to, during, and after administration. Do not give vesicant through midline without a blood return.

e) Instruct the patient to promptly report symptoms of extravasation.

4. Signs and symptoms: Burning or stinging at site; pain; erythema; difficulty infusing solution; leaking around the insertion site; absence of blood return during or following infusion, followed by blistering, tissue necrosis, and ulceration; decreased IV flow

5. Diagnostic tests: Not indicated

6. Management

a) Stop infusion and aspirate residual drug from the catheter using a 3 ml syringe.

b) Remove midline catheter, unless antidote is given through existing midline; in that case, remove after administration of antidote.

c) Assess site and estimate amount of vesicant extravasated.

d) Administer antidote or extravasation treatment, as indicated.

e) Apply cold or heat, as indicated.

f) Determine the cause of extravasation, notify the physician, measure and photograph the site, document patient assessment and nursing care, and provide patient education and follow-up.

X. Practicum on midline insertion and care (see Appendix 6)

XI. Education and documentation (See Appendix 6 and Chapter 17 for competency.)

XII. Special considerations for pediatrics and older adults

A. Pediatrics: Available in 24- and 22-gauge sizes in 6–8 cm in length

B. Pediatric insertion sites: Basilic and cephalic vein in the upper extremity

C. Older adults: Avoid tourniquet use in older adults with fragile veins and thin skin. Excessive antiseptic can dry already compromised skin (INS, 2013).

XIII. Infusion teams (Hadaway et al., 2013; Harpel, 2013; O’Grady et al., 2011, Sabri et al., 2013) (see Figure 2-5 in Chapter 2)

References


Chapter 3. Midline Catheters


Wang, R., Luo, O., He, L., Li, J.X., & Zhang, M.G. (2012). Preservative-free 0.9% sodium chloride for flushing and locking peripheral intravenous access device: A prospective controlled trial. *Journal of Evidence-Based Medicine, 5*, 205–208. doi:10.1111/jebm.12004
Chapter 4

Nontunneled Central Venous Lines

Dawn Camp-Sorrell, RN, MSN, FNP, AOCN®, and Lauri Matey, MSN, RN, CHPN

I. History (Aubaniac, 1990; Cheung, Baerlocher, Asch, & Myers, 2009; Gallieni, Pittiruti, & Biffi, 2008)
   A. Nontunneled catheters have continued to evolve since 1945, when polyurethane material was beginning to be used in catheter development.
   B. By 1949, access was mainly accomplished through the femoral and external jugular veins.
   C. In 1952, the subclavian vein was used for central line access to allow for rapid resuscitation for injured war victims.
   D. Total parenteral nutrition (TPN) was being administered successfully with available central line access in dogs in 1966, proving this method safe and effective.
   E. Newer polyurethane and power-injectable models were introduced in the mid-2000s.

II. Device characteristics (see Figures 4-1 and 4-2)
   A. Short-term catheter
   B. Can be used for immediate access for all types of therapy, including emergencies
   C. Often used for rapid resuscitation or pressure monitoring

III. Device features (Gentile et al., 2013)
   A. Size: Ranges from 14–24 gauge, 4–8.5 Fr, and 10–30 cm length in single-lumen and multi-lumen designs. Four- and five-lumen catheter designs recently have become available.
   B. Catheter material: Polyurethane and silicone with available options, including latex free, radiopaque, chlorhexidine-sulfadiazine impregnated, and heparin coated
   C. Distal tip opening design
   D. Distal tip openings on multilumen catheters may be side by side or staggered.
   E. Power-injectable design
   F. Clamps attached per lumen

IV. Device advantages and disadvantages (see Figure 4-3)

V. Patient selection criteria (Alexandrou et al., 2014; Chung & Beheshti, 2011; Dassinger et al., 2015; Gibson & Bodenheim, 2013; Kim et al., 2012; Lennon, Zaw, Pöpping, & Wenk, 2012; Perbet et al., 2014; Youn et al., 2015)
   A. Use a catheter with the smallest gauge necessary for indicated therapy to decrease the incidence of venous thrombosis.
   B. Patients receiving short-term treatment with no need for extended therapy
   C. Patients with poor peripheral venous access
   D. Patients who require treatment with fluids that are hyperosmolar, alkaline, or acidic
   E. Patients who require frequent venous access for infusion or blood specimens
   F. Patients who are poor surgical candidates for long-term catheter placement
   G. Critically ill patients requiring multilumen access or central venous pressure monitoring
   H. Patients needing emergent central access
   I. Absolute contraindication is a combative patient.

VI. Insertion techniques (Brass, Hellmich, Kolodziej, Schick, & Smith, 2015; Chung & Beheshti, 2011; Dassinger et al., 2015; Gibson & Bodenheim, 2013; Kim et al., 2012; Lennon, Zaw, Pöpping, & Wenk, 2012; Perbet et al., 2014; Youn et al., 2015)
   A. Only healthcare professionals who have successfully completed a specialized training course should insert nontunneled central venous access devices (CVADs) (Alexandrou et al., 2014). In the United States, state boards of nursing govern who may insert and remove nontunneled CVADs; laws governing this practice vary widely from state to state.
B. Prior to placement, ensure that contraindications do not exist, informed consent is obtained, preplacement assessment is completed, laboratory studies are verified, and the medication/chemotherapy order is reviewed (see Appendix 4).

C. Vein selection
1. Use the right internal jugular vein because it follows a fairly straight course to the subclavian.
2. The left subclavian vein is an acceptable choice, as it has a smooth curve to the superior vena cava without an acute turn.
3. If the right internal jugular is not available, the left internal jugular, the external jugular, or the right subclavian vein may be used. The following conditions may require femoral placement:
   a) Enlarged axillary or subclavian nodes
   b) Tumor mass of neck or chest region
   c) Previous surgery or radiation therapy to the axillary or subclavian area
   d) History of previous thrombosis
   e) Presence of cardiac pacemaker
   f) Superior vena cava syndrome
4. Femoral insertion with the tip in the inferior vena cava is possible but has an increased risk of infection and thrombotic complications.

D. Insertion procedure (Tang et al., 2014)
1. Prepreparation
   a) Explain the insertion procedure to the patient and answer any questions the patient or caregiver may have.
   b) Ensure that informed consent is obtained.
   c) Determine if the patient has allergies to cleansing agents or tape products, and inform the practitioner placing the line.
   d) Evaluate prior to placement for obesity, coagulation disorders, short neck stature (limited space to access vein in the neck region), acute respiratory failure, thrombocytopenia, and history of central venous catheter insertions.

2. Position the patient.
   a) Unless contraindicated, place the patient in the Trendelenburg position, which distends the vein selected for cannulation and decreases the risk of air embolism.
   b) Position the patient’s neck and shoulders to increase venous distention (e.g., placing a rolled towel beneath the area).

3. Use maximum sterile barrier precautions, including mask, cap, sterile gown, and sterile gloves, for all practitioners involved with the insertion procedure, and cover the patient with a sterile drape to reduce infection risk.

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**Figure 4-2. Triple-Lumen, Nontunneled Catheter**


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**Figure 4-3. Advantages and Disadvantages of Nontunneled Central Venous Lines**

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• May be used to infuse all IV therapies and draw blood</td>
<td>• May be associated with discomfort at insertion</td>
</tr>
<tr>
<td>• May be inserted at the bedside or in ambulatory surgery using sterile technique</td>
<td>• More prone to infection because of a lack of tunnel/cuff, the external portion, and insertion at bedside</td>
</tr>
<tr>
<td>• May be inserted without general anesthesia or procedural sedation</td>
<td>• Require diligent aseptic care to prevent infection and maintain line function</td>
</tr>
<tr>
<td>• May be used to monitor central venous pressure</td>
<td>• May require checking of placement with x-ray prior to use</td>
</tr>
<tr>
<td>• May be placed in an emergency situation and used immediately</td>
<td>• Not used for long-term venous access</td>
</tr>
<tr>
<td>• Does not require needle access for use after insertion</td>
<td></td>
</tr>
<tr>
<td>• Designed for short-term use</td>
<td></td>
</tr>
<tr>
<td>• Available in a variety of gauges, in single, double, triple, quad, and five lumens, and as power-injectable versions</td>
<td></td>
</tr>
<tr>
<td>• Can be used for multiple, incompatible solutions concurrently (multilumen)</td>
<td></td>
</tr>
<tr>
<td>• Available antimicrobial-impregnated catheters may decrease risk of infection.</td>
<td></td>
</tr>
<tr>
<td>• Available heparin-coated catheters may decrease risk of venous thrombosis.</td>
<td></td>
</tr>
</tbody>
</table>
4. Cleanse the insertion site (see Appendix 2). If necessary, clip (do not shave) long hair to decrease contamination.
5. Use local anesthetic to decrease insertion discomfort (see Appendix 7).
6. Percutaneous placement
   a) Ultrasound guidance: Decreases the risk of arterial puncture and hematoma formation
   b) Landmark approach: Uses anatomic areas to locate and access the central vein without imaging studies. A triangle of landmarks (clavicle and the two heads of the sternocleidomastoid muscle) identifies the insertion site.
   c) Electrocardiogram and fluoroscopy guidance techniques have been used with success in nontunneled placement (Rossetti et al., 2015; Wang et al., 2015).
7. Insert the needle percutaneously into the vein with a stylet and guidewire, using the clavicle as a guide, according to the Seldinger technique.
   a) When a flashback is observed, remove the syringe and advance the guidewire into the vein. To minimize complications, the guidewire is not advanced further than 18 cm.
   b) Advance the catheter over the guidewire into the subclavian vein until it reaches the superior vena cava.
   c) Remove the guidewire and flush each lumen with saline.
8. Avoid suturing; secure catheter with a securement device. Apply an occlusive dressing over the exit site (O’Grady et al., 2011).
9. Confirm correct placement prior to use to determine proper location of tip and to detect pneumothorax. When ultrasound guidance is used for placement, a chest x-ray is not necessary. Proper catheter tip location is just above or in the lower third of the superior vena cava at the cavoatrial junction or in inferior vena cava, if placed femorally.
10. Document the length of the catheter, the presence of blood return, and the patient’s condition.
11. To minimize infection, replace catheters inserted during an emergency or in the femoral vein as soon as possible.

VII. Unique maintenance and care: No definitive recommendations can be made for flushing solution, volume, and frequency; frequency of dressing and needleless connector changes; or blood sampling technique (see Appendices 2, 3, 4, 5, and 8).

A. Dressing: Change 24 hours after insertion.
B. Flushing: Use heparin 10–100 IU/ml, 2–3 ml/day per lumen; heparin lock after use for intermittent infusions after flushing with 0.9% normal saline (NS). When flushed every eight hours, 10 ml NS has been effective in maintaining lumen patency (Gorji, Rezaei, Jafari, & Cherati, 2015). Clamps are used when accessing or deaccessing nontunneled VADs.
C. Needleless connector: Change connector after each use, if damaged, or if contaminated with blood.
D. Blood sampling: Discard 3–5 ml of blood, obtain specimen, and flush with 10–20 ml NS.
   1. A recent study revealed accurate complete blood count, chemistry panel, and coagulation tests compared to peripheral samples when a 2 ml discard volume was used from the proximal lumen.
   2. Researchers proposed to use middle and distal lumens for drugs and TPN and proximal lumens for fluid therapy, electrolyte replacement, and blood sampling (Villalta-García et al., 2015).

VIII. Removal technique
A. Remove nontunneled lines when therapy is completed, when the line is no longer functional because of thrombus or mechanical failure, or when the line is infected.
B. Do not routinely replace (O’Grady et al., 2011).
C. Verify order for removal and indication. Prior to removal, verify scope of practice with the individual state board of nursing and institutional guidelines.
D. Explain the procedure to the patient.
E. Place the patient in a reclining position.
F. Inspect the general condition of the catheter.
G. Discontinue all infusions into the device.
H. Put on gloves, remove the dressing, remove the securement device, and inspect the exit site for redness, pain, swelling, exudate, or other problems.
I. Change gloves and remove sutures, if present.
J. Have the patient perform the Valsalva maneuver. Performing the Valsalva maneuver decreases the risk of an air embolism during catheter removal.
   1. Instruct the patient to take a deep breath and hold it.
   2. Instruct the patient to “bear down” for 10 seconds.
K. Grasp the hub of the catheter, and gently and steadily retract catheter until it is completely removed.
L. Apply constant, firm pressure to the exit site until bleeding stops (longer in patients with coagulopathies or decreased platelet count). Apply sterile,


References


Chapter 5

Peripherally Inserted Central Catheters

Diane G. Cope, PhD, ARNP-BC, AOCNP®

I. History
   A. First introduced in the 1980s and primarily used for venous access in homecare patients (Bowe-Geddes & Nichols, 2005; Cotogni & Pittiruti, 2014)
   B. Designed for long-term central venous access (six months or greater)
   C. Increased popularity in part due to lower insertion costs, lower risks of insertion complications, and the fact it is within the scope of nursing practice to have RNs trained to perform insertion procedure

II. Device characteristics (Chopra et al., 2015; Hagle & Cook, 2014; Park & Kim, 2015; Sekold, Walker, & Dwyer, 2015)
   A. Commonly used in intensive care units with the advent of power-injectable peripherally inserted central catheters (PICCs)
   B. Introduced percutaneously into a palpable peripheral vein above and below the antecubital fossa and terminated in the central venous system

III. Device features (Baskin et al., 2014; Park & Kim, 2015)
   A. Catheter material: Silicone, polyurethane, or elastomeric hydrogel; radiopaque
   B. Range from 3–6 Fr in single-, double-, and triple-lumen designs; pediatric sizes from 1.9–2.6 Fr in single-, double-, and triple-lumen designs
   C. Lengths range from 50–60 cm.
   D. Prime volume of 0.5–1.5 ml
   E. Valved or open-ended distal tips are available.
   F. Power-injectable PICCs (valved and nonvalved) are available for the delivery of power injection flow rates required for contrast-enhanced injections. A randomized study failed to demonstrate a significant functional, maintenance, or complication rate advantage with use of the more expensive valved PICC versus the nonvalved PICC (Pittiruti et al., 2014).
   G. Available with pressure-activated safety valves designed to prevent blood backflow
   H. Available with polymer infused into the catheter shaft material that remains present throughout the life of the catheter, providing long-term durability and decreased accumulation of catheter-related thrombosis
   I. Approved for use up to 12 months; however, evidence supports a longer duration if the device is functioning without complications (O’Grady et al., 2011).

IV. Device advantages and disadvantages (Johansson, Hammaskjöld, Lundberg, & Arnlind, 2013) (see Figure 5-1)

V. Patient selection criteria (Bourgeois, Lamagna, & Chiang, 2011; Chopra et al., 2015; Cotogni & Pittiruti, 2014; Gabriel, 2013; Green et al., 2015; Hagle & Cook, 2014; Wojnar & Beaman, 2013)
   A. Patients with poor, fragile, or small peripheral veins for administration of therapy with long-term duration
   B. Patients receiving administration of solutions that are irritants or vesicants or solutions with a pH less than 5 or greater than 9, glucose greater than 10%, protein greater than 5%, or osmolality greater than 900 mOsm/L (Boullata et al., 2014; Chopra et al., 2015; Cotogni & Pittiruti, 2014)
   C. Patients who prefer this type of device over other venous access devices (VADs)
   D. In the home setting, patients who have a caregiver who can properly care for the device
   E. Patients with anatomic abnormality or tumor burden in the chest, chest wall, or neck that would contraindicate placement of an implantable port or tunneled catheter
   F. Contraindicated in patients with severe renal dysfunction who may require an arteriovenous fistula formation

VI. Insertion techniques (Chopra et al., 2015; Cotogni & Pittiruti, 2014; Johansson et al., 2013; Moureau et al., 2013; Park & Kim, 2015; Steele & Norris, 2014; Wang et al., 2015) (see Figure 5-2)
   A. Only healthcare professionals who have successfully completed a specialized training course should insert PICCs.
      1. In the United States, state boards of nursing govern who may insert, access, man-
age, and remove PICCs; laws governing this practice vary widely from state to state.

2. Research supports high insertion success rates and low malposition rates of bedside insertions performed by trained RNs, requiring minimal support from interventional radiology and substantially reducing insertion costs (Sainathan, Hempstead, & Andaz, 2014).

B. Pediatric considerations: Conscious or general sedation typically is used for insertion to ensure that the patient remains still for the procedure (Braswell, 2011; Cotogni & Pittiruti, 2014; Westergaard, Classen, & Walther-Larsen, 2013).

C. Insertion may be performed by skilled practitioners using ultrasound guidance or anatomic landmarks.

1. Use of ultrasound versus anatomic landmarks reduces incidence of insertion failure, decreases the costs of multiple cannulations, and can confirm correct tip position. Research demonstrates that avoiding injury of the vein wall during placement via ultrasound guidance correlates positively with reduced rates of catheter-related thrombosis (Bowen, Mone, Nelson, & Scaife, 2014; Katheria, Fleming, & Kim, 2013; Lamperti et al., 2012; O’Grady et al., 2011; Teichgräber, Kausche, Nagel, & Gebauer, 2011).

2. Studies demonstrate high technical success, low patient distress, and low early complication rates when ultrasound guidance is used (Bortolussi et al., 2015; Katheria et al., 2013).

3. Electrocardiogram guidance techniques have been used with success for tip placement verification (Rossetti et al., 2015; Wang et al., 2015).

D. Prior to placement, ensure that contraindications do not exist. Informed consent is obtained, the preplacement assessment is completed, laboratory studies have been verified, and the medication or chemotherapy order has been reviewed (see Appendix 4).

E. Insertion methods (Cotogni & Pittiruti, 2014)

1. Peel-away sheath technique: Puncture vein with a needle/sheath device. Remove stylet and thread into the vein. Peel the sheath/
cannula down to the hub of the catheter, break away, and then remove from the catheter.

a) Advantages: Risk of catheter damage is low, a variety of gauge sizes are available, and this technique can be performed virtually without blood spills.

b) Disadvantages: A larger introducer unit is required. This technique has a higher incidence of thrombophlebitis than the modified Seldinger method and may cause more bleeding around the exit site during the first few hours after insertion.

2. Over-wire Seldinger method: Puncture vein with a smaller gauge steel needle. Observe for blood in the attached syringe. Remove syringe and thread guidewire through the needle into the vein. Remove needle and cannula. Thread peel-away sheath down to the skin over the guidewire introducer. Remove guidewire and advance the catheter to correct position and stabilize.

a) Advantages: This method requires a smaller venipuncture, a variety of gauge sizes are available, and the risk of catheter damage is eliminated.

b) Disadvantages: This method is more complex and may require a minor surgical incision, which increases cost.

F. Catheter tip is just above or in the lower third of the superior vena cava at the cavoatrial junction. European guidelines recommend tip location in the right atria. Most literature cites termination at the cavoatrial junction as optimal placement (Association for Vascular Access, 1998; Johnston, Bishop, Martin, See, & Streater, 2013; Moureau et al., 2013; Oliver & Jones, 2014; Perin & Scarpa, 2015; Pittiruti, Hamilton, Biffi, MacFie, & Pertkiewicz, 2009).
G. Guidance systems are available to identify the placement of PICCs.
1. A Doppler method is used with internal physiologic parameters to accurately guide PICCs into the superior vena cava.
2. Some PICCs have guidance systems that detect slight magnetic fields generated by the preloaded stylet to guide the catheter into position. Audible or visual signals indicate the location of tip position.

H. Insertion procedure (Baskin et al., 2014; Hagle & Cook, 2014; Infusion Nurses Society, 2013, 2016)
1. Choose appropriate PICC size (diameter) and number of lumens, as indicated.
2. Explain the insertion procedure to the patient and answer any questions the patient or significant others may have. Ensure that informed consent is obtained.
3. Gather all necessary supplies, including any IV administration sets and medications or IV fluids to be used.
4. Wash hands.
5. Examine the patient’s arms and select the best vein for cannulation.
   a) Avoid veins that are sclerotic on inspection and palpation.
   b) Select the patient’s nondominant arm, if possible. If the patient has undergone axillary dissection, use the contralateral arm.
   c) Avoid extremities that may have compromised circulation, such as those with the presence of lymphedema or venous congestion secondary to superior vena cava syndrome.
   d) The basilic vein is the best choice, as it is the straightest and has the most direct route to the central venous system (Bourgeois et al., 2011; Hagle & Cook, 2014).
   e) The cephalic vein is the secondary choice because its abrupt angle that joins the axillary vein makes advancement of the line more difficult.
   f) Adult considerations: The preferred vein choices include cephalic, accessory cephalic, basilic, and median cubital.
   g) Geriatric considerations: Consider that fragile skin and veins can tear easily; use tourniquet with caution.
   h) Pediatric considerations
      (1) Three months of age: Superficial temporal, posterior auricular, saphenous, or median cubital veins are preferred.
      (2) Four months of age until ambulatory: Saphenous, cephalic, basilic, or median cubital veins are preferred.
      (3) Ambulatory child: Basilic, cephalic, brachial, or median cubital veins are preferred.
6. Use local anesthetic with order (Bourgeois et al., 2011) (see Appendix 7).
7. Use a measuring tape to determine appropriate catheter length.
   a) Measure from the point of venipuncture, over the course of the selected venous pathway, across the shoulder to the right side of the sternal notch, and down to the third intercostal space.
   b) The tip of the catheter should rest in the cavoatrial junction (see Figure 5-3).
   c) Add 2.5 cm (1 inch) onto this measurement to account for the length of the catheter outside of the insertion site (Sharp et al., 2013).
8. Use maximum sterile barrier precautions, including mask, sterile gown, gloves, and drapes. Open the PICC tray and add additional supplies. The general insertion procedure may vary according to the type of PICC being used and institutional policy. Ensure familiarity and skill with the product selected and follow the manufacturer’s directions (Bourgeois et al., 2011; O’Grady et al., 2011).
9. Position the patient’s arm at a 45°–90° angle from the body, below heart level, to aid in vein engorgement.
10. Place a sterile drape under the patient’s arm.
11. Cleanse the area and allow to air-dry before initiating cannulation. Do not fan the area to facilitate drying (see Appendix 2).
12. Fill two syringes with 0.9% normal saline (NS). Use one syringe to prime extension tubing, which may be needed during the procedure.
13. Place fenestrated (opened-center) sterile drape over the arm, leaving the insertion site exposed.

14. Prepare the catheter.
   a) Using sterile measuring tape, measure the length of catheter needed based on previous assessment.
   b) Pull the guidewire back half an inch from this distance.
   c) No definitive recommendation can be made regarding the catheter trim procedure. Trim the catheter with sterile scissors according to the manufacturer’s recommendation.
      (1) Some PICC manufacturers do not recommend trimming the catheter. Others recommend trimming at a 45° or 90° angle.
      (2) Valved PICCs are trimmed proximally and not at the distal tip.
   
   (3) Altering the PICC by cutting or trimming the tip prior to insertion may increase the occurrence of deep vein thrombosis (Steele & Norris, 2014).
   (4) Apply a tourniquet approximately four inches above selected site. Check distal pulse to ensure that arterial circulation has not been compromised. Change sterile gloves.
   (5) While stabilizing the vein, perform venipuncture and observe blood return.
   (6) Release the tourniquet and continue to advance the catheter.
   (7) Attach prefilled syringe, and flush with NS. Ensure adequate blood return. Primed exten-
sion tubing may be attached at this time.

(8) After securing the catheter hub with a securement device, flush with heparin solution.

(9) Place an occlusive dressing over the insertion site and external part of the catheter up to the hub. Change the dressing 24 hours after initial insertion to a transparent occlusive dressing (see Appendix 5).

(10) Check catheter placement.
   
   (a) If catheter is placed under ultrasound guidance, placement has been confirmed after insertion. A follow-up chest x-ray is not necessary.
   
   (b) Tip placement must be confirmed prior to use. Some institutions may require that the guidewire be left in place to aid in PICC line verification during radiographic study because the small size of PICCs makes radiographic visualization challenging; this can be facilitated with the guidewire in place. Extreme caution should be used during the radiographic study to prevent catheter puncture. Guidewires should not be left in place for long periods of time.

(11) Document the number of attempts, location, type and gauge of catheter, dressing type, securement method, and the patient’s response.

VII. Insertion complications (see Table 9-1 in Chapter 9)

VIII. Unique maintenance and care (see Appendices 2, 4, 5, and 9): No definitive recommendations can be made for flushing solution, volume, and frequency; frequency of dressing and needleless connector changes; or blood sampling technique (see Figure 5-4).

A. Dressing changes
   1. Change initial dressing 24 hours after insertion.
   2. Remove the dressing over exit site toward the upper extremity to prevent catheter dislodgment.
   3. Change securement devices at the time of dressing changes.
   
   B. Change needleless connectors with each use, if damaged, or if contaminated with blood.
   
   C. Flushing: Flush with NS 5–10 ml after each use. Use 3 ml of 10–100 IU/ml heparin daily, every other day, or three times weekly, per lumen. Use 5–10 ml NS flush with valved PICCs daily, every other day, or three times weekly, per lumen.
   
   D. Blood sampling: Smaller gauge PICCs may not yield blood return. A recent study revealed that vancomycin and tobramycin antibiotic levels can be drawn from PICCs in children with accurate results compared with peripheral catheters. A 3–5 ml discard was used, the blood sample was obtained, and the catheter was flushed with NS then flushed with heparin (Green et al., 2015).

IX. Removal technique (Costa, Dorea, Kimura, Yamamoto, & Damiani, 2014; Hagle & Cook, 2014; Park & Kim, 2015; Wojnar & Beaman, 2013)

A. Indications (Chopra et al., 2015)
   1. Completion of therapy
   2. Infection not responsive to treatment
   3. Radiologically confirmed thrombosis not responsive to fibrinolytic therapy
   4. Catheter fracture
   5. Phlebitis not responsive to treatment
B. Prior to removal, verify scope of practice with the individual state board of nursing and institutional guidelines.
   1. Verify order for removal of catheter.
   2. Gather materials needed, including measuring tape, gauze, and occlusive dressing.
   3. Wash hands and put on gloves.
   4. Remove existing dressing. Remove contaminated gloves and put on a new pair.
   5. Grasp PICC at the insertion site and slowly pull outward about one inch, pulling parallel to the skin.
   6. Release it and grasp again at insertion site, continuing to pull the PICC out in short increments.
   7. When the PICC is completely removed, place gauze over the site and apply light pressure until bleeding stops, then apply occlusive dressing. Remove the dressing in 24 hours and observe site. Apply new dressing, if needed.
   8. Observe catheter tip for integrity, and measure length and compare it to the length documented at insertion. If the catheter is not intact, notify the provider. If the PICC is removed for infection, send the tip for culture, if ordered.

9. Removal complications
   a) Venospasm
      (1) Stop the procedure if resistance is felt. Reposition the patient’s arm and attempt again.
      (2) If resistance continues, apply warm compress to the upper arm for 15–20 minutes and reattempt gentle removal.
      (3) If resistance persists and the catheter has been removed far enough to do so, apply a tourniquet above the proximal end of the catheter and reattempt removal. This causes internal pressure that may release the venospasm and allow the catheter to be removed.
      (4) If resistance persists, apply a gauze and tape dressing to the insertion site for 12–24 hours, then reattempt removal.
   b) Thrombosis
      (1) Thrombosis in the lumen can cause the catheter to adhere to the vessel wall during removal.
      (2) If the catheter is difficult to remove, stop the procedure.
      (3) Use interventions recommended for venospasm.
      (4) If these attempts fail, notify the provider for possible radiologic studies to rule out thrombosis.

   c) Catheter fracture
      (1) Damage can occur prior to removal or if excessive force is applied during the removal process.
      (2) If fracture occurs during removal but sufficient catheter length distal to insertion site exists, clamp the catheter and continue removal.
      (3) If fracture occurs at the insertion site, clamp the catheter and apply a tourniquet around the upper arm to prevent migration of the fragment. The tourniquet should not impede the arterial flow; check radial pulse.
      (4) Notify the provider immediately.
      (5) If complete fracture occurs within the vein proximal to the insertion site, immediately apply the tourniquet at the highest point possible on the arm; risk of fragment embolus is present.
      (6) Place the patient in the Trendelenburg position; contact the provider immediately. Closely monitor the patient for shortness of breath, tachycardia, confusion, pallor, or hypotension. Prepare the patient for removal by an interventional radiologist, thoracic surgeon, or vascular surgeon.

X. Complications (see Chapter 9)
XI. Practicum on long-term VAD insertion and care (see Appendix 9)
XII. Education and documentation
A. Patient education unique to PICCs (Park & Kim, 2015)
1. Inform the patient that a central VAD has been inserted and describe any features (e.g., power-injectable PICC, valved).
2. Instruct the patient on the use of an ice pack for comfort if the PICC insertion site is tender.
3. Instruct the patient to carry a PICC identification card.
4. Instruct the patient to avoid allowing peripheral blood sampling or blood pressure monitoring in the arm where the PICC is placed.

B. Documentation (see Chapter 17)

XIII. Infusion teams (see Figure 2–5 in Chapter 2)

References


Steele, D., & Norris, C.M. (2014). Cutting peripherally inserted central catheters may lead to increased rates of catheter-related deep vein thrombosis. Journal of Infusion Nursing, 37, 466–472. doi:10.1097/NAN.0000000000000073


Chapter 6
Tunneled Central Venous Catheters
Heather Thompson Mackey, RN, MSN, ANP-BC, AOCN®

I. History (Heberlein, 2011; Weinstein, 2014)
   A. The first tunneled venous access device (VAD), the Broviac® catheter, was introduced in 1973 for administration of long-term hyperalimentation in children. It was inserted into the subclavian vein and tunneled under the subcutaneous (SC) tissue to increase the longevity of the catheter and to decrease infection.
   B. A larger bore catheter, the Hickman® catheter, was introduced in 1976 to expand the applications and patient populations for tunneled catheters.

II. Device characteristics (Hagle & Cook, 2014; Heberlein, 2011; O'Grady et al., 2011)
   A. Flexible catheter inserted into central vein with the tip lying in the superior vena cava. External portion pulled (or tunneled) through the SC skin to exit distally from the insertion site.
   B. Used for longer-term therapy (typically greater than six months)
   C. Typically has lower rates of infection when compared to nontunneled VADs

III. Device features (Hagle & Cook, 2014; Infusion Nurses Society [INS], 2016; O'Grady et al., 2011; Schiffer et al., 2013) (see Figures 6-1 and 6-2)
   A. Lengths range from 47–97 cm.
   B. Sizes range from 2.7–12.5 Fr.
   C. Internal diameters range from 0.5–1.6 mm.
   D. Available in single-, double-, and triple-lumen designs
   E. Prime volume of 0.6–1.8 ml, allowing variable flow rates, including high flow (in excess of 300 ml/min) for hemodialysis
   F. Designed with polyurethane, silicone, or a combination of the two materials
   G. Power-injectable design available
   H. Designed with cuffs to aid in securing the device and reducing risk of infection
      1. Positioned in the SC tunnel 1–2 inches from the exit site. Cuff becomes enmeshed with fibrous SC tissue within several weeks after insertion; SC tissue aids in securing the catheter. Cuff can minimize but cannot guarantee that dislodgment is avoided.
   2. The cuff potentially minimizes the risk of ascending infection from the exit site into the tunnel.
   3. An antimicrobial cuff design is available, which releases an antimicrobial agent for approximately four to six weeks or until the catheter is embedded into tissue.

I. Heparin coating available
   1. Promotes biocompatibility within the vein, thereby reducing fibrin formation
   2. Heparin is intended to decrease fibrin buildup and decrease occurrence of organisms adhering to fibrin, resulting in an infection.
   3. May cause heparin-induced thrombocytopenia, increased risk of bleeding, or allergic reactions
   4. Although more research on heparin coating is needed, limited studies show that heparinization reduces the frequency of catheter-related bloodstream infections at a relatively low cost over a short time period (Abdelkefi et al., 2007; Shah & Shah, 2014).

Figure 6-1. Single-Lumen Tunneled Catheter With Open Distal Tip

Note. Copyright 2015 by Oncology Nursing Society. All rights reserved.
J. Distinguished by type of distal tips
   1. Open-ended distal tip catheters: Most common
      a) Catheters require clamping when not in use with release of clamp (“unclamping”) prior to infusion and aspiration.
      b) Catheters may have clamps located directly on fortified areas.
   2. Closed-ended distal tip catheters
      a) Rounded, closed-tip catheters with an internal three-way, pressure-sensitive valve that opens inwardly with aspiration and outwardly with flushing or infusion. The valve remains closed when not in use.
      b) Does not require clamping or unclamping
   3. Available with three-way, pressure-activated safety valves (PASVs) located in the catheter hub
      a) Designed to permit fluid infusion and reduce the risk of blood backflow into the catheter lumen during increases in central venous pressure that can occur with exercise or involuntary responses, such as coughing
      b) The three-way safety valve resists fluid or blood backflow, reducing need for clamps and potentially reducing the risk of occlusion and infection.
      c) Pressure activated and direction specific, generally eliminating the need for heparin flush. It opens with minimal positive pressure during infusion and requires up to four times as much negative pressure for aspiration.
   K. Radiopaque markings along the catheter for identification during radiographic imaging

IV. Device advantages and disadvantages (see Figure 6-3)

V. Patient selection criteria (Albuquerque, 2015; Keebler, 2014; Lopez et al., 2014; Newman et al., 2012; O’Grady et al., 2011; Schiffer et al., 2013)
   A. Patient’s age, in general, does not restrict use of tunneled central VAD.
   B. Indications for tunneled VAD include the following:

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>- Can be used immediately after placement once radiographic confirmation is made</td>
<td>- Require routine exit-site care</td>
</tr>
<tr>
<td>- Preserve peripheral veins</td>
<td>- Require routine flushing of catheter lumens</td>
</tr>
<tr>
<td>- Provide a means for rapid hemodilution of infused solutions</td>
<td>- Pose risk of complications, such as catheter-related infection and thrombosis</td>
</tr>
<tr>
<td>- Provide a reliable source of IV access</td>
<td>- Cost of maintenance supplies</td>
</tr>
<tr>
<td>- Designed for long-term IV therapy for frequent venous access and are functional for years</td>
<td>- Body image changes</td>
</tr>
<tr>
<td>- Available in single-, double-, and triple-lumen designs</td>
<td>- Surgical procedure (insertion)</td>
</tr>
<tr>
<td>- Provide preattached clamps, except for valved catheters</td>
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</tr>
<tr>
<td>- Decrease risk of microorganisms entering the venous system through tunneling because of anatomic distance between insertion and exit sites</td>
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<tr>
<td>- Repair kits for external segments available for tunneled catheters</td>
<td></td>
</tr>
<tr>
<td>- Come in a variety of sizes to accommodate pediatric and adult patients</td>
<td></td>
</tr>
<tr>
<td>- Available in power-injectable design</td>
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</tbody>
</table>
1. Any patient population that requires long-term IV access, such as hematopoietic stem cell transplant recipients, those with hematologic disease, or those with malignant diseases requiring IV chemotherapy that will result in a prolonged nadir of blood counts.

2. Drugs that cannot be given orally because the molecules are too large to be absorbed, or because they are destroyed by digestion.

3. Administration of solutions that are irritants, vesicants, solutions with a pH less than 5 or greater than 9, glucose greater than 10%, protein greater than 5%, or osmolarity greater than 900 mOsm/L (Boullata et al., 2014; Chopra et al., 2015; Cotogni & Pittiruti, 2014).

C. Contraindications (Heberlein, 2011; Kugler et al., 2015)
   1. Systemic infection or sepsis.
   2. Infection overlying the insertion site; presence of coagulopathies and platelet defects. Coagulopathies and thrombocytopenia should be corrected, when possible, prior to catheter insertion.

   A. Inserted by surgeon or interventional radiologist using ultrasound or fluoroscopy.
   B. Prior to placement, ensure that contraindications do not exist, informed consent is obtained, pre-placement assessment has been completed, laboratory studies are verified, and a medication/chemotherapy order is reviewed (see Appendix 4).
   C. Vein selection
      1. Selected according to patient’s anatomic structure, type and purpose of catheter, and vessel used.
      2. No definitive recommendation can be made regarding a preferred vein (except femoral vein) for insertion of tunneled VADs to minimize infection risk (O’Grady et al., 2011).
      3. Most common veins used for insertion (see Figure 6-4)
         a) Internal jugular vein: The right internal jugular is preferred due to ease of insertion into the junction of the superior vena cava and right atrium.
         b) Subclavian vein
         c) Femoral vein: Avoid in adult patients (O’Grady et al., 2011) and in patients with cancer (Schiffer et al., 2013).
   D. Procedure description
      1. Depending on the type of catheter and indication for placement, the insertion site will vary.
         a) Most commonly inserted via the percutaneous insertion technique using the internal jugular or subclavian vein
            (1) Once vein is cannulated, the guidewire is advanced into the vein.
            (2) A pull-apart sheath introducer is threaded over the guidewire and the guidewire is removed. The catheter is advanced through the introducer into the vein.
            (3) The catheter is tunneled through the SC tissue, with the tunnel created from the vein entry site to the exit site.
            (4) The catheter is pulled from the exit site through the tunnel to the vein entry site and trimmed via an anterograde technique. For a valved or closed distal tip catheter, the retrograde technique is used, where the catheter is pulled from the vein entry site to the exit site and trimmed.
(5) The exit site depends on male or female anatomy; however, usually it is above the nipple line midway between the sternum and clavicle.

b) Catheters also can be inserted using the cut-down insertion method.
   (1) Greatly reduces risk of hemothorax or pneumothorax
   (2) Is more time consuming and difficult to perform than other methods
   (3) Requires more manipulation of skin and SC tissue, thereby increasing infection rate
   (4) Veins used: Axillary, external jugular, internal jugular, cephalic, and subclavian

2. Catheter tip must be confirmed prior to use. The catheter tip is just above or in the lower third of the superior vena cava at the cavoatrial junction. A retrospective analysis concluded that tunneled catheters placed with ultrasound or fluoroscopy do not require postoperative chest x-ray to confirm placement (Bowen et al., 2014).

3. Secure catheter with sutures.
   a) Exit-site sutures remain in place until healing occurs, which can range from 10 days to 6 weeks (or longer if immunosuppression is present).
   b) Sutures are removed after healing in order to prevent irritation and infection at the exit site.

E. Postprocedure care
   1. Label dressing with time, date of dressing placement, and initials.
   2. Monitor the patient’s vital signs every 15 minutes for the first hour and then PRN based on organizational policy and procedure. Monitor for bleeding at insertion and exit site.
   3. Document the catheter type and size, date, time, provider name, and the patient’s response in the medical record.

F. Insertion complications: Pneumothorax, arterial injury, catheter malposition, bleeding, arrhythmia, and air embolism (Bowen et al., 2014) (see Chapter 9)

VII. Unique maintenance and care: No definitive recommendations can be made for flushing solution, volume, and frequency; frequency of dressing and needleless connector changes; or blood sampling technique (Hagle & Cook, 2014; INS, 2016; Kee- ler, 2014; O’Grady et al., 2011; Schiffer et al., 2013) (see Appendices 4 and 5 and Figure 6-5).

A. General care
   1. Clamps are used when accessing or deaccessing open-ended distal tip tunneled VADs to prevent air embolism or blood backflow.
      a) Never use a hemostat or sharp-edged clamp that could damage or cut the catheter. Keep toothless plastic clamps available for emergency use. Do not use scissors near the catheters.
      b) If clamping is not possible, have the patient perform the Valsalva maneuver (forcefully exhale and hold breath) whenever the catheter is open to air.
   2. Valved, closed-ended distal tip catheters or catheters with PASV do not require clamping if the valve is functioning properly. Clamping will damage the catheter.
   3. Catheter material weakens if exposed to alcohol and iodine-containing products with long-term use.
   4. Instruct the patient to completely cover the exit site and external catheter with a waterproof covering while swimming or showering. Some providers prefer that patients

Figure 6-5. Tunneled Central Venous Catheter

Note. Image courtesy of Dawn Camp-Sorrell. Used with permission.
with external catheters refrain from swimming entirely. Little evidence is available regarding the increased risk of infection when swimming (Miller et al., 2014).

B. Dressing changes
1. Change dressing 24 hours after insertion. Change dressing if wet, soiled, contaminated, or nonocclusive.
2. Use an aseptic no-touch technique.
3. No definitive recommendation can be made regarding the need for a dressing over well-healed exit sites of long-term, tunneled VADs (O’Grady et al., 2011).

C. Flushing
1. Solution
   a) Open-ended distal tip catheters: Use heparin 10–100 IU/ml; 3 ml/day or every other day; or 5 ml three times a week or 5 ml weekly, per lumen.
   b) Closed-ended distal tip tunneled VAD: Use 5–10 ml 0.9% normal saline after each use; 5 ml daily, every other day, or three times weekly.
2. Technique
   a) Flush vigorously using a pulsatile (push-pause motion) technique, maintaining pressure at the end of the flush to prevent backflow.
   b) Maintain a positive pressure technique while flushing a tunneled central VAD by clamping the extension tubing while still flushing the line. This will help prevent the development of fibrin sheath, leading to withdrawal or infusion occlusions and contributing to the development of venous thrombosis.
   c) Flush tunneled central VADs that do not have a clamp with positive pressure by disconnecting the syringe from the needless connector while continuing to push fluid.

D. Blood sampling
1. Stop the infusion and clamp all lumens not being used for blood withdrawal on open-ended distal tip tunneled central VADs.
2. Discard 3–5 ml of blood, obtain specimen, and flush vigorously using pulsating (push-pause motion) technique with 10–20 ml of normal saline after blood withdrawal.
3. If using a vacutainer with a closed-ended distal tip or PASV catheter, the procedure may not yield a blood sample because the pressure may collapse the catheter.

E. Needleless connector: Change with each use, every week if not in use, or if damaged or contaminated with residual blood.

VIII. Removal technique (Boddi et al., 2015; INS, 2016; Keeler, 2014; O’Grady et al., 2011; Schiffer et al., 2013)
A. Prior to removal, verify scope of practice with the individual state board of nursing and institutional guidelines.

B. Indications
1. Remove when no longer required for therapy.
2. Remove if systemic infection does not respond to antibiotics, if tunnel becomes infected, or if thrombosis is occluding or is a source of infection.

C. Procedure
1. Verify order for removal and indication.
2. Note length of catheter on insertion.
3. Gather required equipment.
4. Explain procedure to the patient.
5. Wash hands.
6. Place the patient in a reclining position.
7. Inspect the general condition of the catheter and tunneled pathway.
8. Discontinue all infusions into the device.
9. Put on gloves, remove dressing, and observe site for edema, erythema, or other problems.
10. Change gloves and remove sutures as needed.
11. Have the patient perform the Valsalva maneuver.
12. Grasp the hub of device and gently and steadily retract the catheter until completely removed.
13. Send the catheter tip for culture with provider order if infection is suspected.
14. Apply constant, firm pressure to exit site until bleeding stops (longer in patients with coagulopathies, thrombocytopenia, or those on anticoagulant therapy). Apply occlusive dressing. Change dressing after 24 hours and assess site.
15. Instruct the patient or caregiver to report any discomfort or signs of bleeding, bruising, erythema, edema, and drainage.
16. Inspect the device for defects. Report any defects to the manufacturer and regulatory agencies. Examine the distal tip for signs of jagged, uneven edges suggestive of breakage.
17. Discard used supplies and remove gloves.
18. Wash hands.
20. Contact the provider immediately if difficulty occurs in retrieving the cuff or removing the catheter.
21. If tunnel infection is suspected, a cut-down procedure may be performed to remove the cuff, based on provider preference.

22. If questions exist concerning incomplete device removal, call the provider immediately. A chest x-ray or cathetergram is recommended.

IX. Complications (Albuquerque, 2015; Boddi et al., 2015; Heberlein, 2011; Lipitz-Snyderman et al., 2014; Newman et al., 2012) (see Chapter 9)

X. Education and documentation (Heberlein, 2011) (see Chapter 17)

XI. Competency documentation for tunneled VAD care (see Appendix 9)

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References


Chapter 7

Implanted Venous Ports

Lisa Schulmeister, RN, MN, ACNS-BC, FAAN

I. History
   A. First introduced in 1982 (Gyves et al., 1982)
   B. Totally implanted venous access device
   C. Intended to reduce the risk of infection, improve quality of life, reduce maintenance care, and provide an alternative to external catheters
   D. Designed for long-term use

II. Device characteristics (Biffi, Toro, Pozzi, & Di Carlo, 2014; Bonciarelli et al., 2011) (see Figures 7-1 and 7-2)
   A. Completely implanted device
   B. Placement locations (O'Grady et al., 2011; Schiffer et al., 2013)
      1. Usually placed in anterior chest wall or peripheral ports placed in upper arm
      2. Less commonly placed in abdomen in patients with central vein occlusions, with catheter tip in the inferior vena cava at the level of the diaphragm (Goltz, Janssen, Petritsch, & Kickuth, 2014)
   C. Has evolved over the past three decades (Biffi, Toro, et al., 2014; Zaghal et al., 2012)
1. Smaller and lighter, with additional features
2. Available as valved and open-ended catheters
3. Plastic polymer and titanium designs permit magnetic resonance imaging.
4. Power-injectable ports (also called CT-injectable or power ports) allow injection of contrast media at high infusion pressures (Goltz et al., 2012).

III. Device features (Indrajit et al., 2015; Walser, 2012) (see Figure 7-3)

A. Portal body
   1. Consists of septum and reservoir within the portal body
   2. Made of plastic polymers, stainless steel, titanium, or a combination of materials
   3. Has several suture holes to secure portal body in the port pocket
   4. Available in full size, intermediate, and low profiles in single or dual chambers to accommodate patient’s size
   5. Reservoir volume varies with size of reservoir and usually is 0.4–1.5 ml. (Consult the manufacturer’s website for reservoir volumes for specific brands and types of implanted ports.)
   6. Power-injectable portal bodies have different configurations (e.g., palpation bumps, triangular or angled shapes) than round or rectangular nonpower-injectable venous ports to facilitate proper identification. These portal bodies are imprinted or engraved with manufacturer identifiers (Goltz et al., 2012).
   7. A peripheral port also is available for placement distal or proximal to antecubital fossa in single-port designs. The portal body is approximately half the size of a standard port. The peripheral port features a longer catheter (open ended, valve ended, or pressure-activated safety valve [PASV]).

B. Septum of portal body
   1. Comprised of self-sealing silicone
   2. Must only be accessed using a noncoring needle. Hollow-bore needles will “core” or damage the silicone, resulting in leakage.
   3. Able to withstand hundreds of noncoring needle punctures. Consult the manufacturer’s website for data for specific brands and types of implanted portal septum.
   4. PASV design available; the valve is located in the portal body and designed to open for infusion and close after blood sampling or infusion.

C. Catheter attached to portal body
   1. Available as a preattached catheter or attached during implantation using a locking mechanism (sleeve or collar)
   2. Made of radiopaque silicone or polyurethane to ensure tip placement confirmation with imaging studies
   3. Range in length from 50–90 cm (preinsertion) and in circumference (size) from 4–12 Fr
   4. Typically trimmed upon insertion; priming volume dependent on length
   5. Available in polymer design infused throughout the catheter shaft material and remains present throughout the life of the catheter, providing long-term durability and decreased accumulation of catheter-related thrombus

IV. Device advantages and disadvantages (see Figure 7-4)

V. Patient selection criteria

A. Any patient population that requires long-term IV access, such as hematopoietic stem cell transplant recipients, those with hematologic disease, or those with malignant diseases requiring IV chemotherapy that will result in a prolonged nadir of blood counts

B. Drugs that cannot be given orally because the molecules are too large to be absorbed or because they are destroyed by digestion

C. Administration of solutions that are irritants, vesicants, solutions with a pH less than 5 or greater than 9, glucose greater than 10%, protein greater than 5%, or osmolarity greater than 900 mOsm/L (Boullata et al., 2014; Chopra et al., 2015; Cotogni & Pitteruti, 2014)

D. Poor peripheral veins

E. A peripherally placed (arm) port is ideal for patients who are not candidates for chest wall

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Figure 7-3. Implantable Port Diagram

[Diagram of implantable port showing self-sealing septum, skin line, catheter, fluid flow, and suture.]
Chapter 7. Implanted Venous Ports

F. Special population considerations
1. Pediatric patients must have sufficient chest wall muscle to support an implanted port (i.e., older than 6 months to 1 year of age).
2. Metallic ports in radiation fields (e.g., chest wall) have resulted in dose perturbation (alteration and deflection or increased absorption) due to electrons emerging from the metallic portion of the port. Plastic ports or peripherally placed ports should be considered (Chatzigiannis et al., 2011; Gossman et al., 2009).

VI. Insertion techniques (Biffi, Pozzi, et al., 2014; Granziera et al., 2014; Iorio & Cavallaro, 2015; Teichgräber, Kausche, Nagel, & Gebauer, 2011; Walser, 2012) (see Figure 7-5)
A. Prior to placement, ensure that contraindications do not exist, informed consent is obtained, pre-placement assessment is completed, laboratory studies are verified, and medication/chemotherapy order is reviewed (see Appendix 4).
B. Location of portal body placement is ideally determined prior to insertion procedure in a consultation with the patient and nurse.
1. The portal body should be located over a rib for stability and placed in a nonobstructed area (e.g., away from bra straps and/or pacemaker).
2. Sternal placement in obese patients may facilitate access.
3. Deeply placed portal bodies and portal bodies in the axilla, breast tissue, or soft tissue of the abdomen may be difficult to access and should be avoided.
4. Femoral placement for central vein occlusion (Goltz et al., 2014)
C. An implanted port placement is inserted by a surgeon or interventional radiologist under conscious or general anesthesia.
D. Ultrasound-guided insertion by skilled practitioners should be used to decrease number of cannulation attempts, reduce complications, and guide correct catheter tip placement by those trained and skilled in this technique (Bowen, Mone, Nelson, & Scaife, 2014; Brass, Hellmich, Kolodziej, 2014; Walser, 2012).

Figure 7-4. Advantages and Disadvantages of Implanted Venous Ports

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>• Long-term device</td>
<td>• Insertion and removal are performed by a surgeon or interventional radiologist.</td>
</tr>
<tr>
<td>• Ideal for intermittent access or continuous IV therapies, including vesicants</td>
<td>• Most expensive venous access devices to insert</td>
</tr>
<tr>
<td>• Less potential for infection than external catheters</td>
<td>• Must be accessed with a specialized noncoring needle</td>
</tr>
<tr>
<td>• No dressing required when not accessed; ideal for patients with tape sensitivities and active lifestyles and occupations</td>
<td>• Catheter can disconnect from port and migrate, causing extravasation.</td>
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<tr>
<td>• Require infrequent maintenance when not in use</td>
<td>• May interfere with sleep</td>
</tr>
<tr>
<td>• Can be used to draw blood</td>
<td>• Over time, “sludge” (e.g., clotted blood, drug precipitates) may collect in port reservoir and decrease flow efficiency.</td>
</tr>
<tr>
<td>• Have less effect on body image than external catheters; newer models are lower profile.</td>
<td>• Require a skilled nurse to access and deaccess</td>
</tr>
<tr>
<td>• The power-injectable model allows the injection of contrast media at high infusion pressures.</td>
<td>• Not available in triple lumen</td>
</tr>
<tr>
<td></td>
<td>• If infection cannot be successfully treated, surgical removal is required.</td>
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<td></td>
<td>• Peripheral port use limits access for blood sampling, IVs, and blood pressure monitoring to the contralateral limb.</td>
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</table>

Figure 7-5. Radiographic Placement Confirmation of Implanted Port
Schick, & Smith, 2015; Lamperti et al., 2012; O’Grady et al., 2011; Sofue et al., 2015; Teichgräber et al., 2011; Thomopoulos et al., 2014). Electrocardiogram and fluoroscopy guidance techniques have been used with success (Rosssetti et al., 2015; Wang et al., 2015).

1. Subclavian approach: An incision is made under the clavicle, and a subcutaneous (SC) pocket is created. The SC vein is percutaneously entered and a guidewire is passed into the superior vena cava (SVC). A dilator and peel-away sheath are passed over the guidewire, and the guidewire and dilator are removed. The catheter is threaded into place, and the peel-away sheath is removed.

2. Internal jugular (IJ) approach: The IJ vein is identified using ultrasound. A small incision is made in the patient’s neck, and a guide wire is passed into the SVC via the IJ. A tunnel is created in the SC tissue between the neck incision and the port pocket incision. A dilator and peel-away sheath are passed over the guidewire, the guidewire and dilator are removed, the catheter is threaded into place, and the peel-away sheath is removed.

3. Cut-down approach: The skin overlying the deltopectoral groove is cut to visualize the cephalic vein, the cephalic vein is cannulated, and a guidewire is placed in the vein. A dilator and peel-away sheath are passed over the guidewire, the guidewire and dilator are removed, the catheter is threaded into place, and the peel-away sheath is removed. Alternately, a cut-down approach to the external jugular vein may be used (Iorio & Cavallaro, 2015).

4. Peripheral implantation: A port pocket site in upper arm is identified; the cephalic, basilic, or median cubital basilic vein is accessed using an introducer needle attached to a syringe; a blood return is confirmed and the syringe is removed; the tapered end of a J-wire is inserted into the needle; the guidewire is advanced to the SVC; the needle is withdrawn; the dilator and peel-away sheath are advanced over the guidewire; the dilator and guidewire are removed; the catheter is inserted into the sheath and advanced to the cavoatrial junction; and the peel-away sheath is removed (Wildgruber et al., 2015).

5. For all insertion approaches, a nonattached catheter is trimmed to the appropriate length and attached to the portal body. The appropriate length of an attached catheter is estimated prior to insertion and trimmed to desired length.

6. The length of a catheter is based on the distance from the planned catheter tip position to the planned location of the portal body.

7. Mathematical formulas assist in determining appropriate catheter lengths in children and adults (Shin et al., 2015; Stroud et al., 2014).

8. Venous access ports with catheter tips that are too high (above the cavoatrial junction) are at higher risk for further malposition and thrombosis; tips that are too low (in the right atrium) increase the risk of arrhythmia (Linnemann, 2014; Moureau et al., 2013).

9. For all insertion approaches, the portal body is sutured into the fascia and the exit site is sutured closed.

10. A noncoring needle is inserted into the portal body, blood is aspirated, and the device is flushed.

11. Implanted ports with confirmed placement and patency can be used immediately and the noncoring needle is left intact. The catheter tip is just above or in the lower third of the SVC at the cavoatrial junction; consensus guidelines support these preferred tip locations (Ahn & Chung, 2015; Gonda & Li, 2011; Moureau et al., 2013).

12. A retrospective analysis of 1,378 patient electronic medical records concluded no significant increase in infection rates when used on the same day as insertion for outpatient therapy (Young, Young, Vogel, Sutkowski, & Venkataperumal, 2016).

13. A retrospective analysis concluded that if a port is placed with ultrasound or fluoroscopy, a postoperative chest x-ray is not needed to confirm placement (Bowen et al., 2014).

14. Multicenter research revealed that intracavitary electrocardiography is a safe and accurate alternative method of positioning the catheter tip in the pediatric popu-
lation (Rossetti et al., 2015); similar find-
ings have been noted in adult patient pop-
ulations (Wang et al., 2015).

E. Insertion complications (see Chapter 9, Table 9-1)

VII. Unique maintenance and care (see Appendices 2, 4, 5, 7, and 10). No definitive recommendations can be made for flushing solution, volume, and frequency; frequency of dressing and needleless connector changes; or blood sampling technique (see Figure 7-6).

A. Peripheral ports
1. Do not obtain blood pressure measurements from the arm with the peripheral port.
2. Do not attempt to draw blood or insert a peripheral IV catheter above the peripheral portal body.

B. Accessing and deaccessing implanted ports (see Appendix 10)
1. Patient assessment (Bustos, Aguinaga, Carmona-Torre, & Del Pozo, 2014)
   a) Wash hands.
   b) Examine the skin integrity overlying the portal body for redness, edema, or bruising.
   c) Palpate the area around the portal body for warmth and tenderness, and ask the patient about a fever or other signs of infection.
   d) Assess for potential or actual portal body erosion through the skin (Burris & Weis, 2014). Risk is higher in patients with portal bodies implanted close to the skin surface and in patients with significant weight loss.
   e) Inspect the anterior chest wall for collateral veins (dilated superficial veins), which may be a sign of catheter occlusion.
   f) Observe the face and neck for edema, which may be a sign of catheter-related thrombosis or SVC syndrome.
2. Use only noncoring needles.
   a) A specially designed needle tip separates the silicone septum and prevents “coring,” which could lead to debris in the reservoir and leakage.
   b) An offset bevel allows the tip of the needle to be flush with the bottom of the portal body without impeding the flow of solution.
   c) Needle lengths range from 0.5–2 inches.
   d) The most commonly used gauges range from 19–22.

   c) Configuration is straight for flushing and immediate deaccess or bent at a 90° angle for intermittent or continuous infusions.
   f) Available with short pieces of extension tubing, with and without clamps (Extension tubing also may have a Y-site.)
   g) Most include needlestick prevention features.
   b) Power needles are available in 19, 20, and 22 gauge with 0.75–1.5 inch lengths used with power-injectable design ports (e.g., contrast media) (Goltz et al., 2012; Indrajit et al., 2015).

3. Accessing procedure (O’Grady et al., 2011; Schiffer et al., 2013)
   a) Assess need for a topical anesthetic (see Appendix 7).
   b) Determine appropriate noncoring needle size and length based on the patient’s prior use, type and duration of therapy, and patient assessment findings. Ideally, the 90° turn of the noncoring needle should rest as close to the skin as possible; a gap greater than quarter of an inch indicates that a shorter needle should be used.
   c) Palpate the outline of the port body.
   d) Wash hands.
   e) Apply gloves and cleanse the implanted port site (see Appendix 2).
research is insufficient to support routine use of sterile gloves during accessing and deaccessing procedures (see Chapter 1 for controversial issues).

f) Remove the cap on the distal end of the noncoring needle connection tubing and prime the tubing with saline.

g) Stabilize the portal body with one hand and insert the noncoring needle into the center of the portal body until the bottom of the portal body is felt. For obese patients and those with deeply implanted ports, a second person may be helpful in locating and stabilizing the port and a longer needle may be needed (see Figures 7-6 and 7-7).

b) In vitro research has suggested that orienting the noncoring needle bevel opening toward the bottom of the port increases flushing efficiency (Guiffant, Durussel, Flaud, Vigier, & Merckx, 2012).

i) Aspirate to confirm a blood return and flush with 5 to 10 ml of 0.9% normal saline (NS).

j) Secure the noncoring needle using a transparent dressing or a securement device. For short-term use, gauze and tape may be used if properly secured (Webster, Gillies, O’Riordan, Sherriff, & Rickard, 2016) (see Appendix 5).

k) Instruct the patient to report tugging or pulling on the infusion tubing and any activity that may cause the noncoring needle to dislodge. Use a tension loop to prevent needle dislodgment. Consider use of a secondary securement device, if needed, to ensure that the needle is secured.

4. Deaccessing procedure

a) Wash hands and apply gloves.

b) Flush the noncoring needle with NS and follow with a heparin flush solution for open-ended catheters. Valved catheters may be flushed with NS only.

c) Remove the dressing.

d) Use nondominant hand to stabilize portal body.

e) Use dominant hand to gently remove noncoring needle and engage the safety mechanism that encloses the needle point, if present.

f) Discard the noncoring needle in a sharps container.

g) Apply adhesive bandage, as needed.

C. Flushing (Dal Molin et al., 2014; Kefeli et al., 2009; Odabas et al., 2014; Schiffer et al., 2013) (see Appendix 5)

1. No definitive recommendation can be made for flushing volume, solution, or frequency.

2. Research has suggested that the use of NS for intermittent locking of ports may be as effective as using heparinized solution (Bertoglio et al., 2012; Dal Molin et al., 2014; Goossens et al., 2013; Gorji, Rezaei, Jafari, & Cherati, 2015; López-Briz et al., 2014).

3. Heparin flush: Use 10–100 IU/ml, 5 ml after each use, per lumen; every 4–8 weeks if not in use.

4. For valved ports not in use, flush with 5 ml saline every 4–8 weeks to maintain patency.

5. Evidence has suggested that flushing intervals can approach up to three months without severe complications when flushing with 10 ml NS and 3 ml (100 IU/ml) heparinized saline (Odabas et al., 2014).

6. Due to the potential for an increased risk of microbial antibiotic resistance, no definitive recommendation can be made regard-
ing the routine use of antibiotic lock technique for the prevention of catheter-associated infection (van de Wetering, van Woensel, & Lawrie, 2013).

7. Consider the use of antibiotic lock therapy once a port-related infection is diagnosed, or if the patient is at high risk of infection; however, the frequency, length of dwell time, and whether or not to discard or flush antibiotic dwell have not been determined. Sensitivities of the organism dictate antibiotic use (Chesshyre, Goff, Bowen, & Carapetois, 2015; Fernández-Hidalgo & Almirante, 2014; Justo & Bookstaver, 2014; Raad & Chafiri, 2014; van de Wetering et al., 2013; Zhang, Gowdwardman, Morrison, Runnegar, & Rickard, 2016).

D. Blood sampling: Discard 3–5 ml and flush with 10–20 ml NS (Conway, McCollom, & Bannon, 2014; Dailey, Berger, & Dabu, 2014; Rosenbluth et al., 2014) (see Appendix 5).

E. Dressing changes: Remove dressing 24 hours after insertion. No dressing is needed unless being used for therapy; following chlorhexidine (CHG) skin preparation, use a CHG-impregnated sponge dressing for any long-term infusion exceeding 4–6 hours or if the port remains accessed for intermittent infusion for greater than 4–6 hours (O’Grady et al., 2011; Schiffer et al., 2013) (see Appendix 5).

VIII. Removal technique

A. Indications (Granziera et al., 2014; Kim, Oh, Chang, & Jeong, 2012)
1. Completion of therapy
2. Infection (port pocket or catheter-related sepsis) not responsive to treatment
3. Radiologically confirmed thrombosis not responsive to fibrinolytic therapy
4. Dehiscence of port pocket incision
5. Portal body erosion through the skin
6. Catheter fracture or malposition
7. Port body separation from catheter

B. Removed by surgeon or interventional radiologist

IX. Complications (Ignatov et al., 2009; Klösges et al., 2015) (see Chapter 9)

XI. Unique patient education

A. Inform the patient that a venous access port has been implanted, and describe any features (e.g., power port, dual lumen, open ended, valved).

B. Instruct the patient to use an ice pack for comfort if the port is used prior to the resolution of postoperative edema and tenderness.

C. Instruct the patient to carry a port identification card.

D. If the patient has a metal port, inform the patient to alert radiology staff if an MRI is scheduled.

E. Remind the patient to avoid manipulating the portal body; twiddler’s syndrome occurs when a portal body is rotated by the patient and may result in malposition of the portal body or a catheter fracture near the catheter or portal body connection area (Busch et al., 2012).

F. Instruct the patient to not allow peripheral blood sampling or blood pressure monitoring in the arm where the peripheral port is placed.

XII. Competency documentation for implanted port care (see Appendix 10)

The author would like to acknowledge Debra J. McCorkindale, RN, BSN, for her contribution to this chapter that remains unchanged from the previous edition of this book.

References


Chapter 8

Apheresis Catheters

Heather Thompson Mackey, RN, MSN, ANP-BC, AOCN®

I. History (Biffi, 2014; McLeod, 2010; Weinstein, 2014)
   A. Apheresis catheters were introduced with the first polyethylene IV catheters in 1945.
   B. The first type of tunneled central venous catheter, the Broviac® catheter, was introduced in 1973 for use in long-term hyperalimentation in children.
   C. A larger bore catheter, the Hickman® catheter, was introduced in 1976 to expand the applications of a tunneled catheter as well as the patient population (see Chapter 6).
   D. As improvements have been made in catheter technology (e.g., multilumen catheters, increased flow rates), clinical applications have expanded to areas such as hemodialysis and therapeutic apheresis.

II. Device characteristics (Dierickx & Macken, 2015; Golestaneh & Mokrzycki, 2013; Kalantari, 2012; O’Grady et al., 2011)
   A. A large-bore central venous catheter is designed with a high flow rate to allow for collection and reinfusion of blood products (i.e., red or white blood cells, platelets, plasma).
   B. Catheter designs are tunneled or nontunneled, depending on the intended duration of therapy.
      1. With proper care, tunneled catheters have a dwell time of several years.
      2. Nontunneled catheters are designed for temporary use, approximately seven days.
   C. Internal diameters range from 1.5–2 mm.
   D. Available in single- and double-lumen designs. Tunneled also are available in a triple-lumen design, with the third lumen consisting of a smaller diameter as compared to other lumens.
   E. A prime volume of 0.8–1.5 ml allows a flow rate of 300–400 ml/hour or greater.
   F. Typically stiffer as compared to other VADs to allow for higher blood flow rates and volumes. Stiff material makes the catheter more difficult to secure and preserve than other VADs.
   G. Catheters are made of polyurethane.
   H. Distal tips are open ended and require clamping during IV access for connection of IV tubing or syringes. Clamps typically are different colors to allow for identification of specific lumens.
   I. Tunneled are available with a cuff on the catheter.
      1. The cuff is positioned in the subcutaneous tunnel, 1–2 inches from the exit site for fixation of the catheter.
      2. The cuff potentially minimizes the risk of ascending infection from the exit site into the tunnel.
   J. Catheters have radiopaque markings.

III. Device features (Delaney et al., 2014; Golestaneh & Mokrzycki, 2013; Hattori, 2014; Kalantari, 2012; Karakukcu & Unal, 2015; O’Grady et al., 2011; Schiffer et al., 2013)
   A. Typically shorter than other types of central venous access devices (VADs), with lengths ranging from 12-40 cm (4.7–15.8 inches)
   B. Designed with larger lumens compared with other types of central VADs, with sizes ranging from 10–18.5 Fr in adult patients and 6–8 Fr in pediatric patients
   C. Internal diameters range from 1.5–2 mm.
   D. Available in single- and double-lumen designs. Tunneled also are available in a triple-lumen design, with the third lumen consisting of a smaller diameter as compared to other lumens.

IV. Device advantages and disadvantages (Golestaneh & Mokrzycki, 2013; Kalantari, 2012) (see Table 8-1)

V. Patient selection criteria (Delaney et al., 2014; Golestaneh & Mokrzycki, 2013; Kalantari, 2012; Karakukcu & Unal, 2015; O’Grady et al., 2011; Schwartz et al., 2013)
   A. Patient age, in general, does not restrict use of apheresis catheters.
   B. Indications
      1. Apheresis of blood components, including autologous stem cells, to be used with hematopoietic stem cell transplant. A temporary catheter may be used for stem cell collection from allogeneic donors who have poor peripheral venous access.
      2. Leukapheresis
      3. Plasmapheresis
      4. Tunneled catheters may be used for long-term IV access; however, other types of VADs usually are placed if this is the only indication for access.
C. Contraindications
   1. Systemic infection or sepsis
   2. Infection overlying the insertion site, presence of coagulopathies and platelet defects. Coagulopathies and thrombocytopenia should be corrected, when possible, prior to catheter insertion.

VI. Insertion techniques: Method is similar to nontunneled and tunneled VADs (Bowen, Mone, Nelson, & Scaife, 2014; Golestaneh & Mokrzycki, 2013; Kalantari, 2012; O’Grady et al., 2011).

A. Inserted by a surgeon or interventional radiologist using ultrasound or fluoroscopy
B. Prior to placement, ensure that contraindications do not exist, informed consent is obtained, preplacement assessment is completed, laboratory studies are verified, and the medication/chemotherapy order is reviewed (see Appendices 4, 5, and 9).
C. Vein selection
   1. Selected according to the patient’s anatomic structure, type and purpose of catheter, and vessel used. In children, vein selection also is dependent on age, activity level, and anatomy.

Table 8-1. Advantages and Disadvantages of Apheresis Catheters

<table>
<thead>
<tr>
<th>Type of Catheter</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Temporary apheresis catheter</td>
<td>Can be inserted at the bedside when immediate access is required</td>
<td>Designed for short-term use, increased incidence rate of catheter-related infection and sepsis, increased risk of catheter displacement because usually not sutured, often restricted to use for apheresis only</td>
</tr>
<tr>
<td></td>
<td>Can be used immediately after placement</td>
<td>Insertion is a surgical procedure, thrombosis: More likely with polyurethane catheter, poor flow may occur because of the technique used for catheter placement and the rigidity of catheter material.</td>
</tr>
<tr>
<td>Tunneled apheresis catheter</td>
<td>Can be used immediately after placement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide long-term access for apheresis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide high flow rate because of large internal diameter of catheter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower incidence rate of catheter-related infection than with temporary catheters</td>
<td></td>
</tr>
</tbody>
</table>

2. No definitive recommendation can be made regarding a preferred vein for insertion of tunneled VADs to minimize infection risk (Golestaneh & Mokrzycki, 2013; Kalantari, 2012; O’Grady et al., 2011).
3. Most common veins used for insertion
   a) Internal jugular vein
      1) Preferred for tunneled apheresis catheters that will be used long term
      2) Right internal jugular: Preferred due to ease of insertion into the junction of the superior vena cava and right atrium
   b) Subclavian vein: Due to the risk of venous stenosis, avoid if intended for apheresis.
   c) Femoral vein: Avoid in adult patients (O’Grady et al., 2011).

4. Verify catheter position prior to use. Verification of position is not required if placed by ultrasound or fluoroscopy (Bowen et al., 2014). The catheter tip is just above or in the lower third of the superior vena cava at the cavoatrial junction.

VII. Unique maintenance and care: No definitive recommendations can be made for flushing solution, volume, and frequency; frequency of dressing and needleless connector changes; or blood sampling technique (Delaney et al., 2014; Dierickx & Macken, 2015; Golestaneh & Mokrzycki, 2013; Infusion Nurses Society, 2016; O’Grady et al., 2011) (see Appendices 4, 5, and 9).

A. Replace all catheters inserted under emergency conditions as soon as possible when adherence to aseptic technique cannot be ensured.
B. Do not routinely replace apheresis catheters.
C. Apheresis catheter general care
   1. Obtain specific manufacturer information for apheresis catheters prior to use.
   2. Some institutions require a provider order if the catheter is to be used for reasons other than apheresis.
   3. Clamps are used when accessing or deaccessing to prevent air embolisms or blood backflow.
   4. Never use a hemostat or sharp-edged clamp, as these could damage or cut the catheter. Keep toothless plastic clamps available for emergency use. Scissors should never be used on or near the catheters.
   5. If clamping is not possible, have the patient perform the Valsalva maneuver (forcefully exhale and hold breath) whenever the catheter is open to air.
6. A catheter becomes weakened with long-term use of alcohol and iodine-containing products.

D. Dressing changes
1. Change dressing 24 hours after insertion.
2. Change dressing if wet, soiled, contaminated, or nonocclusive. Apheresis catheter sites tend to bleed more easily due to the stiffness of the catheter, which may lead to increased dressing changes from bleeding or oozing around the exit site.
3. Use an aseptic no-touch technique.
4. No definitive recommendation can be made regarding the need for a dressing over a well-healed exit site of long-term, tunneled VADs (see Chapters 4 and 6).

E. Flushing
1. Solution
   a) Use heparin 1,000 IU/ml after each use, 1–2 ml/day. Some settings support the use of concentrations of up to 5,000 IU/ml.
   b) If the heparinized saline is not aspirated and discarded, monitor coagulation levels (e.g., partial thromboplastin time), as this amount of heparin may lead to therapeutic serum levels.
   c) Data support the use of 3 ml of sodium citrate 4% in place of heparin for apheresis catheter locks in apheresis patients, although more research is needed for use with other catheters and patient populations (Passero et al., 2015).
   d) Acid citrate dextrose formula A (2 ml per lumen as locking solution) has been found to be as effective as heparin flush when evaluating for occlusion in short-term dwell times. Heparin was superior in long-term courses and long dwell times. No volume recommendation was given; further research is warranted (Osby et al., 2014).
2. Technique
   a) Flush vigorously using a pulsatile (push-pause motion) technique, maintaining pressure at the end of the flush to prevent reflux back into the catheter.
   b) Maintain a positive pressure technique while flushing an apheresis catheter by clamping the extension tubing while still flushing the line. This will help prevent the development of fibrin sheath, leading to withdrawal or infusion occlusions and contributing to the development of venous thrombosis.

F. Blood sampling techniques
1. Clamp all lumens not being used for blood withdrawal on the apheresis catheter.
2. Discard 3–5 ml of blood, obtain specimens, and flush vigorously using pulsatile technique with 10–20 ml of 0.9% normal saline after blood withdrawal.

VIII. Removal technique: Method is similar to nontunneled and tunneled VADs (see Chapters 4 and 6).
IX. Complications (Golestaneh & Mokrzycki, 2013; Osby et al., 2014) (see Chapter 9)
X. Education and documentation (see Chapter 17)
XI. Practicum on apheresis catheter care (see Appendix 9)

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References


I. Prevention of complications
   A. Staff education and training (Ferrer et al., 2014; Floedgren et al., 2013; Stone et al., 2014)
   1. Implementation of evidence-based measures helps prevent venous access device (VAD)-related complications, improves patient outcomes, and reduces healthcare costs.
   2. Higher levels of education and experience have been linked to a higher rate of successful VAD insertions and fewer complications.
   3. Training programs and dedicated staff (e.g., infection preventionists, vascular resource teams) decrease catheter-related bloodstream infection rates and increase patient satisfaction scores (Broadhurst, Moureau, & Ullman, 2016; Mermel & Parienti, 2015; Molas-Ferrer et al., 2015; O'Grady et al., 2011).
   4. Predictive simulation studies suggest that reduced nurse staffing resources are associated with higher catheter-related bloodstream infection rates; increasing the nurse workload is positively correlated to increased infection rates.
   B. Hand hygiene is critically important before patient contact, before performing an aseptic task, after patient contact and exposure to body fluids, and after contact with a patient’s surroundings (O'Grady et al., 2011; World Health Organization, n.d.).
   C. Disinfection of catheter hubs, connectors, and injection ports is vital to VAD infection prevention (Berardi et al., 2015; Bustos, Aguinaga, Carmona-Torre, & Del Pozo, 2014; Chesshyre, Goff, Bowen, & Carapetis, 2015; Chopra, O’Horo, Rogers, Maki, & Safdar, 2013; García-Gabás et al., 2015; Kulkarni, Wu, Kasthuri, & Moss, 2014).
   D. Decisions about the need for a VAD should be individualized to the patient and based on patient factors (e.g., comorbidities, ability or willingness to participate in device care when applicable), risks and benefits, and the overall cost to the patient, including ongoing maintenance costs such as dressing and flushing supplies.
   E. Considerations for the patient with cancer include the treatment regimen (e.g., irritants, vesicants), length of treatment (e.g., short versus long-term infusion time, continuous infusion), overall duration of therapy (e.g., number of planned cycles), and need or potential need for parenteral nutrition.
   F. Select a device for insertion that minimally meets the patient’s needs (e.g., minimum number of lumens, shortest dwell time).
   G. Central VADs must be considered at the initial treatment planning phase of care.
   H. Perform central venous catheterization only when potential benefits outweigh inherent risks.
   I. Central VAD tips are placed above or in the lower third of the superior vena cava at the cavoatrial junction; less commonly, the tip is placed in the inferior vena cava at the level of the diaphragm (Clemente & Maneval, 2014; York, 2012).
   J. VAD tips above the cavoatrial junction may result in subsequent malposition of the tip and catheter-related thrombosis, and VAD tips in the right atrium may trigger arrhythmias (Clemente & Maneval, 2014; York, 2012).

II. Insertion procedure-related complications (Calvache et al., 2014; Mermel & Parienti, 2015; Parienti et al., 2015) (see Table 9-1)
   A. Monitor the patient closely after placement of VAD for signs of complication, such as shortness of breath, edema, bleeding, or fever.
   B. Inform the patient and caregiver to notify the provider if symptoms occur after placement.
   C. Pediatric considerations: A case report cited that failure to place the catheter tip as close to the cavoatrial junction as possible can increase risk of vascular erosion into the pleural space (Blackwood, Farrow, Kim, & Hunter, 2015).
III. Postinsertion complications and management (see Table 9-1)

A. Catheter migration: The catheter tip migrates spontaneously from the superior vena cava following initial placement (Ast & Ast, 2014; Becaria et al., 2015; Brass, Hellmich, Kolodziej, Schick, & Smith, 2015; Jin et al., 2012; Prabaharan & Thomas, 2014).

1. Etiologies: Change in intrathoracic pressure from coughing, sneezing, or vomiting; forceful flushing; vigorous upper extremity movements; changing body position, weight lifting, or by accidental pulling on an external catheter. Patient level of activity can be a contributor to late catheter migration.

2. Signs and symptoms: Inability or difficulty infusing fluids or withdrawing blood, increased external VAD catheter length, reports of tingling sensation or gurgling in neck, arm or shoulder pain, vague back discomfort, swelling at exit site, pain during injection, or complaints of palpation or chest pain

<table>
<thead>
<tr>
<th>Table 9-1. Venous Access Device Insertion Complications</th>
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<tbody>
<tr>
<td><strong>Complication</strong></td>
</tr>
<tr>
<td>Air embolism (Cook, 2013)</td>
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<tr>
<td>Arrhythmias (Hodzic et al., 2014; Khasawneh &amp; Smalligan, 2011)</td>
</tr>
<tr>
<td>Brachial plexus injury (Kim et al., 2014)</td>
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<table>
<thead>
<tr>
<th>Complication</th>
<th>Symptoms and Physical Exam Findings</th>
<th>Clinical Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial puncture (Hodzic et al., 2014)</td>
<td>Rapid hematoma formation; internal or external bleeding at insertion site; pallor; weak pulse; tachycardia; stroke; hypotension; upper airway impingement if trachea is compressed</td>
<td>Treatment: Remove needle or catheter; apply local pressure; obtain chest x-ray with order; observe site and patient closely for several hours.</td>
</tr>
<tr>
<td>Venous perforation (Khasawneh &amp; Smalligan, 2011)</td>
<td>Shortness of breath; Internal bleeding, tachycardia; unexplained drop in hemoglobin, unilateral pleural effusion ipsilateral to a recently placed VAD</td>
<td>Can be catastrophic but avoidable with careful technique. Treatment: Surgical intervention is required.</td>
</tr>
<tr>
<td>Cardiac tamponade (Khasawneh &amp; Smalligan, 2011)</td>
<td>May occur hours or days after insertion; anxiety; tachypnea; mild dyspnea to severe respiratory distress; light-headedness; restlessness; confusion; chest discomfort (fullness, heaviness); cyanosis; face and neck vein distention; decreased heart sounds; hypotension; tachycardia; syncope</td>
<td>Treatment: Requires immediate intervention. Immediate chest x-ray or echocardiogram is needed for diagnosis; pericardiocentesis may be life-saving. May require surgery to perform pericardial window and placement of drainage tubes.</td>
</tr>
<tr>
<td>Catheter fracture or embolism (Shah &amp; Shah, 2014; Shimizu et al., 2014; Sundriya et al., 2014; Tamura et al., 2014)</td>
<td>Chest pain, cardiac arrhythmias, hypotension, pallor, shortness of breath, tachycardia, confusion; can also be asymptomatic</td>
<td>Treatment: Requires immediate intervention. Place the patient in Trendelenburg; observe the patient for shortness of breath, tachycardia, confusion, and hypotension; obtain immediate consultation from interventional radiology, thoracic or vascular surgeon for removal. Percutaneous retrieval occurs under fluoroscopy or ultrasound imaging or guidewire exchange; percutaneous retrieval may also be performed using percutaneous retrieval systems; surgical intervention may be necessary.</td>
</tr>
<tr>
<td>Catheter tip malposition (Cortelaro et al., 2014; Massmann et al., 2015; Salimi et al., 2015)</td>
<td>Withdrawal occlusion; sluggish infusion; patient report of tingling sensation and gurgling sounds in neck; arm or shoulder pain; chest pain; cardiac dysrhythmias; cardiac arrest</td>
<td>Confirm placement. Treatment: Reposition catheter using imaging or guidewire exchange; remove catheter and replace.</td>
</tr>
<tr>
<td>Exit-site bleeding or hematoma (Hodzic et al., 2014)</td>
<td>Oozing or frank bleeding from the exit site, sometimes persisting for several hours; discoloration or bruising; may result in compartment syndrome (large pooling of blood)</td>
<td>Treatment: Apply local pressure; change dressing, as needed; drain compartment; observe area frequently; remove catheter, if necessary. Apply hemostatic dressing to minimize bleeding.</td>
</tr>
</tbody>
</table>

Table 9-1. Venous Access Device Insertion Complications (Continued)

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### Table 9-1. Venous Access Device Insertion Complications (Continued)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Etiology</th>
<th>Symptoms and Physical Exam Findings</th>
<th>Clinical Intervention</th>
</tr>
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<tbody>
<tr>
<td>Pneumothorax, hemothorax, chylothorax, or hydrothorax (Calvache et al., 2014; Tsotsolis et al., 2015)</td>
<td>Caused by air, blood, lymph, or infusion fluid into the pleural cavity due to pleura, vein, or thoracic duct injury during catheter insertion Risk increases significantly if three or more attempts to cannulate vein occur.</td>
<td>Chest pain; tachypnea; dyspnea; decreased breath sounds; shift in location of heart sounds; cyanosis; decreased cardiac output</td>
<td>Treatment: Obtain chest x-ray and discontinue infusions; administer oxygen; prepare for needle aspirations and chest tube drainage. Perform thoracotomy for drainage, if necessary. Remove device.</td>
</tr>
<tr>
<td>Left innominate vein stenosis (Song et al., 2015)</td>
<td>Can occur in some patients after placement via internal jugular vein; significantly more common in left-sided placement Incidence increased when the distance between sternum and left innominate vein was less than 16 mm.</td>
<td>Pain, swelling in affected arm and ipsilateral side of face and neck; headache; pressure</td>
<td>Prevention: Consider an ipsilateral approach in patients with right-sided cancer and a retrosternal space of &lt; 16 mm. Treatment: Remove device.</td>
</tr>
<tr>
<td>Phlebitis (Cotogni &amp; Pittiruti, 2014; Jumani et al., 2013; Schneider et al., 2015)</td>
<td>In peripherally inserted central catheters, can occur as a result of traumatic insertion or mechanical or chemical irritation</td>
<td>Pain, erythema, streak formation, palpable cord, edema</td>
<td>Prevention: Keep manipulation of the catheter to a minimum to prevent mechanical phlebitis and avoid stabilizing with sutures. Treatment: Apply warm compresses, elevate extremity, and administer pain medication.</td>
</tr>
<tr>
<td>Guidewire entanglement, kink, breakage, or loss (Khasawneh &amp; Smalligan, 2011)</td>
<td>Kinking or looping of the guidewire, entanglement in existing intravascular equipment (e.g., pacers, wires, superior vena cava filters), or loss of entire guidewire or breakage resulting from excessive force used to thread guidewire through introducer</td>
<td>May be dependent on location of defect; often causes inability to advance or withdraw guidewire; typically is observed as resistance during insertion or withdrawal of guidewire or complete loss of guidewire, which may result in arrhythmias, damage to vessels, or thrombosis</td>
<td>Prevention: Skilled technique can ensure avoidance of most guidewire complications. Treatment: Guidewire is retrieved by an interventional radiologist.</td>
</tr>
</tbody>
</table>

3. Diagnostic tests: Chest x-ray or dye study/cathetergram
   a) May be kinked, looped, coiled, or curled
   b) The tip may migrate from the cavoatrial junction to the internal jugular vein in the neck, contralateral brachiocephalic vein, or axillary vein.

4. Management: An appropriate repositioning method should be selected according to location of catheter tip, cause of malposition, length of malposition, and the patient’s condition. Invasive and noninvasive procedures include the following:
   a) Percutaneous catheter repositioning using snares or wire-assisted long-loop snaring under fluoroscopic guidance
   b) Catheter-exchange procedure using a guidewire (for nontunneled, percutaneous VADs)
   c) Pulsatile (push-pause) flushing of device
   d) Device removal and replacement
   e) Repositioning should fail if the catheter length is insufficient to ensure proper placement; caution should be used to ensure that the catheter length is sufficient to allow for successful repositioning (Massmann, Jagoda, Kranzhoefer, & Buecker, 2015).
   f) A catheter too deep into the atrium can be withdrawn to the correct placement at the time of insertion.
   g) Consequences of uncorrected malposition: Delayed hydrothorax and sud-
den deaths have been reported (Jabeen, Murtaza, Hanif, Morabito, & Khalil, 2014).

B. Rotation of port (see Figure 9-1)

1. Etiologies
   a) Implanted portal bodies that are minimally secured during implantation may rotate or flip in the subcutaneous (SC) tissue upon rotation of the arm or shoulder, commonly referred to as “flipped port.”
   b) Twiddler’s syndrome occurs when a portal body is manipulated and rotated by the patient. It may result in malposition of the portal body or catheter fracture (Busch et al., 2012).
   c) Significant weight loss contributes to rotation of the portal body in the SC port pocket.

2. Signs and symptoms: Inability to palpate or access portal body

3. Diagnostic tests: Chest x-ray or chest computed tomography scan to visualize the portal body

4. Management: Depends on degree of rotation and coiling of catheter
   a) May be able to subcutaneously rotate into correct position
   b) May require surgical repositioning of device
   c) If catheter or portal device has become damaged during reposition, the device may need to be removed and replaced.

C. Portal body erosion: Erosion of portal body through the skin surface (Burris & Weis, 2014; Harish, 2014)

1. Etiologies
   a) Significant weight loss after port insertion
   b) Repeated improper access technique into port body
   c) Repeated use of ethyl chloride spray as topical anesthetic
   d) Wound dehiscence after port placement
   e) Poor wound healing of the insertion site after port placement

2. Signs and symptoms: Visualization of the portal body outline just below the skin surface (impending erosion) or visualization of the portal body (partial or complete explantation) (see Figure 9-2)

3. Diagnostic tests: Wound culture, as indicated

4. Management: Device removal

D. Mechanical VAD catheter compression and fracture (El Hammoumi et al., 2014; Sugimoto, Nagata, Hayashi, & Kano, 2012; Sundriyal, Jain, & Manjunath, 2014; Tamura et al., 2014; Tazzioli et al., 2015): This also is called pinch-off syndrome or spontaneous catheter fracture (see Figures 9-3 and 9-4).

1. Etiology: The catheter is compressed between the clavicle and first rib in the cos-
When a complete catheter fracture occurs, the distal portion of the catheter can travel to the jugular vein, superior vena cava, heart cavities, or lung.

2. Prevention: Research has shown that ultrasound-guided placement reduces the risk of catheter compression versus the use of the landmark technique (Brass et al., 2015).

3. Signs and symptoms
   a) Difficulty infusing fluids or withdrawing blood, despite patient repositioning
   b) Signs and symptoms of fracture depend on presence or location of embolized catheter fragment and may include palpitations, shortness of breath, and chest pain.

4. Diagnostic tests: Compression may be visualized on chest x-ray (with arms at the side and not rolled over) or dye study/cathetergram.

5. Management
   a) If a complete fracture and embolization occurs, a catheter fragment may be retrievable.
   b) Remove any remaining device components.
   c) No definitive recommendation can be made regarding the frequency or type of imaging needed for surveillance to detect mechanical failure.
   d) Persistent withdrawal and flushing problems should be monitored closely, including imaging studies, as these findings in a catheter indicate compression.

E. Catheter occlusion: Partial to complete obstruction within the lumen or at the distal tip. Partial (incomplete) is defined as the ability to flush fluid yet unable to withdraw blood. Complete is defined as the inability to flush or withdraw blood (Anderson, Pesaturo, Casavant, & Ramsey, 2013; Baskin et al., 2012; Boddi et al., 2015; D’Ambrosio, Aglietta, & Grignani, 2014; Linnemann, 2014; Murray, Precious, & Alikhan, 2013).

1. Etiologies
   a) Fibrin sheath: The fibrin adheres to the catheter tip and external surface forming a tail or sheath, which can extend the entire length of catheter. The sheath acts as a one-way valve that permits infusion but prevents withdrawal of blood. A fibrin sheath is one of the most common causes of thrombotic occlusion and is the most common cause of partial obstruction.
   b) Intraluminal clots: Form around the catheter surface, causing incomplete occlusion (see Figures 9-5 and 9-6)
   c) Mural thrombosis: Intraluminal clots adhere to the vessel wall, forming a venous thrombus and causing incomplete occlusion.
d) Deep vein thrombosis (DVT): Catheter-related thrombosis that occludes the vein; typically located in the upper extremity. It most commonly is found in the subclavian, followed by axillary, brachial, and brachiocephalic veins (Jasti & Streiff, 2014; Zwicker, Connolly, Carrier, Kamphuisen, & Lee, 2014).

e) Infusion of incompatible solutions or inadequate flushing, causing precipitation, crystallization, or lipid deposits within the catheter or at the distal tip

   a) Past medical history of venous thromboembolism; undergoing a surgery when a peripherally inserted central catheter (PICC) already is in place; hypercoagulable state
   b) Presence of sludge (sediment containing blood components, drug and mineral precipitates or residue, or lipid residue) adhering to the internal path of the port reservoir
   c) Use of larger gauge catheter or multilumen catheter
   d) Improper positioning of the catheter tip
   e) Specific cancer tumor types (e.g., breast, lung, lymphoma)
   f) History of recent surgery, immobilization, chemotherapy, or targeted therapies (Elyamany, Alzahrani, & Bukhary, 2014)

3. Prevention (D’Ambrosio et al., 2014; Duffy, Rodgers, Shever, & Hockenberry, 2015; Hajjar, 2015; Odabas et al., 2014; O’Grady et al., 2011; Snarski et al., 2015; Stone et al., 2014)
   a) Early identification of at-risk patients helps guide practice.
   b) Adequate catheter flushing and heparinization (open-ended catheters). Data suggest that no difference exists in rate of occlusion when VADs are flushed with heparin or normal saline (Heidari Gorji, Rezaei, Jafari, & Yazdani Cherati, 2015), whereas some studies report statistical trends toward higher incidence of complications in saline-only cohorts (López-Briz et al., 2014). Manufacturers of open-ended VADs continue to advise the use of
heparin flushes for “locking” after VAD use, and it continues as a common clinical practice (Heidari Gorji et al., 2015; López-Briz et al., 2014; Lyons & Phalen, 2014).

c) Pediatric: Weak evidence exists for daily flushing of noninfusing implanted ports to prevent fibrin accumulation; however, evidence does not support definitive heparin volumes and concentrations, as the study did not report heparin volumes and concentrations. No recommendations were made for PICC flushing in this population (Conway, McCollom, & Bannon, 2014).

d) Some studies suggest that systemic anticoagulation for thromboprophylaxis confers a benefit; use must be weighed against the potential harm associated with anticoagulant therapy. No recommendation can be made regarding prophylactic anticoagulation in pediatric and adult populations (Akl et al., 2014; Ast & Ast, 2014; Geerts, 2014; Jasti & Streiff, 2014; Park et al., 2014; Schiffer et al., 2013; Wiegering et al., 2014).

4. Signs and symptoms
   a) Partial occlusion allows fluid to be infused but not withdrawn.
   b) Total occlusion prevents infusion of fluids and withdrawal of blood.
   c) Mural thrombosis may cause pain or edema in neck or upper extremities.
   d) DVT reveals edema of extremity, warmth, and palpable cord.

5. Diagnostic tests
   a) Based on symptoms
   b) Based on medications administered prior to onset of symptoms
   c) A chest x-ray may be ordered to rule out mechanical causes of occlusion.
   d) Perform a cathetergram/dye study to visualize catheter patency and the presence of fibrin tail, which may be causing backtracking along the catheter toward the venotomy site.
   e) Ultrasound demonstrates high specificity and sensitivity as the initial diagnostic test if upper-extremity DVT is suspected (Fallouh, McGuirk, Flanders, & Chopra, 2015).

6. Management (see Figures 9-7 and 9-8)
   a) Treatment of occlusions caused by intraluminal blood or fibrin, precipitates, and lipid deposits (see Table 9-2)
   b) Blood or fibrin occlusion: Instill 2 mg tissue plasminogen activator, followed by a period of dwell time. Refer to the manufacturer’s package insert for dosage and dwell time (Ragsdale, Oliver, Thompson, & Evans, 2014; Schiffer et al., 2013).
   c) Upper-extremity DVT: Initiate systemic anticoagulation therapy with low-molecular-weight heparin alone or low-molecular-weight heparin followed by warfarin for the life of the VAD. If the VAD is removed, continue anticoagulation therapy for three months. Consider VAD removal if symptoms persist, infection is suspected within the clot, or if the VAD is dysfunctional or no longer necessary (Debourdeau et al., 2013; National Comprehensive Cancer Network®, 2016).
   d) Removal: Although it is not always necessary to remove a catheter with a catheter-associated thrombosis, radio logically confirmed thrombi unresponsive to fibrinolytic treatment requires catheter removal (Schiffer et al., 2013).
   e) Removal alternative: Mechanical thrombolysis using a hair wire under fluoroscopy followed by aspiration of the fragments and remnant thrombus removal by saline flush has been reported to be successful (Oh, Choi, Chun, & Lee, 2015).

F. Infection (Berardi et al., 2015; Bustos et al., 2014; Chesshyre et al., 2015; Chopra et al., 2013; Ciocson, Hernandez, Atallah, & Amer, 2014; García-Gabás et al., 2015; Kulkarni et al., 2014; Mermel, 2015, Mermel & Parienti, 2015)

1. Etiologies
Chapter 9. Complications of Long-Term Venous Access Devices

Figure 9-7. Management of Occlusion Algorithm

- **Complete Catheter Occlusion** (unable to flush or aspirate)
  - **ASSESSMENT**
    - Time since last flush
    - Recent usage for blood or drugs or TPN
    - Check that catheter tubing is unclamped
    - Individual history of complications (e.g., "pinch-off" syndrome)
  - **Probable Cause of Occlusion**

1. **Mechanical**
   - Verify proper needle placement (port)
   - Change needle (port)
   - Change position of patient (as for partial occlusion)
   - **OPTIONS**
     - Imaging study to verify placement
     - Remove catheter
     - Radiological reposition of catheter
     - If "pinch-off" is the source of the problem, replace catheter

2. **Blood clot**
   - **OPTIONS**
     - Imaging study to verify placement
     - Instillation of alteplase
     - Remove catheter

3. **Precipitate**
   - **OPTIONS**
     - Imaging study to verify placement
     - Instillation of alteplase
     - Remove catheter

TPN—total parenteral nutrition


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*a)* Most infections originate from the skin microbiota surrounding the catheter insertion site.

*b)* Catheter manipulation and repeated implanted port accessing are associated with development of intraluminal biofilm.

*c)* Biofilm development begins shortly after VAD insertion; however, clinical features of infection may not be apparent for days to weeks.

2. **Risk factors** (Bustos et al., 2014; Chesshyre et al., 2015; Chopra et al., 2013; Ciocson et al., 2014; Freire et al., 2013; Jia et al., 2015; Kaur, Gupta, Gombar, Chander, & Sahoo, 2015; Rhee, Heung, Chen, & Chenoweth, 2015)

*a)* Hematologic malignancies (particularly when immunosuppressed or if device is implanted when patient is neutropenic)
   - (1) Probability scoring using a modified Infection Probability Score has been shown to be a useful measure of probability of central line–associated bloodstream infection (CLABSI) development in patients with hematologic malignancies.

*b)* Prolonged neutropenia

*c)* Older age
**Figure 9-8. Catheter Withdrawal Algorithm**

- **Catheter Withdrawal Occlusion (flushes easily)**
  - Assessment
    - Reposition patient
    - Time since last flush
    - Recent usage for blood or drugs
    - Individual history of complications
  - **Flushes freely**
    - No blood return
    - No pain or discomfort
  - **Turn from side to side**
    - Raise arms
    - Hold breath
    - Breathe deeply
  - **Patency restored**
  - **Withdrawal occlusion remains**
    - **Alteplase**
  - **May use, but continue to evaluate for presence of pain or sluggish flow**
  - **Cathetergram with contrast media**

- **Pinch-off syndrome**
  - **Remove catheter**
  - **Thrombosis**
    - **Alteplase**
  - **Malpositioned in jugular or internal mammary veins**
    - **Consider device removal**
  - **Reposition catheter**
  - **Embedded in vessel wall**
    - **Reposition catheter**
  - **Withdrawal occlusion remains**
    - **Patency restored**
  - **Sluggish flow**
    - No blood return
    - No pain or discomfort
  - **Cathetergram with contrast media**

---

- Use of catheter for nonchemotherapy indications
- Comorbidities
- Prolonged intensive care unit (ICU) hospitalization
- Increased number of catheter days (e.g., dwell time)
- PICCs are associated with a lower risk of CLABSI in outpatients; however, if a patient is admitted to the hospital with a PICC, the risk of CLABSI is equal to that of other VADs.
- Research correlates central line infections in children with increased mortality, increased length of hospital and ICU stays, treatment interruptions, and increased complications (Chesshyre et al., 2015).

3. **Prevention** (Bustos et al., 2014; Duffy et al., 2015; Mermel, 2015; Mermel & Parent, 2015; Morano et al., 2015; O’Grady et al., 2011; Schiffer et al., 2013; Snarski et al., 2015; Stone et al., 2014; Walz et al., 2015)
   - The goals are to diminish colonization of the catheter insertion site and hub, minimize the spread of microorganisms from the skin to the catheter hub, and reduce microbial spread.
through the catheter lumen to the bloodstream.

b) Incorporate central line bundle principles into daily maintenance and care, including hand hygiene, optimal catheter site selection, maximal barrier precautions during catheter insertion, chlorhexidine skin antisepsis during catheter insertion, and daily review line necessity, with prompt removal of unnecessary lines (Institute for Healthcare Improvement, 2016).

<table>
<thead>
<tr>
<th>Occlusion Type</th>
<th>At Risk</th>
<th>Prevention</th>
<th>Intervention</th>
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<tbody>
<tr>
<td>Mechanical obstruction</td>
<td>At catheter placement; inadequate securement of device</td>
<td>Astute assessment and early intervention of potential obstructions can prevent occurrence.</td>
<td>Dependent on etiology. May include catheter migration, port rotation, catheter compression (e.g., pinch-off syndrome), kinks in catheter or securement device, or catheter fracture</td>
</tr>
<tr>
<td>Blood/fibrin</td>
<td>Hypercoagulable state; type of malignancy; inadequate flushing</td>
<td>Meticulous catheter care and adequate flushing using a push-pause, pulsatile, or turbulent technique facilitates thorough rinsing of the intraluminal spaces and can prevent occurrence.</td>
<td>The goal is to dissolve the blood/fibrin: Instillation of 2 mg tissue plasminogen activator recommended, followed by a period of dwell time to restore patency and preserve catheter function occluded by intraluminal blood or fibrin. Refer to manufacturer’s package insert for dosages and dwell times. Repeat if unsuccessful. Remove device if radiologically confirmed thrombosis is not responsive to fibrinolytic treatment or if fibrinolytic or anticoagulation therapy is contraindicated (Anderson et al., 2013; Ast &amp; Ast, 2014; Ragsdale et al., 2014; Schiffer et al., 2013).</td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>Hypercoagulable state; type of malignancy; inadequate flushing</td>
<td>Evidence does not support routine administration of prophylactic systemic anticoagulation to decrease incidence of catheter-associated thrombosis. Routine and thorough flushing of the catheter in all lumens with normal saline with use and after blood sampling is recommended to prevent fibrin accumulation that can result in a thrombosis. Meticulous catheter care and adequate flushing using a push-pause, pulsatile, or turbulent technique facilitates thorough rinsing of the intraluminal spaces.</td>
<td>For an occluded clot of the upper extremity, three to six months of anticoagulant therapy with low-molecular-weight heparin (LMWH) or LMWH followed by warfarin is recommended for treatment of symptomatic thrombosis for the life of the catheter. Remove device if not functional, no longer needed, symptoms persist, if infection is suspected within the clot, if radiologically confirmed thrombosis is not responsive to fibrinolytic treatment, or if fibrinolytic or anticoagulation therapy is contraindicated (Anderson et al., 2013; Ast &amp; Ast, 2014; Jasti &amp; Streiff, 2014; Ragsdale et al., 2014; Schiffer et al., 2013).</td>
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<tr>
<td>Mineral precipitate</td>
<td>Patients receiving concentrated levels of calcium and phosphate in total parenteral nutrition (TPN) at increased risk; inadequate flushing after incompatible medications or solutions</td>
<td>Be aware that 3-in-1 solutions can cause slow occlusions over time. Observe TPN for signs of precipitation prior to administration. Filtering is necessary to avoid occlusion; regular flushing with ethanol alcohol (EtOH) has been shown to decrease the incidence of TPN 3-in-1 precipitation. Change administration set used with TPN solution at least every 24 hours. Meticulous catheter care and adequate flushing using a push-pause, pulsatile, or turbulent technique facilitates thorough rinsing of the intraluminal spaces.</td>
<td>The goal is to increase the solubility of the identified precipitate by altering the pH in the catheter lumen. Sodium bicarbonate (8.4%) is used to dissolve alkaline precipitations. Sodium hydroxide (NaOH) (0.1 normality [N]) also may dissolve alkaline precipitations. Hydrochloric acid (HCl) (0.1 N) compounded specifically for this purpose is used to dissolve acidic precipitations. Extreme caution should be used when instilling HCl into the venous system, as fever, phlebitis, and sepsis can result. Cysteine HCl has been identified in the literature for use in neonates to decrease the pH of TPN solutions. Calcium-phosphate precipitation can be treated with an HCl (0.1 N) instillation (Ast &amp; Ast, 2014; Baskin et al., 2012; Pal &amp; Plogsted, 2014).</td>
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(Continued on next page)
Table 9-2. Device Obstructions: Risks, Prevention, and Management (Continued)

<table>
<thead>
<tr>
<th>Occlusion Type</th>
<th>At Risk</th>
<th>Prevention</th>
<th>Intervention</th>
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<tbody>
<tr>
<td>Drug precipitate</td>
<td>Patients who have received incompatible drugs, forming a precipitate often exhibited as an abrupt occlusion. Phenytoin and heparin are at high risk for precipitation; inadequate flushing between medications.</td>
<td>Proper saline flushing prior to and after drug administration can prevent precipitation. Assess for potential of drug incompatibility. Use separate lumens to infuse drugs, if possible. Meticulous catheter care and adequate flushing using a push-pause, pulsatile, or turbulent technique facilitates thorough rinsing of the intraluminal spaces. Ensure adequate flushing between medications. Examples of drugs prone to intraluminal precipitation include • Calcium gluconate • Phenytoin • Diazepam Examples of drugs incompatible with heparin include • Codeine • Cytarabine • Daunorubicin • Dobutamine • Erythromycin • Gentamycin • Hyaluronidase • Kanamycin • Levorphanol • Meperidine • Methadone • Morphine • Polymyxin B • Promethazine • Streptomycin</td>
<td>The goal is to dissolve precipitate. HCl 0.1 N instilled into occluded catheter lumen may dissolve low pH drug precipitates. Extreme caution should be used when instilling HCl into the venous system, as fever, phlebitis, and sepsis can result. Sodium bicarbonate instilled into occluded catheter lumen may dissolve high pH drug precipitates (Ast &amp; Ast, 2014; Baskin et al., 2012).</td>
</tr>
<tr>
<td>Lipid residue</td>
<td>Patients receiving regular infusion containing lipids</td>
<td>Use TPN solutions in the first 28 hours after preparation to decrease risk of residue buildup in the catheter.</td>
<td>The goal is to dissolve lipid residue. Instillation of EIOH, NaOH, or ethanol into occluded catheter lumen may restore patency, especially if lipid emulsion buildup associated with TPN is suspected. Meticulous catheter care and adequate flushing using a push-pause, pulsatile, or turbulent technique facilitates thorough rinsing of the intraluminal spaces. A 70% EtOH solution is cited as successful in treatment for mainly lipid residue-based occlusion. Literature supports a combination treatment containing NaOH and EIOH if treatment with one of the agents is ineffective. Note: Alcohol solutions (ethanol or ethyl alcohol) may damage some catheter types; review manufacturer directions and warnings prior to instillation.</td>
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<tr>
<td>Unresolved controversies (see Chapter 1)</td>
<td>Ethanol locks may be associated with plasma protein precipitation</td>
<td>May be minimized or eliminated by limiting the concentration of the lock solution (Schilcher et al., 2013)</td>
<td>Most efficacious irrigation protocol (solution used, time between flushes) remains controversial (Palese et al., 2014; Ragsdale et al., 2014; Restrepo et al., 2015; Schiffer et al., 2013; Schilcher et al., 2013).</td>
</tr>
</tbody>
</table>
4. Research on infection prevention (O’Grady et al., 2011; Schiffer et al., 2013)
   a) Antibiotics: Do not administer antibiotics before the insertion of long-term VADs to prevent gram-positive catheter-related infections.
   b) Antimicrobial catheters: Limited evidence suggests that antimicrobial VADs reduce catheter colonization; however, benefits vary by setting and were only significant in studies conducted in ICUs. The use of antimicrobial-impregnated catheters (chlorhexidine and silver sulfadiazine, or minocycline/rifampin-coated) is recommended for short-term VADs; use remains controversial due to benefits weighed with increased costs. Limited evidence suggests that antimicrobial VADs do not appear to significantly reduce clinically diagnosed sepsis or mortality (Lai et al., 2016; Schiffer et al., 2013).
   c) One quasiexperimental study in ICU/burn/trauma patients found that a switch from uncoated catheters to chlorhexidine-silver-sulfadiazine-coated catheters resulted in a reduction in CLABSI incidence (Mermel, 2015).
   d) Further study is needed (Lai et al., 2016; Schiffer et al., 2013).
   e) No definitive recommendation can be made regarding routine use of antibiotic flushing or antibiotic lock solutions.
   f) Heparin-bonded catheters: Weak evidence exists that time to infection is longer in pediatric patients with heparin-bonded catheters, likely due to decreased fibrin accumulation. No definitive recommendation can be made based on available evidence (Shah & Shah, 2014).
   g) Use a chlorhexidine gluconate (CHG)-impregnated sponge dressing for all catheters, including specialty catheters in patients older than 2 months of age, unless sensitive to CHG (Karpanen et al., 2016; Kerwat et al., 2015; Safdar et al., 2014; Ullman et al., 2015; Wibaux et al., 2015).
   b) Analyses suggest increases in catheter-related bloodstream infections (CRBSIs) with polyurethane (transparent) dressing use; likewise, data also suggest no statistical differences between dressings (gauze versus transparent) in regard to infection incidence.
   i) Further research on gauze and tape versus polyurethane dressings for VAD sites is needed (Pedrolo, Danski, & Vayego, 2014; Webster, Gillies, O’Riordan, Sherriff, & Rickard, 2016).
   j) Catheter lock treatment: Meta-analysis in pediatric patients showed no significant difference between ethanol or urokinase lock treatments with concomitant systemic antibiotics and antibiotics alone regarding the number of catheter-related infections, days to first negative blood culture, number of ICU admissions or cases of sepsis, or number of catheters prematurely removed; however, study group sizes were small (Schoot, van Dalen, van Ommen, & van de Wetering, 2013).
   k) Use of topical antibiotic cream or ointment on insertion sites is not recommended because of the potential to promote fungal infections and antibiotic resistance (Schiffer et al., 2013).

5. Signs and symptoms (see Figure 9-9)
   a) Local infection signs and symptoms include swelling, tenderness, erythema, induration, cellulitis, drainage with positive culture, and tunnelitis (tunneled catheters).
b) Signs of systemic infection include fever, chills, diaphoresis, fatigue, arthralgia, weakness, hypotension, tachycardia, hyperventilation, mental status changes, abdominal pain, vomiting, and diarrhea; may progress to infective endocarditis and septic shock.

6. Diagnostic tests (Bustos et al., 2014; Schiffer et al., 2013)
   a) VAD-related infection is diagnosed when no other detectable site of infection, except for the catheter, is identified.
   b) VAD-related infections can be grouped into three categories: localized insertion-site infections, tunnel or port pocket infections, and CRBSIs.
   c) Local infection is diagnosed by culture of insertion sites, tunnels, and local purulence.
   d) Diagnosis of CRBSIs is based on fever (> 38°C [100.4°F]), chills or hypotension, and positive blood cultures with isolation of the same microorganism from the catheter and bloodstream.
   e) Diagnosis requires that the same microorganism grows from at least one blood culture or from the culture of the catheter tip; with infections of less virulent microorganisms (e.g., Micrococcus, Corynebacterium, Bacillus), diagnosis requires that at least two positive results of blood cultures are obtained from samples from different sites. Research suggests that cultures of closed needleless connectors can be used to evaluate catheter tip colonization and are superior to hub cultures for identification of catheter colonization (Guembe, Pérez-Granda, Cruces, Martín-Rabadán, & Bouza, 2015).
   f) Draw blood cultures from each catheter lumen. A positive differential quantitative blood culture that is threefold greater than an identical bacterial colony count in a specimen from a peripheral vein is indicative of infection.
      (1) When it is not possible to obtain blood from a peripheral vein or if the patient has a multilumen catheter, guidelines suggest that diagnosis of catheter-related bacteremia can be made by isolating 100 or greater colony-forming units per milliliter of bacteria from a single quantitative blood culture drawn from one of the lumens of the catheter.
      (2) Recent evidence suggests that, in the event of inadequate sample size from any specific lumen, sampling each catheter lumen and pooling the blood into one culture bottle is as effective as individually cultured samples to substantiate colonization or CLABSI diagnosis. This option is considered a better choice than sampling only one lumen when sending multiple blood culture bottles (Herrera-Guerra, Garza-González, Martínez-Resendez, Llaca-Díaz, & Camacho-Ortiz, 2015).
   g) Diagnosing catheter-related bacteremia after catheter removal has traditionally required a culture of 4 cm of the catheter tip.
   h) Following removal, the portal bodies of implanted ports should be cultured by slicing the silicone septum and culturing the portal body reservoir. Microorganisms most commonly implicated in CRBSI are coagulase-negative Staphylococcus, Staphylococcus aureus, enteric gram-negative bacilli, Pseudomonas species, and Candida species.

7. Management (Bustos et al., 2014; Schiffer et al., 2013; Yacobovich et al., 2015)
   a) Most insertion-site infections can be successfully treated with appropriate antimicrobial therapy, with the catheter remaining in place.
b) Infected catheters are treated by initiating local and systemic antimicrobials. Choice of antimicrobial agent depends on culture results; empiric treatment is typically started until culture results are available.

c) Vancomycin is considered the drug of choice for empiric treatment.

d) When the catheter remains in place, empiric antimicrobial treatment is administered systemically (IV) and locally (antibiotic lock technique) for 10–14 days and sometimes longer.

e) Use antibiotic lock therapy once catheter-related infection is diagnosed, or if the patient is at high risk of infection; however, the frequency, length of dwell time, and whether or not to discard or flush antibiotic dwell has not been determined. Sensitivities of the organism dictate antibiotic use (Chesshyre et al., 2015; Fernández-Hidalgo & Almirante, 2014; Justo & Bookstaver, 2014; Raad & Chaftari, 2014; van de Wetering, van Woensel, & Lawrie, 2013; Zhang, Gowardman, Morrison, R unnegar, & Rickard, 2016).

f) Flushing or locking long-term VADs with a combined antibiotic and heparin solution appears to reduce gram-positive catheter-related sepsis in people at risk of neutropenia from chemotherapy or bone marrow disease. However, the use of a combined antibiotic and heparin solution may increase microbial antibiotic resistance; therefore, it should be reserved for those at high risk or where baseline VAD infection rates are high (>15%) (Centers for Disease Control and Prevention, 2016; Justo & Bookstaver, 2014; Raad & Chaftari, 2014; van de Wetering et al., 2013).

g) Antibiotic lock technique consists of infusing a concentrated antimicrobial solution in a small volume to fill the catheter lumen to penetrate biofilm and eradicate bacteria (Schiffer et al., 2013).

h) VAD removal is required for signs of SC tunnel infection (tunneled catheters); suppurative phlebitis; septic shock; peripheral or pulmonary embolization; infective endocarditis; persistent bacteremia; or recurrent infection despite adequate antimicrobial treatment.

i) Catheter retention is associated with a high risk of bacteremia recurrence as well as hospital readmission (Khong, Baggs, Kleinbaum, Cochran, & Jernigan, 2015).

G. Device damage (Balsorano et al., 2014; Busch et al., 2012; El Hammoumi et al., 2014; Gha derian, Sabri, & Ahmadi, 2015; Gurkan et al., 2015)

1. Etiologies: Preinsertion damage or damage during insertion (e.g., nicking of catheter, guidewire puncture of catheter; suture occlusion of catheter); postinsertion damage of external catheters (e.g., nicking with scissors or clamping); forceful flushing that ruptures catheter; separation of catheter from portal body

2. Signs and symptoms: Visible leak, moist dressing, pain, edema, visible portal body, inability to withdraw blood; evidence of extravasation; note that the patient may be asymptomatic, despite catheter fracture with embolization of fragments (Shimizu et al., 2014).

3. Diagnostic tests: Observation of leak in external catheter during flushing; chest x-ray or dye study/cathetergram

4. Management

   a) Over-the-guidewire exchange of ruptured external venous catheter

   b) Repair of external portion of PICC or tunneled catheter using manufacturer’s repair kit using maximum sterile barrier precautions

   c) Device removal and replacement

H. Extravasation of vesicant or irritant chemotherapy and noncytotoxic drugs (Gonzalez, 2013; Le & Patel, 2014; Molas-Ferrer et al., 2015): Leakage or escape of infusate from the vessel into the surrounding tissue; severity depends on the drug used and its mechanism of action and/or properties (see Figure 9-10).

1. Etiology

   a) Irritants may cause inflammation, pain, or burning, with rare subsequent tissue necrosis that is volume or high-concentration dependent.

   b) Vesicants may cause local blisters, pain, or extensive damage of underlying layers of tissue, leading to tissue necrosis if left untreated.
c) Irritants with vesicant properties can cause damage similar to vesicants.  
d) Antineoplastics that bind with DNA cause indolent and progressive tissue destruction; agents that do not bind with DNA remain contained locally.

2. Risk factors  
   a) Patient movement that causes dislodgment of noncoring needle from implanted port  
   b) Incomplete noncoring needle insertion into implanted port  
   c) Separation of catheter from portal body  
   d) Ruptured/damaged catheter  
   e) VAD catheter tip migration into the SC tissue  
   f) Backtracking of vesicant along extraluminal surface of catheter due to fibrin sheath  
   g) Low pH and high osmolar solutions, diluents used in solutions, vasoactive properties of drug infused, presence of inactive ingredients that may cause vein irritation  
   h) Treatment regimens with more than one vesicant or irritant drug

3. Prevention  
   a) Use an appropriate size and length of noncoring needle and ensure needle stabilization.  
   b) Ensure brisk blood return. Ensure consistent verification of blood return prior to, during, and after infusion.  
   c) Use short-acting topical anesthetics prior to port access (if indicated) to ensure that the patient can sense early symptoms of extravasation.  
   d) Use a transparent dressing to allow visualization of the site. Secure port needle. Consider tension loop or use of other securement device.  
   e) Monitor IV site throughout the infusion.  
   f) Instruct the patient to promptly report signs and symptoms of extravasation, such as burning, pain, or discomfort; discontinue vesicant administration at first sign of extravasation.

4. Signs and symptoms: Absence of blood return during or following infusion; redness; edema; pain; burning; difficulty infusing solution; leaking around the port noncoring needle, tunnel exit site, or PICC exit site or under dressing

5. Management (Polovich, Olsen, & LeFebvre, 2014)
a) Stop infusion.
b) Aspirate residual drug from the catheter or noncoring needle using a 5 ml syringe.
c) Remove noncoring needle from port septum, unless antidote is given through existing port needle; then remove.
d) Assess site of suspected extravasation; estimate amount of extravasated vesicant.
e) Administer antidote or extravasation treatment, as indicated.
f) Apply cold or heat, as indicated.
g) Determine the cause of extravasation, notify the physician, measure and photograph the site, document findings, provide patient education, and schedule follow-up appointments.

References


Chopra, V., O’Horo, J.C., Rogers, M.A.M., Maki, D.G., & Safdar, N. (2013). The risk of bloodstream infection associated with peripherally inserted central venous catheters compared with central venous catheters in adults: A systematic review and meta-analysis. Infection Control and Hospital Epidemiology, 34, 908–918. doi:10.1086/671737


   A. The term hypodermoclysis (originating from hypo + derma [skin] + clysis [to clean] [Greek]) is also used to describe subcutaneous (SC) infusions.
   B. The first reported use of hypodermoclysis was in 1913 for pediatric dehydration. By the 1950s, hypodermoclysis was out of favor because of reports of shock and deaths caused by severe osmotic shifts as a result of therapy. These complications subsequently were found to be the result of improper technique, inappropriate fluids, excessive fluid volumes, and rapid infusion rates.
   C. SC analgesia infusions were first introduced in England in 1979. Shortly after, this practice began in the United States.
   D. SC therapy has been recognized as a cost-effective means of delivering medication fluid. Although SC therapy is a viable choice for an access device, it often is not reimbursed.

II. Device characteristics (Bartz et al., 2014; Dychter et al., 2012)
   A. Provides continuous, prolonged, or short-term administration of parenteral drugs or fluids into the loose connective tissue underlying the dermis, which consists of large blood vessels, nerves, and adipose tissue (Arthur, 2015; Gabriel, 2013). A short-length catheter or needle is used for several days.
   B. Fluid is absorbed into the intravascular compartment by a combination of perfusion, diffusion, hydrostatic pressure, and osmotic pressure.
   C. SC infusions are particularly well suited for non-acute care settings because of the ease of maintenance, the low probability of systemic complications, the reduced pain on insertion, and the decreased number of needlesticks.
   D. Continuous SC infusion is shown to be as effective as and more cost-effective than IV therapy; it is also a safe option for homecare delivery (Spandorfer, 2011).

III. Device features
      1. Products used for SC infusions are similar to peripheral IVs.
         a) Small-gauge, short-length, metal butterfly needles: Use only 24 or 27 gauge. Shielded needles are available.
         b) Small-gauge, short-length catheter
            1) Over-the-needle design
            2) Use only 24-gauge, ¾-inch catheter.
   2. Use a catheter instead of a butterfly needle to promote increased dwell time, improved patient comfort, and reduced risk of needlestick injury.
   3. Use smaller needles or cannulas to minimize discomfort during insertion.
   4. SC infusion sets are available with a 27-gauge, 90° needle situated on a clear, flexible anchoring disk. Various needle and tubing lengths are available. Sets are designed specifically for pediatric patients with a smaller half-inch disk and 27-gauge needle.
   5. Closed catheter systems are available in needle sizes from 18–24 gauge with an over-the-needle Vialon™ catheter. A telescoping needle shield device minimizes the risk of accidental needlestick (see Figure 10-1).

IV. Device advantages and disadvantages (see Figure 10-2)

V. Patient selection criteria (Arthur et al., 2012; Bartz et al., 2014; Humphrey, 2011; Neo, Khemlani, Sim, & Seah, 2016; Spandorfer, 2011)
   A. Patient age generally does not restrict use.
   B. Primarily used in geriatric and palliative medicine; suitable in acute care, home care, long-term facilities, or hospice settings.
C. Administered by a caregiver or nurse at home

D. Indications
1. When an oral or transdermal route is inappropriate or ineffective (e.g., bowel obstruction, intractable nausea or vomiting, dysphagia, malabsorption, inadequate oral fluid intake secondary to confusion or infection)
2. Poor peripheral veins (e.g., obese, older adults, very young patients, those whose veins have been overused)
3. If a single-lumen, long-term venous access device is being used for other incompatible IV therapy

4. Patients with delirium, confusion, stupor, or other mental status changes for which oral administration is contraindicated because of aspiration risk
5. Pain management
   a) Acute pain management when vascular access is difficult (e.g., patients with sickle cell disease who are in pain crisis) (Sandoval, Coleman, Govani, Siddiqui, & Todd, 2013)
   b) Chronic pain management when oral or transdermal route is not available, transdermal route is not tolerated, or no other indications exist for IV therapy (Kawabata & Kaneishi, 2013)
   c) Short-term, self-limiting infusion with a local anesthetic directly into the incision site for operative and postoperative pain
6. Reduction or alleviation of intractable nausea and vomiting
7. Hypercalcemia treatment
8. Iron chelation: For iron removal from transfusional iron overload or hemochromatosis
9. Fluid replacement: For short-term, reversible fluid deficits when fluid replacement is not an emergency and is less than 3,000 ml/24 hours (Spandorfer, 2011)
10. Infusion of amino acid solution (Lybarger, 2009)
11. Infusion of immune gamma globulin
12. Insulin infusion

E. Contraindications (Arthur, 2015; Spandorfer, 2011)
1. Generalized edema, poor peripheral circulation, or minimal SC tissue. Cachexia is not an absolute contraindication for SC infusion.
2. Severe pain when frequent boluses or changes are needed
3. Bleeding or coagulation disorder
4. Rapid infusion
5. Emergency situations (e.g., circulatory failure, severe electrolyte imbalance, severe dehydration)
6. Medications that are irritants to SC tissue which require IV administration (e.g., potassium, phenytoin)

VI. Insertion techniques (Bartz et al., 2014; Bruno, 2015; D’Arcy, 2010; Gabriel, 2012, 2013)
A. Infusion sites: Anterior chest wall, upper abdomen, anterior or lateral aspects of thighs, between the scapula on the back, and outer upper arm
1. For ambulatory patients, the upper chest area (subclavicular area) is recommended because it allows full range of movement.
2. The upper abdomen is best for patients with little peripheral SC tissue, such as with cachectic patients.
3. The access site must have intact skin and be located away from bony prominence and the patient’s umbilical area (Scales, 2011).
4. Rotate sites when changing the needle; the needle may remain in the same region.
5. Interscapular or subscapular regions can be useful for confused patients who may attempt to remove the device.

B. Insertion procedure
1. Explain the purpose of the infusion, the rationale for the type of infusion, and the procedure to the patient and family or significant others.
2. Select the site. Maintain strict aseptic technique (see Appendix 4).
3. Prepare the site with a cleansing agent and allow it to dry without fanning (see Appendix 2).
4. Select the smallest gauge needle or catheter available.
5. Attach the tubing and infusion bag with fluids or medication and prime the set.
6. Put on gloves. Stabilize tissue with free hand, holding hand flat in a natural position, or pinching skin slightly. Local anesthetic may be used (see Appendix 7).
7. Insert the needle with bevel down at about a 20°–30° angle almost up to the hub.
   a) A 45° insertion angle has been recommended as an alternate position (Gabriel, 2012; Spandorfer, 2011).
   b) The angle of the needle depends on the amount of SC tissue available and whether the tissue is held flat or pinched. When minimal SC tissue is available, use a smaller angle to ensure correct placement.
   c) Place needle bevel down so that the fluid is infused into the SC tissue and also to promote absorption.
8. Secure wings or hub with a securement device.
9. Check for blood return (i.e., lower unclamped solution bag or pull back on syringe). There should be no blood return, although an air bubble may be seen.
   a) If blood is seen in the tubing, clamp the tubing and remove the needle.
   b) Repeat this procedure using a new needle at an adjacent site.
   c) If no blood is seen, clamp the tubing.
10. Attach the tubing to the pump, set the correct rate, unclamp the tubing, and turn the pump on. If infusion is not being used, attach a needleless connector.

VII. Unique maintenance and care (Arthur, 2015; D’Arcy, 2010; Gabriel, 2013, 2014a; Neo et al., 2016) (see Appendices 2 and 4)
A. Observe the site every eight hours during infusions for local irritation or leakage, and assess the patient’s comfort with placement and infusion rate.
B. No definitive recommendation can be made regarding the frequency of catheter or needle placement. Intervals could include every three days, five days, weekly, or as clinically indicated.
C. Change transparent dressings at one week and change with insertion of a new catheter or needle (O’Grady et al., 2011).
D. Instruct patients and caregivers to report any leakage, erythema, edema, or pain at injection site as soon as possible.
E. Use medications and fluids that are isotonic, non-irritating, nonviscous, and water soluble (Spandorfer, 2011).
1. Medications for symptom management (Bruno, 2015)
   a) Analgesics: Any analgesic available for parenteral use is acceptable for SC infusion, except for meperidine hydrochloride, which causes tissue necrosis.
      (1) Morphine and hydromorphone are the preferred analgesics for home administration.
      (2) Hydromorphone is recommended as the most cost-effective analgesic because it is very potent, and high doses can be delivered in small amounts. Stability has been found to be 28 days. Hydromorphone is at least as effective as morphine using the SC infusion route (D’Arcy, 2010).
      (3) Morphine was found to be equipotent analgesic for IV and SC routes when administered as a continuous infusion (Arthur, 2015).
      (4) Other commonly used opioids include methadone, fentanyl, and ketorolac.
      (5) Methadone causes skin irritation with SC infusion (erythema and induration). Successful interventions to minimize this com-
Application include the use of dexamethasone or hyaluronidase in the infusion and site rotation every 24 hours (Jabalameli & Kalantari, 2014).

(6) Ambulatory pumps with a patient-controlled analgesia mode allow for rapid individual dose titration and provide a sense of control for the patient (see Chapter 16). This can be done in both the hospital and in the home.

b) Nonanalgesic medication examples (Kawabata & Kaneishi, 2013; Pérez, Farriols, Puente, Planas, & Ruiz, 2011)
(1) Octreotide, scopolamine, lidocaine, and phenobarbital have been used for various symptom management needs.
(2) Metoclopramide has been used for intractable nausea and vomiting in SC infusions.

2. Fluids
a) Isotonic solutions can include 0.9% normal saline (NS) or a mixture of NS and 5% dextrose.
b) The addition of the enzyme hyaluronidase to SC fluid infusion acts as a physical adjunct to increase absorption and dispersion of fluid (Wasserman, 2014). It facilitates fluid absorption, especially when fluid is infused rapidly or in large quantities.
(1) The rate of perfusion is proportional to the amount of hyaluronidase present; the extent of diffusion is proportional to the volume of solution present.
(2) Can cause systemic reaction; therefore, an intradermal test dose should be performed (0.02 of a 150 units/ml solution); see drug package insert for drug testing procedure. The usual dose is 150 units in a liter or more of fluid.
c) Rate of infusions (Arthur, 2015)
(1) Infusion rates for medications are 3–5 ml/hour. Faster infusion rates result in tissue irritation and sloughing, unless other measures are taken, such as using hyaluronidase in the infusate.
(2) Concentrate the drug dose to ensure the maximum flow rate of 3–5 ml/hour or less, taking bolus dosing into consideration.
(3) Rates for fluid replacement depend on how quickly the replacement must be achieved but range from 20–80 ml/hour. For patients who generally are active during the day, fluids can be administered at night (Scales, 2011).
d) Rates as high as 400 ml/hour may be tolerated when administered with human recombinant hyaluronidase (Arthur, 2015; Arthur et al., 2012; Soremekun, Shear, Connolly, Stewart, & Thomas, 2012).
e) An electronic infusion device should be used to deliver the infusion to lessen the likelihood of fluid overload or excess fluid into the SC tissue. Examples include an electronic syringe driver, elastomeric balloon pump, or peristaltic pump (see Chapter 16).

VIII. Removal technique
A. Verify order or indication for removal when SC therapy is discontinued.
B. Explain the procedure to the patient.
C. Place the patient in a chair or bed for stabilization.
D. Wash hands.
E. Discontinue all infusions.
F. Put on gloves, remove dressing, and observe site for edema, erythema, or discharge. Remove gloves. Wash hands and put on new gloves.
G. Pull catheter/needle out in the same angle as insertion while stabilizing the skin with sterile gauze.
H. Apply constant, firm pressure to the exit site if bleeding. Apply bandage.
I. Instruct the patient and caregiver to report any discomfort or signs of bleeding, bruising, erythema, edema, or drainage.
J. Document observations, patient tolerance, catheter integrity, and actions.
IX. Complications (Dychter et al., 2012; Griffith, 2011; Mitchell, Pickard, Herbert, Lightfoot, & Roberts, 2012; Scales, 2011; Spandorfer, 2011)
   A. Adverse effects are minimal and typically are local and associated with the type of solution, infusion rate, and volume. Instruct patients and caregivers to assess the SC site twice daily or every eight hours during infusions. Report any problems to the home health nurse or provider.
   B. Local reactions at the insertion site include erythema, edema, or induration.
      1. Etiology: Prolonged duration of catheter or needle placement, rapid infusion, or irritation from solution
      2. Management: Remove needle and restart in another site.
   C. Pain or discomfort at infusion site may develop.
      1. Etiology: Needle migration, prolonged duration of needle placement, inadvertent placement in muscle tissues, or rapid infusion
      2. Signs and symptoms: Edema if present, try slowing infusion or restarting in another site.
      3. Management: Apply warm compress at the site after needle removal for comfort.
   D. Leakage or pooling of fluid at infusion site also may occur.
      1. Etiology: Poor absorption or too-rapid infusion
      2. Signs and symptoms: Decreased infusion rate
      3. Management: If persistent leakage or pooling is noted despite rate reduction, stop infusion, remove catheter/needle, and restart in another site.
   E. Management of edema
      1. If a small amount, slow infusion and monitor for absorption.
      2. If a large, generalized area, change the site for SC infusion.
      3. Gently massage the area and monitor for underlying tissue damage. Excessive or deep massage can cause tissue damage.
      4. Add hyaluronidase to the infusate to improve absorption.
   F. Management of insertion site abscess or cellulitis formation
      1. Remove the device and culture the insertion site.
      2. Administer systemic antibiotics as indicated per culture results.
      3. Apply warm compresses to the site for comfort.
   G. Rare complications: Sloughing of tissue, infection, and puncture of vessels with bleeding and bruising. Prevention includes frequently assessing the site and avoiding SC infusion in patients with coagulation or bleeding disorders to minimize possibility of occurrence.
X. Education and documentation (see Chapter 17)

References


Chapter 11
Arterial Access Devices
Lisa Hartkopf Smith, MS, RN, AOCN®, CNS

I. History (Inoue & Kusunoki, 2014; Karanicolas et al., 2014; Leal & Kingham, 2015; Parks & Routt, 2015; Petre, Sofocleous, & Solomon, 2015; Shields et al., 2014)
   A. The first use of intra-arterial devices to administer chemotherapy appeared in the literature in the 1950s with the administration of nitrogen mustard to treat melanoma.
   B. The percutaneous catheter placement technique for hepatic arterial infusion with chemotherapy initially was developed in the 1980s in Japan. It was fully established in the United States by 2000 (Arai et al., 2015).
   C. Other early reports included the treatment of gliomas and sarcomas (Joshi, Ellis, & Emala, 2014).
   D. The technology to deliver intra-arterial infusions into the hepatic artery has evolved since its inception.
      1. Initially, temporary external catheters were used; treatment advanced to using tunneled catheters and intra-arterial ports connected to ambulatory infusion pumps.
      2. The first subcutaneous (SC) implanted hepatic intra-arterial infusion pump was placed in 1977 for the treatment of hepatic metastases from colon cancer.
      3. More recently, hepatic chemoembolization using chemotherapy, followed by embolization of the hepatic artery, has become a recommended treatment for a subgroup of patients with unresectable hepatocellular carcinoma and neuroendocrine tumors involving the liver using a temporary arterial catheter (National Comprehensive Cancer Network®, NCCN®, 2016).
      4. Intra-arterial chemotherapy also is used in combination with systemic chemotherapy (Kemeny et al., 2011).

II. Device characteristics (De Baere & Mariani, 2014; Deschamps et al., 2010; Inoue & Kusunoki, 2014; Leal & Kingham, 2015; Petre et al., 2015; Shi et al., 2015)
   A. Temporary percutaneous catheters, ports, and implanted pumps are most frequently used to deliver intra-arterial therapies. Arterial pressure lines are outside the scope of these standards.
   B. Delivers high concentrations of drug directly to the tumor, with decreased systemic exposure (Royal, 2013)
   C. Intra-arterial therapies are considered regional forms of treatment. For all types of intra-arterial devices, the catheter is threaded directly to the artery that feeds the tumor.
   D. Temporary devices remain in place for minutes to hours and are removed immediately after drug administration; long-term devices may remain in place a year or longer (Perez et al., 2014).

III. Device features
   A. Compared to venous catheters, arterial catheters have smaller internal diameters and thicker catheter walls to withstand higher arterial pressures.
   B. Temporary percutaneous catheters
      1. Type, French size (e.g., 2.7–5 Fr), and length of catheter used is dependent on the procedure to be performed, the artery that is being cannulated, and provider preference.
      2. Open ended and commonly made of polyurethane
      3. A tapered tip design is available.
   C. Arterial ports (De Baere & Mariani, 2014; Ganesan, Upponi, Hon, Warakaulle, & Uberoi, 2008; Shi et al., 2015): At the time of publication, intra-arterial ports are not being manufactured specifically for this use in the United States.
      1. Design is similar to venous ports, consisting of a portal body with a self-sealing silicone septum connected to a catheter.
      2. Portal body is plastic or titanium and typically is not preattached to a catheter made of polyurethane or silicone.
      3. Catheter is designed with a fixed tip versus nonfixed tip with side hole. Metallic coils are an available design to secure the catheter fixed tip within the artery. Catheter design can be tapered or nontapered.
D. Hepatic artery infusion pumps (Leal & Kingham, 2015; Liu, Cui, Guo, Li, & Zeng, 2014; Parks & Routt, 2015): At the time of publication, one implanted pump is approved for intra-arterial drug delivery. The following details relate to the Codman pump (Codman & Shurtleff, Inc., 2016). It is a fully implanted drug delivery system. The pump is connected to an arterial catheter that is placed into the hepatic artery.

1. The pump typically delivers a constant infusion rate, ranging from 1–2.5 ml/day.
2. Reservoir volumes range from 16 ml, 20 ml, and 50 ml.
3. Side bolus port and center septum for access to reservoir
4. Titanium disk pump is 7 cm in diameter, ¾–1 inch thick, and weighs 4–6 oz.
5. Pump typically consists of two chambers.
   a) The inner chamber contains drug to be infused.
   b) The outer chamber contains charging fluid (a volatile liquid/vapor mixture) used as the chemical power source.
   c) Once inserted in the body, the pump is regulated to the temperature of the body, leading to expansion of the charging fluid, which pressurizes the medication chamber to push the drug through the chamber.
   d) The pump does not need to be recharged and does not require batteries.

IV. Device advantages and disadvantages (see Table 11–1)

V. Patient selection criteria (Allard & Malka, 2014; Basile, Carrafiello, Ierardi, Tsetis, & Brountzos, 2012; Ganeshan et al., 2008; Grigorovski et al., 2014; Guillaume et al., 2010; Inoue & Kusunoki, 2014; Karanicolas et al., 2014; Ko & Karanicolas, 2014; Koganemaru et al., 2012; Leal & Kingham, 2015; Liu et al., 2014; Parks & Routt, 2015; Petre et al., 2015; Shi et al., 2015)

A. Use arterial devices in the following types of therapies and treatments.

1. Transhepatic chemoembolization
2. Isolated limb perfusion and infusions such as for melanoma, sarcoma, or cancerous ulcers in extremities
3. Intra-arterial chemotherapy with osmotic blood–brain barrier disruption
4. Intra-arterial therapy for retinoblastoma
5. Local regional unresectable liver metastases
6. Palliative treatment for unresectable disease

B. Appropriate arterial anatomy providing adequate blood supply to tumor bed documented by arteriogram

C. Expertise in administration of therapies through arterial devices

VI. Insertion techniques (Allard & Malka, 2014; Basile et al., 2012; De Baere & Mariani, 2014; Deschamps et al., 2010; Ganeshan et al., 2008; Gottlieb & Bailitz, 2016; Parks & Routt, 2015; Shi et al., 2015)

A. Prior to placement, ensure that contraindications do not exist, informed consent is obtained, a pre-placement assessment is completed, and laboratory studies are verified (see Appendix 4). An angiogram or similar study is done preplacement and/or postplacement to confirm location, confirm arterial blood flow, and to assess for complications.

B. Temporary percutaneous catheter placement

1. Placed by interventional radiologist. Ultrasound guidance is used.
2. Maximum sterile barrier precautions are used during artery catheter insertion (O’Grady et al., 2011).
3. Location of the catheter and tip are dependent on the area to be infused. The most common sites for insertion are the femoral or brachial artery, and then threaded into the artery that perfuses the tumor (Abdalla et al., 2013; Basile et al., 2012).
4. Postprocedure care
   a) Monitor the patient’s vital signs post-procedure every 15 minutes for at least 2 hours. Monitoring varies among institutions.
   b) Assess the involved limb for peripheral pulses, color, temperature, capillary refill, numbness or tingling, edema or signs of bleeding, or hematoma formation with each set of vital signs.
   c) Certain activities are restricted depending on location of catheter.

C. Arterial port: Placed by surgeon or interventional radiologist

1. With side-hole technology, the catheter tip is fixed within the artery (Deschamps et al., 2010; Ishikawa et al., 2012; NCCN, 2016; Shi et al., 2015).
Chapter 11. Arterial Access Devices

2. The portal body is placed in a SC pocket, frequently over a bone to stabilize. The catheter is threaded into the appropriate artery to be infused.

D. Implanted arterial pump: Used for hepatic artery placement for liver cancer involvement (Abdalla et al., 2013; Karanicolas et al., 2014; Leal & Kingham, 2015).

1. Implanted by surgeon or interventional radiologist
2. Pump insertion into the gastroduodenal artery and threaded to the hepatic artery is preferred. The catheter is attached to the pump placed in a SC pocket. The pocket is created superficial to the abdominal wall fascia for ease of pump refill (Kanat, Gewirtz, & Kemeny, 2012; Ko & Karanicolas, 2014).
3. To prevent possible drug-induced cholecystitis, the gallbladder is removed at the time of surgical resection or pump placement.
4. Blood vessels from the distal stomach and proximal duodenum are embolized to prevent extrahepatic perfusion. A methylene blue dye study and/or a nuclear hepatobiliary scan (i.e., TC-99m) verifies pump placement (Kanat et al., 2012; Perez et al., 2014).

VII. Unique maintenance and care: Prior to accessing arterial catheters, ports, and pumps, scope of practice must be verified with the individual state board of nursing and institutional guidelines. RNs managing arterial devices must be knowledgeable of the principles of drug administration and care of patients with these devices (see Appendices 2, 4, 7, 11, and 12). Use strict sterile technique at all times (i.e., sterile gloves, face mask, sterile field).

A. Avoid blood pressure monitoring on the involved extremity.
B. Ensure that all tubing connections are Luer lock. Label all lines as close to the patient as feasible. Secure catheter to prevent kinks and tension, which may lead to malposition. Consider tension loop.
C. Use specialized tubing without injection ports, as indicated, to prevent accidental injection of unintended medication.

### Table 11-1. Advantages and Disadvantages of Arterial Catheters, Ports, and Pumps

<table>
<thead>
<tr>
<th>Device</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
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<tbody>
<tr>
<td>Percutaneous temporary arterial catheters (those removed at the end of each infusion cycle)</td>
<td>Can be used for multiple drug infusions at one setting</td>
<td>Potential activity restriction until catheter removal depending on location</td>
</tr>
<tr>
<td></td>
<td>Can be used in palliative or neoadjuvant setting</td>
<td>Hospitalization is required. Short-term infusions of eight hours or less can be done during a 23-hour observation instead of a full hospitalization admission.</td>
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<tr>
<td></td>
<td>No device in place after the procedure</td>
<td>Insertion of the catheter typically performed in interventional radiology by trained personnel</td>
</tr>
<tr>
<td></td>
<td>Tip of catheter stability is less than with implanted devices.</td>
<td>Possible complications secondary to repeated insertions into artery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Required monitoring of site during infusion</td>
</tr>
<tr>
<td>Arterial ports</td>
<td>Allows repeated access to arterial system</td>
<td>Patient discomfort with needlesticks</td>
</tr>
<tr>
<td></td>
<td>Allows for long-term use</td>
<td>Special noncoring, single-use needle required</td>
</tr>
<tr>
<td></td>
<td>Can be used for multiple drug infusions at one setting</td>
<td>Required monitoring of site during infusion</td>
</tr>
<tr>
<td></td>
<td>Tip of catheter stability increased compared to percutaneous temporary catheter</td>
<td>Specially trained personnel required for all care</td>
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<tr>
<td></td>
<td>Depending on insertion site, the patient may be able to ambulate during infusion.</td>
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<td></td>
<td>More cost-effective if long-term use is planned</td>
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<tr>
<td></td>
<td>Can be used in an outpatient or inpatient setting if properly trained personnel are available</td>
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<tr>
<td>Arterial implanted pumps</td>
<td>Allows prolonged access to arterial system</td>
<td>Cost of initial insertion</td>
</tr>
<tr>
<td></td>
<td>Allows repeated access to arterial system</td>
<td>Specially trained personnel are required for all care.</td>
</tr>
<tr>
<td></td>
<td>No immobility required</td>
<td>Patient discomfort with needlesticks</td>
</tr>
<tr>
<td></td>
<td>Tip of catheter stability increased compared to percutaneous temporary catheter</td>
<td>Special noncoring straight needle required for access</td>
</tr>
<tr>
<td></td>
<td>Has lower rate of malfunction than arterial ports</td>
<td>Limited indication for liver perfusion</td>
</tr>
</tbody>
</table>
D. Trace tubing or catheter from the patient to point of origin each time the catheter is accessed, at hand-off, and at transitions to a new setting or service.

E. Temporary percutaneous catheters (Ashton, 2012; Robertson-Malt, Malt, Farquhar, & Greer, 2014; Scales, 2010)

1. Frequently assess the involved extremity for peripheral pulses, skin color and temperature, capillary refill, swelling, numbness, tingling, dysesthesias, bleeding, and hematoma formation. Frequently observe dressing for drainage and bleeding.

2. Place infusions on pumps (see Chapter 16).

3. Because of the circulatory risk associated with flushing and potential for dislodgment of clots and creation of air bubbles, no definitive recommendation can be made regarding the frequency or volume of flushing. During periods where chemotherapy is not infusing, heparinized solution may be ordered as a continuous infusion to maintain patency. Volume, concentration, and frequency varies; no evidence exists to support a particular volume or concentration. The literature reports use of heparin solution 1,000–5,000 IU/ml, 1–3 ml every eight hours (daily) to maintain patency.

4. No definitive recommendation can be made regarding blood sampling from temporary percutaneous arterial catheters.

5. Access location

   a) Femoral access (Ashton, 2012; Barosh et al., 2011)
   (1) Place the patient on bed rest to prevent catheter dislodgment.
   (2) Consider placing a loose restraint on the involved extremity as a reminder to keep leg straight and to not get out of bed. If a restraint is used, follow the institutional policy and procedure for restraints.
   (3) Implement strategies for deep vein thrombosis prophylaxis.

   b) Brachial or subclavian access
   (1) Secure arm in a sling or other immobilization device.
   (2) Assist the patient with ambulation until the patient’s understanding of restrictions regarding arm use is validated (e.g., do not use arm to support weight).

6. Dressing changes: A chlorhexidine dressing/sponge has been found to decrease infection in temporary arterial lines (Safdar et al., 2014). The dressing may be left intact to prevent dislodgment or may be changed 24 hours after insertion.

F. Arterial ports (Arai et al., 2015; De Baere & Mariani, 2014; Deschamps et al., 2010; Matsumoto et al., 2014; Shi et al., 2015): No definitive recommendations regarding blood sampling through long-term catheters can be made.

1. No definitive recommendation can be made regarding the frequency, volume, or concentration of flush. Flushing protocols include 2–5 ml of heparinized saline (100–1,000 IU/ml) every week. If 1,000 IU/ml is used, aspirate and discard prior to infusions and monitor coagulation values as warranted (i.e., every 12 hours, daily).

2. After infusions, flush with 10 ml of 0.9% normal saline followed by heparinized saline lock.

3. Safety considerations
   a) Ensure that all tubing connections are Luer lock.
   b) Label all arterial lines as close to the patient as feasible.
   c) Use specialized tubing without injection ports, as indicated, to prevent accidental injection of unintended medication.
   d) Secure tubing to prevent kinks, tension, and possible needle dislodgment. Consider tension loop.
   e) Place infusions on pumps (see Chapter 16).
   f) Refer to Chapter 7 for instructions on port access with a noncoring needle and for dressing recommendations.
   g) Educate the patient regarding signs and symptoms of infiltration, occlusion, tubing disconnection, infection, pump malfunction, and interventions to prevent and manage complications.
   h) No definitive recommendation can be made regarding blood sampling from arterial ports. Typically, blood sampling is avoided due to the high pressure in arterial systems.

G. Implanted arterial pumps (Leal & Kingham, 2015; Parks & Routt, 2015): Prior to pump care, obtain the specific pump model and maintenance procedures from the manufacturer for further details. Use a noncoring needle to prevent damage to the pump’s septum (see Appendix 11).

1. The current pump approved for intra-arterial use delivers at a constant infusion rate and cannot be programmed to change rates. The medication delivered per hour is
changed by modifying the concentration of the medication; the rate and total volume of the medication remains the same.

2. Locate the septum(s) to refill pump: The pump may be designed with a side port to provide bolus dosing and a center port to refill the center chamber where medication infuses.

3. Reservoir volume: Verify reservoir volume to ensure that the amount and volume of medication ordered can be instilled into the pump.

4. Refill pump reservoir with chemotherapy or heparinized saline to maintain patency every two weeks. If the pump will not be used for an extended period of time, glycerin has been used to decrease the frequency of pump refill. The refill interval varies with the pump reservoir volume (e.g., 16 ml, 20 ml, 50 ml) and the percentage of glycerin used (Parks & Routt, 2015). Refill schedules should accommodate office closures and holidays. Detailed instructions are available from the manufacturer.

5. Pump refill kits are available from the pump manufacturer.
   a) Kits contain 22-gauge straight noncoring needles, an extension tubing with clamp or stopcock, an empty syringe, antiseptic for cleansing the site, sterile gloves, sterile drape, and adhesive dressing.
   b) One type of noncoring needle is used for the bolus side port and another type of noncoring needle is for the mid-septum reservoir. These needles are not interchangeable. Do not use the bolus needle to fill the reservoir; the bolus needle has a slot opening midway on the needle shaft.
   c) In contrast to the noncoring needles used to access venous implanted ports, noncoring needles for pumps are straight (i.e., not bent at 90 degrees).
   d) To verify correct needle placement prior to pump refill and to determine dose of medication delivered (total volume infused at previous fill minus amount removed), empty the pump completely prior to refilling.
   e) Pumps are not designed for blood sampling.

VIII. Removal technique (Barosh et al., 2011; Deschamps et al., 2010)
A. Whether a trained RN or an advanced practice nurse can remove arterial temporary percutaneous catheters depends on the individual state board of nursing. For states that do permit RNs to remove arterial catheters, training and competency records must be maintained.

B. Temporary percutaneous catheters can be removed at the bedside or in interventional radiology, depending on location of catheter, mechanism of catheterization securement, and institutional policy or preference.

1. Remove securement mechanism (e.g., sutures) and remove line in one uninterrupted motion.

2. Apply prolonged digital pressure. The amount and duration of pressure is specific to the institution and the patient. No definitive recommendation supports the use of sandbags.
   a) Vascular closure devices are sometimes used for femoral arterial catheters. Delivery mechanisms use a suture, a bovine collagen plug, and a polymer (polyactic and polyglycolic acid) to form a mechanical plug that is fully bioabsorbable over time.
   b) Other bioabsorbable devices use a polyethylene glycol polymer to adhere to the contours of the vessel lumen. These devices decrease the time required for hemostasis, with more rapid insertion site healing and earlier patient mobility (Alshehri & Elsharawy, 2015; Hon et al., 2010; Lucatelli et al., 2013).

3. Assess circulation in the involved extremity after catheter removal (e.g., pulse, temperature, color, swelling).

4. Activity restrictions following temporary catheter removal are dependent on the location of the catheter. Femoral sites traditionally involve bed rest for up to eight hours following removal; however, vascular closure devices can decrease this time (Alshehri & Elsharawy, 2015; Hon et al., 2010; Lucatelli et al., 2013). One study with a small number of patients with short-term femoral artery catheters used for hemody-
dynamic monitoring suggested that mobility and walking are safe with no catheter-related complications (Perme, Lettvin, Throckmorton, Mitchell, & Masud, 2011).
C. Arterial ports are removed by a surgeon or an interventional radiologist in a method similar to venous implanted port removal (see Chapter 7).
D. Implanted arterial pumps are removed by a surgeon or an interventional radiologist.

IX. Complications (Basile et al., 2012; Deschamps et al., 2010; Ganeshan et al., 2008; Karanicolas et al., 2014; Leal & Kingham, 2015; Perez et al., 2014) (see Table 11-2)
A. Temporary percutaneous catheters: Complications are related to the type of procedure, the length of time the catheter remains in place, and the catheter location.
B. Arterial ports: Extravasation can occur if the needle is dislodged from the portal body or if the catheter migrates, resulting in the infusion of chemotherapy into the SC tissue (Seo et al., 2015).

<table>
<thead>
<tr>
<th>Complication</th>
<th>Prevention</th>
<th>Signs and Symptoms</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>Sterile barrier precautions</td>
<td>Tenderness, erythema, or drainage at site; fever; skin necrosis over port or pump; dehiscence; pump or port extravasation</td>
<td>If chemotherapy is infusing, notify provider, as infusion may need to be stopped. Culture site and catheter exit tip, as ordered. Administer port or pump pocket washout with local antibiotics, or give systemic antibiotics, as ordered. Have the surgeon or interventional radiologist assess if the device requires removal. If removed, send the catheter for culture, if ordered.</td>
</tr>
<tr>
<td>Catheter migration/dislodgment</td>
<td>The catheter is sutured in place during placement. Braided or beaded catheter can assist to secure placement. Routine assessment of placement with imaging study</td>
<td>Hepatic artery infusion: Epigastric pain, nausea, vomiting, or diarrhea Extrahepatic infusion: Pain over site or in surrounding area of infusion; edema or erythema over site For any arterial infusion: Weak or absent peripheral pulse Inability to infuse infusate; patient discomfort during infusion Temporary percutaneous catheter: Patient discomfort, wet dressing, leakage, and increase length of external catheter</td>
<td>Stop infusion and notify the provider or interventional radiologist. Flush the catheter, as ordered, with normal saline or other solution compatible with chemotherapy that was infusing. Obtain imaging study, as ordered. The device may require removal.</td>
</tr>
<tr>
<td>Occlusion/thrombosis</td>
<td>Apply positive pressure when deaccessing the catheter or port. Flush with saline or compatible solution between drugs. Use heparinized solution for flushing the catheter between use.</td>
<td>Unable to flush or withdraw fluid (if catheter has a one-way valve, withdrawal of fluid is not possible.) If a temporary percutaneous catheter is in place, a change occurs in color, pulse, and temperature of the involved extremity. If catheter tip is in hepatic artery, any abdominal pain needs to be assessed immediately.</td>
<td>Do not force flushing, as it could cause a rupture of the catheter or diaphragm. Notify the provider. After assessment by a trained provider, tissue plasminogen activator may be used. Evaluate the need to remove the device. A replacement will be based on the clinical situation, as such replacement may not be able to be done at the same time as removal.</td>
</tr>
<tr>
<td>Bleeding at exit site</td>
<td>Baseline and frequent observation of exit site</td>
<td>For temporary percutaneous catheter placement, more drainage than would be expected after placement should be considered a problem.</td>
<td>Apply a pressure dressing. Notify the provider. Educate the patient to immediately report any swelling, erythema, or pain.</td>
</tr>
</tbody>
</table>

Note. Based on information from De Baere & Mariani, 2014; Deschamps et al., 2010; Karanicolas et al., 2014; Leal & Kingham, 2015.
C. The arterial port or pump may rotate in the SC pocket (i.e., “flip”), requiring surgical manipulation.

D. The pump can cause abdominal herniation from the pump weight. An abdominal binder may be worn to stabilize the pump.

X. Education and documentation (see Chapter 17)

The author would like to acknowledge Donna L. Gerber, PhD, RN, AOCN®, for her contribution to this chapter that remains unchanged from the previous edition of this book.

References


I. History: In 1963, Dr. Ayub K. Ommaya developed the Ommaya® subcutaneous (SC) reservoir for sterile access to the ventricular system as an alternative to repeated lumbar punctures in patients with cryptococcal meningitis (Kramer, Smith, & Souweidane, 2014; Ommaya, 1963; Szvalb et al., 2014; Weiner et al., 2015).

II. Device characteristics: Intraventricular catheter connected to an SC drug delivery reservoir to give medications directly to the intraventricular system

III. Device features (Mascitelli, De Los Reyes, Steinberger, & Zou, 2013; Szvalb et al., 2014) (see Figure 12-1)
   A. A dome-shaped, self-sealing silicone reservoir is attached to an intraventricular catheter.
   B. The reservoir volume is 1.5–2.5 ml.
   C. The dome size is 1.5–3.5 cm in diameter.
   D. Catheter length is measured and cut intraoperatively to fit within the ipsilateral frontal horn of the lateral ventricle.
   E. The reservoir is radiopaque.
   F. The device also may include a ventriculoperitoneal shunt with an on/off valve.

IV. Device advantages and disadvantages (see Figure 12-2)

V. Patient selection criteria (Aiello-Laws & Rutledge, 2008; Gabay, Thakkar, Stachnik, Woelich, & Villano, 2012; Graber & Omuro, 2011; Kramer et al., 2014; Lee et al., 2014; Roguski et al., 2015; Van Horn & Chamberlain, 2012)
   A. Leptomeningeal disease or primary central nervous system (CNS) tumors
   B. Need for intermittent administration of chemotherapy or antibiotics into the cerebrospinal fluid (CSF)
   C. Intractable headaches: Limited publications exist referencing the use of intraventricular access devices to instill opioid medications for individuals with refractory headaches.
   D. Alternative device for anticipated repeated lumbar punctures for CSF access
   E. Pediatric patients receiving radioimmunotherapy for CNS malignancies

VI. Insertion techniques (Mascitelli et al., 2013; Ozerov, Mel'nikov, Ibragimova, Tereshchenko, & Rachkov, 2014) (see Figure 12-3)
   A. Prior to placement, ensure that contraindications do not exist, informed consent is obtained, a preplacement assessment is completed, and laboratory studies and medication/chemotherapy orders are verified (see Appendix 4).
   B. While the patient is under general anesthesia, the device is inserted by a surgeon with maximum sterile barrier precautions.
      1. The patient is placed in a supine position, and the insertion site is cleaned and draped.

Figure 12-1. Intraventricular Reservoir

Note. Image by Manuel Bieling. This file is licensed under the Creative Commons Attribution 2.5 Generic license (https://creativecommons.org/licenses/by/2.5/deed.en). Retrieved from https://commons.wikimedia.org/wiki/File:Rickham-reservoirs.jpg.
2. A flap is created by cutting a U-shaped incision in the scalp, and a burr hole is made through the cranial bone.

3. A reservoir is implanted subcutaneously under the scalp above the frontal lobe and secured to the pericranium, while the catheter is threaded through the burr hole into the ventricle. The catheter tip typically is placed in the frontal horn of the lateral ventricle.

4. The reservoir is covered by the flap of scalp tissue, which is then sutured closed. Patency is verified by withdrawal of CSF through the reservoir, and a sterile dressing is applied.

5. The use of stereotactic placement with a neuronavigation system improves placement success in patients with narrow and slit-like ventricles.

6. A postoperative imaging is required to confirm placement prior to use.

C. Postoperative care

1. Maintain original sterile dressing for at least 24 hours. Follow with gauze and tape dressing for several days. After, no dressing is needed. Keep sutures dry until removal (approximately 7–10 days).

2. Monitor site for bleeding, leakage of CSF, and excessive edema.

3. Monitor for and notify the provider of changes in neurologic status (e.g., headache, vomiting, cognitive changes, vision changes, progressive lethargy, dysarthria, seizures) and signs of infection (e.g., fever, neck stiffness, headache, changes in level of consciousness).

4. Ensure that radiologic imaging and flow studies verify patency and CSF flow tracts prior to use.

5. Caution the patient regarding protection of the insertion site to prevent damage to the reservoir or dehiscence of the surgical wound.

VII. Unique maintenance and care (Aiello-Laws & Rutledge, 2008; Kramer et al., 2014; Peyrl et al., 2014) (see Appendices 2, 4, and 12)

A. Prior to accessing or caring for an intraventricular device, verify scope of practice with the individual state board of nursing and institutional guidelines. RNs and advanced practice nurses managing these devices must be knowledgeable of the principles of drug administration and the care of patients with these devices.

B. No definitive recommendation can be made regarding time interval between placement and first access of an intraventricular device; intervals range from day of surgery to multiple days after placement.

C. Use strict sterile technique at all times (i.e., sterile gloves, face mask, sterile field). Use maximum sterile barrier precautions.

D. Use only preservative-free drugs and diluents to prevent meningeal irritation.

E. Use a 25-gauge or smaller needle to preserve dome integrity.
F. Ensure CSF patency prior to intraventricular drug administration.

G. Accessing technique (Gabay et al., 2012)
   1. Assess the patient’s vital signs and neurologic status prior to procedure.
   2. Clip (do not shave) hair, if needed. The syringe containing the medication is not sterile. Once retrieved, the hand is no longer sterile and should touch only the non-sterile syringe throughout the remainder of the procedure.
   3. Cleanse reservoir. Ensure antiseptic is air-dried prior to access.
   4. Palpate the reservoir and assess for signs of infection. Pump the reservoir three to four times to fill with CSF from the ventricle.
   5. Insert a butterfly needle with extension tubing at a 45°–90° angle into the reservoir (see Figure 12-2). A release of resistance will be felt when the reservoir is penetrated. The presence of blood in the tubing indicates needle tunneling between the scalp and dome of the reservoir; if present, withdraw the needle and insert a new sterile needle at a 90° angle.
   a) Withdraw CSF volume equal to the amount of drug to be infused, plus an additional volume to use as flush following the procedure, according to institutional policy.
   b) If CSF is bloody or cloudy, preserve the specimen, notify the provider, and stop the procedure. An order may be given to send the sample for culture, sensitivity, Gram stain, protein, glucose, and cell count with differential.
   c) Infuse the medication into the reservoir, followed by reserved CSF flush or preservative-free normal saline, according to institutional policy.
   6. Remove the needle and apply gentle pressure with a sterile gauze.
   7. Gently pump the reservoir three to five times to distribute the drug. Apply sterile dressing.

H. Postprocedure care
   1. Obtain vital signs and assess neurologic status following the procedure.
   2. Keep the patient supine or in a semi-recumbent position for at least 30 minutes following medication administration. Monitor for drug-related side effects and potential complications of the reservoir.

3. Instruct the patient to report headache, nausea, dizziness, neck or back pain, stiffness, or other neurologic symptoms (e.g., change in level of consciousness).

VIII. Removal technique
   A. Rarely removed once implanted, except for unre solvable device malfunction or infection
   B. Intraventricular reservoirs removed by surgeon
   C. May be removed if implanted for the purpose of delivering prophylactic therapy

IX. Complications (Kramer et al., 2014; Peyr et al., 2014; Weiner et al., 2015; Zairi et al., 2015)
   A. Infection
      1. Etiology (Bin Nafisah & Ahmad, 2015; Mead, Safdieh, Nizza, Tuma, & Sepkowitz, 2013; Ng, Mabasa, Chow, & Ensom, 2014; Szvalb et al., 2014)
         a) Improper access technique
         b) Surgical contamination
         c) Systemic complication of immunosup pressed patient
         d) Noniatrogenic trauma to site
      2. Prevention
         a) Maintain sterile barrier precautions when accessing the system.
         b) Ensure that only specially trained personnel access the device.
         c) Protect the device from trauma and damage.
      3. Signs and symptoms
         a) Site tenderness, warmth, erythema, or drainage
         b) Fever
         c) Headache with or without vomiting, neck stiffness, seizures, altered level of consciousness
         d) Bloody or purulent CSF
         e) Wound dehiscence with device exposure
      4. Diagnostic tests
         a) Complete blood count: Elevated white blood cell count
         b) CSF specimen: Obtain sample for culture and sensitivity, Gram stain,
protein, glucose, and cell count with differential. Typical findings indicative of infection in CSF include elevated protein, low glucose, and microbial growth (gram-positive organisms commonly found). c) Infection may be present without abnormal laboratory findings.

5. Management
   a) Systemic antimicrobials or direct instillation of antimicrobials into the reservoir
   b) Persistent infection requires device removal.

B. Malposition or migration of catheter (Bot, Constantini, & Roth, 2013; Kramer et al., 2014)

1. Etiology
   a) Kinking of catheter
   b) Migration of catheter out of ventricle

2. Signs and symptoms
   a) Poor or absent refilling of the reservoir when depressed
   b) Inability to gently aspirate CSF
   c) Inability to instill fluid into the reservoir
   d) CSF leakage around the reservoir
   e) Change in neurologic status (i.e., dizziness, headache, lethargy, altered level of consciousness)

3. Diagnostic tests: Radiologic imaging (e.g., computed tomography [CT] or magnetic resonance imaging [MRI] scan of brain).

4. Management: Referral to a neurosurgeon to evaluate the need for revision or removal

C. Blood in CSF

1. Etiology
   a) Intraventricular hemorrhage
   b) Subdural hematoma
   c) Subarachnoid hematoma
   d) Improper positioning of butterfly needle during access, causing SC bleeding

2. Signs and symptoms
   a) Change in neurologic status (e.g., vision changes, headaches, confusion)
   b) Sensory or motor deficits (e.g., ataxia, slurred speech)

3. Diagnostic tests: CT or MRI of brain

4. Management: May require surgical intervention

X. Education and documentation (see Chapter 17)

XI. Patient education special considerations

A. Care of device
   1. Avoid getting incision wet while sutures are present.
   2. No special care is required once sutures are removed.

3. Hair may grow back, except for a small 2–3 cm area over the device.

4. Protect the site from trauma.

B. Signs and symptoms of infection or malfunction (e.g., fever, headache, neck stiffness, vision changes, nausea/vomiting, neurologic changes, altered level of consciousness)

XII. Special considerations

A. Pediatric

1. The use of ventriculoperitoneal shunts with programmable valves for administration of chemotherapy has been described in pediatric patients with hematologic malignancies, intracerebral hemorrhage, or hydrocephalus (Kramer et al., 2014; Palejwala et al., 2014). The device allows for intraventricular chemotherapy and subsequent concomitant CSF diversion through the shunt.

2. Percatheter cyst formation has been reported in one series of pediatric patients following placement of an intraventricular reservoir or ventriculoperitoneal shunt (Kramer et al., 2014).

B. Older adults: Underlying dementia may complicate assessment and diagnosis of medication-induced mental status changes in patients receiving intrathecal chemotherapy.

The author would like to acknowledge Julie G. Walker, MSN, RN, FNP-C, for her contribution to this chapter that remains unchanged from the previous edition of this book.

References


I. History (Bauer, George, Seif, & Farag, 2012; Botton & Christo, 2014; Calthorpe, 2004; Toledano & Tsen, 2014)
   A. In 1885, Dr. J. Leonard Corning accidentally discovered epidural anesthesia when he introduced cocaine between the lumbar vertebral processes to treat habitual masturbation.
   B. In 1901, French physicians Jean-Anthanase Sicard and Fernand Cathelin independently introduced single-shot epidural blocks via the caudal approach for neurologic and genitourinary procedures, respectively (Toledano & Tsen, 2014).
   C. By 1910, caudal block use for gynecologic and obstetric procedures was found beneficial (Toledano & Tsen, 2014).
   D. Intrathecal injections of alcohol for palliation of pain associated with malignant and nonmalignant disease was first described in the 1930s.
   E. In 1940, Dr. William Lemmon developed a malleable spinal needle made of German silver to provide continuous spinal anesthesia.
   F. By 1942, continuous caudal analgesia techniques were developed for obstetrical patients using a modified Lemmon needle (Toledano & Tsen, 2014).
   G. In 1944, Dr. Edward Tuohy developed a nylon ureteric catheter for continuous spinal analgesia, thereby eliminating some of the drawbacks associated with the malleable needle.
   H. By the early 1950s, intraspinal segmental alcohol blocks used the Tuohy catheter to treat intractable pain associated with malignancy.
   I. Broad commercial availability of epidural catheters, the first report of intrathecal opioid efficacy, and the formation of pain services began in the 1970s (Toledano & Tsen, 2014).
   J. Implantable drug delivery systems were trialed in the early 1980s for treatment of cancer-related pain and chemotherapy administration (Wilkes, 2014).

II. Anatomy and physiology (Bauer et al., 2012; Farquhar-Smith & Chapman, 2012; McHugh, Miller-Saultz, Wuhman, & Kosharskyy, 2012; National Cancer Institute, n.d.)
   A. Vertebral column (see Figure 13-1)
      1. 33 vertebrae
         a) Cervical: 7 (C1–C7)
         b) Thoracic: 12 (T1–T12)
         c) Lumbar: 5 (L1–L5)
         d) Fused sacral: 5 (S1–S5)
         e) Coccyx, formed by four fused vertebrae; small, triangle-shaped bone attached to the bottom of the sacrum
   2. The spinal cord typically ends between the last thoracic and first lumbar vertebra; subsequently, lumbar punctures are performed below the second lumbar vertebra (L2).
3. Cerebrospinal fluid (CSF) flows throughout the vertebral column.

B. Intraspinal spaces
1. Epidural space
   a) Lies between periosteum (the inner portion of the vertebrae) and dura mater of the vertebral column
   b) Extends from the foramen magnum (base of the skull) to the sacrococcygeal ligament (sacrum)
   c) Contains adipose tissue, blood vessels, lymphatic vessels, and spinal nerves
2. Intrathecal space (subdural space)
   a) A potential space is located between the dura mater and arachnoid membrane.
   b) The small volume space is filled with CSF.
   c) Drug delivery catheters are usually placed in this space to provide site-specific delivery of pain medications, antibiotics, or antineoplastic therapy (e.g., morphine).

III. Device characteristics (Bottros & Christo, 2014; Calthorpe, 2004; Farquhar-Smith & Chapman, 2012; Heo et al., 2014; Kim, Jung, & Cho, 2013; McHugh et al., 2012; Smyth, Jarvis, & Poulin, 2014)

A. Epidural
   1. Medications injected into the epidural space are slowly spread throughout the thoracic, lumbar, and sacral areas.
   2. Catheters inserted into the epidural space are used to deliver opioids with or without anesthetics or steroids.

B. Intrathecal
   1. Medications are delivered directly into CSF fluid surrounding the spinal column.
   2. Catheters inserted into the intrathecal space are used to deliver medications with or without anesthetics or steroids.

IV. Device features (Bottros & Christo, 2014; Calthorpe, 2004; Farquhar-Smith & Chapman, 2012; Kim et al., 2013; McHugh et al., 2012)

A. External epidural or intrathecal catheters
   1. Percutaneous or short tunneled catheters
      a) Short-term use only (hours to days) due to increased risk of infection, dislodgment, and skin irritation
      b) Made of radiopaque polyamide, polyurethane, Teflon™, or nylon
      c) Available with open- or closed-end tips with three-eyed multiport configuration
      d) Sizes from 19 to 20 gauge, 40-inch length; pediatric sizes 20 and 24 gauge
      e) Exit site: Lower back
      f) Drug delivery: Intermittent injection or an external pump
   2. Long-term tunneled catheters
      a) Made of radiopaque polyamide, polyurethane, or nylon
      b) Exit site: Usually the abdomen

B. Implanted epidural or intrathecal ports (Heo et al., 2014; Kim et al., 2013; Smyth et al., 2014)
   1. Similar in structure to venous ports (e.g., comprising a portal body, reservoir, septum, catheter) (see Chapter 7)
   2. Reservoirs contain a filter (e.g., 20 or 60 micron filter) to prevent infusion of large particulate matter into the catheter.
   3. Reservoir volume approximately 0.3–0.5 ml
   4. Completely implanted, similar to venous port in a subcutaneous (SC) pocket
   5. Indicated for long-term therapy
   6. At the time of publication, not being manufactured in the United States

C. Implanted pump with attached intrathecal or epidural catheter (Bottros & Christo, 2014; Farquhar-Smith & Chapman, 2012; Smyth et al., 2014; Wesemann et al., 2014)
   1. Contains an intrinsic power source and refillable drug reservoir
   2. Totally implanted in an SC pocket
   3. Pump: Small and disc-shaped septum(s), reservoir, and catheter
   4. Catheter: Radiopaque silicone, attached at time of surgery or available preattached
   5. Pump reservoir: 20 ml or 40 ml with a diameter of 6.5 mm, weighing 30 g and up to 212.6 g (7.5 oz) when full
   6. Indicated for long-term therapy
   7. Available with side port for bolus injection
   8. Available with filter to prevent infusion of large particulate matter into the catheter
   9. Pump types (Bottros & Christo, 2014; McHugh et al., 2012; Rosen et al., 2013; Wilkes, 2014)
      a) Battery powered
Drug delivery is achieved with a battery-powered peristaltic pump.

Within the pump, pressurized gas exerts pressure on the reservoir to assist in drug delivery.

Because of the pressurized gas, the pump will deliver different drug amounts in high pressure atmospheres (e.g., high altitudes) or high temperatures (e.g., hot tubs).

The pump is available with an external device to allow bolus infusion and is programmed similarly to ambulatory pumps, where bolus dose, lockout time, and total number of doses are programmed.

Non–battery powered

The pump is divided into inner and outer chambers by accordion-like bellows.

The inner chamber contains the drug to be infused.

The outer chamber contains propellant permanently sealed inside.

Body temperature warms the propellant, exerting constant pressure on the bellows and infusing the drug through the inner chambers filter and through the catheter.

Dosages are changed by adjusting drug concentration during the pump refill process.

Externally operated programmable pump

A drug reservoir automatically delivers a controlled amount of the drug through a filter and then through the catheter.

Constant pressure on the reservoir mechanically pushes the medication forward.

An external, handheld, battery-operated programmer is used to control flow rate by electronically controlled valves in the pump.

Pumps are magnetic resonance imaging (MRI) compatible; however, a pump may have to be emptied prior to MRI imaging.

Device advantages and disadvantages (see Table 13-1)

Patient selection criteria (Bhatnagar & Gupta, 2015; Farquhar-Smith & Chapman, 2012; Heo et al., 2014; Kim et al., 2013; Lin et al., 2012; Saulino, Kim, & Shaw, 2014; Smyth et al., 2014; Wesemann et al., 2014; Wilkes, 2014)

Indications for epidural or intrathecal access devices

1. Chronic localized intractable cancer pain
2. Noncancer pain (e.g., chronic, intractable back or pelvic pain)
3. Postsurgical pain needing temporary epidural anesthesia or patient-controlled anesthesia
4. Spasticity requiring an intrathecal baclofen pump
5. Leptomeningeal or primary neurologic cancers requiring frequent administration of intrathecal chemotherapy
6. Frequent intrathecal access, such as acute lymphoblastic leukemia

Contraindications for epidural or intrathecal access device

1. Local or systemic infection
2. Uncorrected coagulopathy (international normalized ratio > 1.5; platelet count < 50,000)
3. Epidural metastasis or suspected spinal cord compression
4. Patients with opioid addiction or drug-seeking behavior
5. Patients with multiple sites or various types of pain
6. Large volume infusion required
7. Increased intracranial pressure
8. Some institutions will not place in the presence of unstable neurologic findings and brain metastases due to risk of herniation and hemorrhage.
9. Cancer of the spine (depending on the spinal level and degree of stenosis)

Insertion techniques (Bauer et al., 2012; Bottros & Christo, 2014; Farquhar-Smith & Chapman, 2012; Heo et al., 2014; Smyth et al., 2014; Wilkes, 2014)

Before insertion procedure, verify scope of practice with the individual state board of nursing and institutional guidelines. Credentialing and ongoing competency validation is required. Advanced practice nurses in many states have the ability to insert temporary catheters within scope of practice (see Appendix 4).

Patient preparation: Prior to placement, review the provider order for catheter placement and recent imaging studies and laboratory studies,
including coagulation tests, current medications, and the most recent doses and clinical notes.

C. Procedure

1. Typically performed under fluoroscopy. Ultrasound is preferred for intraoperative and bedside insertion and is beneficial as a radiation-free technique (Bauer et al., 2012; Bottros & Christo, 2014).

2. Use sterile technique and maximum sterile barrier precautions for insertion and handling of devices.

   a) Epidural insertion: Percutaneously into epidural space and approximately 4 cm, usually at L2–L3, L3–L4, or L4–L5

   b) Intrathecal insertion: Advanced below the dura where the CSF circulates, usually at L2–L3, L3–L4, or L4–L5

3. Percutaneous temporary catheters (epidural or intrathecal)

4. Tunneled catheters (epidural or intrathecal)

   a) May be placed at the bedside or in a procedural area using local anesthesia

   b) The external portion is secured using tape along the patient’s back to the anterior chest wall or around the flank and secured using a transparent dressing and securement device.

   c) Label the transparent dressing with date of insertion and placement site.

   d) Label the device as either epidural or intrathecal.

Table 13-1. Advantages and Disadvantages of Epidural or Intrathecal Access Devices

<table>
<thead>
<tr>
<th>Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Overall (compared to other routes)</td>
<td>Less sedation with narcotics, less effect on cardiovascular or respiratory status</td>
<td>Require skilled personnel to manage catheter, which may be problematic in some rural areas</td>
</tr>
<tr>
<td></td>
<td>Preservative-free medications used with epidural and intraspinal may be difficult to obtain.</td>
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</tbody>
</table>
c) The exit site is secured using a transparent dressing and securement device.
d) Label the transparent dressing with date of insertion and placement site (e.g., epidural, intrathecal).
c) Label the tubing as either intrathecal or epidural.

5. Implanted port (epidural or intrathecal)
a) Placed by a surgeon or interventional radiologist
b) The proximal end of the catheter is subcutaneously tunneled around the flank to the abdomen or anterior chest wall and connected to the portal body.
c) The port is attached to the catheter that is inserted percutaneously approximately 4 cm into the epidural space.
d) The portal body is sutured to the fascia over a bony prominence, such as the lower rib.
c) Cover the portal body insertion site with a transparent dressing.
f) Label the transparent dressing with date of insertion and placement site (e.g., epidural or intrathecal).

6. Implantable pump (intrathecal)
a) Inserted in the operating room or interventional radiology using local anesthesia with fluoroscopic guidance
b) Pumps should be placed away from bony landmarks, such as the lower thoracic ribs or iliac crest, to avoid irritation.
c) The pump is implanted into an SC pocket in the lower quadrant of the left or right abdomen or gluteal region approximately 2.5 cm deep to accommodate refilling of the pump. The catheter is tunneled and threaded into the epidural or intrathecal space (Bottros & Christo, 2014).
d) The pump reservoir is filled and catheter access port is flushed after connecting the catheter to the pump.

D. Immediate postoperative care (McHugh et al., 2012)
1. Check dressing for bleeding or drainage.
2. Assess site for hematoma or excessive postoperative edema.
3. Perform frequent neurologic assessments.
4. Monitor vital signs per postoperative routine and then every four hours until stable. Monitor blood pressure frequently for hypotension.
5. Analgesics may take one hour to take effect.
6. Assess for pain.
7. Assess respiratory rate after placement, then frequently if device is being used for pain medication.

VIII. Unique maintenance and care (Bottros & Christo, 2014; McHugh et al., 2012)
A. Prior to accessing or caring for epidural or intrathecal catheters or pumps, verify scope of practice with the individual state board of nursing and institutional guidelines. RNs managing epidural and intrathecal devices must be knowledgeable of the principles of epidural and intrathecal drug administration and the care of patients with these devices.
B. Maintain maximum sterile barrier precautions with mask and sterile gloves with any access or maintenance procedure (O’Grady et al., 2011).
C. Use preservative-free medications and preservative-free solutions. Attach a 0.2 micron filter to eliminate debris entering into the epidural or intrathecal space.
D. Do not use alcohol for cleaning these devices; alcohol is neurotoxic. Use chlorhexidine gluconate and let dry (see Appendix 2).
E. Flushing: Routine flushing is not indicated.
1. Catheter (temporary and tunneled): 1–2 ml of preservative-free 0.9% normal saline (NS) after each use
2. Epidural or intrathecal port: 3 ml of preservative-free NS after each use
3. Infusion pump: No flushing is required.
F. Tubing
1. Ensure that all tubing connections are Luer lock. Label all lines closest to the patient as feasible. Secure the catheter to prevent kinks and tension, which may lead to malposition. Consider a tension loop.
2. Attach a 0.2 micron filter to all epidural and intrathecal infusions and change if damaged, leaking, and when tubing is changed. A filter may not be needed if the drug is filtered prior to administration or if the portal body or pump contains a filter.
3. Use specialized tubing without injection ports, as indicated, to prevent accidental injection of unintended medication into epidural or intrathecal space (Institute for Safe Medication Practices, 2008) (see Chapter 17).
4. Label any injection tubing for epidural or intrathecal use only (see Figure 13-2).
5. Trace the tubing or catheter from the patient to point of origin each time the catheter is accessed, at handoff, and at transitions to a new setting or service.

G. A chlorhexidine-impregnated dressing or sponge has been found to significantly reduce the rate of epidural catheter infections (Kerwat et al., 2015).

H. Medication administration considerations (Bottros & Christo, 2014; Saulino et al., 2014)
1. Only preservative-free NS may be used as diluent for medications administered via an epidural or intrathecal catheter, with the exception of methotrexate and cytarabine administration; Elliotts B® Solution should be used as the diluent.
2. Be aware that opioid dosing for epidural drug administration may be up to 10 times higher than intrathecal administration.
3. Ensure placement prior to drug administration by gently aspirating. If clear fluid volume is greater than 0.5 ml or if blood is obtained, notify the provider and do not administer the drug. The presence of CSF indicates that the catheter has punctured the dura and migrated into the intrathecal space.
4. Continuous infusions of epidural or intrathecal medication: Secure with a tension loop or other securement device to prevent accidental dislodgment.

I. Routine monitoring for opioid administration (Bottros & Christo, 2014; Saulino et al., 2014)
1. Monitor carefully during initial dose of opiate and with each subsequent increase in dose. Assess pain levels before, during, and after opioid administration.
2. The patient may be weaned off other systemic opioids while receiving epidural analgesia.
3. Monitor for signs of respiratory and central nervous system depression based on individual risk factors, treatment-related risks, and type of drug regimen administered (Jarzyna et al., 2011).
   a) Patients are at highest risk for opioid-induced respiratory depression within the first 24 hours of epidural or intrathecal opioid administration.
   b) Delayed respiratory depression usually occurs 3–12 hours after administration, but may occur as late as 24 hours following opioid administration.
   c) Ensure that resuscitation equipment is available.
   d) Ensure presence of IV access for at least 24 hours after initiation of epidural or intrathecal opioids for rescue drug, if needed.
   e) Use evidence-based recommendations for monitoring patients at risk for opioid-induced sedation (e.g., American Society for Pain Management Nursing, National Comprehensive Cancer Network®).

J. Implanted pump (Bottros & Christo, 2014; Saulino & Gofeld, 2014)
1. Ensure familiarity with the device and its complications.
2. Document the pump model number, reservoir size, and flow rate in the patient’s medical record. Prior to pump care, obtain the specific pump model and maintenance procedures from the manufacturer for further details.
3. Use maximum sterile barrier precautions when accessing the pump septum. A kit is provided by the pump manufacturer, which includes an access needle and pump template to locate the septum. Ultrasound has successfully been used to access the pump septum (Gofeld & McQueen, 2011; Saulino & Gofeld, 2014).
4. The pump must be refilled on a schedule. The refill interval depends on drug concentration, drug stability, pump reservoir vol-
5. Pump refills typically occur every two to eight weeks; however, they can occur up to six months. Refill schedules should accommodate office closures and holidays.

6. The U.S. Food and Drug Administration requires pumps to be refilled every six months, even if the pump is not completely empty.

7. Do not overfill pump, which can result in overpressurization and subsequent overinfusion of medication.

8. Drug dose calculations
   a) Use manufacturer guidelines for calculating the amount of drug needed to refill the pump.
   b) Evaluate the actual (measured) volume (the volume initially placed in the pump) minus the volume of drug withdrawn from reservoir.

   a) Date and time of refill and the number of days since last refill
   b) Return volume from pump after access
   c) Infused volume (previous refill volume minus return volume)
   d) Pump flow rate (infused volume divided by number of days since last refill)
   e) Pump drug, concentration, and drug refill volume
   f) Patient’s response to the procedure

IX. Removal technique
A. Whether a trained RN or advanced practice nurse can remove temporary catheters depends on the individual state board of nursing and institutional guidelines. Training and competency records must be maintained.

B. Temporary catheters are pulled directly out of the epidural or intrathecal system using maximum sterile barrier precautions. The catheter is assessed for integrity.

C. Pumps and ports are removed by a surgeon or interventional radiologist. Devices may be left in place except in the occurrence of catheter migration, infection, CSF leak, hematoma, menigitis, sciatic nerve damage, catheter occlusion, or persistent or severe spinal headaches.

X. Complications (Bauer et al., 2012; Bottros & Christo, 2014; Deer & Provenzano, 2013; Farquhar-Smith & Chapman, 2012; Gevirtz, 2010; Heo et al., 2014; Smyth et al., 2014)
A. Infection
   1. Etiology
      a) Surgical contamination
      b) Improper technique when accessing the system
      c) Systemic complication of an immunosuppressed patient
      d) Non-iatrogenic trauma to the site

2. Potential sites of infection
   a) Catheter exit site
   b) Tunnel
   c) Port pocket
   d) Pump pocket
   e) Epidural space
   f) Surgical wound or wound dehiscence

3. Signs and symptoms
   a) Site tenderness, warmth, erythema, or drainage
   b) Hypo- or hyperthermia
   c) Headache with or without vomiting
   d) Bloody or purulent CSF from reservoir
   e) Pain during injection
   f) Decreased analgesic effects following pain medication administration
   g) Changes in sensory or motor function
   h) Nuchal rigidity
   i) Mental status changes
   j) Port or pump pocket erythema
   k) Seizures
   l) Photophobia

4. Diagnostic testing
   a) Complete blood count: Elevated white blood cell count
   b) CSF: Elevated protein and microbial growth
   c) Wound culture: Culture of CSF

5. Prevention
   a) Evidence-based recommendations for preventing infections in epidural and intrathecal devices are limited in the literature.
      (1) For implanted drug delivery devices, preoperative prophylactic antibiotic therapy has been recommended (Deer & Provenzano, 2013; Gevirtz, 2010).
      (2) A randomized, prospective trial by Kerwat et al. (2015) of 337 patients with epidural and peripheral regional catheters used for pain medication administration demonstrated that chlorhexidine gluconate dressings significantly reduced bacterial colonization of the tip and insertion site of epidural and peripheral regional catheters compared to
conventional dressings with no difference in local infections between the two groups. Subsequently, the use of chlorhexidine-impregnated dressings may decrease infection rate.

3. Recommendations
   (a) Use maximum sterile barrier precautions during insertion, routine maintenance, and medication administration.
   (b) Maintain integrity of dressing for percutaneous catheters and all others until insertion site has healed.
   (c) Ensure that only specially trained personnel access the device.
   (d) Protect the exit site from injury and the device from damage.
   (e) Use a microporous filter to decrease introduction of pathogens.

6. Management
   a) Administer antibiotics systemically.
   b) Persistent infection may require device removal. If the device is removed, a culture of the catheter tip may be obtained if ordered.

B. Epidural hematoma (Margo et al., 2011)
1. Etiology: Blood filling the brain area and compressing the brain tissue, resulting in intracranial hypertension; considered an emergency situation.
2. Signs and symptoms: Headache, neurologic changes, behavior changes, aphasia, dizziness, nausea and vomiting, lethargy, and confusion.
3. Diagnostic tests: computed tomography (CT) or MRI of brain.
4. Management: Surgical drainage of hematoma by a surgeon.

C. Post–dural puncture headache syndrome (Neuman, Eldridge, Qu, Freeman, & Hoelzer, 2013; Zencirci, 2010)
1. Etiology: Leakage of CSF through the dura mater puncture, causing reduced CSF levels in the brain and spinal cord; more common with intrathecal devices.
2. Signs and symptoms: Headache, neck pain, shoulder pain, paresthesia, nausea and vomiting, photophobia, and vision changes.
3. Prevention: Keep the patient supine after procedure; encourage fluids.
4. Management
   a) Epidural blood patch
   b) Postprocedure: Hydration and oral intake of caffeine

D. Fibrin formation at catheter tip (Jhas & Tuli, 2008)
1. Etiology: Fibrin sheath forms around catheter distal tip, applying pressure to the dorsal nerve, nerve roots, and spinal cord. Backtracking of the drug can occur outside the catheter, with deposition of drug into the SC tissue.
2. Signs and symptoms
   a) Inadequate pain management
   b) Neurologic deficits
   c) Paralysis
   d) Bowel or bladder retention or incontinence
   e) Pain with injection: Radicular pain is more frequent with intrathecal catheters.
3. Diagnostic tests: Imaging of catheter tip.
4. Management
   a) Evaluate the location of the catheter tip by imaging procedure.
   b) Removal of the device may be necessary.

E. Bleeding (Bauer et al., 2012)
1. Etiology: Epidural or subarachnoid bleeding, exit-site bleeding; considered a potential emergency.
2. Signs and symptoms
   a) Neurologic changes
   b) Severe back pain
   c) Sensory or motor deficits
   d) Bleeding noted at exit site.
3. Management
   a) Notify the provider; a CT or MRI may be ordered.
   b) Establish IV access.
   c) Elevate the head of the bed 30°.
   d) Monitor neurologic status and vital signs.
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e) If neurologic status is deteriorating, obtain a neurosurgery consult.

f) If bleeding persists, the provider may need to remove the device.

F. Displacement or migration of catheter (Jeon, Lee, Yoon, Kim, & Lee, 2013; Strandness, Wiktor, Varadarajan, & Weisman, 2015; Tandon & Pandey, 2015)

1. Etiology
   a) Kinking or blockage of catheter
   b) Catheter migration out of epidural space
   c) Inadvertent dural puncture during epidural placement
   d) Spinal cord puncture either by migration of the intrathecal catheter or during insertion

2. Signs and symptoms: Associated with a variety of effects from the displacement
   a) Ineffective pain control
   b) Traumatic syrinx (fluid filled cavity inside the spinal cord or brain stem)
   c) Epigastric arterial erosion
   d) Cerebral hypotension
   e) Herniation associated with excessive CSF leakage

3. Assessment parameters
   a) Change in neurologic status
   b) Spinal headache
   c) CSF leakage around the exit site, port, or pump pocket
   d) Slow or resistant filling of pump reservoir or port
   e) Easy mobility of the port under the skin
   f) Outward migration of the catheter judged by catheter marks outside the patient’s body

4. Prevention: Avoid trauma to the implant site or device. Patients who weigh less than 40 kg (88 lbs) are at increased risk for epidural catheters that move inward and fall out as compared to patients who weigh more (Strandness et al., 2015).

5. Management
   a) Attempt to gently irrigate with preservative-free NS.
   b) Notify the provider if blood or greater than 0.5 ml of CSF is aspirated, and do not administer drug.
   c) Imaging studies may be ordered to assess placement of the catheter.
   d) Radiation therapy may be considered to decrease size of the tumor if growth blocks the catheter.
   e) Administer pain medication, as needed.
   f) The device may be removed.

G. Dislodgment of the needle from port or pump
   1. Etiology: Needle dislodged from septum
   2. Signs and symptoms: Edema at insertion site, possible erythema, pain
   3. Prevention: Secure needle within the septum with securement device and place occlusive dressing.
   4. Management: Reaccess device.

H. Implantable pump complications (see Table 13-2)

1. “Pocket fill” (Gofeld & McQueen, 2011; Saulino & Gofeld, 2014; Wesemann et al., 2014; Wilkes, 2014)
   a) Etiology: Medication is improperly administered into the SC tissue pump pocket.
   b) Signs and symptoms: Depend on drug administered and concentration
   c) Prevention
      1) Use ultrasound guidance to locate septum for access.
      2) Use the template provided by the manufacturer to locate the septum prior to access. Management includes supportive care and possible reversal agents.

2. Radiation effects on implanted pump functioning (Gebhardt, Ludwig, Kirchner, Kissling, & Kosturakis, 2013)
   a) Gebhardt et al. (2013) studied 39 patients (12 of whom received external beam radiation therapy with either the pump or the catheter in the treatment field) with cumulative device doses ranging from 5–36 Gy and 15–45 Gy, respectively. At the completion of radiation, no evidence was found of pump malfunction for any of the 39 patients. Median follow-up was 4.5 months.
   b) Guidelines from manufacturers have recommended a cumulative dose of 5 Gy; however, no definitive recommendation can be made.
   c) Check device functioning following completion of radiation or sooner if analgesic requirements change.

3. Silicone septum leakage (Perruchoud, Bovy, Rutschmann, Durrer, & Buschser, 2013)
   a) Etiology: Multiple access within septum, needles constantly rubbing against metallic pump body, inability to access septum
   b) Signs and symptoms: Depend on drug administered
c) Prevention: Use ultrasound guidance to access; only trained personnel should access the pump.

d) Diagnostic tests: CT of abdomen

e) Management: Remove pump and replace.

XI. Education and documentation (see Chapter 17)

The authors would like to acknowledge Julie G. Walker, MSN, RN, FNP-C, for her contribution to this chapter that remains unchanged from the previous edition of this book.

References


Table 13-2. Implantable Intrathecal Pump Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Prevention</th>
<th>Presentation</th>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seroma, hematoma</td>
<td>Instruct the patient to avoid sports and other activities that may cause injury.</td>
<td>Tenderness, edema, fluid leakage, and erythema occurring within 72 hours after surgery</td>
<td>Apply pressure dressing or abdominal binder daily for 1–2 months, if needed. Avoid trauma to the pump.</td>
</tr>
<tr>
<td>Catheter occlusion: Thrombus, catheter kinking/dislodgment</td>
<td>Instruct the patient to keep refill appointments. Do not let the pump become completely empty.</td>
<td>Excess fluid remaining in pump, abdominal pain, medication withdrawal symptoms Lower extremity weakness Groin pain Uncontrolled pain</td>
<td>Imaging or catheter contrast study to confirm placement Prepare the patient for pump removal (rare) if occlusion cannot be cleared.</td>
</tr>
<tr>
<td>Equipment problems, program problems, incorrect setup, improper rate</td>
<td>Confer with company technical support staff. Provide competency-based education.</td>
<td>Excess or less fluid remains in the pump, and systemic toxicity from incorrect drug dose infusion</td>
<td>Preprogram pump or remove fluid/drug from reservoir and refill with proper concentration. Avoid extreme temperature or altitudes.</td>
</tr>
<tr>
<td>Infection: Subcutaneous pocket, sepsis</td>
<td>Use sterile technique. Examine fluid for discoloration. Maintain closed system.</td>
<td>Tenderness, warmth, erythema, swelling, drainage at pump site Fever/chills Headache Neck pain</td>
<td>Culture site or fluid. Administer antibiotics, as prescribed. Assess for signs of sepsis. Pump removal may be necessary.</td>
</tr>
<tr>
<td>Pump inversion in subcutaneous pocket</td>
<td>Instruct the patient to avoid sports and other activities that may cause injury. Encourage patient to maintain weight.</td>
<td>Unable to access pump</td>
<td>Imaging to evaluate pump Surgical intervention to reposistion pump</td>
</tr>
<tr>
<td>Skin necrosis over pump</td>
<td>Implant with sufficient tissue over pump. Encourage patient to maintain weight. Routinely inspect skin over pump.</td>
<td>Erythema, pain, and skin breakdown</td>
<td>Apply semipermeable transparent dressing over skin to avoid friction with clothing. Remove pump and consider a new pump site.</td>
</tr>
</tbody>
</table>

Note. Based on information from Bottros & Christo, 2014; Farquhar-Smith & Chapman, 2012; Rosen et al., 2013; Saulino et al., 2014; Wesemann et al., 2014.
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Chapter 14

Intraperitoneal Catheters

Miriam Rogers, EdD, MN, RN, AOCN®

I. History (Helm, 2012)
   A. Initially developed to access the peritoneal cavity for drainage of ascites fluid and for peritoneal dialysis
   B. Insertion techniques, access methods, and materials have evolved over time, but requirements for accessing the device and maintenance care under sterile conditions have not changed.
   C. As early as 1923, equipment used for other purposes, such as metal trocars and glass cannulas for surgical drains, was adapted to access the peritoneal cavity. The rigidity of these materials led to problems of leakage, infection, and catheter occlusion.
   D. In the 1940s and 1950s, discovery of less rigid materials, such as nylon and polyvinyl, improved the drainage of peritoneal fluid, yet infection and leakage remained a problem.
   E. In the 1960s, a silicone rubber model became the prototype of the current peritoneal catheters. This model featured a coiled intraperitoneal (IP) end with multiple perforations extending 23 cm from the tip and a long subcutaneous (SC) tunnel.
   F. In 1965, an improved peritoneal catheter was created for peritoneal dialysis, allowing for frequent access of abdominal cavity. A Dacron cuff was placed subcutaneously and a second external cuff was used, allowing for direct secure connection to external devices.
   G. Implanted SC ports were first used for peritoneal access in the early 1980s.
   H. Research continues on catheter modifications in an effort to decrease infection, leakage, and obstructive complications.

II. Device characteristics (Helm, 2012) (see Figure 14-1)
   A. Permanently or temporarily placed in the abdominal cavity
   B. Used intermittently or continuously
   C. Designed to provide sterile access into the abdominal cavity

III. Device features (Anastasia, 2012; Ellsworth, 2016; Gynecologic Oncology Group, n.d.; Helm, 2012)
   A. Overview
      1. Implanted SC or tunneled devices
      2. Contain a single lumen or have multiple holes (fenestrated) that permit increased distribution of solutions
      3. Available with or without cuff
   B. An implanted SC port is secured in the abdomen with the portal body placed over a bony prominence (Anastasia, 2012; Ellsworth, 2016; Gynecologic Oncology Group, n.d.; Helm, 2012).
      1. Materials: A titanium or plastic portal body has a self-sealing silicone septum and may have preattached or an attachable radiopaque polyurethane or silicone single-lumen or fenestrated catheter.
      2. The septum diameter is 12.7 mm and is accessed with a noncoring needle.
      3. The attached catheter is 8–16 Fr, with lengths ranging from 31 to 48 cm.
      4. The cuff is located between the IP and the SC sections of the catheter (if used).
   C. External tunneled catheters placed through abdominal wall with external access (Anastasia, 2012; Ellsworth, 2016; Gynecologic Oncology Group, n.d.; Helm, 2012; Piraino et al., 2011; Ques et al., 2013)
      1. Placed for paracentesis or delivery of medications into the peritoneum over variable amounts of time, such as a course of IP che-
motherapy or palliative frequent paracentesis at end of life

2. Materials: Silicone or polyurethane with radiopaque stripe

3. Consist of three parts that are available in multiple styles, sizes, and configurations to adapt to body habitus: infant (31 cm), child (37 cm), and adult (42–47 cm) lengths
   a) The external segment generally is 20 cm.
   b) The SC segment is the shortest, ranging from 2–10 cm.
   c) The intra-abdominal segment is the longest, ranging from 31–48 cm.

4. The internal portion of the catheter may be coiled or straight with outer diameters ranging from 8–15 Fr. Coiled catheters decrease the incidence of catheter migration.

5. May have single or double Dacron cuffs on the catheter to secure its position, and may prevent infection within the IP cavity
   a) One cuff: Located between the external exit site and SC segments, placed 2–3 cm from the catheter exit site, deep subcutaneously to prevent cuff infection and extrusion
   b) Two cuffs: One located between the external exit site and SC segments and one between the SC and intra-abdominal segments, anchored to the rectus sheath, making a watertight seal to prevent leakage and infection

6. Available with clamps

IV. Device advantages and disadvantages (see Table 14–1)

V. Patient selection criteria (Al-Quteimat & Al-Badaineh, 2013; Anastasia, 2012; Echarri Gonzalez, Green, & Muggia, 2011; Ellsworth, 2016; Grosso et al., 2014; Jaaback, Johnson, & Lawrie, 2016; Robella et al., 2014; Ryan, Lyons, Hansen, & O’Gorman, 2013; Small, 2013; Sun et al., 2013)

A. IP antineoplastic therapy; delivers a high concentration of drug directly into the peritoneal space, allowing prolonged exposure

B. Palliation of metastasis such as abdominal carcinomatosis and intermittent drainage of ascites (Malayev, Levene, & Gonzalez, 2012; Ryan et al., 2013)

C. IP chemotherapy is rarely used in the pediatric population. If a pediatric patient requires an IP catheter, it is most likely being used for peritoneal dialysis.

D. A patient able to tolerate large volumes of IP fluid. The volume of fluid for IP treatment must be adjusted to the size of the patient.

E. A patient or caregiver able to care for an external catheter

VI. Insertion techniques (Abdel-Aal, Gaddikeri, & Saddekni, 2011; Ellsworth, 2016; Kim et al., 2015; Ryan et al., 2013)

A. Preassessment
   1. Prior to placement, ensure that contraindications do not exist, informed consent is obtained, preplacement is completed, laboratory studies are verified, and a medication/chemotherapy order is reviewed (see Appendix 4).
   2. Techniques, timing, and placement are varied. No standard approach has been established.
   3. Prior omentectomy is recommended to facilitate distribution of fluid drainage or instillation.

B. External tunneled catheter considerations
   1. Inserted by a surgeon or interventional radiologist using maximum sterile barrier precautions under fluoroscopy with local or general sedation; can be placed at any time over the course of disease, from initial surgery through end-of-life care
   2. The catheter tip is directed toward the cul-de-sac of the pelvis, the peritoneum is closed, and a SC tunnel is made. The catheter exits through the anterior abdominal wall.
   3. The entire IP segment of the catheter, with its multiple exit holes or single lumen, must be placed in the peritoneum to avoid drug extravasation.
   4. The external portion of the catheter is placed away from the initial puncture site and sutured in place.
   5. The external portion of the catheter is placed off the side of the midline to provide easy access for the patient.
   6. Change postoperative dressing 24 hours after placement, unless excess soiling occurs.

C. Implanted SC port (Dawson et al., 2011; Ellsworth, 2016; Helm, 2012; Kim et al., 2015; Risson et al., 2012)
   1. Inserted by a surgeon or interventional radiologist using maximum sterile barri-
ers under fluoroscopy and conscious sedation or general anesthesia
2. Placed similarly as described in the external catheter procedure
3. After closure of the peritoneum, a SC tunnel is made to the selected port site over a bony prominence (preferably over the costal margin) to stabilize access.

D. Insertion complications (Ellsworth, 2016; Helm, 2012; Kim et al., 2015; Piraino et al., 2011) (see Table 14-2)
1. Pain: May require analgesics
2. Bleeding: Large amounts of blood in abdominal fluid. Bleeding may be significant enough to require blood transfusions or surgery to remove or replace the catheter, or it may be sign of perforation or blood vessel or tumor erosion. Consult a surgeon or interventional radiologist immediately.
3. Bowel perforation: Severe abdominal pain, fever, and tense abdomen. Consult a surgeon or interventional radiologist immediately.
4. Peritonitis: Fever, nausea, vomiting, severe abdominal pain, and cloudy peritoneal fluid. Consult the provider; cultures may be sent. Otherwise, antibiotics and analgesics, as ordered.


VII. Unique maintenance and care: Determine the type of IP access device implanted and review the manufacturer’s instructions prior to use (Anastasia, 2012; Ellsworth, 2016; Gynecologic Oncology Group, n.d.; Helm, 2012; Piraino et al., 2011; Ques et al., 2013; Warady et al., 2012) (see Appendices 2, 4, 7, 12, and 13 and Figure 14-2).

A. Prior to accessing or caring for catheters or ports, verify scope of practice with the individual state board of nursing and institutional guidelines.
B. RNs managing peritoneal devices must be knowledgeable of the principles of drug administration and care of patients with these devices.
C. Maintain maximum sterile technique to prevent catheter tunnel infection and peritonitis. Use of sterile mask and gloves is highly recommended because of the vulnerability of the patient population to infection.
D. Ensure that all tubing connections are Luer lock. Label all lines close to the patient as feasible. Secure the catheter to prevent kinks and ten-

<p>| Table 14-1. Advantages and Disadvantages of Intraperitoneal Devices |
|-------------------------|-----------------|-----------------|
| <strong>Type</strong>                | <strong>Advantages</strong>  | <strong>Disadvantages</strong> |
| External tunneled peritoneal catheters | Serve as a semipermanent access device that allows cyclic treatments over a long period of time | Increase risk of infection because of external portion; exposed tubing provides direct access to peritoneal cavity. |
|                        | Decrease risk of visceral or bowel perforation when compared to temporarily placed intraperitoneal catheters for peritoneal access | Increase risk of leakage around the exit site |
|                        | Permit faster fluid infusion rate: 2 L in 10–15 minutes | Insertion must be performed in the operating room. |
|                        | Permit rapid drainage of fluid | Increase risk of dislodgment |
|                        | Allow for collection of fluid samples | Require maintenance: Dressing changes, exit site, and catheter care |
|                        | Allow for high-pressure forced irrigation or manipulation to loosen fibrin clots | Increase cost because of necessary maintenance supplies |
|                        | Access is less painful to the patient. | May require more office visits or use of home health agency, adding to cost |
|                        | Can be removed at the bedside or as outpatient if a cuff is used | Inconvenience: Limit ability to swim, bathe, and wear certain clothing |
|                        | Available repair kits for the external portion | Can have a negative influence on the patient’s body image |
|                        | Inexpensive catheter | |
|                        | Patient and caregivers can learn how to care for the catheter and how to drain fluid for palliation of ascites. | |
| Implanted peritoneal ports | Serve as a semipermanent access device that allows cyclic treatments over a long period of time | Must be surgically placed and removed in the operating room |
|                        | Potentially decrease risk of infection because of lack of external portion | Require a needlestick to access device, which may cause discomfort to the patient |
|                        | No risk of accidental removal | Do not allow for high-pressure forced irrigation or manipulation to dislodge fibrin |
|                        | Do not require dressing or flushing between treatments | Slower infusion rate: 2 L in 30–45 minutes because of needle size limitations |
|                        | No restrictions on activity, bathing, or swimming | Decrease rate of fluid return: 2 L in 1–2 hours |
|                        | Increase patient acceptance because of lack of external component | Inability to drain off or aspirate fluid because of needle size limitations |
|                        | | More expensive with insertion |</p>
<table>
<thead>
<tr>
<th>Complication</th>
<th>Etiology</th>
<th>Signs/Symptoms</th>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient discomfort</td>
<td>Increased fluid volume in abdomen</td>
<td>Abdominal distention</td>
<td>Loosen clothing. Administer analgesics, as ordered. Provide reassurance that problems are temporary. Evaluate the patient’s size and adjust fluid volume and rate.</td>
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<tr>
<td>Fluid loculation</td>
<td>Shortness of breath</td>
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<td>Abdominal pain</td>
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<tr>
<td>Rapid fluid infusion</td>
<td>Abdominal or rectal pressure</td>
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<td></td>
<td>Complaints of pain</td>
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<td></td>
<td>Shivering, complaints of cold feeling</td>
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<tr>
<td>Inflow failure</td>
<td>Needle misplacement</td>
<td>Inability to infuse solution or difficulty flushing</td>
<td>Assess port and needle placement. Deaccess and reaccess port.</td>
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<tr>
<td></td>
<td>Implanted port inversion</td>
<td>Inability to access</td>
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<tr>
<td>Catheter kinks</td>
<td>Blood or fibrin clots in catheter</td>
<td></td>
<td>Reposition patient. Flush vigorously with sterile 0.9% normal saline (NS). Prepare for an imaging study to check catheter position. If catheter is in place but unable to irrigate, instill tissue plasminogen activator (tPA). If still no success, the catheter may need to be removed.</td>
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<td></td>
<td>Obstruction of catheter by abdominal adhesions or omental blockage</td>
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<tr>
<td>Catheter migration</td>
<td>Fluid loculation</td>
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<td>Tumor progression</td>
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<tr>
<td>Outflow failure</td>
<td>Fibrin sheath formation creating a one-valve effect</td>
<td>Inability to sample peritoneal fluid for diagnosis or specimen collection</td>
<td>Reposition the patient: attempt to flush with 20 ml NS. If still unsuccessful, attempt to withdraw a fluid sample after 30 minutes. Notify the provider if no improvement occurs.</td>
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<tr>
<td></td>
<td>Omental adhesion or tumor causing outflow blockage of catheter</td>
<td>Inability to drain solution, although able to infuse solutions</td>
<td>Assure the patient that the fluid will eventually absorb. Prepare the patient for an imaging study to diagnose the problem. If the catheter still infuses, future treatments may continue, as ordered, without the drainage of contents. tPA may be ordered.</td>
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<tr>
<td></td>
<td>Catheter migration</td>
<td>Ascites fluid may require paracentesis for removal.</td>
<td></td>
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<tr>
<td>Drug extravasation</td>
<td>Separation of port from catheter</td>
<td>Inability to aspirate fluid</td>
<td>Stop the drug infusion. Notify the provider. Attempt to aspirate the drug, if possible. Prepare the patient for diagnostic studies to determine placement. The device may be removed.</td>
</tr>
<tr>
<td></td>
<td>Dislodgment of port needle from septum</td>
<td>Poor rate of infusion and difficulty flushing</td>
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<td></td>
<td>Migration of catheter out of the peritoneum</td>
<td>Local swelling around exit site or port diaphragm</td>
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<td></td>
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<td>Patient complains of pain</td>
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<td>Erythema at the site</td>
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<tr>
<td>Exit-site infection</td>
<td>Improper sterile technique when performing treatments, dressing changes,</td>
<td>Marked erythema or discharge from exit site</td>
<td>Culture exudate. Administer PO or IV antibiotics, as ordered. Increase local measures: Clean exit site once or twice a day, and apply sterile dressing. If cuff erosion exists, the device will have to be removed.</td>
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<tr>
<td></td>
<td>combining and catheter care</td>
<td>Increased scab formation</td>
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<td></td>
<td>Contamination of open area at exit site (usually from skin flora)</td>
<td>Local tenderness around exit site or tunnel</td>
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<td></td>
<td>An immunosuppressed patient Erosion of tunnel cuff through the skin</td>
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(Continued on next page)
Table 14-2. Complications of Peritoneal Therapies and Interventions (Continued)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Etiology</th>
<th>Signs/Symptoms</th>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunnel infection</td>
<td>Same as for exit-site infection</td>
<td>Infection occurring between the two cuffs, manifesting as inflammation appearing along the tunnel line of the catheter</td>
<td>Same as for exit-site infection Decreased chance of resolution Catheter removal usually is required. Ultrasound will reveal fluid collection around the catheter. Administer oral or IV antibiotics, as ordered.</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>Infection occurs because of improper sterile technique when accessing device, changing dressing, or performing therapies. Immunocompromised patients are at an increased risk for infection. Less likely cause: Catheter erosion into small or large bowel</td>
<td>Fever and chills Abdominal tenderness to light palpation Rebound tenderness Cloudy fluid Positive cultures Peritoneal fluid with white blood cells greater than 100 cells/mm³</td>
<td>Send cultures. Administer IV or intraperitoneal (IP) antibiotics, as ordered. Administer analgesics. The catheter may need to be removed if infection does not resolve or recurs with the same organism.</td>
</tr>
<tr>
<td>Slow infusion rate of solution</td>
<td>Kinks in catheter or tubing Fibrin sheath formation Obstruction of catheter by adhesions, omentum, or tumor</td>
<td>Increased time to infuse solution is more than 2 hours/L.</td>
<td>If using a port, check needle placement and gauge. Increase height of bag. Irrigate catheter with 20 ml sterile NS. Change the patient’s position.</td>
</tr>
<tr>
<td>Leakage at exit site</td>
<td>Incomplete healing of surgical wound Dislodgment of port needle from septum</td>
<td>Visible leakage of IP fluid around catheter or insertion site: Redness, local pain Dressings saturated</td>
<td>Stop the treatment immediately. Check needle placement. Notify the provider. Perform sterile exit-site catheter care and place a sterile dressing over the site. Imaging may be required to verify catheter placement.</td>
</tr>
<tr>
<td>Catheter migration and erosion into other pelvic organs</td>
<td>Fistulization of catheter into pelvic organs: Small or large intestine, vagina, or bladder</td>
<td>Leakage of IP fluid from vagina, rectum, or bladder Abdominal/pelvic pain; urinary urgency</td>
<td>Stop infusion. Notify the provider. Imaging may be required to verify catheter placement; device may be removed.</td>
</tr>
<tr>
<td>Bleeding at exit site (external catheter)</td>
<td>Excessive movement of external tubing Removal of a crust (scab) before the natural separation has occurred</td>
<td>Bleeding when performing exit-site care, when dressing is removed Blood-stained gauze</td>
<td>Apply local pressure with sterile gauze. Anchor tubing with securement device. Perform gentle exit-site care; do not pull or twist the catheter.</td>
</tr>
</tbody>
</table>

2. Apply mask. Open supplies, including syringe, needleless connector, catheter clamp, gauze, and gloves, onto a sterile field.

3. Cleanse exit site, catheter, and needleless connector. Do not use alcohol long term, as it can cause discoloration and damage to the device. Do not use acetone-based cleaning solutions because they are incompatible with the polymer material used in the peritoneal device.

4. Gently aspirate to confirm no blood return is present. If present, discontinue use and notify the provider. Flush the catheter with 20 ml 0.9% normal saline (NS).
5. Connect infusion tubing; start infusion and assess for leakage, ease of flow, SC infiltration, and pain.

6. Apply occlusive dressing and secure with a stress loop, attaching to the abdomen to prevent excess pulling.

7. Change dressing 24 hours postoperatively or with excess soiling. Dressings are changed three times a week; needleless connectors are changed after each use, if damaged, or if contaminated.

H. An implanted port requires a noncoring needle to access, regardless of implantation site.

1. Use maximum barrier precautions at all times.

2. Apply sterile mask and open supplies, including syringe, noncoring needle, needleless connector, gauze, and gloves, onto a sterile field.

3. After accessing port, gently aspirate to confirm that no blood return is present. If present, discontinue procedure and notify provider. Flush with 20 ml NS. Assess for leakage, ease of flow, SC infiltration, and pain. Withdraw peritoneal specimen, as ordered. Often, peritoneal ports may not yield a specimen. Use of heparinized solution flush after NS remains controversial.

4. Apply sterile occlusive dressing over access site after needle is removed, if needed.

5. An implanted port does not require dressing change and access site cleaning when not in use.

I. Administration considerations

1. After access, peritoneal fluid may be drained or allowed to be absorbed per provider order. In patients with gynecologic cancers receiving IP treatment, fluid typically is not drained in order to provide absorption into the systemic circulation.

2. Drugs considered irritants and vesicants to the venous system have a similar effect on the peritoneum, causing pain, burning, and sclerosing and may be difficult for the patient to tolerate. These agents may be selected for their sclerosing effect rather than their chemotherapy effect.

3. Drugs that have a high local toxicity that causes pain and the tendency to create adhesions are not used for planned multi-course therapies.

VIII. Special considerations (Al-Quteimat & Al-Badaneh, 2013; Anastasia, 2012; Chan, Morris, Rao, & Chua, 2012; Ellsworth, 2016; Gynecologic Oncology Group, n.d.; Helm, 2012; Neuss et al., 2013; Sun et al., 2013)

A. If ascites is present, drain fluid prior to infusion of chemotherapy to promote comfort and tolerance. Attach a peritoneal drainage bag for collection of fluid.

B. Warming IP fluid to body temperature has not been determined to be more tolerable than room temperature. No definitive recommendation regarding methods to warm fluid can be made with available evidence.

C. Infuse fluids, as ordered, through specialized tubing without injection ports.

1. Ensure position by infusing a small amount of NS, observing for leakage, difficult flow, or extravasation. Proceed with therapy if no issues are noted.

2. When fluid has infused, close the clamp for the duration of dwell time. During that time, assist the patient to turn from side to side every 15–30 minutes to improve distribution throughout the abdomen.

3. If the fluid will not be drained, flush the catheter with 20 ml NS and disconnect.

4. If fluid is to be drained, open the drainage clamp and allow fluid to drain by gravity. If fluid will not drain, reposition the patient, instruct the patient in performing the Valsalva maneuver, apply manual pressure to the abdomen, or irrigate the catheter with NS. Drainage is more rapid with an external catheter. An implanted port may or may not allow drainage of fluid.

D. Hyperthermic IP chemotherapy: Administered in specialized gynecologic oncology centers in
the operating room at the time of surgery. The complexity and risks associated with this procedure require special training and precautions (Dubé et al., 2015; Robella et al., 2014; Small, 2013; Wademan et al., 2012).

1. Highly concentrated, heated chemotherapy is delivered directly to the abdomen during surgery without the need for a permanent device.
2. Allows for higher chemotherapy dose
3. Heating solution may improve absorption of chemotherapy and destroy microscopic cells. Once the solution circulates throughout abdomen, it is drained and the incision is closed.

E. Palliative management of ascites (Malayev et al., 2012)

1. Patients and caregivers are taught how to perform drainage of peritoneal fluid using an external catheter in the home. Infection risks increase over time.
2. Educate the patient and caregiver about external catheter maintenance (Piranino et al., 2011; Ques et al., 2013; Ryan et al., 2013). a) Exit-site, catheter, and cap care b) Dressing change three times a week c) Weekly cap and clamp change d) Signs and symptoms of infection e) Signs and symptoms to call provider, such as acute pain, infection, changes in condition, decrease or increase in ascetic fluid amounts

IX. Removal technique (Helm, 2012; Milczek, Klasa-Mazurkiewicz, & Wydra, 2015)

A. Whether an advanced practice nurse can remove temporary catheters depends on the individual state board of nursing and individual institution. Training and competency records must be maintained.
B. External catheters are removed by a surgeon or interventional radiologist under local anesthesia. Inspect the catheter for intactness following removal.
C. Implanted SC ports are removed by a surgeon or interventional radiologist under local anesthesia.

X. Complications (Chan et al., 2012; Ellsworth, 2016; Emoto et al., 2012; Gynecologic Oncology Group, n.d.; Helm, 2012; Kim et al., 2015; Milczek et al., 2015; Piraino et al., 2011; Ques et al., 2013; Ryan et al., 2013; Sun et al., 2013; Warady et al., 2012) (see Table 14-2)

A. The risk of infection increases over time with repeated access.
B. An inflammatory reaction can occur when instilling chemotherapy agents into the abdomen and also may contribute to catheter complications.
C. A. B. The author would like to acknowledge Lois Anaya Winkelman, RN, MS, AOCN, for her contribution to this chapter that remains unchanged from the previous edition of this book.

XI. Education and documentation: Review patient education, including aspects of drugs, infusion, access, potential for systemic effects, and the need to wear loose clothing with an expandable waistline (see Chapter 17).

XII. Practicum on IP catheters (see Appendix 13)

References


Chapter 15

Pleural Catheters

Heather Thompson Mackey, RN, MSN, ANP-BC, AOCN

I. History (Walcott-Sapp & Sukumar, 2015)

A. The oldest documented use of a tube for thoracic drainage dates back to the time of Hippocrates in the fifth century B.C., when metal tubes were used to drain empyema from the chest cavity to promote health by restoring balance to the “humors” of the body.

B. In subsequent years, chest tubes in varying forms were used to help remove infection and fluid, most extensively among soldiers in various wars from the time of the Crusades to modern day. In 1961, the first plastic chest tube was introduced, and thoracostomy was established as a standard of care for surgical and trauma patients during the Vietnam War.

C. Modern day pleural catheters, including chest tubes and indwelling pleural catheters, are used in a variety of clinical applications, including both drainage and instillation in children and adults.

II. Device characteristics (Bhatnagar & Maskell, 2014; Cooke & David, 2013; Mahmood & Wahidi, 2013) (see Figure 15-1)

A. Plastic, hollow cylindrical catheter with drainage side holes inserted through the chest wall into the pleural cavity between the visceral (lining the outer surface of each lung) and parietal (lining the thoracic cavity) pleura

B. Used to drain air and fluid (including blood and empyema) from the pleural cavity

III. Device features (Cooke & David, 2013; Kuhajda et al., 2014; Mahmood & Wahidi, 2013; Myers & Michaud, 2013)

A. Defined by size, shape, and manner of insertion and securement

1. Gauges range from 6–40 Fr. Gauges ranging from 6–26 Fr are most commonly used in children. Gauges ranging from 20–40 Fr are most commonly used in adults. Smaller tubes typically are used for drainage of air and larger tubes for drainage of fluid.

a) Large-bore chest tubes: > 14 Fr

b) Small-bore chest tubes: ≤ 14 Fr

2. Shape includes both straight tubes and coiled (“pigtail”) catheters. Pigtail catheters are curved at the distal end to better secure in place.

B. Can be classified based on insertion method

C. Catheter materials (Cooke & David, 2013)

1. Large-bore catheters are made of polyvinyl chloride and typically are stiff. Small-bore catheters, including pigtail and indwelling pleural catheters, are made of silicone and are more flexible.

2. Silicone is preferred because of its better visualization on x-ray, less pleural inflammation, and more drainage holes than other catheters.

D. Tunneled (long-term) versus nontunneled (short-term) catheters

1. Large-bore chest tubes and pigtail catheters are not tunneled under the skin; they are inserted and secured with sutures.
2. Indwelling (tunneled) pleural catheters are small-bore catheters with a one-way valve system at the proximal hub. These are placed similarly to other types of chest tubes but tunneled to secure in place. A polyester cuff located on the catheter aids in securement.

3. Radiopaque markings are present along the catheter.

4. Heparin-coated catheters are available to help reduce thrombus formation and increase ease of insertion.

5. Heimlich valves (i.e., simple one-way valves) may be attached to large-bore chest tubes to provide intermittent temporary suction. Long-term indwelling pleural catheters contain a one-way valve at the proximal tip.

IV. Device advantages and disadvantages (Azan, Lim, & Guthrie, 2014; Gillen & Lau, 2013; Hogg et al., 2011; Lenker, Mayer, & Bernard, 2015; Mahmood & Wahidi, 2013; Myers & Michaud, 2013) (see Figure 15-2)

V. Patient selection criteria (Azan et al., 2014; Gilbert et al., 2015; Gillen & Lau, 2013; Hogg et al., 2011; Kheir, Shawwa, Alokla, Omballi, & Alraiyes, 2015;

Kuhajda et al., 2014; Lenker et al., 2015; Mahmood & Wahidi, 2013; Myers & Michaud, 2013; Rodriguez-Panadero & Romero-Romero, 2011)

A. Patient age, performance status, and surgical candidacy in general do not restrict the placement of pleural catheters.

B. Contraindications: Situations where lung is completely adherent to chest wall

1. Infection overlying the insertion site

2. History of multiple pleural adhesions

3. Presence of emphysematous blebs or scarring, coagulopathies, or platelet defects; correct coagulopathies and thrombocytopenia

4. Chest mass or tumor

C. Indications

1. Pneumothorax: Presence of air in the pleural cavity; may vary in size and can be spontaneous or related to illness, injury, or treatment

2. Hemothorax: Presence of blood

3. Malignant pleural effusion (MPE): Collection of malignant pleural fluid between the visceral and parietal pleura. Approximately 75% of MPEs result from lung and breast cancer (Gilbert et al., 2015; Gillen & Lau, 2013; Kheir et al., 2015; Lenker et al., 2015; Yu, 2011).

a) Treatment usually includes tube thoracostomy, drainage, and sclerosis (i.e., chemical pleurodesis) of pleural space to prevent or slow recurrence following thoracentesis.

b) Pleurodesis involves instillation of drug or sclerosing agent into pleural space that is irritating to the membranes, causing pleuritis. The inflammatory process causes the visceral and parietal pleura to adhere to one another, obliterating the pleural space and preventing reaccumulation of fluid.

c) Historically, large-bore chest tubes were required for pleurodesis; small-bore catheters have now been shown to be as effective, with a minimum of 10–14 Fr recommended (Davies et al., 2012; Light, 2011; Roberts et al., 2010; Yu, 2011).

d) For patients with recurrent MPE refractory to pleurodesis, tunneled small-bore pleural catheters can be used with fluid drainage bags to allow for outpatient management.

e) Nontunneled chest tubes are used in patients with short life expectancies (Cooke & David, 2013; Stokes, 2007).
D. Pleural catheter selection: Determined by indication and patient factors, such as size and health condition. Catheters are selected based on intended purpose, expected length of therapy, viscosity of fluid, fluid components, and the experience of the provider (Cooke & David, 2013).

1. Large-bore chest tubes.
   a) Medical–surgical or trauma requiring short-term management of pneumothorax, hemothorax, drainage of pleural effusion and postsurgical drainage
   b) Instillation of medications or sclerosing agents

2. Small-bore chest tubes
   a) Long-term management of MPEs, removal of empyema, or recurrent pleural effusions
   b) Pneumothorax or hemothorax management (Protic et al., 2010; Rahman et al., 2010; Rivera et al., 2009)

VI. Insertion techniques (Bhatnagar & Maskell, 2014; Cooke & David, 2013; Gillen & Lau, 2013; Hogg et al., 2011; Kuhajda et al., 2014; Mahmood & Wahidi, 2013; Myers & Michaud, 2013; Wiegand, 2011) (see Figure 15-3)

A. Prior to insertion, verify scope of practice with the individual state board of nursing and institutional guidelines.
B. Credentialing and ongoing competency validation is required.
C. Pleural catheters are inserted by a surgeon, interventional radiologist, or advanced practice registered nurse (APRN) using maximum sterile barrier precautions under local or general sedation.
D. Prior to placement, ensure that contraindications do not exist, informed consent is obtained, a preplacement assessment is completed, laboratory studies are verified, and the medication/chemotherapy order is reviewed (see Appendix 4).
E. Use fluoroscopy or ultrasound to assist positioning of the chest tubes (Gillen & Lau, 2013; Shojaee & Argento, 2014).
F. Insert into the “triangle of safety” (i.e., area bordered anteriorly by the lateral border of the pectoralis major, posteriorly by the lateral border of the latissimus dorsi, and inferiorly by a horizontal line at the level of the fifth intercostal space) (Havelock, Teoh, Laws, Gleeson, & BTS Pleural Disease Guideline Group, 2010).

1. Gather required supplies.
2. Position the patient.
3. Wash hands.
5. Cleanse skin, allowing it to air-dry (see Appendix 2).
6. Administer a local anesthetic, as needed (Bhatnagar & Maskell, 2014; Kuhajda et al., 2014) (see Appendix 7).
7. Insertion site and technique of temporary catheters will vary.
   a) Typically inserted at the second intercostal space for pneumothorax as air rises to the top of the pleural space. When hemothorax or pleural effusion is present, insertion is made at the sixth to eighth intercostal space, midaxillary line, as fluid falls to the bottom of the pleural space.
   b) Insertion using blunt dissection: Use a scalpel to make a small incision at the insertion site. Insert a closed clamp to perform a blunt dissection. Palpation of the pleural space is made with the finger. Insert the chest tube and advance into the pleural space.
   c) Insertion using a trocar (i.e., single-use device): Pierce the pleural space following incision into the skin. This method holds a higher risk of complications, including chest penetration and damage to intrathoracic structures because of the increased force required for insertion.
   d) Once in place, connect the chest tube immediately to suction, the thoracic
drainage system, or a clamp close to the patient’s skin to prevent air from entering the pleural space. Three-chamber water seal systems commonly are used with chest tubes in the inpatient setting.

c) Suture the chest tube into place and secure it to the patient’s skin distal to the insertion site with tape or a securement device. Apply sterile dressing.

8. Indwelling (tunneled) intrapleural catheter insertion: Use Seldinger technique; insert at the fourth to eighth intercostal space, midaxillary line.

a) Insert a blunt intrapleural needle (i.e., introducer) through the skin incision into the intercostal space 3–4 inches from the posterior midline. The needle, with the bevel tilted upwards, is directed medially at a 30°–40° angle to the skin over the superior edge of the patient’s rib.

b) Ask the patient to hold breath as the needle punctures through the intercostal muscles while gently aspirating on the attached syringe.

c) Advance the introducer needle slowly until penetration into the parietal pleura. Aspiration from the syringe should produce air or fluid (depending on indication for use).

d) Introduce the guidewire through the introducer needle into the pleural space. Once the guidewire is in place, withdraw the introducer. Pass the chest tube catheter over the guidewire into the desired position within the pleural space; carefully withdraw the guidewire.

e) Introduce the tunneled catheters into the pleural space using a modified Seldinger technique through two small skin incisions. Incisions usually are 7–10 cm apart, allowing easy access to the drain and sufficient length of tunnel to reduce chance of dislodgment (Bhatnagar & Maskell, 2014).

f) Coil the external portion of the catheter to prevent pulling or kinking and suture into place.

g) Apply sterile dressing.


a) If ultrasound guidance is not used for insertion, perform a chest x-ray to confirm chest tube placement.

b) For intrapleural catheters, aspirate the catheter following suturing to the patient’s skin. If resistance is met, this indicates proper placement into the pleural space. If air or blood is obtained, this indicates placement in the lung or blood vessel, respectively. Obtain a chest x-ray to evaluate for pneumothorax resulting from catheter insertion.

10. Label dressing with time, date, and initials of placement.

11. Monitor the patient’s vital signs every 15 minutes for the first hour and then as needed, based on institutional policy.

12. Document the catheter type, size, date, time, provider name, and the patient’s response in the patient medical record.

G. Insertion complications: A small pneumothorax is commonly seen on a chest x-ray and usually does not require intervention (Cooke & David, 2013).

1. Malposition is the most common complication (Kuhajda et al., 2014).

2. Complications are extremely rare with indwelling pleural catheter placement (Bhatnagar & Maskell, 2014).

3. Complications include bleeding, infection, subcutaneous (SC) emphysema, injury to the lung or diaphragm, and re-expansion pulmonary edema.

VII. Unique maintenance and care (Gillen & Lau, 2013; Hogg et al., 2011; Kuhajda et al., 2014; Myers & Michaud, 2013) (see Appendices 12 and 14)

A. Prior to accessing, verify scope of practice with the individual state board of nursing and institutional guidelines.

B. RNs managing pleural devices must be knowledgeable of the principles of drug administration and care of patients with these devices.

C. Ensure that all tubing connections are Luer lock. Label all lines close to the patient as feasible. Secure the catheter to prevent kinks
and tension, which may lead to malposition. Consider tension loop. Use specialized tubing without injection ports, as indicated, to prevent accidental injection of unintended medication.

D. Trace the tubing or catheter from the patient to the point of origin each time the catheter is accessed, at handoff, and at transitions to a new setting or service.

E. Inspect the catheter insertion site and palpate for tenderness, crepitus, or SC emphysema at least daily through the intact dressing.

F. The catheter is not routinely changed unless complications such as obstruction or infection develop.

G. Dressing changes: Change if wet, soiled, or non-occlusive. Use maximum sterile barrier precautions to change dressing.
   1. Split 4 × 4 gauze dressings are used around the catheter exit site.
   2. Apply occlusive dressing over the split gauze dressing.
   3. Do not use petroleum gauze because of its increased risk of suture failure (Muffly et al., 2012).
   4. Avoid getting the exit site wet. Shower only with the exit site covered with sterile, watertight occlusive dressing (Gillen & Lau, 2013).
   5. Change gauze-only dressings every 48 hours; change sterile occlusive dressings at least weekly.

H. To avoid the creation of high-negative intraluminal pressure that can lead to damage of the lung tissue, do not strip chest tubes. In the event of clots or debris in the tubing, the tube can be gently “milked” by pinching the tubing around the clot to help move the clot into the drainage system, as appropriate.

I. Flush small-bore tunneled pleural catheter to dislodge clots and debris from the lumen of the tube. Use 30 ml of 0.9% normal saline (NS) every 6–8 hours to help prevent tube blockage (Yar- mus & Feller-Kopman, 2012).

J. Fibrinolytics have been used in management of obstructions and are performed by experienced providers (Lui, Thomas, & Lee, 2016; Thomas et al., 2015; Vial et al., 2016).
   1. Dilute 2–6 mg of tissue plasminogen activator into 25–100 ml NS and instill into tube; allow a dwell time of at least 1–2 hours in the pleural space while the tube remains clamped (Hogg et al., 2011).
   2. Unclamp and allow to drain.

K. Drainage of tunneled pleural catheters can be performed by patients and caregivers in the outpatient setting after receiving education and training. Follow the drainage procedure outlined by the device manufacturer. A drainage kit may be used by the manufacturer (Bhatnagar & Maskell, 2014; Gillen & Lau, 2013).
   1. Infection risk increases with repeated access. Pleural fluid typically is drained every one to two days.
   2. Normally, discomfort occurs when fluid is being drained; however, if the pain is severe or does not stop with slowing or discontinuing the drainage procedure, the provider should be notified as soon as possible, as this may be indicative of infection or other complications.
   3. Avoid removing large amounts of fluid at one time.
   4. Tunneled pleural catheters
      a) Use maximum sterile barrier precautions.
      b) Remove the catheter valve hubcap and discard. Cleanse the catheter hub. Attach the end of the catheter to the access end of the sterile drainage tubing or the vacuum bottle or bag.
      c) Once locked into place, remove the support clip on the bottle and puncture the foil seal, establishing the vacuum.
      d) Unclamp the catheter, if present; fluid will drain into the vacuum bottle.
      e) Once the fluid has stopped draining, clamp the catheter (if present) and remove the access tip from the catheter valve. Cleanse the valve; a new sterile catheter valve cap is placed and locked into position.
      f) Record the time, date, and amount of fluid.

L. Intrapleural chemotherapy (den Hollander et al., 2014; Gilbert et al., 2015; Kheir et al., 2015; Thomas et al., 2014)
   1. Can be administered using a temporary thoracentesis needle or through chest tubes and intrapleural catheters
   2. Typically performed by a trained physician or nurse practitioner
      a) Situate the patient in Fowler or high Fowler position.
      b) Drain pleural fluid prior to instillation of infusion agent.
      c) Use maximum sterile barrier precautions and observe safe handling technique.
      d) Administer medication into the catheter and clamp.
1. After prescribed dwell time, drain fluid and dispose using safe handling technique.

VIII. Removal technique (Bhatnagar & Maskell, 2014; Cooke & David, 2013; Kuhajda et al., 2014; Wiegand, 2011)

A. Can be removed by a surgeon, interventional radiologist, or possibly an APRN. APRN removal depends on the individual state board of nursing and institutional guidelines. Training and competency records must be maintained.

B. The device is removed when signs and symptoms of infection are present, an obstruction cannot be relieved, damage has occurred, or when the device is no longer required for therapy.

1. Temporary catheters typically are removed within one week of placement to reduce infection risk.

2. Indwelling catheters can remain indefinitely (Bhatnagar & Maskell, 2014).

C. Prior to removal, chest tubes typically are clamped or removed from suction intermittently (while leaving the tube to water seal) to assess for signs of respiratory compromise indicating that the tube should not be removed. A serial chest x-ray may be used to determine if removal is appropriate.

D. Temporary catheter removal

1. Gather supplies.

2. Premedicate with analgesics.

3. Clamp the catheter and discontinue suction.

4. Wash hands.

5. Position the patient.

6. Use maximum sterile barrier precautions.

7. Hold the chest tube in place with sterile forceps and cut the suture anchoring the chest tube to the patient’s skin.

8. Ask the patient to perform the Valsalva maneuver after a few deep breaths.

9. Hold an occlusive dressing over the insertion site and remove the catheter; stop immediately if resistance is met. Immediately cover the site with occlusive dressing. Tie off the stay suture (e.g., sutures placed by some providers at the time of insertion to help secure the catheter) and close the suture using square knots, if present. Otherwise, close with butterfly wound closure strips.

10. Apply a sterile occlusive dressing.

11. Discard used supplies and remove gloves.

12. Wash hands.

E. Indwelling pleural catheter removal: Follow the procedure for temporary catheter removal above.

1. Locate the SC polyester cuff of catheter along the tunnel site. Mark the skin, as needed, to indicate location.

2. A small incision is made over the cuff and is dissected away from the underlying tissue.

3. Close the incision site over the cuff area with butterfly closures.

4. Cover the insertion site with gauze and secure the dressing with tape.

F. Postprocedure

1. Obtain the patient’s vital signs and assess respiratory status.

2. Obtain a chest x-ray, as ordered.

3. Monitor the patient’s respiratory status postprocedure and document observations and actions.

IX. Complications (Bhatnagar & Maskell, 2014; Cooke & David, 2013; Fysh, Wrightson, Lee, & Rahman, 2012; Gillen & Lau, 2013; Hogg et al., 2011; Kuhajda et al., 2014; Lui et al., 2016; Mahmood & Wahidi, 2013; Myers & Michaud, 2013; Rodriguez-Panadero & Romero-Romero, 2011; Thomas et al., 2014; Yarmus & Feller-Kopman, 2012) (see Figure 15-4)

A. Both chest tubes and indwelling pleural catheters can develop pneumothorax, infection, bleeding, kinking, obstruction, air leak, cellulitis of tract site, pain, and tumor seeding.

B. Small-bore catheters are more likely to develop tube blockage by debris and clots.

C. Breakage: Rubber-tipped clamps should be kept at the patient’s bedside or within reach at all times. If the catheter breaks, clamps should be applied as close to the insertion site as possible. The provider should be immediately notified.

D. Dislodgment

1. Cover the site immediately with sterile gauze and tape into place.

2. Notify the provider immediately; monitor the patient for signs and symptoms of tension pneumothorax.

X. Education and documentation (see Chapter 17)

XI. Practicum on pleural catheters (see Appendix 14)

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**Figure 15-4. Potential Complications of Pleural Catheters**

<table>
<thead>
<tr>
<th>Early</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pneumothorax</td>
<td>• Catheter dislodgment</td>
</tr>
<tr>
<td>• Postprocedure pain</td>
<td>• Clot, debris, or loculation</td>
</tr>
<tr>
<td>• Bleeding</td>
<td>• Infection, superficial cellulitis, empyema</td>
</tr>
<tr>
<td>• Lung injury</td>
<td>• Metastases along catheter tract</td>
</tr>
<tr>
<td>• Pleural fluid leakage</td>
<td>• Fracture of the catheter</td>
</tr>
<tr>
<td>• Catheter dislodgment</td>
<td>• Fibrosis and scarring around catheter cuff</td>
</tr>
</tbody>
</table>

**Note:** Based on information from Bhatnagar & Maskell, 2014; Cooke & David, 2013; Gillen & Lau, 2013; Lui et al., 2016; Thomas et al., 2015; Vial et al., 2016.
References


Chapter 16
Ambulatory Infusion Pumps
Andrea B. Moran, RN, APRN

I. History (Fry, 2012; McKeag, 2015)
   A. The first ambulatory pump was marketed in the late 1950s to infuse the chemotherapy agent 5-fluorouracil. Lightweight pumps were created to allow treatment outside of the hospital.
   B. Initially, a mechanical windup watch motor with a rotary peristaltic mechanism was used as a power source.
   C. Over the next two decades, pump manufacturers developed smaller, more cost-effective pumps. In the early 1980s, the computerized ambulatory drug delivery system pump was developed. The use of home infusion therapy grew, and manufacturers introduced ambulatory infusion pumps.
   D. In the early 1990s, multi-therapy pumps were programmed to administer various infusions.
   E. By the 2000s, "smart" pumps were developed with the ability to store dosing guidelines and provide warnings to clinicians for potentially unsafe infusions.

II. Device characteristics (Broadhurst, 2012; Emergency Care Research Institute [ECRI], 2014; Freemantle, Clark, & Crosby, 2011; Lee, 2014; Mohseni & Ebnesahidi, 2014)
   A. Parenteral agent delivery is peristaltic (see Figure 16-1), syringe driven (see Figure 16-2), or elastomeric (see Figure 16-3).
   B. The small size of the pump allows the patient to carry or wear in a pouch.
   C. Home use gives the patient freedom of movement while receiving prescribed therapy.
   D. Reliable delivery of accurate volumes and consistent flow for small fluid volumes; reliability is preserved if refilled repeatedly.

III. Device features (ECRI, 2014; Mohseni & Ebnesahidi, 2014)
   A. Sizes are compact and small.
      1. Peristaltic pumps: 1–3 pounds
      2. Syringe pumps: 1–7 pounds
      3. Elastomeric pumps: 0.5–2 pounds
   B. The device provides continuous or intermittent infusion for medications and nutrition in flow rates varying from 0.02–300 ml/hour.
   C. Pumps are designed for small volumes, such as an antibiotic, or for large volumes, such as total parenteral nutrition (TPN).
   D. Reservoirs are available as bags, cassettes, elastomeric balloons, or syringes.
   E. Peristaltic pumps are used to administer a variety of fluids, medications, or TPN in intermittent or continuous modes. High volumes and higher flow rates can be accommodated by peristaltic pumps.
   F. Syringe pumps typically are used to administer highly concentrated drugs or antibiotics.
   G. Elastomeric pumps consist of an elastomeric membrane containing the drug inside a protective shell (conformable elastomer or rigid plastic).
1. Membranes are made of natural and synthetic material, such as isoprene rubber, latex, and silicone.
2. Membranes can be single layered or multilayered.
H. Operational procedures: See the specific pump manufacturer for detailed instructions (Broadhurst, 2012; Weisman, Missair, Pham, Gutierrez, & Gerbhard, 2014; West, 2014).
1. Power source
   a) Peristaltic pumps
      (1) Alkaline batteries
      (2) Rechargeable battery packs
      (3) Nine-volt batteries
   b) Syringe pumps provide a constant force to plunger, creating constant pressure within the syringe.
      (1) Nonelectronic with constant flow and no-bolus or free-flow features
      (2) Lithium-ion battery
   c) Elastomeric balloons use an elastomeric membrane to generate infusion pressure.
2. Method of infusion and rate regulation: Flow rates should remain within 5% of the rate provided by the manufacturer (ECRI, 2015).
   a) Linear peristaltic/rotary peristaltic
      (1) The mechanism propels fluid forward using appendages that move in a wave-like motion.
      (2) The rotary rotates the tubing between a cam (or disk) and cylinder to move fluid forward with a specific rocking or reciprocating motion.
      (3) The rate is programmed into the pump as continuous or intermittent. Some have an optional programmed bolus feature.
      (4) Delivery capability is 1–3,000 ml/day, with program flexibility of milliliters, milligrams, or micrograms.
      (5) A dual channel is available for simultaneous infusion.
   b) Syringe infusions
      (1) A motor-driven gear mechanism propels fluid by forcing a plunger or piston on the syringe barrel.
      (2) The rate is regulated by the size of the syringe and speed of the motor.
   c) Elastomeric
      (1) An elastomeric membrane generates infusion pressure when filled with fluid. As gravity or positive pressure causes the membrane to deflate, fluid is forced out.
      (2) Rate regulation is controlled by an inline orifice or flow restric-
tor within the administration set and is affected by the pressure gradient across the flow restrictor and by fluid viscosity.

(3) The type of membrane determines the pressure generated on the fluid when stretched. Multilayered membranes can generate higher pressure compared to single-layered membranes.

(4) Infusion rate is 0.5–500 ml/hour (Mohseni & Ebneshahidi, 2014).

3. Alarm system
   a) Peristaltic pumps: Available with audible or visual alarms for occlusion, air in line, low reservoir volume, low battery, and pump malfunction
   b) Syringe pumps: Intermittent audible tone when infusion ends or with occlusion
   c) Elastomeric: No alarm system

4. Advantages and disadvantages of ambulatory infusion pumps (see Table 16-1)

IV. Patient selection criteria (Kumpf & Tillman, 2012)
   A. In general, patient age and performance status do not restrict use.
   1. Pediatrics: Smaller, less-obtrusive pump devices may better enable participation in school or outdoor activities.
   2. Neonatal and pediatrics primarily use syringe pumps.
   3. Older adults: Consider weight of pump and reservoir for the patient.
   4. Consider ability of the patient or caregiver to provide pump care and troubleshooting for complications.
   B. All disease states are appropriate for treatment or symptom management medications administered by an ambulatory pump.
   C. Administration of therapy (McKeag, 2015; Newston & Ingram, 2014; Pajarón et al., 2015; Schaepelynck et al., 2011; West, 2014): Medications can be delivered by an ambulatory pump to any body system (e.g., venous, arterial, epidural, subcutaneous, peritoneal).
      1. TPN: Continuous or cyclic therapy
      2. Antibiotics
      3. Pain management
      4. Chemotherapy
      5. Insulin
      6. Hydration

V. Unique maintenance and care: Refer to manufacturer instructions for operational procedure prior to use.

Table 16-1. Advantages and Disadvantages of Ambulatory Infusion Pumps

<table>
<thead>
<tr>
<th>Type of Pump</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peristaltic</td>
<td>Provide intermittent and continuous infusions</td>
<td>Require programming</td>
</tr>
<tr>
<td></td>
<td>Used for all types of therapy</td>
<td>Potentially cumbersome and heavy to carry pouches when full</td>
</tr>
<tr>
<td></td>
<td>Alarm features</td>
<td>Free-flow risk</td>
</tr>
<tr>
<td></td>
<td>Wide range of infusion rates and volumes</td>
<td>Labor intensive</td>
</tr>
<tr>
<td></td>
<td>Easy-to-read displays for adjustments and troubleshooting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump memory available</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smart pump technology</td>
<td></td>
</tr>
<tr>
<td>Syringe</td>
<td>Lightweight and portable</td>
<td>Can fracture or break if dropped</td>
</tr>
<tr>
<td></td>
<td>Cost-effective</td>
<td>Limited volumes</td>
</tr>
<tr>
<td></td>
<td>Easy to use</td>
<td>Not for large-volume infusions</td>
</tr>
<tr>
<td></td>
<td>Require little or no maintenance</td>
<td>Drug stability factor</td>
</tr>
<tr>
<td></td>
<td>Ability to visualize drug flow</td>
<td>Require adequate manual dexterity to maintain syringe and tubing</td>
</tr>
<tr>
<td></td>
<td>Alarm features</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disposable syringe</td>
<td>Free-flow risk</td>
</tr>
<tr>
<td></td>
<td>Smart pump technology</td>
<td></td>
</tr>
<tr>
<td>Elastomeric</td>
<td>Lightweight, portable, and concealable</td>
<td>Difficult to fill, especially those with multilayer membranes</td>
</tr>
<tr>
<td></td>
<td>Easy to use</td>
<td>Admixture considerations</td>
</tr>
<tr>
<td></td>
<td>No programming</td>
<td>Drug stability factor</td>
</tr>
<tr>
<td></td>
<td>No maintenance</td>
<td>Require calculation of concentrations and volumes</td>
</tr>
<tr>
<td></td>
<td>Reservoir and tubing attached</td>
<td>Limited infusion rates</td>
</tr>
<tr>
<td></td>
<td>Disposable</td>
<td>Not for large-volume infusions</td>
</tr>
<tr>
<td></td>
<td>Simple directions</td>
<td>Not all insurances reimburse</td>
</tr>
<tr>
<td></td>
<td>No batteries</td>
<td>No alarms</td>
</tr>
</tbody>
</table>
A. Continuous infusion minimizes necessity to disconnect the system, which obviates the requirement to flush the access device.

B. Intermittent infusion requires the access device to be flushed with 10–20 ml 0.9% normal saline after drug is completed and the appropriate lock solution is administered.
   1. For some devices, such as the syringe and elastomeric device, the patient or caregiver may need to disconnect the pump after flushing.
   2. Patient teaching is necessary to ensure proper disconnection from the pump.

C. Tubing and reservoir changes
   1. Peristaltic: The bag or cassette may be changed up to every seven days depending on drug, drug stability, and reservoir size. Reservoir covers are available.
   2. Syringe: The syringe (5–60 ml) will depend on the pump. Change syringe every 12–24 hours or at end of infusion.
   3. Elastomeric devices are disposable with each dose and available with or without filters. A filling device is available to fill the pump with the drug.
   4. The patient and caregiver can be taught to change the cassette or syringe or connect the elastomeric devices.
   5. Reservoirs, syringes, or elastomeric devices may necessitate one home or clinic visit per day to change the drug reservoir. Or, these devices may be changed every three to seven days depending on the drug and treatment plan. Some patients may need to go to the clinic to have the pump reservoir changed, depending on insurance coverage or the ability to care for the pump.
   6. Tubing for TPN should be changed every 24 hours.

D. Drug calculations
   1. Ascertain drug concentration required for stability for dose in a reservoir.

   2. The drug dose must be stable for the duration of the infusion at room temperature.
   3. The rate of infusion is programmed into the pump according to the drug concentration.
   4. Dose error reduction systems (DERs) are available and referred to as smart syringe pumps and peristaltic pumps (ECRI, 2015; Harding, 2011; Kastrup, Balzer, Volk, & Spies, 2012; McKeag, 2015; Orto, Hendrix, Griffith, & Shaikewitz, 2015; Schraagen & Verhoeven, 2013).
      a) DERs provide guided manual programming using pump-based software.
      b) Drug libraries are downloaded to the pump.
      c) The software checks programmed doses against preset limits stored in drug libraries.

E. Because elastomeric pumps do not have alarms, they can be weighed several times a day to detect potential infusion abnormalities.
   1. Monitor for reduction in balloon size, indicating a reduction in volume.
   2. A recent study showed significant variations when patients weighed their elastomeric pumps at home, suggesting measuring errors.
   3. No definitive recommendation can be made regarding weighing elastomeric pumps. More research is needed to prove that weighing elastomeric pumps to monitor proper infusion is an adequate safety measure (Cormack, Iliov, & Kluger, 2015).

F. Educate patients and caregivers to maintain pump data logs to record pump settings, setting changes, alarm activations, and when batteries are changed or charged (ECRI, 2015; Prakash et al., 2014).

VI. Complications
   A. Occlusion
      1. An empty reservoir can cause an occlusion and increase the risk of a clot formation. Instruct the patient on how to disconnect the pump or to return to the clinic to have the pump disconnected.
      2. Kinked tubing: Secure a tension loop to prevent kinking and occlusion.
      3. IV catheter infiltration: Teach the patient signs of infiltration and how to stop the pump from continuing to infuse. The clinic should be called immediately.
      4. Pump malfunction: Provide the patient and caregiver contact information for the clinic and the pump manufacturer in the event of an emergency.
a) Most troubleshooting can be conducted over the phone. If the pump malfunction cannot be corrected, the patient should be instructed to stop the pump and return to the clinic for a backup pump.

b) Some pump companies will allow a second pump to be kept at the patient’s home to be used as a backup.

c) Exposure to radiation may lead to electronic pump malfunction. Ensure pumps are shielded from radiation or disconnected (if feasible). After exposure to radiation (including x-rays), infusion pumps should be checked to ensure proper functioning. If possible, use elastomeric pump for patients undergoing radiation to avoid this complication (Bak et al., 2013).

B. Incorrect programming of pump (ECRI, 2015; Kastrup et al., 2012; McKeag, 2015; Orto et al., 2015; Prakash et al., 2014; Schraagen & Verhoeven, 2013)

1. Causes: Bypassing programming procedure alert messages (i.e., safeguards of the pump, input of incorrect pump settings)
2. Verify pump settings with another nurse to ensure accuracy prior to connecting to patient.
3. Barcode technology on the drug bag, cassette, or syringe allows information to be compared with the patient’s prescribed information.
4. Label each syringe, cassette, or bag with drug, rate of infusion, and patient’s name.
5. Smart pump technology is recommended to minimize the risk of incorrect dosing (ECRI, 2015).

a) Technology warns users of incorrect medicine orders, calculation errors, and misprogramming.

b) Soft limits require confirmation prior to initiating the infusion if preset limits differ from the program.

c) Hard limits will not allow infusion if preset limits differ from the program.

d) Some pumps are available to store alerts and log information, which can be analyzed to improve drug libraries and subsequent clinical practice.

6. Check pumps frequently to ensure correct infusion.

C. Incorrect flow rate of elastomeric pump (Cormack et al., 2015; Grissinger, 2013; Mohseni & Ebneshaehidi, 2014; Wang, Moeller, & Ding, 2012; Weisman et al., 2014)

1. Back pressure in the pump can occur as a result of vertical displacement of the device to the infusion set. Keep the device steady in the carrying case.
2. Use a filling device to measure medication accurately and avoid underfilling or overfilling.
3. Variations in atmospheric pressure can cause flow rate to increase.
4. Variations in temperature may affect rate. In general, an increase or decrease in flow rate can occur by 2.96–3% for every one degree of temperature increase or decrease for water-based solutions.
5. Increased viscosity of the drug will decrease the flow rate.

VII. Education and documentation (see Chapter 17)

References


I. Education
   A. Education should be individualized to the patient’s and caregiver’s age, developmental and cognitive level, cultural influences, and language and learning preferences. Assess and address factors such as emotional state, sensory deficits, functional limitations, educational level, and other barriers to learning (Polovich, Olsen, & LeFebvre, 2014).
   B. Provide the patient and caregiver with comprehensive education about the specific access device being used, with subsequent documentation of education made in the medical record (see Figures 17-1 and 17-2). Such education includes the following:
      1. Indications
      2. Type of device and insertion procedure
      3. Potential complications
      4. Signs and symptoms to report to the healthcare team
      5. Demonstration of self-care skills, as appropriate
      6. Resources for supplies and emergency care
      7. Care and maintenance instructions
      8. Method of instruction used (e.g., verbal explanation, demonstration, return demonstration, written instructions, educational video, websites, online instructions) (see Figure 17-3)
      9. Assessment of the patient’s and caregiver’s level of understanding with return demonstration of care provided, as needed

II. Staff training and education: Improves access device competency; document in personnel records (O’Grady et al., 2011) (see Figure 17-2).
   A. Educational activities should address the following:
      1. Appropriateness of access device management within the nurse’s scope of practice
      2. Insertion and access procedures

III. Patient documentation (DeLa Cruz, Caillouet, & Guerrero, 2012; Doyle-Lindrud, 2015; Polovich et al., 2014)
   A. Legibly document accurate and descriptive information in a timely manner regarding the patient, access device, and nursing care provided.
   B. Follow standards outlined in institutional policies and evidence-based practice guidelines.
   C. Documentation (Gallieni et al., 2011) (see Appendices 4, 5, and 12)
      1. Assessment
         a) Rationale for device
         b) Type, purpose, and duration of therapy; previous access device complications; and comorbidities that could affect the functioning of the access device
      2. Interventions
         a) Insertion
            (1) Informed consent
            (2) Date and time of insertion
            (3) Type of device inserted: Include name, manufacturer, lot or serial number, gauge, length, and size.

3. Care and maintenance procedures
4. Assessment of catheter function, potential complications, and interventions
5. Elements of patient and family education about access devices
6. Standards of care, including institutional policies pertaining to access devices
7. Risk management strategies to decrease exposure to legal threats associated with access device use

B. Comprehensive competency documentation that demonstrates gap analysis of learning needs for nurses may assist training validation.
C. Documentation of regular continuing education opportunities can maintain and update knowledge, including advances made in access device technology.
### Figure 17-1. Essentials for Patient and Caregiver Education

<table>
<thead>
<tr>
<th>Completed (date/time and initials)</th>
</tr>
</thead>
</table>

1. Indications for access device

*Venous access devices:*

- Administration of IV medications and therapies
- Administration of IV fluids
- Blood sampling for routine laboratory studies

*Specialty access devices (specific to type of catheter placed):*

- Infusion of medications and therapies
- Drainage or withdrawal of bodily fluids

2. Type of device inserted

- Specific type of catheter placed (name, manufacturer, lot or serial number)
- Details of catheter (gauge, length, size)

3. Review of potential complications of access device

- Breakage
- Infection
- Malposition
- Obstruction preventing flushing or withdrawal of blood or body fluids

4. Signs and symptoms of access device complications to monitor for and report

- Breakage in catheter
- Inability to flush or withdraw
- Temperature greater than 100.5°F (38°C)
- Chills when flushing catheter, as appropriate
- Redness or tenderness at insertion site (based on anatomical location of catheter)

5. Demonstration of self-care skills related to access device, as appropriate

6. Identification of community resources for supplies and emergency care related to access device, if appropriate

7. Care and maintenance of device

- Keeping dressing clean and dry and changing immediately if wet
- Dressing change procedure, if appropriate
- Flushing procedure, if appropriate
- Other maintenance procedures, as appropriate

8. Additional resources for the patient and caregiver
# Figure 17-2. Essentials for Competency Documentation

<table>
<thead>
<tr>
<th>Assessment of Access Device</th>
<th>Completed (date/time and initials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Need for access device and type of device needed</td>
<td></td>
</tr>
</tbody>
</table>
| 2. Regular assessment findings of the patient and device  
  • Type  
  • Purpose  
  • Duration of therapy  
  • Previous access device problems  
  • Other health problems |

<table>
<thead>
<tr>
<th>Insertion of Access Device</th>
<th>Completed (date/time and initials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Informed consent prior to insertion</td>
<td></td>
</tr>
<tr>
<td>2. Date, time, and setting of insertion</td>
<td></td>
</tr>
</tbody>
</table>
| 3. Type of device inserted, including  
  • Name  
  • Manufacturer  
  • Lot or serial number  
  • Gauge or length and size |
| 4. Location of insertion device |
| 5. Preparation of insertion site including local anesthetic, as appropriate |
| 6. Presence of blood return or other body fluid; ability to flush |
| 7. Complications of insertion procedure |
| 8. Method used to secure device and type of dressing used |
| 9. Confirmation of catheter placement and location (e.g., ultrasound; x-ray, if appropriate; location of catheter tip) |

<table>
<thead>
<tr>
<th>Use of Access Device</th>
<th>Completed (date/time and initials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Date, time, and purpose for device use</td>
<td></td>
</tr>
<tr>
<td>2. Methods used to evaluate proper functioning of device prior to use</td>
<td></td>
</tr>
<tr>
<td>3. Complications noted with use, if any</td>
<td></td>
</tr>
<tr>
<td>4. Notification of provider, if troubleshooting needed</td>
<td></td>
</tr>
<tr>
<td>5. Strategies used to manage complications</td>
<td></td>
</tr>
<tr>
<td>6. Compliance with regulatory agency standards and guidelines</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Care and Maintenance of Access Device</th>
<th>Completed (date/time and initials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dressing change</td>
<td></td>
</tr>
<tr>
<td>2. Flushing procedure</td>
<td></td>
</tr>
<tr>
<td>3. Needleless connector change</td>
<td></td>
</tr>
<tr>
<td>4. Use of clamps on the device or extension tubing, as appropriate</td>
<td></td>
</tr>
<tr>
<td>5. Assessment of insertion site and exit site; intactness of device</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Removal of Access Device</th>
<th>Completed (date/time and initials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Indication for removal</td>
<td></td>
</tr>
<tr>
<td>2. Date and time of removal</td>
<td></td>
</tr>
<tr>
<td>3. Type of device removed and description of device following removal</td>
<td></td>
</tr>
<tr>
<td>4. Procedure used for removal and observations of complications during device removal</td>
<td></td>
</tr>
<tr>
<td>5. Patient teaching about postremoval care and potential complications</td>
<td></td>
</tr>
</tbody>
</table>
Figure 17-3. Example of a Patient Education Sheet: Venous Access Devices (VADs)

When to contact your healthcare professional:
You have a VAD in place. It may be totally implanted under your skin, or you may have one or two tubings (lumens) on your chest or in your arm. The device will be used for your IV medications, delivery of fluids, or to draw blood for monitoring of laboratory tests. Your nurse will let you know how she or he will use the device and will show you how to care for your device.

There are several things you will need to let your nurse or doctor know about if they should occur.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever of 100.5°F (38°C) or higher or chills when flushing catheter</td>
<td>The VAD is placed in a large vein in your chest. Bacteria can enter the bloodstream through the catheter and cause a bloodstream infection (sepsis). This is an emergency and you should call your healthcare professional immediately.</td>
</tr>
<tr>
<td>Redness or tenderness at insertion site or up the arm</td>
<td>This can be a sign of infection or irritation of the vein. Notify your doctor's office as soon as possible, especially if you have a fever.</td>
</tr>
<tr>
<td>Inability to flush a lumen</td>
<td>If you are administering your IV therapy at home and are unable to flush the line, do not force it. If your catheter has clamps, make sure they are open. Try flushing again. If you are still unable to flush the line, you will need to contact your home healthcare nurse or your doctor's office immediately.</td>
</tr>
<tr>
<td>Breakage of line</td>
<td>If you have tubing coming from your arm or your chest and the tubing breaks, immediately clamp the tubing closest to your body and contact your doctor's office or go to the nearest emergency department.</td>
</tr>
</tbody>
</table>

4. Removal of access device  
   a) Indication for removal  
   b) Date and time  
   c) Type of device removed and description after removal, including catheter tip  
   d) Removal procedure used and complications, if any  
   e) Wound or catheter tip culture, as ordered  
   f) Patient education about postremoval care, potential complications, and what to report to the provider

IV. Legal issues  
A. Scope  
1. Historically, nurses were not named in medical malpractice suits, as they were not felt to be true professionals, but rather individuals who simply followed the orders provided by others (e.g., physicians). This has changed in the latter part of the 20th century with the establishment of nursing as a discipline and with the increased recognition of nursing’s ability to be autonomous and independent (Karno, 2011).
2. Today, nurses are responsible for providing increasingly complex care across a variety of delivery systems, such as preventive, acute, and end-of-life care; rehabilitation; and survivorship (Brant & Wickham, 2013).
3. In an effort to provide the highest quality cancer care, nurses have a “steadfast commitment to patient care, improved safety and quality, and better outcomes” (Institute of Medicine [IOM], 2010, p. xi).
4. Nurses have a responsibility to critically evaluate patient factors and exercise good judgment in patient care (Alexander & Webster, 2010; Dychter, Gold, Carson, & Haller, 2012).
5. Malpractice claims against nurses have risen over the past decade, accounting for 2 in every 100 payments (Reising, 2012). Oncology nursing is a specialty that carries a higher risk for nursing malpractice because of the nature of the work (Masoorli, 2005).
   a) Performance of invasive procedures  
   b) Administration of infusion therapy, including vesicant chemotherapy  
   c) Low-volume, high-risk interventions
B. Legal standard of care  
1. The concept of legal standard of care specific to nursing is considered the level of care that a reasonably prudent nurse would provide in the same or similar circumstances where behavior is evaluated against a similarly experienced and educated nurse who possesses ordinary skills, knowledge, and abilities (Karno, 2011).
2. A reasonably prudent nurse whose conduct sets the standard is a person of average and ordinary caution and skill (Karno, 2011).

3. Several characteristics related to access devices and nursing should be considered when evaluating care (Alexander & Webster, 2010).
   a) The standard of care is a reasonable expectation of nursing care.
   b) The standard of care is measurable (e.g., a nurse trained to access an implanted port should know what site care is needed prior to access to prevent catheter-related bloodstream infections).
   c) The standard of care is valid based on location of care (e.g., a nurse practicing in a state that permits insertion of peripherally inserted central catheters [PICCs] should be able to perform insertion and care following appropriate training).
   d) The standard of care must be applicable based on the current state of knowledge.

4. Standards
   a) Voluntary (e.g., professional standards)
   b) Required nationally
   c) Required by individual state laws
   d) Required by individual institutional practices
   e) Regulated by a combination of these standards or governing bodies

C. Negligence
1. Negligence is the failure to implement the standard of care a reasonably prudent person would provide in the same or similar circumstances (Karno, 2011). When it affects a nurse, it is referred to as professional negligence or malpractice.
   a) Acts of negligence can result from committing an act (commission) or failure to act (omission). Examples include failing to monitor a vesicant infusion via a peripheral IV site that results in extravasation (omission) or flushing of an implantable port with 10 ml of 1,000 IU/ml of heparin instead of the flush prescribed (commission).
   b) Negligence per se, or negligence as a matter of law, occurs when an individual violates a duty required by a law. In the case of nursing, if a nurse inserts a PICC without training, this practice would be beyond the scope of his or her state practice act and considered negligence per se.
2. To prove professional negligence of a nurse, certain elements must be established by the plaintiff, or the person bringing the suit against the nurse:
   a) The nurse had a duty to the plaintiff.
   b) The nurse violated, or breached, a standard of care.
   c) The breach caused the plaintiff’s injury.
   d) Damages resulted from breach of the standard of care.

3. Nine common areas of nursing negligence, or malpractice, exist in the nursing care of an infusion patient or patient with an access device (Alexander & Webster, 2010; Dychter et al., 2012; Gilbar, 2014; Karno, 2011; Ranchon et al., 2011; Reising, 2012).
   a) Failure to administer medication appropriately (e.g., giving the wrong medication; giving medication at the wrong time; giving an incorrect dose of medication, including chemotherapy; giving a contraindicated medication via a venous access device [VAD], such as administering vincristine through an epidural or intrathecal access device)
   b) Failure to use equipment in a competent manner (e.g., improper VAD selection or access technique used, improper use of infusion pumps or administration sets)
   c) Failure to assess and monitor (e.g., failing to monitor an infusion site during vesicant administration, failing to assess a device insertion site for evidence of infection)
   d) Failure to act (e.g., failure to administer prescribed medication to treat a life-threatening condition)
   e) Failure to communicate (e.g., failure to share abnormal assessment findings or a patient’s deteriorating condition with the provider)
   f) Failure to document (e.g., neglecting to document blood return status prior to...
vesicant administration despite physically checking for blood return)

\( g \) Failure to prevent infection (e.g., lack of adherence to organizational policies and procedures with dressing changes to an access device, not using sterile technique for PICC insertion)

\( h \) Failure to appropriately identify and label access device line(s) (e.g., patient with a venous port and a peritoneal port) (see Figure 17-4)

\( i \) Negligent conduct of another (e.g., assisting or allowing the negligence of another healthcare provider)

D. Risk management strategies (Alexander & Webster, 2010; DeLa Cruz et al., 2012; Karna, 2011)

1. Adherence to standard of care

\( a \) One of the primary actions nurses can take to limit their exposure to legal suits is to practice within established standards of care.

\( b \) Nurses must maintain knowledge of the legal and voluntary standards that govern their practice, regularly reviewing these requirements that include, but are not limited to, their individual job description, state nurse practice act, Occupational Safety and Health Administration regulations, Joint Commission standards, and organizational policies and procedures.

\( c \) Nurses must provide comprehensive nursing care at all times and must not practice outside their scope of practice or job setting. Nurses also must be aware of limitations to nursing practice as related to insertion, access, manipulation, or removal of specific access devices as defined by state board of nursing promulgated laws.

\( d \) Nurses must maintain competency with current access devices and their management and undergo an in-depth assessment at regular intervals to ensure that their practice is consistent with current standards of care. Nurses must identify and participate in regular continuing nursing education opportunities for their personal and professional development.

\( e \) Nurses must regularly identify learning gaps and seek education to meet learning needs (IOM, 2010).

2. Patient rights (Gallieni et al., 2011)

\( a \) A critical nursing responsibility is to ensure that patient rights (e.g., informed consent, refusal of treatment, discharge planning, freedom from restraints, confidentiality) are maintained at all times.

\( b \) One of the most effective proactive risk mitigation strategies is informed consent, a process of detailed discussion and decision making between a provider and a patient. Patients must be educated regarding the nature of the procedure; on reasonable alternatives; and the risks, benefits, and uncertainties of access devices. Documentation must reflect that the patient has received the information and agreed to the insertion of a device. For consent to be valid, a patient must have decision-making capacity; if the patient is incapacitated or incompetent to make decisions, consent must be provided by the surrogate decision maker.

\( c \) Patients may refuse an access device, and providers are legally required to honor their decision, including any advance directives.

\( d \) Discharge planning must begin as soon as possible to adequately prepare patients.

\( e \) Information about patients must be kept private and confidential at all times.

3. Documentation (Doyle-Lindrud, 2015)
a) Accurate and comprehensive documentation that is objective, timely, and legible is imperative.
b) Documentation increasingly is challenging in the current environment of electronic medical records (EMRs) and “checkbox” documentation.
c) The reliability of a medical record is discredited because of inconsistencies, unexplained time gaps, omissions, or changes made to the record.
d) Documentation commonly is the only effective evidence that actions provided by a nurse meet the legal standard of care when caring for a patient (Alexander & Webster, 2010).

4. Unusual occurrence reports
a) Learning documents without punitive intent
b) Help provide factual, specific information concerning an event that may increase risk of harm to the patient

5. Professional liability insurance
a) Most healthcare facilities and agencies carry insurance against negligent acts by their employees performed within the course of the job. In some cases, the interest of the nurse may conflict with another employee named in a lawsuit; nurses must determine when or if maintaining an individual liability insurance policy would be of personal benefit.
b) Purchasing an individual liability insurance policy requires consideration of risks and benefits, including evaluation of personal liability risk, contractual obligations between the nurse and the insurer, and the availability of personal assets to compensate for a patient’s injury in the event the institution or agency does not provide coverage or when the injury occurs outside the employee’s job (e.g., volunteer work).

6. Continuing competence and professional improvement
a) Continued competence is defined as “the ongoing ability to render safe, direct nursing care, or the ongoing ability to make sound judgments upon which nursing care is based” (Alexander & Webster, 2010, p. 58).
b) Strategies such as continuing nursing education, self-assessment, professional certification and recertification, chart audits, and clinical simulations mitigate legal risks.

E. Special considerations
1. EMR: A variety of unanswered legal and ethical concerns exist with the growing use and implementation of EMRs (Doyle-Lindrud, 2015; Sittig & Singh, 2011).
a) With the development of health information exchanges, healthcare providers have greater access to information beyond their institutions. Subsequently, the volume of records and information available can be cumbersome and difficult to review.
b) EMRs may increase a provider’s legal responsibility and accountability. Computer audits can provide extensive information on which provider had access to a patient’s record and what actions were taken.
c) Liabilities arise when data, such as laboratory values, are imported into a medical record automatically without a provider reviewing (and acting upon) the information.
d) Documentation made by cutting and pasting from previous notes could contribute to error in the EMR.
e) EMRs raise ethical issues concerning the ownership of protected health information. De-identified data sets of patients have been sold by various EMR vendors, raising questions of what happens to data if reidentified. Breaching of systems and firewalls allows the opportunity for data to be stolen with ramifications beyond the Health Insurance Portability and Accountability Act as it relates to identify theft and fraud.

The author would like to acknowledge Debra J. McCorkindale, RN, BSN, for her contribution to this chapter that remains unchanged from the previous edition of this book.

References
DeLa Cruz, R.F., Caillouet, B., & Guerrero, S.S. (2012). Strategic patient education program to prevent catheter-related bloodstream


Appendices

<table>
<thead>
<tr>
<th>Author</th>
<th>Design/Sample</th>
<th>Intervention/Variables Examined</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Brass et al., 2015</td>
<td>Design: Meta-analysis</td>
<td>Evaluation of safety and efficacy of two-dimensional US or Doppler US versus traditional landmark technique in adults and children</td>
<td><strong>Subclavian vein puncture:</strong> A two-dimensional US reduced the risk of arterial puncture and hematoma formation. No evidence was found to suggest a difference in total or other complications, overall or first-time success rates, number of attempts until success, or the time taken to insert the catheter. No evidence was found to suggest a difference in outcomes with use of a US device. Femoral vein puncture: Minimal evidence was available. No evidence was found to suggest a difference in complication rates, time taken for insertion, arterial puncture, or hematoma formation with use of two-dimensional US; however, success on the first attempt was more likely with two-dimensional US, and a small increase in overall success rate was noted. The use of US guidance for insertion of subclavian or femoral catheters was not supported. The authors cautioned that the reviewed studies were not of optimum quality; current evidence is insufficient to support the use of US-guided catheter insertion.</td>
</tr>
<tr>
<td>Bowen et al., 2014</td>
<td>Design: Retrospective analysis Sample: 351 CVADs** placed in the internal jugular vein</td>
<td>Evaluation of US guidance for complication rate and costs</td>
<td>US guidance proved to have reduced complications and costs and elimination of postprocedural chest x-rays.</td>
</tr>
<tr>
<td>Ahn et al., 2012</td>
<td>Design: Retrospective analysis Sample: 1,254 central venous ports implanted via the internal jugular vein using US and fluoroscopy guidance</td>
<td>Evaluation of US and fluoroscopy guidance for technical success and complication rates</td>
<td>Technical success rate was 99.9% with a 5% complication rate. Complications included infection, thrombotic malfunction, nonthrombotic malfunction, venous thrombosis, and wound problems.</td>
</tr>
<tr>
<td>Lamperti et al., 2012</td>
<td>International evidence-based recommendations on US-guided vascular access: Systematic literature review</td>
<td>Literature on US vascular access for central, peripheral, and arterial short- and long-term catheters from January 1985 to October 2010</td>
<td>Recommendations suggest that two-dimensional vascular screening prior to CVAD cannulation and real-time US needle guidance with a long axis/in-plane technique optimize the probability of correct needle placement. US guidance can also be used for peripheral and arterial cannulation, to assess for the catheter’s tip position, and for immediate and life-threatening complications. Educational courses and training are required to achieve competence and minimal skills when cannulation is performed with US guidance.</td>
</tr>
<tr>
<td>Teichgräber et al., 2011</td>
<td>Design: Retrospective analysis Sample: 3,160 implanted port catheter systems</td>
<td>Evaluation of successful insertion and complication rates after US-guided port implantation</td>
<td>US-guided port implantation via the internal jugular vein route had low postprocedural complications; 922,599 catheter days were evaluated and 374 (11.8%) adverse events were reported, with the most common being BSI catheter-induced venous thrombosis and catheter migration.</td>
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### Intracavitary Electrocardiography Insertion Techniques

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<th>Author</th>
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<th>Findings</th>
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<tbody>
<tr>
<td>Rossetti et al., 2015</td>
<td>Design: Case-controlled cohort Sample: 309 patients with different catheters (e.g., PICC, short-term CVAD, long-term CVAD)</td>
<td>Evaluation of safety and accuracy of IC-ECG in pediatric patients for the placement of CVADs</td>
<td>No complications were reported; IC-ECG is safe and accurate in pediatric patients. Accuracy is 95.8% and is higher (98.8%) when using a dedicated ECG monitor.</td>
</tr>
<tr>
<td>Walker et al., 2015</td>
<td>Design: Systematic literature review Sample: 5 studies involving 729 participants</td>
<td>Comparison of IC-ECG–guided catheter placement with surface anatomy–guided insertion plus chest x-ray confirmation to assess accurate catheter tip placement</td>
<td>IC-ECG–guided insertion was significantly more accurate than surface anatomy–guided insertion. The authors concluded that IC-ECG–guided catheter insertion could potentially eliminate the requirement of a postprocedural chest x-ray to assess catheter tip placement.</td>
</tr>
<tr>
<td>Wang et al., 2015</td>
<td>Design: Prospective, nonrandomized Sample: 1,160 patients with cancer with PICCs or CVADs** placed in the internal jugular vein</td>
<td>Evaluation of sensitivity and specificity amplitude changes in P-waves of IC-ECGs to assess the tip placement of CVADs</td>
<td>Amplitude change of P-wave proves good sensitivity and excellent specificity; better sensitivity was observed in the placement of centrally inserted versus peripherally inserted VADs.</td>
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### Placement Confirmation Imaging

<table>
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<tr>
<th>Author</th>
<th>Design/Sample</th>
<th>Intervention/Variables Examined</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walker et al., 2015</td>
<td>Design: Retrospective analysis Sample: 891 participants with implanted port placement</td>
<td>Evaluation of the necessity of a systematic postoperative chest x-ray following implanted port insertion under fluoroscopic guidance</td>
<td>A very low incidence of immediate complications was identified in chest x-rays. The authors concluded a chest x-ray should be performed postprocedurally only in cases of clinical suspicion of malposition.</td>
</tr>
</tbody>
</table>

### Transparent Versus Gauze and Tape Dressings

| Author                     | Design/controlled Sample: 2 subsamples of 75 patients: (1) 50 patients with short- and medium-peripheral catheters, including 21 patients with gauze and 29 with transparent dressings, and (2) 25 patients with central catheters**, including 13 patients with gauze and 12 with transparent dressings Device: Gauze and tape; transparent polyurethane dressing | Comparison of safety and costs of transparent versus gauze dressings in IV short- and medium-peripheral catheters and intravascular central catheters | No significant differences were found in complication rates between the types of dressings. Increased costs were associated with gauze versus transparent dressings due to the increased frequency of dressing changes needed with gauze. |

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<th>Author</th>
<th>Design/Sample</th>
<th>Intervention/Variables Examined</th>
<th>Findings</th>
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</thead>
<tbody>
<tr>
<td>O’Grady et al., 2011</td>
<td>Guidelines for the prevention of intravascular catheter-related infections, 2011: Systematic literature review</td>
<td>Systematic literature review and expert work group committees of representatives from healthcare member services and professional organizations to update evidence and recommendations to include changes from the previous edition in 2002 to 2011</td>
<td>Guidelines suggest no difference in use of transparent or gauze and tape dressing; the choice of dressing could be matter of preference.</td>
</tr>
<tr>
<td>Pedrolo et al., 2011</td>
<td>Design: Randomized, case controlled Sample: 21 nontunneled CVADs Device: Gauze and tape; transparent polyurethane dressings</td>
<td>Comparison of stability, rate of catheter-related infections, local reaction, and exudate absorption</td>
<td>No significant differences were found in catheter-related infections, dressing stability, or exudate absorption. Local reactions were more prevalent in the gauze and tape dressings.</td>
</tr>
<tr>
<td><strong>Chlorhexidine-Impregnated Dressings or Sponges</strong></td>
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<tr>
<td>Karpanen et al., 2016</td>
<td>Design: Randomized Sample: Skin samples, sutures, CVC intradermal and tip samples; CHG-impregnated dressing group (n = 136); nonantimicrobial dressing group (n = 137)</td>
<td>Comparison of transparent film dressing incorporating a 2% CHG gel with a nonantimicrobial dressing</td>
<td>A significantly reduced number of microorganisms was recovered from the CVC insertion site, suture site, sutures, and catheter surface in the CHG-impregnated dressing group compared with the nonantimicrobial dressing group.</td>
</tr>
<tr>
<td>Kerwat et al., 2015</td>
<td>Design: Prospective, nonrandomized Sample: 308 patients and 337 catheters; nontunneled catheters receiving regional anesthesia (peripheral nerve block) Device: CHG-impregnated sponge or dressing</td>
<td>Comparison of the rate of bacterial colonization at the insertion site and the catheter tip of catheters dressed with a CHG-impregnated sponge or dressing with conventional dressing</td>
<td>CHG-impregnated dressings significantly reduced bacterial colonization of the catheter tip and of the insertion site of epidural and peripheral regional catheters.</td>
</tr>
<tr>
<td>Ullman et al., 2015</td>
<td>Design: Systematic review Sample: 22 studies involving 7,436 participants</td>
<td>Different interventions and comparisons involving sterile gauze, standard polyurethane, CHG-impregnated dressings, silver-impregnated dressings, hydrocolloid dressing, second-generation gaseous permeability standard polyurethane, and sutureless securement devices</td>
<td>Medication-impregnated dressing products, defined as only CHG-impregnated dressings as either a patch or a whole dressing, reduced the incidence of CVAD-related BSI relative to all other dressing types.</td>
</tr>
<tr>
<td>Pedrolo et al., 2014</td>
<td>Design: Randomized, case-controlled cohort Sample: 85 patients with short-term CVADs Device: CHG-impregnated dressing, gauze and tape dressing</td>
<td>Comparison of BSI rates, local reactions, and dressing fixation between the two types of dressings</td>
<td>No statistical differences were found in BSIs, local reaction, or fixation between the types of dressings.</td>
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<tr>
<th>Author</th>
<th>Design/Sample</th>
<th>Intervention/Variables Examined</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Safdar et al., 2014</td>
<td>Design: Meta-analysis</td>
<td>Evaluation of CHG-impregnated sponge dressing for prevention of catheter colonization and catheter-related BSI</td>
<td>A significant reduction in catheter colonization and catheter-related infections resulted with the use of the dressing.</td>
</tr>
<tr>
<td></td>
<td>Sample: 9 randomized trials</td>
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<tr>
<td></td>
<td>Device: CHG-impregnated sponge or dressing used with various short- and long-term VADs and short-term temporary arterial catheters</td>
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<td></td>
<td>Topical skin antisepsis preinsertion included studies comparing CHG 0.5% in 70% EtOH; 10% povidone-iodine versus 70% alcohol; alcohol-povidone-iodine 10%; alcohol spray; CHG alone, 4% aqueous povidone-iodine scrub followed by 5% povidone-iodine in 70% EtOH; or did not report</td>
<td></td>
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<tr>
<td>Timsit et al., 2012</td>
<td>Design: Prospective, randomized</td>
<td>Comparison of CHG-impregnated dressing, highly adhesive dressing, and standard dressing for catheter colonization and catheter-related infections in patients in ICUs</td>
<td>CHG-impregnated dressings showed a significantly lower catheter-related infection rate (67%) and catheter-related BSI rate (60%) compared to non–CHG-impregnated dressings. Highly adhesive dressings decreased dressing detachment rates but increased skin colonization and catheter colonization without influencing catheter-related infections or catheter-related BSI rates.</td>
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<tr>
<td></td>
<td>Sample: 1,879 patients with intravascular catheters inserted for an expected duration of &gt; 48 hours</td>
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<td></td>
<td>Device: CHG-impregnated dressing, highly adhesive dressing, and standard dressing</td>
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<tr>
<td>Kao et al., 2014</td>
<td>Design: Prospective, case-controlled cohort</td>
<td>Comparison of CHG and povidone-iodine for prevention of BSI associated with accessing implantable venous ports, including type of bacteria and time to infection rates</td>
<td>No significant difference was found in preventing port-associated BSIs. CHG: A significant improvement was found in time to first BSI caused by gram-positive bacteria; no significant preventive effects were found on time to first BSI caused by gram-negative bacteria or fungi.</td>
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<tr>
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<td>Sample: 396 patients, consecutive</td>
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<td>Device: Implanted ports</td>
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<tr>
<td>Moreau &amp; Flynn, 2015</td>
<td>Design: Systematic literature review</td>
<td>Evaluation of NC disinfection practices, influence of hub contamination on infection, and measure of education and compliance</td>
<td>Following insertion, the greatest risk of catheter contamination is the NC, with 33%–45% of the sample contaminated and compliance with disinfection protocols as low as 10%. Reduction of 48%–86% in infections was noted with use of passive alcohol disinfection caps. No optimal technique or disinfection can be recommended. Recommendations given: 1. Use CHG-alcohol, povidone-iodine, an iodophor, or 70% alcohol as antisepsis on NCs, stopcocks, and access ports. 2. Scrub connectors with 70% alcohol for 5–60 seconds to decrease infection risk.</td>
</tr>
<tr>
<td></td>
<td>Sample: 140 studies and 34 abstracts</td>
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<tr>
<td></td>
<td>Device: NC hubs</td>
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<tr>
<td>Hong et al., 2013</td>
<td>Design: Experimental model</td>
<td>Comparison of different scrub times (swipe, 5, 15, or 30 seconds) of CHG-alcohol compared to alcohol to determine residual disinfectant activity</td>
<td>Alcohol swipe did not adequately disinfect NCs. CHG-alcohol and alcohol performed similarly at &gt; 5-second scrubs. CHG-alcohol resulted in residual disinfectant activity for up to 24 hours.</td>
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<tr>
<td></td>
<td>Sample: In vitro</td>
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<tr>
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<td>Device: MaxPlus® MP1000 positive pressure NCs</td>
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<thead>
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<tbody>
<tr>
<td>Sweet et al., 2012</td>
<td>Design: Observations before and after trial</td>
<td>Comparison of number of days to CLABSI rates in the preintervention versus the postintervention time periods</td>
<td>The intervention period (3,005 catheter days) experienced one CLABSI; the historical period (6,851 catheter days) experienced 16 CLABSIIs. Use of the alcohol-impregnated port protectors and needleless neutral pressure connectors significantly reduced the rates of CLABSIIs in the oncology population.</td>
</tr>
<tr>
<td>Simmons et al., 2011</td>
<td>Design: Experimental</td>
<td>Comparison of cleaning duration and reduction in bacterial load when using alcohol disinfection at 3, 10, and 15 seconds</td>
<td>No significant difference in bacterial load was found between each of the three levels of disinfection duration; however, any disinfection significantly decreased the bacterial load as compared to controls.</td>
</tr>
<tr>
<td>Bilir et al., 2013</td>
<td>Design: Prospective, randomized, case controlled</td>
<td>Evaluation of the effect of multiple disease and demographic variables, including use of CHG solution or povidone-iodine on the development of catheter colonization and related BSIs in CVCs</td>
<td>The CHG cohort demonstrated no catheter-related sepsis or colonization. The octenidine and povidone-iodine cohorts demonstrated a 10.5% catheter-related sepsis rate; colonization was 26.3% in the povidone-iodine cohort and 21.5% in the octenidine cohort.</td>
</tr>
<tr>
<td>Atahan et al., 2012</td>
<td>Design: Prospective, randomized, case controlled</td>
<td>Comparison of alcoholic povidone-iodine with CHG antiseptic solution for prevention of central venous device infections (colonization and incidence)</td>
<td>A significant reduction was found in catheter-related BSIs and colonization with the use of CHG compared to povidone-iodine antiseptic solution. No other statistically significant differences were found. Variables included patient age and gender, presence of malignancy and coexisting diseases, catheter duration, use of total parenteral nutrition, and blood products.</td>
</tr>
<tr>
<td>Girard et al., 2012</td>
<td>Design: Prospective, randomized</td>
<td>Comparison of cost, efficacy, and side effects of 10% povidone-iodine and 2% CHG for skin disinfection prior to insertion</td>
<td>When switched from povidone-iodine to CHG, a significant reduction in colonization was noted, but no significant difference was found in CVC-related infection or bacteremia. Povidone-iodine was associated with higher risk of colonization and infection.</td>
</tr>
<tr>
<td>Kulkarni &amp; Awode, 2013</td>
<td>Design: Prospective, randomized</td>
<td>Comparison of CHG-alcohol and povidone-iodine for skin disinfection (cultures of insertion site and immediately following antiseptic) prior to neuraxial blockade procedure</td>
<td>Findings suggest no differences in all variables.</td>
</tr>
<tr>
<td>Krobbuaban et al., 2011</td>
<td>Design: Prospective, randomized</td>
<td>Comparison of CHG-alcohol and povidone-iodine for skin disinfection (cultures of insertion site and immediately following antiseptic) prior to neuraxial blockade procedure</td>
<td>The incidence of positive skin culture was significantly lower in CHG cohort compared to povidone-iodine cohort in cultures taken immediately after skin infection (35% versus 10%, respectively).</td>
</tr>
</tbody>
</table>

### Cleansing Agents: Before Catheter Site Care and Dressing Changes

- **Bilir et al., 2013**  
  Design: Prospective, randomized, case controlled  
  Sample: 109 patients  
  Device: CVC** and arterial catheters**, CHG, octenidine, and povidone-iodine  
  Comparison of CHG, octenidine, and povidone-iodine for prevention of catheter-related infections (colonization and rate of sepsis)

- **Atahan et al., 2012**  
  Design: Prospective, randomized, case controlled  
  Sample: 50 patients, convenience  
  Device: CVADs** inserted in the operating suite  
  Evaluation of the effect of multiple disease and demographic variables, including use of CHG solution or povidone-iodine on the development of catheter colonization and related BSIs in CVCs

- **Girard et al., 2012**  
  Design: Prospective, randomized  
  Sample: 806 catheters, longitudinal convenience  
  Device: CVADs** in patients in an ICU  
  Comparison of alcoholic povidone-iodine with CHG antiseptic solution for prevention of central venous device infections (colonization and incidence)

### Cleansing Agents: Epidural Catheters

- **Kulkarni & Awode, 2013**  
  Design: Prospective, randomized  
  Sample: n = 60 (50 epidural)  
  Device: Epidural; CVAD**  
  Comparison of cost, efficacy, and side effects of 10% povidone-iodine and 2% CHG for skin disinfection prior to insertion

- **Krobbuaban et al., 2011**  
  Design: Prospective, randomized  
  Sample: 98 patients  
  Device: Epidural catheters used for regional anesthesia  
  Comparison of CHG-alcohol and povidone-iodine for skin disinfection (cultures of insertion site and immediately following antiseptic) prior to neuraxial blockade procedure

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<tbody>
<tr>
<td>Gorji et al., 2015</td>
<td>Design: Prospective, randomized, double-blind</td>
<td>Blinded comparison of 3 ml heparinized saline flush or 10 ml NS flush following medication administration; catheters evaluated every 8 hours for blood return and flushing for 21 days</td>
<td>No significant differences in catheter patency between the two solutions were found. The use of heparin had no effect on prolonging catheter survival.</td>
</tr>
<tr>
<td>Ferroni et al., 2014</td>
<td>Design: Experimental, in vitro Sample: 576 polyurethane short-term CVADs</td>
<td>Comparison of efficacy of pulsatile versus continuous flushing versus no flushing (positive control) to prevent bacterial colonization in polyurethane short venous access catheters contaminated with <em>Staphylococcus aureus</em></td>
<td>Significantly higher <em>Staphylococcus aureus</em> endoluminal contamination was found with continuous flushing versus pulsatile flushing.</td>
</tr>
<tr>
<td>López-Briz et al., 2014</td>
<td>Design: Systematic literature review Sample: 6 studies (1,433 participants) with various CVADs (PICC; port; double-, triple-, and quadruple-lumen CVADs)</td>
<td>Comparison of heparin at varying concentrations versus 0.9% sodium chloride intermittent flushing for prevention of occlusion in CVCs in adults</td>
<td>No conclusive evidence of differences in occlusion rates was found between using heparin saline versus using sodium chloride intermittent flushing. No differences in catheter survival, rate of thrombosis, rate of infection, mortality, bleeding rates, or heparin-induced thrombocytopenia were found.</td>
</tr>
<tr>
<td>Lyon &amp; Phalen, 2014</td>
<td>Design: Prospective, randomized, one-way, single-blinded post-test with control Sample: 90 homecare patients (no cancer diagnoses) with PICCs Agent: 3 flushing protocols and the use of alteplase</td>
<td>Flushing protocols: 10 ml NS, medication administration, 10 ml NS flush; 10 ml NS, medication administration, 10 ml NS, 3 ml heparinized saline (100 IU/ml); 10 ml NS, medication administration, 10 ml NS, 5 ml heparinized saline (10 ml) Variables evaluated: Sluggishness, occlusion, missed medication doses, catheter replacement, additional nursing visits, and the use of alteplase</td>
<td>The saline flush group had the highest incidence of occlusions requiring alteplase. The higher concentration heparin flush group and the saline flush group had comparable episodes of sluggishness. The lower concentration heparin flush group had the least number of episodes of occlusions and use of alteplase.</td>
</tr>
<tr>
<td>Goossens et al., 2013</td>
<td>Design: Randomized, open label Sample: 802 patients with cancer with newly inserted implanted venous ports Agent: 3 ml (100 IU/ml) heparin and NS</td>
<td>Comparison of 3 ml (100 IU/ml) heparin lock versus a saline lock for incidence of catheter-related bacteremia, occurrence of functional problems, and blood withdrawal occlusion Both groups received flush with 10 ml NS before and after blood sampling.</td>
<td>No significant difference was found in blood withdrawal occlusion, catheter-related bacteremia, and occurrence of functional problems between the two solutions. The authors concluded that NS is an effective solution if combined with consistent, pulsatile flushing technique followed by a positive pressure locking technique.</td>
</tr>
<tr>
<td>Schallom et al., 2012</td>
<td>Design: Randomized, open label Sample: 341 patients with multilumen CVADs** in the ICU and the burn/trauma ICU Agent: NS and saline-heparin combination</td>
<td>Evaluation of CVC lumen patency comparing 10 ml NS flush q 8 hours versus 10 ml NS flush followed by 3 ml of heparin (10 IU/ml) lock flush solutions q 8 hours</td>
<td>No significant difference in catheter occlusion was found between the two solutions.</td>
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<td><strong>Flushing Protocols: Arterial Catheters</strong></td>
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<tr>
<td>Robertson-Malt et al., 2014</td>
<td>Design: Retrospective analysis of 7 studies Sample: 606 participants in randomized, controlled, and quasi-randomized trials (7 studies) with temporary arterial catheters in ICUs Agent: Heparin</td>
<td>Comparison of heparin at various concentrations versus saline alone for patency and functionality of catheter Concentrations: 1–2 IU/ml under continuous pressure, 3 ml/hour under continuous pressure, and 4 IU/ml under continuous pressure of heparin; 100 IU/ml was studied.</td>
<td>Available evidence is of poor quality with the risk of bias. Due to a high degree of variability in study designs, meta-analysis was not possible. Findings do not support the addition of heparin (100 IU/ml) to a maintenance solution of NS (pressurized to deliver 3 ml/hour).</td>
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<tr>
<td><strong>Catheter Occlusion: tPA Locks or Infusions to Restore Function of Occluded VADs</strong></td>
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<tr>
<td>Ponce et al., 2015</td>
<td>Design: Prospective, case-controlled cohort Sample: 339 tunneled CVADs placed for hemodialysis in 247 patients across two centers Agent: rtPA</td>
<td>Evaluation of the incidence of thrombotic obstruction of tunneled CVADs and the efficacy of treatment with alteplase; secondary aims were to identify factors associated with thrombotic occlusion.</td>
<td>Approximately 87% of patients experienced successful reversal of occlusion using alteplase protocols. The number of catheter days, presence of diabetes, and exit-site infections were associated with thrombotic occlusions.</td>
</tr>
<tr>
<td>van der Merwe, 2015</td>
<td>Design: Observational case series Sample: 3 nonconsecutive patients diagnosed with acute thrombosed arteriovenous fistula Agent: tPA</td>
<td>Demonstration of the successful use of tPA to decrease clot burden in arteriovenous fistula in the dialysis patient</td>
<td>Objective evidence was found of a decrease in clot burden on US or fistulogram in all patients; however, this was a small sample size and more research is needed.</td>
</tr>
<tr>
<td>Ernst, 2014</td>
<td>Design: Retrospective analysis Sample: 34,579 records of patients treated for a CVAD occlusion</td>
<td>Comparison of length of stay, costs, and readmissions associated with the use of alteplase to treat catheter occlusions</td>
<td>Alteplase-treated patients had lower daily and total postocclusion costs as compared to patients who received catheter replacement.</td>
</tr>
<tr>
<td>Manns et al., 2014</td>
<td>Design: Prospective, randomized Sample: Hemodialysis catheters Agent: rtPA 1 mg per lumen, rtPA/heparin-locking solutions, and heparinized solution only</td>
<td>Comparisons of weekly rtPA in each lumen and twice-weekly rtPA/heparin-locking solutions to determine risks of malfunction and bacteremia compared to heparin administered three times a week alone; costs of each regimen were evaluated.</td>
<td>A twice-weekly rtPA/heparin lock protocol used in each lumen of the catheters demonstrated a mean overall cost and efficacy similar to that of a three-times-per-week heparin lock protocol.</td>
</tr>
<tr>
<td>Ragsdale et al., 2014</td>
<td>Design: Retrospective analysis Sample: Data from 150 occlusion events in critically ill pediatric patients who had CVADs**</td>
<td>Evaluation of the safety and efficacy of alteplase infusions and dwells to clear partially occluded catheters</td>
<td>Alteplase infusions are as efficacious as dwells in this population to clear partially occluded catheters. If infusion is used, more occlusions are resolved in older and larger patients and in those with catheters less than 7 days. If dwell is used, more occlusions are resolved in smaller catheters. Safety for both infusion and dwell is acceptable.</td>
</tr>
<tr>
<td>Vercaigne et al., 2012</td>
<td>Design: Prospective, randomized, parallel arm multicenter Sample: 82 patients with CVADs placed for hemodialysis Agent: Alteplase</td>
<td>Comparison of the safety and efficacy of an alteplase dwell over 30–90 minutes versus a new push protocol to restore function to occluded catheters and to increase blood flow in catheters with less than 200 ml/min flow to &gt; 300 ml/min flow</td>
<td>The alteplase push protocol was as safe and effective and more practical than the dwell protocol. Approximately 65% of catheters receiving the dwell protocol achieved the 300 ml/min endpoint, compared to 82% of the catheters in the push protocol achieving the 300 ml/min endpoint. Study limitations included small sample size.</td>
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<tr>
<td>Tebbi et al., 2011</td>
<td>Design: Phase III, single arm Sample: 246 patients with dysfunctional CVADs**</td>
<td>Evaluation of the safety and efficacy of tenecteplase in restoring function to CVADs</td>
<td>Approximately 72% of patients achieved restoration of function within 120 minutes of the first dose; 81% received restoration after two doses. Frequencies were similar among adults and pediatric patients. The authors concluded that one or two doses of tenecteplase showed efficacy and safety in catheter function restoration.</td>
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<tr>
<td>Catheter Occlusion Prophylaxis</td>
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<tr>
<td>Akl et al., 2014</td>
<td>Design: Systematic review Sample: 12 studies with 2,823 participants with CVADs** (adults and children)</td>
<td>Evaluation of the relative efficacy and safety of anticoagulation for thromboprophylaxis in people with cancer and a CVAD</td>
<td>Compared with no anticoagulation, a significant reduction was found in symptomatic DVT with heparin and asymptomatic DVT with vitamin K antagonists. The authors warned that benefits must outweigh harms when considering anticoagulation in this population.</td>
</tr>
<tr>
<td>Lavau-Denes et al., 2013</td>
<td>Design: Phase III, open label, randomized Sample: 407 patients with CVADs**</td>
<td>Comparison of the two kinds of prophylaxis and no prophylaxis on incidence of thrombotic events</td>
<td>Prophylaxis showed a benefit regarding catheter-related and noncatheter-related DVT without an increase in side effects. No difference was found in prophylactic efficacy between warfarin and low-molecular-weight heparin.</td>
</tr>
<tr>
<td>Kahn et al., 2012</td>
<td>Consensus Guidelines: American College of Chest Physicians, 9th ed. Design: Systematic literature review</td>
<td>Consensus recommendations based on previous editions, systematic literature review, and expert opinion</td>
<td>Work provides recommendations of evidence-based anticoagulant therapy, prevention of venous thromboembolism, diagnosis of DVT, and antithrombotic therapy in specific populations (e.g., surgical, nonsurgical, atrial fibrillation, neonates and children, ischemic stroke, cardiovascular disease, pregnancy).</td>
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<tr>
<td>Catheter Occlusion Prevention: Heparin-Bonded Catheters</td>
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<td>Shah &amp; Shah, 2014</td>
<td>Design: Retrospective analysis Sample: 2 studies involving 287 pediatric participants (randomized and quasi-randomized trials) Device: Heparin-bonded catheters and nonheparin-bonded or antibiotic-impregnated catheters with CVADs**</td>
<td>Evaluation of the efficacy of heparin-bonded catheters for prolongation of patency</td>
<td>No difference was found in catheter-related thrombosis with the use of heparin-bonded catheters compared to nonheparin-bonded catheters.</td>
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<tr>
<td>Peripheral IV Maintenance and Dwell Time</td>
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<tr>
<td>Webster et al., 2015</td>
<td>Design: Systematic review Sample: 7 trials with a total of 4,895 patients</td>
<td>Clinically indicated versus routine replacement of peripheral catheters</td>
<td>No significant difference was found in catheter-related BSI or phlebitis rates between those catheters routinely replaced or when clinically indicated. The authors recommended a policy change for catheter replacement only when clinically indicated.</td>
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<tr>
<td>Paşalioğlu &amp; Kaya, 2014</td>
<td>Design: Cross-sectional study Sample: 439 peripheral catheters (103 patients) in one infectious disease inpatient unit (Turkey) hospitalized &gt; 1 day</td>
<td>Evaluation of the effect of indwell time on phlebitis development in peripheral venous catheters</td>
<td>Phlebitis was detected in 41.2% of peripheral IV catheters; 35.8% of catheters did not work properly; treatment ended and the catheter was removed in 3.6% of patients; and 19.4% of catheters were removed after more than 120 hours. Only grades 2 and 3 phlebitis were observed. The risk of phlebitis if the catheter was in place less than 48 hours was 5.8 times more likely than that of patients with catheters in place 49–96 hours, and 2.8 times more likely than that of patients with catheters in place for 97–120 hours.</td>
</tr>
<tr>
<td>Rickard et al., 2012</td>
<td>Design: Randomized Sample: 3,283 patients (5,907 catheters), including 1,593 clinically indicated and 1,690 routine replacement</td>
<td>Comparison of routine replacement (every 72 hours) versus clinically indicated replacement of peripheral catheters</td>
<td>No significant difference was found between the two groups. Mean dwell time for catheters was 99 hours when replaced as clinically indicated and 70 hours when routinely replaced. Phlebitis occurred in 114 of 1,593 (7%) patients in the clinically indicated group and in 114 of 1,690 (7%) patients in the routine replacement group. The authors recommended replacement of peripheral catheters as clinically indicated.</td>
</tr>
<tr>
<td>Flynn et al., 2015</td>
<td>Design: Comparative case design Sample: 150 bone marrow transplant patients with tunneled venous catheters Activity: ANTT and sterile technique</td>
<td>Evaluation of catheter-related BSI rates when ANTT versus sterile technique is used when changing NCs</td>
<td>The authors cautioned a small sample size and concluded that results imply that ANTT is not associated with increased catheter-related BSI, and that quality and consistent ANTT is a safe method for management of tunneled venous catheters.</td>
</tr>
<tr>
<td>Ge et al., 2012</td>
<td>Design: Meta-analysis Sample: 1,513 participants with cancer receiving long- and short-term central hemodialysis catheters Activity: Route of insertion</td>
<td>Evaluation of insertion routes and risks for complications in long- and short-term CVCs and short-term hemodialysis catheters</td>
<td>Subclavian and internal jugular central venous access routes have similar risks and complications in long-term catheterization. A subclavian route is preferable to a femoral route in short-term catheterization (lower risk of colonization and thrombotic complications). Femoral and internal jugular routes have similar risks of catheter-related complications in short-term hemodialysis catheterization, except jugular routes have higher risks of mechanical complications.</td>
</tr>
<tr>
<td>O’Grady et al., 2011</td>
<td>2011 Guidelines for the Prevention of Intravascular Catheter-Related Infections Design: Systematic literature review</td>
<td>Systematic literature review and expert work group committees comprising representatives from healthcare member services and professional organizations to update evidence and recommendations to include changes from the previous edition in 2002 to 2011</td>
<td>Numerous recommendations were made regarding education, training, and staffing to ensure appropriate infection control measures; removal; insertion site; hand hygiene; catheter insertion protocols, dressing, and maintenance; and avoidance of routine use of anticoagulant therapy to decrease CLABSI.</td>
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<td><strong>Infection: Antibiotic Use (Prophylaxis or Lock)</strong></td>
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<td>Kubiak et al., 2014</td>
<td>Design: Retrospective analysis Sample: Patient records of those treated for CLABSI with adjunctive ethanol-lock therapy for CVAD salvage in combination with systemic antimicrobial treatment; 68 patient records; included long-term tunneled silicone, implanted port (polyurethane), PICC (polyurethane), and patients with both implanted port and PICC Activity: Review</td>
<td>Evaluation of adjunctive 70% ethanol-lock therapy for safety and possible efficacy for CLABSI</td>
<td>No adverse events were found with the use of ethanol-lock therapy. The authors reported that it warranted further investigation.</td>
</tr>
<tr>
<td>Schoot et al., 2013</td>
<td>Design: Systematic literature review Sample: 132 pediatric patients with tunneled CVADs among multiple studies Device/Agent: Urokinase lock solution, systemic antibiotics, ethanol lock solutions</td>
<td>Comparison of efficacy of addition of urokinase-lock or ethanol-lock protocols to systemic antibiotics in the treatment of VAD-related infections compared to a control group Secondary endpoint: Adverse events associated with lock protocols</td>
<td>No significant effect was found with urokinase or ethanol lock in addition to systemic antibiotics. Study limitations included low power and short follow-up.</td>
</tr>
<tr>
<td>van de Wetering et al., 2013</td>
<td>Design: Systematic literature review Sample: 11 trials with a total of 828 patients with cancer (adults and children)</td>
<td>Evaluate the efficacy of administering antibiotics prior to the insertion of long-term CVCs, flushing or locking long-term CVCs with a combined antibiotic and heparin solution, or both to prevent gram-positive, catheter-related infections</td>
<td>Most studies were found to be at a low or unclear risk of bias. No benefit was found in administering antibiotics before the insertion of long-term CVCs to prevent gram-positive, catheter-related infections. Flushing or locking long-term VADs with a combined antibiotic and heparin solution appeared to reduce gram-positive, catheter-related sepsis in people at risk of neutropenia from chemotherapy or bone marrow disease.</td>
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<tr>
<td><strong>Infection: Impregnated Catheter</strong></td>
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<td>Lai et al., 2013</td>
<td>Design: Systematic literature review Sample: 56 studies (11 types of antimicrobial impregnations; 16,512 catheters) Device: Any type of impregnated catheter against either nonimpregnated catheters or catheters with another impregnation</td>
<td>Evaluation of the efficacy of antimicrobial-impregnated catheters for the prevention of infection, thrombosis/thrombophlebitis, bleeding, and erythema or tenderness at the insertion site</td>
<td>The use of antimicrobial-impregnated catheters improved outcomes, showing decreased rates of catheter-related BSI and catheter colonization. The magnitude of benefit is varied according to catheter type and setting; significant benefit is seen in ICU settings. Limited evidence exists to support their use to reduce clinically diagnosed sepsis or mortality. Findings suggested caution in routinely recommending across all settings.</td>
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<tr>
<td><strong>Infection: Needleless Connectors</strong></td>
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<tr>
<td>Flynn et al., 2015</td>
<td><strong>See Infection: Sterile Versus Aseptic Catheter or Dressing Care</strong></td>
<td>Infection: Needleless Connectors</td>
<td>Use of the bundle (a neutral pressure mechanical valve connector, more frequent changes of the connector [twice weekly and after each blood sample for a new fever episode], and a more efficient 2% CHG solution to clean the connectors) significantly reduced BSIs and catheter-related BSI rates.</td>
</tr>
<tr>
<td>Martinez et al., 2015</td>
<td>Design: Prospective, nonrandomized Sample: Neutropenic hematology patients with long-term, tunneled Hickman® catheter</td>
<td>Effect of NC bundle on catheter-related BSIs</td>
<td>NCs changed every 24 hours when blood or lipids are infused are associated with increased CLABSI rates.</td>
</tr>
<tr>
<td>Moureau &amp; Flynn, 2015</td>
<td><strong>See Cleansing Agents: Before Accessing Needleless Connectors or Hubs</strong></td>
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<tr>
<td>Sandora et al., 2014</td>
<td>Design: Comparative analysis Sample: Pediatric stem cell transplant recipients</td>
<td>Comparison of NC change frequency and CLABSI rate Collection periods: Baseline sampling during which the connector was changed every 96 hours regardless of the infusate it was exposed to; or the connector was changed every 24 hours with blood or lipid infusions; or a third sampling that mirrored the first study group</td>
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<tr>
<td>Tabak et al., 2014</td>
<td>Design: Meta-analysis Sample: 7 studies; 4 in ICUs, 1 in a home health setting, and 2 in long-term acute care settings</td>
<td>Evaluation of the risk for CLABSI associated with the use of a new NC with an improved engineering design</td>
<td>Newer design, positive-displacement connectors (connection with visible fluid path to assess efficacy of flush technique; a solid, flat, smooth access surface that is easily disinfected; an open fluid pathway that facilitates high flow and avoids hemolysis; a tight septum seal; and a single-part activation of the fluid path) are associated with lower CLABSI risk.</td>
</tr>
<tr>
<td>Sherertz et al., 2011</td>
<td>Design: Comparative analysis Sample: Blood samples from three different NC designs</td>
<td>Comparison of three different NC designs for catheter-related BSI</td>
<td>Blood samples from the Clearlink™ connectors met the Centers for Disease Control and Prevention criteria for BSIs; however, these patients were asymptomatic.</td>
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<td><strong>Removal of VAD With Infection</strong></td>
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<tr>
<td>Lorente et al., 2014</td>
<td>Design: Prospective, multicenter, observational Sample: 384 patients with CVADs in ICUs that suspected catheter-related infections</td>
<td>Evaluation of clinical practice concerning CVADs when catheter-related infection is suspected</td>
<td>No statistical difference was found in mortality in patients with confirmed catheter-related BSIs according to the catheter removal at the moment of suspicion versus removal of catheter at any point later. The authors concluded that immediate removal of the CVAD with the suspected infection may not be necessary in all patients.</td>
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#### Blood Sampling From VADs for Blood Cultures

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<tr>
<td>Herrera-Guerra et al., 2015</td>
<td>Design: Comparative, prospective, nonrandomized      Sample: Blood culture results from double- or triple-lumen or acute hemodialysis CVADs 24 patients eligible during the study period</td>
<td>Comparison of pooled blood cultures from each catheter lumen versus individually cultured venous catheter lumens</td>
<td>Sampling multiple lumens from a central line and incubating them in the same culture bottle is as effective as individual culture bottles in the diagnosis of either colonization or of catheter-related BSI.</td>
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<tr>
<td>Winokur et al., 2014</td>
<td>Design: Nonrandomized Sample: 62 pediatric patients with cancer</td>
<td>Analysis of 5 ml normally discarded blood assessed for pathogens</td>
<td>A correlation between positive blood cultures from the usual blood samples with the normally discarded specimen was found in all cases. In four cases, the normally discarded specimen demonstrated earlier time to positivity compared to the usual care specimen.</td>
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#### Blood Sampling From VADs for Coagulation Studies

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<tr>
<td>Dalton et al., 2015</td>
<td>Design: Systematic literature review Sample: 12 studies/326 participants with various CVADs (e.g., tunneled; implanted port; double- and triple-lumen; valved tunneled; PICC; hemodialysis tunneled; or other CVAD not specified)</td>
<td>Best practices determined for collecting coagulation studies from CVADs</td>
<td>Significant variability was found in sampling techniques and discard volume practices. The only reliable method for obtaining coagulation test results from CVADs is to flush then waste or discard blood sample prior to obtaining coagulation sample; however, this method has been studied only in PICCs</td>
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<td>Humphries et al., 2012</td>
<td>Design: Prospective, quasi-experimental Sample: 30 patients with heparinized PICCs Activity: Aseptic specimen drawing procedure from PICC; sample from venipuncture</td>
<td>Evaluation of an evidence-based procedure of drawing samples of coagulation testing from heparinized PICCs compared with blood results drawn from venipuncture</td>
<td>Blood samples from heparinized PICCs for coagulation tests were almost perfectly correlated with those drawn from venipunctures for prothrombin time, partial thromboplastin time, and fibrinogen in seconds and in milligrams; only the international normalized ratio samples suggested nonagreement.</td>
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#### Safety and Efficacy: Power Ports

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<tr>
<td>Goltz et al., 2014</td>
<td>Design: Retrospective analysis Sample: 729 patients with femoral vein implanted port with 1,979 catheter days analyzed</td>
<td>Evaluation of indication for, technical success of, and clinical outcome and safety of percutaneously implanted venous power ports in a femoral site</td>
<td>Indications were planned chemotherapy for breast and esophagus cancer and long-term central venous access for IV therapy. Technical success was 100%. One device was explanted as a result of infection. No early complications were noted. The authors concluded that if implantation of a totally implantable venous power port is not feasible in a standard chest, upper arm, or forearm site, femoral placement may be alternatively used safely and effectively.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Author</th>
<th>Design/Sample</th>
<th>Intervention/Variables Examined</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teichgräber et al., 2012</td>
<td>Design: Prospective, observational Sample: 78 ports/1,000 catheter days Device: Power-injectable central venous port system</td>
<td>Evaluation of the clinical benefit of power-injectable central venous ports</td>
<td>Complication rates of power-injectable central venous ports are comparable to standard port systems. Use of these ports for contrast injection should be increased.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Author</th>
<th>Design/Sample</th>
<th>Intervention/Variables Examined</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiffer et al., 2013</td>
<td>Central Venous Catheter Care for the Patient With Cancer: American Society of Clinical Oncology Clinical Practice Guideline</td>
<td>Systematic literature review and expert work group to develop evidence-based recommendations specific to the care of patients with cancer who have CVCs.</td>
<td>Numerous recommendations were made regarding general management of short- and long-term CVCs.</td>
</tr>
</tbody>
</table>

* Full references from Appendix 1 are available in the Chapter 1 reference list.
** Additional specifics regarding type of access device are not specified.

ANTT—aseptic no-touch technique; BSI—bloodstream infection; CHG—chlorhexidine gluconate; CLABSI—central line–associated bloodstream infection; CVAD—central venous access device; CVC—central venous catheter; DVT—deep vein thrombosis; ECG—electrocardiogram; EtOH—ethanol; IC-ECG—intracavitary electrocardiography; ICU-intensive care unit; NC—needleless connector; NS—0.9% normal saline; PICC—peripherally inserted central catheter; rtPA—recombinant tissue plasminogen activator; tPA—tissue plasminogen activator; US—ultrasound; VAD—venous access device
## Appendix 2. Cleansing Agents

<table>
<thead>
<tr>
<th>Agent*</th>
<th>Mode of Action</th>
<th>Gram-Positive Organisms</th>
<th>Gram-Negative Organisms</th>
<th>Tuberculosis</th>
<th>Fungi</th>
<th>Viruses</th>
<th>Residual Activity</th>
<th>Duration of Anti-Infective Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol 70%</td>
<td>Denaturation of protein</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>None</td>
<td>Brief</td>
</tr>
<tr>
<td>Iodophor 10% (povidone-iodine)</td>
<td>Oxidation/substitution by free iodine</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Minimal</td>
<td>2 hours</td>
</tr>
<tr>
<td>Chlorhexidine (2% for all insertions; &gt; 0.5% for all maintenance care)</td>
<td>Cell wall disruption</td>
<td>Excellent</td>
<td>Good</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
<td>Excellent</td>
<td>4–6 hours</td>
</tr>
</tbody>
</table>

### Special Considerations*

**Allergic reaction: Chlorhexidine (see Figures 1 and 2)**

**Prevention:** Detailed history of previous allergic reactions. Consider allergy testing with specific immunoglobulin E to chlorhexidine or skin prick test if risks are present.

**Signs/Symptoms:**
- Mild irritant contact dermatitis
- Allergic urticaria
- Generalized erythema
- Periorbital edema
- Stomatitis
- Vesicle formation
- Bronchospasm
- Life-threatening anaphylaxis

**Management:**
- Use povidone-iodine and alcohol for skin preparation.
- If allergic to povidone-iodine, use alcohol or soap and water.
- After procedure, ensure all preparation cleanser is removed from skin.
- Management of anaphylaxis: Epinephrine, corticosteroids, IV fluid bolus

**Chemical irritation: Chlorhexidine**

Chlorhexidine gluconate manufacturer packaging warns of meningeal irritation if contact occurs when accessing intraventricular devices. Ensure skin is completely air-dried prior to access.

**Contraindications: Alcohol**

Alcohol is contraindicated for use with epidural and intrathecal devices prior to access.

*Ensure all products completely air-dry prior to access.*
References


## Appendix 3. Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aseptic</td>
<td>Condition free from septic matter or free from organisms</td>
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<tr>
<td>Care bundles</td>
<td>Group of evidence-based interventions aimed at improving patient care processes and outcomes (e.g., maximum sterile barrier precautions on insertion, hand hygiene, chlorhexidine skin antisepsis, assessment of venous access device necessity).</td>
</tr>
<tr>
<td>Caregiver</td>
<td>Unpaid or paid individual who assists another individual with activities of daily living</td>
</tr>
<tr>
<td>Cathetergram</td>
<td>Also known as a dye study, performed when a central venous access device is improperly functioning (e.g., no blood return) to verify correct placement and patency; provides visualization of the integrity of the catheter</td>
</tr>
<tr>
<td>Clean</td>
<td>Condition free from debris or organisms</td>
</tr>
<tr>
<td>Contralateral</td>
<td>The side of the body that is opposite from the side in question</td>
</tr>
<tr>
<td>Epidural</td>
<td>Space between periosteum and dura matter, extending from base of skull to sacrum and containing adipose tissue, blood and lymph vessels, and spinal nerves</td>
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<tr>
<td>Hand hygiene</td>
<td>Handwashing with conventional soap and water or with alcohol-based hand rubs</td>
</tr>
<tr>
<td>Intrathecal</td>
<td>Space between dura mater and arachnoid membrane, containing cerebrospinal fluid (also called subdural)</td>
</tr>
<tr>
<td>Ipsilateral</td>
<td>Occurring on the side of the body in question</td>
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<tr>
<td>Long term</td>
<td>Greater than six weeks</td>
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<tr>
<td>Maximum sterile barrier precautions</td>
<td>Includes cap, mask, sterile gown, sterile gloves, and sterile full-body drape</td>
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<tr>
<td>Needleless connectors</td>
<td>An access point for infusion connections without the need for a needle; available in a variety of designs</td>
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<tr>
<td>Percutaneous</td>
<td>Procedure where access to an inner vein, artery, or organ is performed via a needle puncture through the skin, rather than an “open” surgical approach</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>Firm, not stiff, material that softens and becomes pliable in the vein in response to body core temperature; provides exceptional tensile strength and flexibility, permitting thinner walled and greater internal diameter lumens for high flow rate catheters; thromboresistant</td>
</tr>
<tr>
<td>Protective caps</td>
<td>Connect to catheter hub or needleless connector to provide a physical barrier to contamination; available with passive disinfectant</td>
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<tr>
<td>Provider</td>
<td>Refers to the healthcare provider (e.g., physician, nurse practitioner, physician assistant)</td>
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<tr>
<td>Short term</td>
<td>Less than six weeks</td>
</tr>
<tr>
<td>Silicone</td>
<td>Flexible material that allows catheter to “float” within the vein, which may decrease damage to intima of the vessel; requires special insertion technique due to flexibility of material; thromboresistant</td>
</tr>
<tr>
<td>Sterile</td>
<td>Condition of being free from living microorganisms or germs</td>
</tr>
<tr>
<td>Temporary</td>
<td>Short-term dwelling; typically 1–3 days</td>
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<tr>
<td>Universal procedures</td>
<td>See Appendix 4</td>
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</table>
### Appendix 4. Universal Concepts for Access Devices

<table>
<thead>
<tr>
<th>Principle</th>
<th>Concepts</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional</td>
<td>Procedures should be performed by personnel skilled in assessing signs of access device–related complications.</td>
<td>Complications include erythema, swelling, tenderness, pain, induration, fever, chills, no blood return, and inability to withdraw or infuse fluid.</td>
</tr>
<tr>
<td>Hand hygiene and asepsis</td>
<td>Wash hands with conventional soap and water or alcohol-based hand rubs. Perform hand hygiene before and after palpation of catheter insertion or exit sites, and before and after any manipulation. Palpation of site should not occur after application of antiseptic unless asepsis is maintained. Wear clean or sterile gloves when changing dressings, as per device recommendations.</td>
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</tr>
<tr>
<td>Insertion</td>
<td>Ensure no contraindications exist for placement. Ensure informed consent is obtained prior to insertion of device. Ensure time-out procedures are used prior to placement of device. Preplacement assessment is completed. Laboratory studies are verified. Medication or antineoplastic agent is verified for accuracy. Strictly maintain hand hygiene. Assess for optimal insertion site; use of the femoral vein in adults is not recommended for IV lines. Use maximum sterile barriers for all devices except peripheral IVs (for which an aseptic no-touch technique may be used). Use a 2% chlorhexidine/alcohol preparation of the skin before insertion unless contraindicated or an allergy exists. Allow antiseptic to air-dry prior to insertion.</td>
<td>Evidence-based sterile precautions exist for specific specialty access catheters (see Appendix 12). Tape can transmit bacterial contamination. Topical antibiotics increase risk of fungal infections and antimicrobial resistance.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Assess daily for the need for continued device use, and remove promptly when no longer needed. Use care bundles for all insertion, access, and maintenance activities. Monitor all exit sites on a regular basis visually or by palpation through an intact dressing. Organize care to minimize entries into the system. Maintain strict aseptic technique for all maintenance procedures. Scrub the hub of the needleless connector vigorously with appropriate antiseptic prior to use. Secure all tubing with a securement device. Do not use tape on tubing connections. Do not use topical antibiotics on insertion sites (except for hemodialysis catheters). Change dressing, IV tubing, or needleless connector when wet, soiled, contaminated, damaged, or nonadherent. Use &gt; 0.5% chlorhexidine for daily skin cleansing (unless allergic).</td>
<td></td>
</tr>
<tr>
<td>Flushing</td>
<td>Flush with 0.9% normal saline (NS) before and after use, as indicated by device. Flush with 10–20 ml NS after blood withdrawal, as indicated by device. Never use excessive force. Use a 10 ml or larger syringe for central venous access devices (VADs). Some prefilled syringes contain less than 10 ml of fluid but have a 10 ml diameter syringe and are safe to use. Use a 3 ml diameter syringe for peripheral IVs and midline catheters. Flush vigorously, using pulsating (push-pause) technique, as indicated by device. NS is comparable to heparin lock for nonvalved VADs.</td>
<td>Blood return is not expected with specialty devices and is to be avoided with arterial devices. Pressure is inversely related to syringe size. High pressure increases the risk of catheter or septum rupture or separation. Maximum tolerated pressure may vary by device or if physiologic factors are present (e.g., fibrin sheath, clot).</td>
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</tbody>
</table>

(Continued on next page)
### Appendix 4. Universal Concepts for Access Devices (Continued)

<table>
<thead>
<tr>
<th>Principle</th>
<th>Concepts</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blood sampling principles for venous devices</strong></td>
<td>Obtain blood cultures from an implanted port with signs of an infection prior to initiation of antibiotic therapy. Useblood-sparing techniques when drawing blood samples. Organizework to minimize number of accesses of device; time blood sampling to coincide with other indications for accessing device, such as administration of another medication (e.g., antibiotic), if possible. During continuous infusion: Discontinue infusate(s) at least one minute before sampling. Clamp all lumens not being used for sampling on open-ended catheters. If results are grossly out of range, redraw sample from a peripheral vein. Coagulation studies: Inconclusive data to support peripheral sampling only; practices vary widely regarding sampling via peripherally or VADs. Some drugs can adhere to catheter wall; consider peripheral sampling.</td>
<td>Studies differ on whether sampling from heparin-locked catheters will confound results. Examples include aminoglycosides, cyclosporine, and gentamicin; may affect serum drug level results.</td>
</tr>
<tr>
<td><strong>Blood sampling methods</strong></td>
<td>Discard method (most common technique): • Withdraw and discard prior to collection of sample: Amounts vary from 3–10 ml (5–6 ml reported most frequently) for adults and 3–5 ml for children. • Flush with 10–20 ml of NS for adults and 3–10 ml for children. (Follow with heparin if necessary, as per catheter type.) Vacutainer method: • Vacutainer is inserted into injection cap to obtain sample. • Withdrawal amount can be collected through vacutainer into empty blood collection tube..Reinfusion method: • Discard sample is saved and reinfused after sample is collected. • Used often in neonate and infant populations Mixing method: • Blood is withdrawn and immediately reinfused; repeated 3–4 times without removing syringe; then sample is taken. • Used in pediatric population</td>
<td>Not routinely used Not routinely used in adult population; caution is necessary to avoid reinfusion of clots. Not routinely used in adult population</td>
</tr>
<tr>
<td><strong>Administration set</strong></td>
<td>Ensure all components are compatible to minimize leaks and maintain integrity. Replacement (including secondary sets and add-on devices that are continuously used): • For equipment used to administer blood, blood products, fat emulsions (e.g., lipids), or total parenteral nutrition: Within 24 hours of initiation and every 24 hours thereafter • For equipment for propofol infusion: Every 6–12 hours and when the vial is changed • For equipment used to administer infusates: No more often than at 96-hour intervals Change needleless connectors after each use, if contaminated, or after breakage. Protective caps (connected to catheter hub or needleless connector, providing physical barrier to contamination): Change every 7 days, if contaminated or after breakage.</td>
<td>Some components may be incompatible with some infusates.</td>
</tr>
</tbody>
</table>
### Appendix 4. Universal Concepts for Access Devices (Continued)

<table>
<thead>
<tr>
<th>Principle</th>
<th>Concepts</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Documentation</strong></td>
<td>Ensure compliance with standards and policies.</td>
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<tr>
<td><strong>Rationale for device:</strong></td>
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<tr>
<td>• For insertion</td>
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<td></td>
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<tr>
<td>– Informed consent</td>
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<tr>
<td>– Date and time of insertion</td>
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<td></td>
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<tr>
<td>– Type of device and location of insertion</td>
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<tr>
<td>– Anesthetic, if used</td>
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<td></td>
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<tr>
<td>– Presence of blood return or other body fluid</td>
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<tr>
<td>– Insertion complications, if any</td>
<td></td>
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<tr>
<td>– Dressing</td>
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<tr>
<td>– Confirmation of placement</td>
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<tr>
<td>– Patient education regarding catheter care, as indicated</td>
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<tr>
<td>• For access</td>
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<tr>
<td>– Date, time, and purpose</td>
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<tr>
<td>– Evaluation of proper functioning</td>
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<tr>
<td>– Type of infusate</td>
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<tr>
<td>– Complications, if any; notify provider and implement strategies</td>
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<tr>
<td>• For maintenance</td>
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<tr>
<td>– Evaluation of device; subjective information</td>
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<tr>
<td>– Type of dressing, frequency of tubing change</td>
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<tr>
<td>– Type, volume, frequency of flushing, as indicated</td>
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<tr>
<td>– Type, frequency of cap change, if any</td>
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<tr>
<td>• For removal</td>
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<td></td>
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<tr>
<td>– Date, time, and rationale</td>
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<td></td>
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<tr>
<td>– Description of removal including catheter tip and assessment for</td>
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<tr>
<td>catheter body intactness</td>
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<tr>
<td>– Wound or tip culture, if ordered</td>
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<tr>
<td>– Patient education regarding postprocedural care</td>
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<tr>
<td><strong>Patient preparation</strong></td>
<td>Always ensure patient understanding of procedure to be performed.</td>
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<td>Always perform preprocedure assessment; consider any special needs</td>
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<td>regarding age, physical condition, or catheter type.</td>
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<td>Always answer any questions the patient or caregiver may have prior to</td>
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<td>initiation of procedure.</td>
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<td>Always perform time-out procedure to verify correct patient, correct site,</td>
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<td></td>
<td>and correct procedure.</td>
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</tbody>
</table>

### References


## Appendix 5. Venous Devices

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Peripheral Intravenous Line</th>
<th>Midline</th>
<th>Central Nontunneled</th>
<th>Peripherally Inserted Central Catheter</th>
<th>Tunneled</th>
<th>Implanted Port</th>
<th>Apheresis</th>
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<tbody>
<tr>
<td>Insertion and replacement or removal considerations</td>
<td>Short term</td>
<td>Short term</td>
<td>Short term</td>
<td>Short term</td>
<td>Long term</td>
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<td>Insertion may require specialized training.</td>
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<td>Avoid femoral site (adults).</td>
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<tr>
<td>Placement and tip location must be confirmed prior to use.</td>
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<tr>
<td>Do not remove on the basis of fever alone; use clinical judgment if infection is suspected.</td>
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<td>Use clean gloves for removal.</td>
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</tr>
<tr>
<td>Maintain maximum sterile barrier precautions.</td>
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<tr>
<td>Placement and tip location must be confirmed prior to use.</td>
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</tr>
<tr>
<td>Do not remove on the basis of fever alone; use clinical judgment if infection is suspected.</td>
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<tr>
<td>Use clean gloves for removal.</td>
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<tr>
<td>Insertion requires specialized training.</td>
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<tr>
<td>Maintain maximum sterile barrier precautions.</td>
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<td>Placement and tip location must be confirmed prior to use.</td>
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<tr>
<td>Do not remove on the basis of fever alone; use clinical judgment if infection is suspected.</td>
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</tr>
<tr>
<td>Use clean gloves for removal.</td>
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</table>

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<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Peripheral Intravenous Line</th>
<th>Midline</th>
<th>Central Nontunneled</th>
<th>Peripherally Inserted Central Catheter</th>
<th>Tunneled</th>
<th>Implanted Port</th>
<th>Apheresis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dressing and securement device change: Sterile transparent</td>
<td>Replace with IV change. Use ANTT. Wear either clean or sterile gloves.</td>
<td>Change 24 hours after insertion and at least every 7 days. Use ANTT. Wear either clean or sterile gloves.</td>
<td>Change 24 hours after insertion and at least every 7 days. Use ANTT. Wear either clean or sterile gloves.</td>
<td>Apply sterile dressing after insertion; change 24 hours after insertion to a transparent dressing and at least every 7 days until healed. Use ANTT. Wear either clean or sterile gloves.</td>
<td>Apply sterile dressing after insertion; change 24 hours after insertion to a transparent dressing and at least every 7 days until healed. Use ANTT. Wear either clean or sterile gloves.</td>
<td>Apply sterile dressing after insertion; change 24 hours after insertion to transparent and at least every 7 days until healed. Short-term catheters: Change at least every 7 days. Long-term catheters: No definitive evidence exists regarding necessity for any dressing on a well-healed exit site. Use ANTT. Wear either clean or sterile gloves.</td>
<td></td>
</tr>
<tr>
<td>Dressing and securement device change: Sterile gauze and tape</td>
<td>Every other day (QOD) or PRN if wet, soiled, or nonocclusive Use ANTT.</td>
<td>QOD or PRN if wet, soiled, or nonocclusive Use ANTT.</td>
<td>QOD or PRN if wet, soiled, or nonocclusive Use ANTT.</td>
<td>QOD or PRN if wet, soiled, or nonocclusive Use ANTT.</td>
<td>QOD or PRN if wet, soiled, or nonocclusive Use ANTT.</td>
<td>QOD or PRN if wet, soiled, or nonocclusive Use ANTT.</td>
<td></td>
</tr>
<tr>
<td>Flush: 0.9% normal saline (NS)*</td>
<td>Flush 1–3 ml every 8, 12, or 24 hours when not in use, following blood sampling.</td>
<td>Flush 1–3 ml every 8, 12, or 24 hours when not in use, following blood sampling.</td>
<td>Flush 5–10 ml after each use, following blood sampling. May use NS 10 ml every 8 hours.</td>
<td>Flush 5–10 ml after each use; following blood sampling. Valved or closed tip: Flush 5–10 ml daily, QOD, or three times weekly.</td>
<td>Flush 5–10 ml after each use, following blood sampling. Valved or closed tip: Flush 5 ml daily, QOD, three times weekly.</td>
<td>Flush 5–10 ml after each use. Flush 5 ml every 4–8 weeks if not in use for valved ports.</td>
<td></td>
</tr>
</tbody>
</table>

(Continued on next page)
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Peripheral Intravenous Line</th>
<th>Midline</th>
<th>Central Nontunneled</th>
<th>Peripherally Inserted Central Catheter</th>
<th>Tunneled</th>
<th>Implanted Port</th>
<th>Apheresis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flush: Heparin</td>
<td>N/A</td>
<td>N/A</td>
<td>Flush 10–100 IU/ml, 2–3 ml/day per lumen.</td>
<td>Flush 10–100 IU/ml, 3 ml/day; 3 ml/day QOD; or three times weekly; per lumen.</td>
<td>Flush 10–100 IU/ml, 5 ml after each use per lumen; and every 4–8 weeks if not in use.</td>
<td>Flush 1,000 IU/ml, 1–2 ml/day after each use or every day.</td>
<td></td>
</tr>
<tr>
<td>Needleless connector</td>
<td>Replace with catheter change or after each use.</td>
<td>Replace with catheter change or after each use.</td>
<td>Replace after each use.</td>
<td>Replace after each use or weekly (if in use).</td>
<td>Replace after each use or weekly (if in use).</td>
<td>Replace after each use.</td>
<td></td>
</tr>
<tr>
<td>Protective caps</td>
<td>N/A</td>
<td>N/A</td>
<td>Replace every 7 days or if damaged or contaminated.</td>
<td>Replace every 7 days or if damaged or contaminated.</td>
<td>Replace every 7 days or if damaged or contaminated.</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Blood sampling</td>
<td>Clamp all lumens not being used for withdrawal; 3–5 ml discard; flush with 10–20 ml NS after sampling.</td>
<td>Clamp all lumens not being used for withdrawal; 3–5 ml discard; flush with 10–20 ml NS after sampling.</td>
<td>Clamp all lumens not being used for withdrawal; 3–5 ml discard; flush with 10–20 ml NS after sampling.</td>
<td>Clamp all lumens not being used for withdrawal; 3–5 ml discard; flush with 10–20 ml NS after sampling.</td>
<td>Clamp all lumens not being used for withdrawal; 3–5 ml discard; flush with 10–20 ml NS after sampling.</td>
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</tr>
</tbody>
</table>

(Continued on next page)
Appendix 5. Venous Devices (Continued)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Peripheral Intravenous Line</th>
<th>Midline</th>
<th>Central Nontunneled</th>
<th>Peripherally Inserted Central Catheter</th>
<th>Tunneled</th>
<th>Implanted Port</th>
<th>Apheresis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other (See specific chapter for details.)</td>
<td>Not indicated for continuous vesicant therapy or certain solutions</td>
<td>Not indicated for continuous vesicant therapy or certain solutions</td>
<td>Indicated for urgent fluid resuscitation and pressure monitoring</td>
<td>Can be used for all types of IV therapy Do not draw peripheral venipuncture blood samples, obtain blood pressures, or insert a peripheral IV catheter into the ipsilateral limb with a peripherally inserted central catheter.</td>
<td>Can be used for all types of IV therapy</td>
<td>Can be used for all types of IV therapy</td>
<td>Larger lumens than other venous access devices; if the heparinized saline is not aspirated and discarded prior to use, monitor coagulation levels, as this amount of heparin may lead to therapeutic serum levels.</td>
</tr>
</tbody>
</table>

* Flush with NS after each drug administration. NS volume is dependent on device used (e.g., 2–10 ml).
### Appendix 6. Peripheral/Midline Venous Device Competency Documentation

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Preparing the Patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient and caregiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Performs preplacement assessment of the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Inserting the Catheter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Organizes equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Examines veins on both extremities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Washes hands again; applies gloves. If inserting midline, uses maximum sterile barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Applies local anesthetic, if ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Applies tourniquet; cleanses site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Stabilizes vein below venipuncture site with nondominant hand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Observes for blood return; advances catheter into vein; pushes catheter off stylet, if used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Releases tourniquet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Occludes tip of catheter by pressing fingers of nondominant hand over vein to prevent retrograde bleeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Attaches to appropriate device for IV therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Secures IV catheter with securement device</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Applies occlusive dressing over the insertion site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Discards all equipment appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Documents appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. Blood Sampling</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Organizes equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Cleans connector with alcohol or chlorhexidine wipe using scrubbing motion and allows to dry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Attaches prefilled syringe of 0.9% normal saline (NS) and checks for blood return using gentle aspiration</td>
<td></td>
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<tr>
<td>6. Removes at least 1 ml of blood (or twice the catheter and add-on device volume) and discards</td>
<td></td>
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</tr>
<tr>
<td>7. Withdraws appropriate amount for laboratory test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Flushes catheter with 1–3 ml NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.Caps the catheter or connects to appropriate solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Discards all equipment appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Documents appropriately</td>
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</tr>
</tbody>
</table>

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### Appendix 6. Peripheral/Midline Venous Device Competency Documentation (Continued)

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Changing the Needleless Connector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Changes needleless connector at appropriate frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Discards all equipment appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Documents appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Caring for the Insertion Site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Removes old dressing carefully and discards dressing and gloves</td>
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<td></td>
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<tr>
<td>5. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Applies new gloves</td>
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<td></td>
</tr>
<tr>
<td>7. Cleanses exit site and allows to dry</td>
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<td></td>
</tr>
<tr>
<td>8. Applies appropriate dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Discards all equipment appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Labels dressing with date, time, and initials</td>
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</tr>
<tr>
<td>12. Documents appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Assessing and Intervening in Catheter Malfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Assesses for infusion complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Is aware of signs and symptoms of phlebitis or infiltration</td>
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<tr>
<td>3. Reassures the patient and prepares for intervention, if needed</td>
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<td></td>
</tr>
<tr>
<td>G. Documenting Findings and Patient Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Documents all assessment findings and procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Evaluates the patient's and caregiver's education and response to teaching, including return demonstration of technical tasks and signs and symptoms of potential complications</td>
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</tbody>
</table>
## Appendix 7. Topical Anesthetics

<table>
<thead>
<tr>
<th>Type</th>
<th>Application</th>
<th>Comments</th>
<th>Applicable Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkane vapocoolant spray</td>
<td>Spray a light mist onto skin from several inches away; allow to air-dry prior to access or insertion.</td>
<td>Frostbite can occur on excessively used or extremely sensitive skin. Spray evaporates rapidly; therefore, effect is transient.</td>
<td>Comparisons of swabs of chlorhexidine-disinfected/no spray and chlorhexidine-disinfected/applied spray IV insertion sites from 50 patients showed no increased risk of infection when spray is used as an anesthetic prior to peripheral IV cannulation following disinfection. When compared to nondisinfected skin, vapocoolant-treated skin had a significantly decreased colonization; however, it was not sufficient to be used as the sole disinfectant. Similar findings have been reported when compared to application of spray following 70% isopropyl alcohol skin preparation. Comparisons of spray to ice in pediatric patients undergoing IV catheter placement showed more satisfaction with the use of spray, which may have been more effective than ice as an analgesic.</td>
</tr>
<tr>
<td>Dry heat</td>
<td>Place dry heated towels wrapped around the extremity; commercial dry hot packs.</td>
<td>Avoid friable skin; no specific time interval is recommended.</td>
<td>Dry heat was found to be successful for pain relief during IV insertions when compared to moist heat. Dry heat resulted in more successful insertions on the first attempt and more comfortable cannulations as compared to moist heat applications.</td>
</tr>
<tr>
<td>Intradermal lidocaine (1% lidocaine without epinephrine)</td>
<td>Insert needle bevel up just proximal to intended insertion site.</td>
<td>Needlestick may cause discomfort; may be sensitive to lidocaine. Burning may occur during injection.</td>
<td>Use provided effective pain relief. Comparison of subcutaneous lidocaine to a lidocaine/tetracaine patch showed comparable pain control during arterial catheter insertions; lidocaine caused discomfort during injection. Use of an air-pressured delivery system rather than a needle to administer lidocaine prior to venipuncture resulted in less reported pain in children aged 1–6 years when compared with vapocoolant alone and with vapocoolant plus placebo air injection.</td>
</tr>
<tr>
<td>Transcutaneous electrical nerve stimulation (TENS)</td>
<td>Apply to radial side of wrist of dominant forearm 20 minutes before insertion.</td>
<td>Local erythema and itching may occur.</td>
<td>A comparison of an active TENS patient group and a placebo TENS group showed incidence of pain to be similar between the groups, but pain intensity was significantly lower in the active TENS group.</td>
</tr>
<tr>
<td>Transdermal cream</td>
<td>Apply thick layer 1–2 hours prior to access or IV insertion. Cover with transparent dressing. Remove completely and cleanse site prior to insertion or access.</td>
<td>Typical preparations are compounds of lidocaine and prilocaine. Local edema, pallor, or erythema may occur.</td>
<td>Cream has been researched in combination with oral paracetamol 40 mg/kg for children prior to one needle insertion; the addition of paracetamol provided no additive effect in reducing fear, distress, or pain when combined with topical anesthesia. A review of 12 clinical trials in pediatric and adult populations revealed nine pediatric and three adult cases of systemic toxicity (e.g., methemoglobinemia, central nervous system toxicity, cardiotoxicity). Factors increasing systemic toxicity risk include excessive dosing of cream, large application surface area, prolonged application time, compromised skin in treatment area, aged &lt;3 months or premature infant, and concomitant use of a methemoglobin-inducing agent.</td>
</tr>
<tr>
<td>Transdermal patch</td>
<td>Apply 20–30 minutes prior to IV insertion or access.</td>
<td>Erythema or edema may occur. Potential exists for systemic toxicity.</td>
<td>Patch may be comprised of tetracaine (4%) or tetracaine (7%) and lidocaine (7%) combination. Comparisons of each compound prove equivalent efficacy in pain management during venous cannulation.</td>
</tr>
</tbody>
</table>

* A provider order is required prior to application of any topical anesthetic.

## References


### Appendix 8. Nontunneled Device Competency Documentation

<table>
<thead>
<tr>
<th>Skill</th>
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<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Preparing the Patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Identifies the patient and verifies order for device placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Explains the procedure to the patient or caregiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Performs preplacement assessment of the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Ensures that informed consent is obtained</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Assisting With Device Placement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Administers premedications, as ordered, prior to procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Obtains necessary equipment and prepares medications or pump, as ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Assists the provider with placing line as requested, maintaining strict sterile technique; supports and reassures the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Ensures confirmation and proper tip placement prior to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Evaluates the patient for postinsertion complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. Accessing the Device</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Organizes maintenance care to minimize entry into the system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Explains the procedure to the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Assembles equipment and washes hands; applies clean gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Ensures the catheter is clamped whenever the line is opened; uses only smooth-edged clamps or latex- or plastic-covered clamps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Vigorously scrubs needleless connector with cleansing agent, and attaches syringe with 0.9% normal saline (NS) to flush</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Opens clamp, flushes catheter, and verifies positive blood return; then removes syringe and attaches IV tubing directly to catheter hub</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. If therapy is intermittent IV push, attaches needleless connector using the SASH (saline, administer medication, saline, heparin) method</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Blood Sampling (Discard Method)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Washes hands and prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Removes 3–5 ml of blood and discards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Removes necessary blood for testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.Flushes the catheter with 10–20 ml NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Heparinizes catheter, if appropriate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 8. Nontunneled Device Competency Documentation (Continued)

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E. Changing the Needleless Connector</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Washes hands, obtains necessary equipment, then applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ensures catheter is clamped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Vigorously scrubs needleless connector with cleansing agent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Scrubs hub, minimizing time catheter is opened</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Changes connector at appropriate frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F. Caring for the Exit Site</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Washes hands and obtains necessary equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Removes old dressing carefully to minimize tugging on the line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Inspects exit site for erythema, tenderness, edema, exudate, length of catheter protruding from the skin, and integrity of external portion of catheter; removes gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Applies new gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Cleanses exit site and applies appropriate dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Secures tension loop or other securement to avoid catheter dislodgment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Changes dressing at appropriate frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G. Removing the Catheter per Licensing and Institutional Restrictions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Verifies order for catheter removal and indication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Explains the procedure to the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Washes hands and assembles necessary equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Removes old dressing and discards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Applies new gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Ensures all IV solutions are discontinued</td>
<td></td>
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</tr>
<tr>
<td>8. Instructs the patient to perform the Valsalva maneuver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Grasps hub and gently and steadily pulls the catheter out until completely removed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Applies pressure to the exit site until bleeding has stopped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. If catheter infection is suspected, ensures tip does not contact any surface, cuts tip off with sterile scissors, and places in a sterile container for culture, if ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Applies occlusive dressing over exit site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Measures catheter and compares to inserted length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Inspects catheter for defects or jagged edges suggestive of breakage</td>
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</tr>
</tbody>
</table>

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### Appendix 8. Nontunneled Device Competency Documentation (Continued)

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. If length or appearance warrant, notifies healthcare provider and preserves line</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### H. Assessing and Intervening in Catheter Malfunction

1. Differentiates between infusion complications, fibrin sheath formation, catheter kinkage, and catheter malposition

2. Is aware of signs and symptoms of infection

3. Obtains order for necessary flush medications, as required (e.g., tissue plasminogen activator)

4. Reassures the patient and prepares for diagnostic procedures, as indicated

#### I. Documenting Findings and Patient Education

1. Documents all assessment findings and procedures

2. Evaluates the patient’s and caregiver’s education and response to teaching, including return demonstration of technical tasks and signs and symptoms of potential complications
Appendix 9. Peripherally Inserted Central Catheter, Tunneled, and Apheresis (Long-Term) Venous Device Competency Documentation

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Preparing the Patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient and caregiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Performs preaccess assessment of the patient and catheter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ensures that informed consent is obtained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Confirms catheter placement prior to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Accessing the Long-Term Venous Device</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Organizes catheter care to minimize entry into the system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Maintains a strict aseptic technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Never leaves catheter open to air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Uses only smooth-edged clamps or latex- or plastic-covered clamps, as appropriate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Uses securement device to stabilize</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Cleanses the needleless connector vigorously; accesses catheter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Flushes the catheter at appropriate frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. Infusing Fluids or Medications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. States appropriate medications/fluids and rates of infusion for device</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. States two possible complications and appropriate interventions, as appropriate, for medication or fluid infused</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Blood Sampling (Discard Method)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Follows procedure for accessing system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Removes at least 3–5 ml of blood or solution and discards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Clamps the catheter at appropriate times</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. withdraws the desired amount of blood</td>
<td></td>
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</tr>
<tr>
<td>5. Flushes the catheter with 10–20 ml of 0.9% normal saline after blood withdrawal</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E. Changing the Needleless Connector</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Cleanses catheter and applies connector using aseptic technique</td>
<td></td>
<td></td>
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<tr>
<td>5. Changes connector at appropriate frequency</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F. Caring for the Exit Site</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Carefully removes old dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Inspects exit site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Removes gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Applies new gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Cleanses exit site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Applies appropriate dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G. Assessing and Intervening in Catheter Malfunction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Differentiates between infusion complications, fibrin sheath formation, catheter kinkage, and catheter migration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Is aware of signs and symptoms of infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Obtains an order for necessary flush medications, as required (e.g., tissue plasminogen activator)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Reassures the patient and prepares for diagnostic procedures, as indicated</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H. Documenting Findings and Patient Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.Documents all assessment findings and procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Evaluates the patient's and caregiver's education and response to teaching, including return demonstration of technical tasks and signs and symptoms of potential complications</td>
<td></td>
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</tr>
</tbody>
</table>
### Appendix 10. Implanted Port Device Competency Documentation

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Preparing the Patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient and caregiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Performs preplacement assessment of the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ensures that informed consent is obtained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Confirms catheter placement prior to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Accessing the Implanted Port</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Washes hands and obtains necessary equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Chooses appropriate size and length of noncoring needle for therapy planned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Applies gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Removes dressing, if appropriate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Palpates port and locates center of septum to be accessed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Observes site for edema; erythema; tenderness; condition of the port pocket; or swelling of ipsilateral chest, neck veins, or extremity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Discards used gloves and reapply new gloves; applies topical anesthetic, if ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Cleanses the area over the septum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Grasps the edges of the portal body firmly through the skin to stabilize, pushing the noncoring needle firmly through the skin and diaphragm, and stopping when the bottom of the reservoir is reached</td>
<td></td>
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</tr>
<tr>
<td>11. Flushes saline into the port and checks for blood return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Applies appropriate dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Attaches IV tubing to the catheter hub if continuous infusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Attaches needleless connector if intermittent infusion is planned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. If continuous infusion, evaluates need to change noncoring needle every 7–10 days or when access is compromised</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. Flushing an Implanted Port</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Washes hands and assembles necessary equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. If port is not accessed, accesses per procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Vigorously flushes catheter using pulsatile technique with 10–20 ml 0.9% normal saline for valved catheters and heparin lock flush for open-ended catheters</td>
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</tr>
<tr>
<td>5. If port does not need to be used, deaccesses per procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Accesses and flushes port every four to eight weeks when not in use</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Deaccessing an Implanted Port</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Washes hands and assembles necessary equipment</td>
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</tbody>
</table>

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## Appendix 10. Implanted Port Device Competency Documentation (Continued)

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Applies gloves and removes dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Discards used gloves and re-applies new gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Stabilizes port through skin with one hand, grasps non-coring needle wings or hub with the other hand, and administers flush</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. While instilling the final 1 ml of flushing solution, simultaneously pulls the needle from the port septum, pushing down on the port edges to prevent tugging the port upward</td>
<td></td>
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</tr>
<tr>
<td>7. Applies pressure over the needle exit site, and then applies appropriate dressing, if needed</td>
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</tbody>
</table>

## E. Blood Sampling From an Implanted Port

1. Explains the procedure to the patient
2. Washes hands and assembles necessary equipment
3. Accesses port per procedure if not accessed
4. Removes at least 3–5 ml of blood and discards
5. Removes necessary blood for testing
6. Flushes the catheter per procedure and either continues infusion, replaces connector, or deaccesses per procedure

## F. Assessing and Intervening in Catheter Malfunction

1. Differentiates between infusion complications, fibrin sheath formation, catheter kinkage, and catheter migration
2. Is aware of signs and symptoms of infection
3. Obtains an order for necessary flush medications, as required (e.g., tissue plasminogen activator)
4. Reassures the patient and prepares for diagnostic procedures, as indicated

## G. Documenting Findings and Patient Education

1. Documents all assessment findings and procedures
2. Evaluates the patient’s and caregiver’s education and response to teaching, including return demonstration of technical tasks and signs and symptoms of potential complications
Appendix 11. Hepatic Arterial Infusion Pump Device Competency Documentation

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Preparing the Patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Assesses the patient's knowledge regarding pump; explains the procedure to the patient and caregiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Reviews pertinent laboratory values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Provides the patient privacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Assesses the patient for signs and symptoms of infection over pump location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Palpates pump location, including estimate of refill chamber septum location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Assesses for signs and symptoms of pump complications, such as hematoma, pump pocket infection, flipped pump, malpositioned catheter (e.g., indigestion, abdominal pain)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Refilling Procedure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Maintains maximum sterile barrier precautions, establishes sterile field, applies sterile gloves and mask, assembles supplies, and then verifies that needle is correct for refill procedure</td>
<td></td>
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</tr>
<tr>
<td>3. Connects the needle to the extension tubing in kit, attaches extension tubing to stopcock, and then attaches stopcock to empty sterile syringe provided in kit</td>
<td></td>
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<tr>
<td>4. Cleanses site with an antiseptic, allows to air-dry, and then removes gloves</td>
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<td></td>
</tr>
<tr>
<td>5. Applies a new pair of sterile gloves</td>
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<td></td>
</tr>
<tr>
<td>6. Repalpates pump and locates refill chamber septum</td>
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</tr>
<tr>
<td>7. Inserts noncoring needle perpendicular into the port septum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Advances needle until it comes into contact with the needlestop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Allows the pump to empty into the syringe and does not aspirate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Closes stopcock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Notes amount in syringe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Leaves needle in place and disconnects syringe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Connects new syringe with medication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Opens stopcock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Confirms that needle is still in place by injecting 5 ml of medication in the syringe, releasing pressure on the syringe, and then allowing the 5 ml of fluid to return in the syringe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Keeps downward pressure on the needle and syringe and injects medication into the pump, checking placement every 5 ml until the syringe is empty</td>
<td></td>
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</tr>
<tr>
<td>17. Closes stopcock and removes needle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Applies appropriate dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Discards syringe and any other contaminated supplies into appropriate waste containers</td>
<td></td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C. Assessing and Intervening in Pump Malfunction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Differentiates between inflow and outflow problems, fibrin sheath formation, catheter kinkage, and catheter migration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Is aware of signs and symptoms of chemical versus bacterial infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Reassures the patient and prepares for diagnostic procedures, as indicated</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Documenting Findings and Patient Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Documents all assessment findings and procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Evaluates the patient's and caregiver's education and response to teaching, including return demonstration of technical tasks and signs and symptoms of potential complications</td>
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</tr>
</tbody>
</table>
## Appendix 12. Specialty Devices

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Arterial</th>
<th>Intraventricular</th>
<th>Epidural and Intrathecal</th>
<th>Implanted Intraperitoneal Port</th>
<th>Intraperitoneal: External/Tunneled</th>
<th>Pleural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short or long term</td>
<td>Arterial ports: Similar to venous ports</td>
<td>Also known as an Ommaya® reservoir Long-term use</td>
<td>External, percutaneous or short-tunneled (short term): For hours to days; exit site in lower back External, percutaneous or short-tunneled (long term): Exit site in abdomen Implanted port: Similar to venous ports; contain filters; for long-term therapy Implanted pump with attached epidural or intrathecal catheter: Long-term therapy</td>
<td>Semipermanent for repeated access</td>
<td>Onetime access (paracentesis) or semipermanent for repeated access (tunneled)</td>
<td>Short term (chest tubes) or long term (indwelling) Include large-bore, “pigtail” nontunneled (chest tubes), and tunneled valved (indwelling) catheters</td>
</tr>
<tr>
<td>Insertion and replacement or removal considerations</td>
<td>Placed by trained provider: Short term: interventional radiology (IR) Port: IR or operating room (OR) Pump: In IR or OR Maximum sterile barrier precautions Short-term catheters can be removed at the bedside or in IR by trained and credentialed individuals.</td>
<td>Placed by trained provider; performed in OR Reservoir implanted subcutaneously under scalp; catheter threaded through burr hole into ventricle Maximum sterile barrier precautions Rarely removed unless malfunction or infection occurs</td>
<td>Placed by trained provider; performed in IR, OR if tunneled, Implanted port, or implanted pump; may be placed at bedside if percutaneous Maximum sterile barrier precautions for all procedures Temporary catheters can be removed directly using sterile technique at bedside. Ports and pumps are removed in the OR.</td>
<td>Placed by trained physician; performed in IR or OR Maximum sterile barrier precautions Typically removed in IR or OR</td>
<td>Placed by trained provider; performed in IR or OR Maximum sterile barrier precautions Not routinely changed unless obstruction or infection occurs External tunneled catheters can be removed in IR, OR, or bedside under local anesthesia.</td>
<td>Placed by trained provider; performed in IR, OR, or bedside if short term Maximum sterile barrier precautions Not routinely changed unless obstruction or infection occurs; short-term chest tubes typically removed within one week; indwelling (tunneled) catheters can remain indefinitely.</td>
</tr>
</tbody>
</table>

(Continued on next page)
## Appendix 12. Specialty Devices (Continued)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Arterial</th>
<th>Intraventricular</th>
<th>Epidural and Intrathecal</th>
<th>Implanted Intraperitoneal Port</th>
<th>Intraperitoneal: External/Tunneled</th>
<th>Pleural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aseptic versus sterile access</td>
<td>Requires specialized training and credentialing to access</td>
<td>Requires specialized training and credentialing to access</td>
<td>Requires specialized training and credentialing to access</td>
<td>May require specialized training and credentialing to access</td>
<td>May require specialized training and credentialing to access</td>
<td>May require specialized training and credentialing to access</td>
</tr>
<tr>
<td></td>
<td>Maximum sterile barrier precautions</td>
<td>Maximum sterile barrier precautions</td>
<td>Alcohol cleansing contraindicated; use chlorhexidine and air-dry completely. Povidone-iodine can be used.</td>
<td>Maximum sterile barrier precautions</td>
<td>Maximum sterile barrier precautions</td>
<td>Maximum sterile barrier precautions</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>flush</td>
<td>Short and long term:</td>
<td>Maintenance flushing not required</td>
<td>Catheter: 1–2 ml preservative-free NS after use</td>
<td>20 ml NS pre- and postadministration; use of heparinized solution flush after NS remains controversial.</td>
<td>20 ml NS pre- and postadministration; use of heparinized solution flush after NS remains controversial.</td>
<td>Small-bore tunneled catheters (to dislodge clots or debris): Use 30 ml NS every 6–8 hours.</td>
</tr>
<tr>
<td></td>
<td>• No definitive recommendation can be made regarding the frequency or volume of flushing.</td>
<td></td>
<td>Port: 3 ml preservative-free NS after use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• During periods where chemotherapy is not infusing, heparinized solution may be ordered as a continuous infusion to maintain patency.</td>
<td></td>
<td>Routine flushing not needed for ports or catheters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Volume, concentration, and frequency varies; no evidence to support a particular volume or concentration.</td>
<td></td>
<td>Pump: Maintenance flushing not required</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Literature reports use of heparin solution 1,000–5,000 IU/ml, 1–3 ml every 8 hours daily to maintain patency.</td>
<td></td>
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<tr>
<td></td>
<td>• Port: Heparinized saline (100–1,000 IU/ml), 2–5 ml every week</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Pump: Glycerin or 0.9% normal saline (NS) or heparinized saline; volume dependent on pump type</td>
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<td></td>
</tr>
</tbody>
</table>

(Continued on next page)
## Appendix 12. Specialty Devices (Continued)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Arterial</th>
<th>Intraventricular</th>
<th>Epidural and Intrathecal</th>
<th>Implanted Intraperitoneal Port</th>
<th>Intraperitoneal: External/Funneled</th>
<th>Pleural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dressing and securement device change</td>
<td>Change dressing 24 hours after insertion. Sterile occlusive dressing, as indicated Use securement device and tension loop to prevent needle dislodgment, as indicated.</td>
<td>Occlusive sterile dressing for at least 24 hours, then gauze and tape for several days No dressing required when healed Sterile dressing applied following access and administration of medications</td>
<td>Occlusive sterile dressing with securement device or tension loop if external catheter Use of chlorhexidine-impregnated dressing or sponge recommended</td>
<td>Occlusive sterile dressing with securement device or tension loop; keep in place postoperatively 24 hours, unless soiled. Apply sterile occlusive pressure dressing after the access needle is removed. Dressing not required if not in use</td>
<td>Occlusive sterile dressing with securement device or tension loop; observe sterile technique. Change dressing if wet, soiled, or nonocclusive. Use split 4 x 4 sterile gauze around exit site; apply a second sterile occlusive dressing over split 4 x 4. Change gauze-only dressings every 48 hours; change sterile occlusive dressing at least weekly.</td>
<td></td>
</tr>
<tr>
<td>Needleless connector</td>
<td>Change after each use, or weekly if not in continuous use. N/A</td>
<td>Change after each use, or weekly if not in continuous use. N/A</td>
<td>Change after each use, or weekly if not in continuous use. N/A</td>
<td>Change after each use, or weekly if not in continuous use. Indwelling: Change after each use, or weekly if not in continuous use.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unique care</td>
<td>Avoid blood pressure monitoring in the ipsilateral limb. Ensure proper labeling of the line on the tubing near the hub. Blood sampling (short term): No definitive recommendation can be made regarding blood sampling from short-term percutaneous arterial catheters. Blood sampling (long term) and ports: Avoid routine blood sampling through a long-term catheter.</td>
<td>Inspect the reservoir for signs of infection prior to access. Keep the patient semirecumbent for at least 30 minutes after medication administration.</td>
<td>Inspect through intact dressing for drainage, erythema, and edema at least daily. Ensure proper labeling of line “epidural” or “intrathecal” on the tubing near the hub. Use a 0.2 micron filter with all epidural and intrathecal infusions, unless the drug is filtered prior to administration or if the port or pump body contains a filter. Change the filter if damaged, leaking, and when tubing is changed. Use specialized tubing to prevent medication administration errors.</td>
<td>Inspect port location for signs of infection prior to access. Ensure proper labeling of the line on the tubing near the hub.</td>
<td>For palliative management of ascites, after first 14 days using sterile technique, the patient and caregiver can be taught to use an aseptic no-touch technique to drain. Ensure proper labeling of line on the tubing near the hub.</td>
<td>Inspect through intact dressing for tenderness, crepitus, or subcutaneous empyema at least daily. Do not strip tubes due to creation of high negative intraluminal pressure. “Milk” tubes gently to dislodge debris or clots, if needed. Do not use petroleum gauze. Ensure proper labeling of line on the tubing near the hub.</td>
</tr>
</tbody>
</table>
### Appendix 13. Intraperitoneal Device Competency Documentation

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Preparing the Patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains procedure with the patient and caregiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Performs preplacement assessment of the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ensures informed consent is obtained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Requests that the patient void before starting procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Assisting With Device Placement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Reviews procedure with the patient and caregiver, if present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Performs preoperative assessment and checklist prior to placement; ensures performance of time out in compliance with universal protocol to verify correct patient, site, and procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Performs postoperative assessment of the patient, catheter, and surrounding skin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Initiates and reviews patient education (home care)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Confirms proper catheter placement prior to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. Accessing the Intraperitoneal Port</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands and assembles supplies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Locates port site and applies topical anesthetic cream, if ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Maintains maximum sterile barrier precautions, establishes sterile field, applies sterile gloves and mask, and assembles supplies (see Appendix 10 for port access)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Is aware that a blood return is not expected as the catheter is not in a vein</td>
<td></td>
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</tr>
<tr>
<td>5. Attempts to withdraw peritoneal fluid, if ordered; if unable to obtain fluid, flushes catheter with 0.9% normal saline (NS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. If flush is successful, attaches infusion tubing or connector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. If resistance is felt with flushing or if swelling or pain occurs, discontinues procedure and reaccesses using new sterile equipment; if resistance is felt again and it is certain that needle is in right place, discontinues procedure and notifies the provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Uses securement device or tension loop to minimize tension on the needle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Encourages the patient to stay in bed during infusion, dwell, and drain time to minimize potential for needle dislodgment</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Accessing the External Peritoneal Catheter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands, maintains maximum sterile barrier precautions, establishes sterile field, applies sterile gloves and mask, and assembles supplies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Explains procedure to the patient and ensures privacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Primed intraperitoneal tubing with NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Opens supplies onto sterile field; dons sterile mask</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Puts on one sterile glove, usually on dominant hand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Picks up sterile syringe in gloved hand and saline in nongloved hand, drawing up 20 ml NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Drops syringe onto sterile field and puts on second sterile glove</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Continued on next page)
### Appendix 13. Intraperitoneal Device Competency Documentation (Continued)

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Cleans catheter and connector with chlorhexidine swab and allows to air-dry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Maintains aseptic technique when disconnecting connector, attaches NS syringe, and flushes system to ensure patency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Withdraws peritoneal fluid for sample, if ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Attaches infusion tubing and applies dressing if infusion is ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Uses securement device or tension loop to minimize tension on the needle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. For palliative drainage of ascites, aseptically attaches drainage bag and allows fluid to drain, controlling rate with roller clamp to prevent the patient from experiencing adverse effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Assesses the patient’s tolerance of the procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Clamps catheter per device, detaches drainage bag and tubing, places new connector aseptically on catheter, and disposes of fluid and tubing properly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Ensures that dressing is changed three times a week and catheter cap and clamp are changed once a week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Documents procedure, assessment of site, size of needle, appearance and amount of peritoneal fluid, and the patient’s response pre-, peri-, and post-treatment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### E. Dressing the Peritoneal Catheter (External or Implanted)

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Changes dressing 24 hours postoperatively or with excess soiling; changes dressings three times a week for an external catheter; is aware that implanted port does not require dressing changes when not in use</td>
</tr>
<tr>
<td>2.</td>
<td>Assembles necessary supplies and washes hands; maintains maximum sterile barrier precautions</td>
</tr>
<tr>
<td>3.</td>
<td>Explains the procedure to the patient and ensures privacy</td>
</tr>
<tr>
<td>4.</td>
<td>Dons nonsterile gloves and removes old dressing, being careful not to touch exit site or needle</td>
</tr>
<tr>
<td>5.</td>
<td>Assesses the site for infection or leakage</td>
</tr>
<tr>
<td>6.</td>
<td>Opens all supplies and puts on sterile gloves</td>
</tr>
<tr>
<td>7.</td>
<td>Cleans around catheter with chlorhexidine swab, working in a circular motion from the catheter outward and being careful not to go over the same area twice; repeats procedure three times</td>
</tr>
<tr>
<td>8.</td>
<td>Allows antiseptic to air-dry</td>
</tr>
<tr>
<td>9.</td>
<td>Applies sterile occlusive dressing</td>
</tr>
<tr>
<td>10.</td>
<td>Disposes of waste in a hazardous waste container</td>
</tr>
</tbody>
</table>

### F. Discontinuing Intraperitoneal Therapy

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Allows intraperitoneal treatment to dwell for the amount of time specified by the provider order</td>
</tr>
<tr>
<td>2.</td>
<td>Drains fluid into sterile peritoneal drainage bag by opening clamp, or allows fluid to be absorbed, as ordered</td>
</tr>
<tr>
<td>3.</td>
<td>Washes hands, maintains maximum sterile barrier precautions, establishes sterile field, applies sterile gloves and mask, and assembles supplies</td>
</tr>
<tr>
<td>4.</td>
<td>Removes old dressing, discards properly, and assesses exit site</td>
</tr>
<tr>
<td>5.</td>
<td>For implantable port, removes the needle; cleanses exit-site area as described for accessing the device; applies pressure to exit site with sterile 2 × 2 gauze to prevent leakage; and applies sterile occlusive dressing</td>
</tr>
</tbody>
</table>

(Continued on next page)
### Appendix 13. Intraperitoneal Device Competency Documentation (Continued)

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. For external catheter, removes old dressing and cleanses exit site, catheter, and connector as described for accessing device</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Applies sterile occlusive dressing to exit site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Is aware that the external catheter dressing should be changed three times a week or more often if soiled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Documents the patient's response to the treatment and procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Disposes of all tubing and supplies into appropriate hazardous waste container</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**G. Assessing and Intervening in Catheter Malfunction**

1. Differentiates between inflow and outflow problem, fibrin sheath formation, catheter kinking, and catheter migration

2. Is aware of signs and symptoms of chemical versus bacterial peritonitis and exit-site versus tunnel-site infection

3. Obtains orders for necessary flush medications, if appropriate

4. Reassures the patient and prepares for the diagnostic procedure to determine the cause of the problem, if applicable

**H. Documenting Findings and Patient Education**

1. Documents all assessment findings and procedures

2. Evaluates the patient’s and caregiver’s education and response to teaching, including return demonstration of technical tasks and signs and symptoms of potential complications

3. Refers to an outside agency if the patient and family need additional assistance or education
## Appendix 14. Pleural Device Competency Documentation

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Preparing the Patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explains the procedure to the patient and caregiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Performs a preplacement assessment of the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ensures informed consent is obtained</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. Assisting With Device Placement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Administers analgesic premedications, as ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Obtains necessary equipment and prepares medications and treatment, as ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Washes hands, maintains maximum sterile barrier precautions, establishes sterile field, applies sterile gloves and mask, and assembles supplies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Ensures performance of time out in compliance with universal protocol to verify correct patient, correct site, and correct procedure</td>
<td></td>
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</tr>
<tr>
<td>5. Assists the provider in placing the catheter as requested, maintaining sterile technique; supports and reassures the patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Confirms proper catheter placement prior to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Evaluates the patient for postinsertion complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. Assisting With Intrapleural Drug Administration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Obtains necessary equipment and prepares medications and treatment, as ordered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Maintains maximum sterile barrier precautions, establishes sterile field, applies sterile gloves and mask, and assembles supplies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Assists the provider with removing pleural catheter dressing and drainage of pleural cavity, as appropriate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Ensures that the pleural catheter tube is clamped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Assists the provider with preparing and disinfecting catheter access site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. After instillation of medication or treatment, ensures that the tubing or catheter is clamped to allow ordered dwell time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Following ordered dwell time, unclamps the catheter or tubing and allows fluid to drain by gravity</td>
<td></td>
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</tr>
<tr>
<td>9. After drainage, disconnects the tubing and discards all equipment appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Documents appropriately in the patient's medical record</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Changing the Dressing and Caring for the Insertion Site</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies clean, nonsterile gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Removes old dressing carefully and discards dressing and gloves</td>
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<td></td>
</tr>
</tbody>
</table>

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### Appendix 14. Pleural Device Competency Documentation (Continued)

<table>
<thead>
<tr>
<th>Skill</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Washes hands; maintains maximum sterile barrier precautions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Applies new sterile gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Cleanses exit site and allows to dry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Applies appropriate occlusive dressing; includes securement device and tension loop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Discards all equipment appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Washes hands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Labels dressing with date, time, and initials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Documents appropriately in the patient's medical record</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### E. Assessing and Intervening in Catheter Malfunction

1. Differentiates between inflow and outflow problem, fibrin sheath formation, catheter kinking, and catheter migration

2. Is aware of signs and symptoms of chemical versus bacterial and exit-site versus tunnel-site infection

3. Obtains orders for necessary flush medications, if appropriate

4. Reassures the patient and prepares for diagnostic procedure to determine cause of problem, if applicable

#### F. Documenting Findings and Patient Education

1. Documents all assessment findings and procedures

2. Evaluates the patient's and caregiver's education and response to teaching, including return demonstration of technical tasks and signs and symptoms of potential complications
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