

Central vascular access device complications

The nurse's role at each point of care

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Editor's note: This article was developed in partnership with the Infusion Nurses Society (ins1.org). The Infusion Therapy Standards of Practice, published in the Journal of Infusion Nursing (2016), were used as a guiding reference. Please see the September issue of American Nurse Today for an article on complications of peripheral vascular access devices.

APPROXIMATELY 5 million central vascular access devices (CVADs) are inserted into U.S. patients every year, and at least 85% of hospitalized patients receive some form of I.V. therapy. The widespread use of CVADs presents considerable challenges for nurses when managing associated complications.

Vascular access device (VAD) complications may delay treatment, damage vessels, limit options for future vascular access, cause pain and illness, decrease or impair quality of life, and increase morbidity and mortality, length of stay, and medical costs. All VAD types are subject to complications that may occur throughout the life of the device. Risk factors for CVAD-associated complications include disease state, concurrent infection, presence of immunosuppression or immunodeficiency, therapeutic regimen and type of infusate, prolonged hospitalization, and age-related or developmental-stage factors (such as fragile skin, changes in cognition/orientation, dexterity, and ability to communicate/learn) that might impact the ability to maintain and use the VAD safely.

The Infusion Nurses Society (INS) states that patient safety requires clinicians to be competent at recognizing signs and symptoms of VAD-related complications during insertion, management, and removal, and to intervene appropriately. This article presents an overview of CVAD terminology and common complications and discusses the nurse's role during insertion; care, use and maintenance; and discontinuation.

Terminology

Before managing CVAD complications, nurses must understand the relevant terminology.

Common CVADs

Peripherally inserted central catheters (PICCs) are inserted through arm or neck veins in adults and children; in infants, they may be inserted through scalp or leg veins.

Regardless of insertion site, the catheter tip is located in the superior or inferior vena cava, preferably at its junction with the right atrium.

Nontunneled CVADs can be vascular or nonvascular. They're inserted by puncture directly through the skin and into the intended location. None of the devices should remain in a subcutaneous tract.

Tunneled cuffed catheters have a segment of the catheter lying in a subcutaneous tunnel, where tissue grows into the cuff for securement. The skin and vein exit sites are separated by the tunnel.

Implanted vascular access ports are surgically placed in a vessel, body cavity, or organ attached to a reservoir located under the skin. They have no external lumen until it's accessed for use with a noncoring needle that has an integral extension set.

CVAD duration

The INS doesn't recommend a specific VAD dwell time duration. Instead, the Infusion Therapy Standards of Practice state:

- **Standard 44.2** VADs are removed if a complication can't be resolved, at discontinuation of infusion therapy, or when they're no longer deemed necessary.
- **Standard 44.3** VADs aren't removed based solely on length of dwell time because no known optimum dwell time exists.

Aseptic vs. sterile

Aseptic technique is a primary infection prevention method for keeping objects and areas free from micro-



LEARNING OBJECTIVES

1. Describe how to prevent central vascular access device (CVAD) complications.
2. Discuss how to manage CVAD complications.

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Insertion-related complications

During central venous access device (CVAD) insertion, nurses must recognize the risk factors, signs, and symptoms of complications and apply prevention and intervention measures.

Complication	Risk factors	Signs and symptoms	Prevention and interventions
Infection (bacteremia/septicemia)	<ul style="list-style-type: none"> Immunosuppression or immunodeficiency Severe chronic illness Multiple infusions Extended hospitalization Concurrent infection Leukopenia Age (very young or very old) Burns Femoral insertion site 	<ul style="list-style-type: none"> Fever Chills General malaise Headache Increased pulse rate Flushed face Backache Nausea Vomiting Hypotension 	<p>Prevention:</p> <ul style="list-style-type: none"> Perform hand hygiene before placement and interventions. Prepare workspace before performing aseptic technique. Perform skin antisepsis at insertion site and to surrounding skin. Maintain aseptic technique throughout insertion and dressing processes. Use maximal sterile barrier precautions during insertion. Disinfect needleless connectors before access using sterile alcohol wipes with or without chlorhexidine or a sterile alcohol cap. Maintain aseptic technique during all infusion therapy administrations and CVAD care. Remove the CVAD when it's no longer necessary. Change administration set and add-on devices at recommended intervals. Minimize the use of add-on devices. <p>Interventions:</p> <ul style="list-style-type: none"> Notify the provider if infection is suspected. If ordered, remove the catheter and culture to determine if it's the infection source. Obtain blood cultures as ordered. Administer antibiotics as ordered.
Catheter malposition	<ul style="list-style-type: none"> Failure to accurately verify anatomic location of catheter tip at insertion and before use Failure to adequately secure CVAD to prevent catheter movement 	<ul style="list-style-type: none"> Absence of blood return from all CVAD lumens Changes in blood color and pulsatility of blood return from all catheter lumens Difficulty with flushing or inability to flush CVAD Arterial and ventricular arrhythmias Blood pressure and/or heart rate changes Shoulder, chest, or back pain Edema in neck or shoulder Respiration changes Patient reports hearing a gurgling sound on the ipsilateral side Paresthesia and neurologic effects due to retrograde infusion into intracranial venous sinuses 	<p>Prevention:</p> <ul style="list-style-type: none"> Use tip location technology during insertion procedure, obtain a chest x-ray, or view tip location under fluoroscopy. <p>Interventions:</p> <ul style="list-style-type: none"> Notify the provider of signs or symptoms associated with a malpositioned CVAD; anticipate diagnostic tests to verify catheter tip termination. Provide the radiology department with clinical assessment information such as changes in blood pressure, heart rate, or respirations to enhance the ability to identify the problem. Don't infuse through the malpositioned CVAD until a proper tip position has been established. Obtain alternative vascular access if the infusion therapy can't be stopped or delayed.
Nerve injury	<ul style="list-style-type: none"> Failure to avoid venipuncture sites associated with nerve injury risk: <ul style="list-style-type: none"> at or above the antecubital fossa (median antecubital interosseous nerve) antecubital fossa lateral and medial antebrachial nerves subclavian and jugular sites (brachial plexus nerve) 	<ul style="list-style-type: none"> Immediate sharp pain at venipuncture site Sharp shooting pain up or down arm Sensation of pain that changes in severity depending on needle position Paresthesia in hand or fingertips 	<p>Prevention:</p> <ul style="list-style-type: none"> Know the anatomic position of veins, arteries, and nerves used for CVAD insertion. Recognize that anatomic variations in these structures are common and can be complex, increasing the risk of temporary or permanent nerve injury during CVAD insertion. Avoid probing with the needle during cannulation attempts. <p>Interventions:</p> <ul style="list-style-type: none"> Stop the insertion procedure immediately. Remove the CVAD. Notify the provider. Collaborate with the provider for rapid interventions that may reduce the risk of permanent injury. <ul style="list-style-type: none"> Interventions may include elevation and/or thermal compresses. Fasciotomy may be indicated. Consultation with a surgeon may be required.

Source: Alexander et al. 2014

organisms using sterile supplies, barriers, and absolute separation of items that are sterile from those that aren't. Dressing changes are performed using aseptic technique.

Sterile means that an environment is free from living organisms. It's achieved by destroying both good and bad organisms. Although the method used for dressing changes is often referred to as "sterile technique," this is a misnomer because a patient's skin can't be sterilized.

Insertion complications

Common insertion-related CVAD complications include infection, catheter malposition, and nerve injury. Patient disease state and physical condition may increase risk factors for complications, but with swift recognition and intervention, nurses can help prevent further patient harm. (See *Insertion-related complications*.)

Infection

Infection is perhaps the most prevalent, yet preventable, CVAD complication. Infections may be localized at the CVAD site or be systemic. To prevent these complications, CVAD insertion must be performed by a skilled clinician who adheres to infection prevention protocols including using a central line bundle with the following interventions:

- Perform hand hygiene before and at appropriate intervals during the procedure.
- Perform skin antisepsis using > 0.5% chlorhexidine in alcohol solution (use chlorhexidine with caution in premature infants or those under 2 months; consider using povidone-iodine instead).
- Use maximal sterile barrier precautions.
- Avoid the femoral vein as an insertion site in adults.

A second clinician trained in CVAD insertion must observe the procedure and complete a standardized checklist. The observer's roles and responsibilities include stopping

the insertion if aseptic technique is breached.

Malposition

CVAD malposition occurs when the catheter tip is located in an aberrant position and no longer located in the original vena cava or cavoatrial junction. Malpositions are categorized as extravascular (catheter tip is located outside of the vein in nearby anatomic structures such as mediastinum, pleura, pericardium, or peritoneum) or intravascular (catheter tip is located in a suboptimal or aberrant position inside a

The nurse should assess the CVAD site visually to observe skin color and comparative extremity size and use palpation to detect swelling, warmth, pain, tenderness, and drainage.

vein). Intravascular CVAD malpositions are further categorized as either primary or secondary. Primary CVAD malposition occurs during the insertion procedure; secondary CVAD malposition may occur at any time during the catheter dwell time and is commonly referred to as tip migration. Using visualization technologies may prevent primary CVAD malposition.

Nerve injury

Nerve injuries during CVAD insertion frequently are attributed to inadvertent puncture of nerve structure near the insertion site or along the intended catheter tract. Clinicians should be aware of this po-

tential complication and respond immediately if the patient complains of unusual pain or discomfort during insertion. Prompt intervention can mitigate or prevent permanent nerve damage. Collaborate with the patient's provider to determine the best intervention.

Care, use, and maintenance complications

CVADs must be regularly assessed for local complications, the most common of which are air embolism, bacteremia and septicemia, occlusions, venous thrombus, phlebitis, and catheter malposition. The nurse should assess the CVAD site visually to observe skin color and comparative extremity size and use palpation to detect swelling, warmth, pain, tenderness, and drainage. To identify systemic complications, the nurse should assess the patient for changes in temperature, heart rate, blood pressure, and patient reports of unusual discomfort, pain, or sensation. The CVAD must be assessed for patency, integrity and function, and malposition or migration. (See *Care, use, and maintenance complications*.)

Air embolism

Although primarily associated with CVAD discontinuation, air embolism can occur during care, use, and maintenance (for example, inadvertent disconnection of the administration set, failure to remove air from the set before use, or catheter fracture). Air embolism occurs when a bolus of air enters the vascular system, creating an intracardiac airlock at the pulmonic valve and preventing blood ejection from the right side of the heart. The force of right ventricular contractions increases, and small air bubbles break loose and enter the pulmonary circulation, obstructing forward blood flow, which results in tissue hypoxemia.

Bacteremia and septicemia

Bacteremia (microorganisms in the

Care, use, and maintenance complications

During central venous access device (CVAD) care, use, and maintenance, nurses must recognize the risk factors, signs, and symptoms of complications and apply prevention and intervention measures. Catheter malposition also can be a complication during CVAD care, use, and maintenance. (See *Insertion-related complications*.)

Complication	Risk factors	Signs and symptoms	Prevention and interventions
Air embolism (not associated with discontinuation)	<ul style="list-style-type: none"> Use of administration sets or add-on devices without Luer lock connectors Failure to tighten Luer lock connectors on preconnected administration sets Use of infusion pumps without functioning air-in-line detectors Inadvertent disconnection of CVAD from needleless connector or administration set without closing clamp 	<ul style="list-style-type: none"> Sudden onset of dyspnea Coughing Chest pain Hypotension Tachyarrhythmias Wheezing Tachypnea Altered mental status Altered speech Changes in facial appearance Numbness Paralysis A loud continuous churning sound heard over precordium during auscultation 	<p>Prevention:</p> <ul style="list-style-type: none"> Maintain a closed system and ensure that connectors are tightened on all segments of the administration set. Ensure syringes contain intended fluid to prevent inadvertent injection of air into a port. Don't allow solution container on the pump to empty without automatic shut-off. Don't use infusion pumps without air-in-line safety alarms. Prime all administration and extension sets to remove air from the system before use. Ensure the CVAD is securely clamped when disconnecting and reconnecting a new administration set, needleless connector, or other add-on device. <p>Interventions:</p> <ul style="list-style-type: none"> Immediately place the patient on his or her left side with the head lower than the heart. Identify the cause and quickly prevent additional air from entering the circulation by closing the breach in the administration set and/or stopping the infusion pump. Immediately notify the provider. Administer oxygen. Check the patient's vital signs, oxygen saturation, and cardiac rhythm.
Infection (bacteremia/septicemia)	<ul style="list-style-type: none"> Immunosuppression or immunodeficiency Severe chronic illness Administration of multiple infusions Extended hospitalization Concurrent infection Leukopenia Age (very young or very old) Burns 	<ul style="list-style-type: none"> Fever Chills General malaise Headache Increased pulse rate Flushed face Backache Nausea Vomiting Hypotension 	<p>Prevention:</p> <ul style="list-style-type: none"> Perform hand hygiene before CVAD placement and before providing CVAD-related interventions. Disinfect needleless connectors before access using a sterile alcohol wipe with or without chlorhexidine or a sterile alcohol cap. Maintain aseptic technique during all infusion therapy administrations and CVAD care. Remove the CVAD when it's no longer necessary. Change the administration set and add-on devices at recommended intervals. Minimize the use of add-on devices. <p>Interventions:</p> <ul style="list-style-type: none"> Notify the provider if an infection is suspected. If ordered, remove the catheter and culture to determine if it's the infection source. Obtain blood cultures as ordered. Administer antibiotics as ordered.
Catheter embolism	<ul style="list-style-type: none"> Catheter placement at site of flexion without joint stabilization device Catheter defect Use of scissors or other sharp implements near the catheter Catheter rupture from forced injection (flushing forcefully when occluded or power injection for computed tomography scans) 	<ul style="list-style-type: none"> Symptoms vary depending on location of catheter fragment but may include cyanosis, dyspnea, chest pain, hypotension, tachycardia, increased central venous pressure, fainting, or loss of consciousness Upon removal of the CVAD, tip fragmentation noted or entire catheter not intact 	<p>Prevention:</p> <ul style="list-style-type: none"> Inspect the catheter for defects before insertion. Prohibit reinsertion of over-the-needle catheters (pulled backward then advanced forward), which can pierce or sever the catheter. Avoid using scissors or other sharp implements near the catheter. Don't forcefully flush an occluded catheter. <p>Interventions:</p> <ul style="list-style-type: none"> Immediately notify the provider. Monitor the patient for level of consciousness, blood pressure, pulse oximetry, pain, heart rate, and cyanosis. Prepare the patient for radiography and surgery if necessary.
Occlusion	<ul style="list-style-type: none"> Allowing solution container to completely empty Inadequate flushing when administering medications, drawing blood, or locking the CVAD Administration of incompatible medications Kinked catheter or administration set 	<ul style="list-style-type: none"> Sluggish infusion or flushing Inability to infuse or flush Inability to obtain a blood return 	<p>Prevention:</p> <ul style="list-style-type: none"> Assess patency of the CVAD regularly. Follow the organization's flushing and locking guidelines. Ensure that incompatible infusates aren't administered through the same catheter without adequate flushing between each instillation. Act promptly to perform catheter clearance on sluggish or occluded catheters. <p>Interventions:</p> <p>Evaluate/identify cause of the occlusion.</p> <ul style="list-style-type: none"> Mechanical: <ul style="list-style-type: none"> External: tight suture, catheter clamped, clamp not attached correctly, kinked tubing, filter obstruction Internal: catheter malposition, kinked catheter, pinch-off syndrome (see table on page 7 for definition) Nonthrombotic: lipid buildup for patients receiving 3-in-1 parenteral nutrition admixtures, drug precipitate

Care, use, and maintenance complications

Complication	Risk factors	Signs and symptoms	Prevention and interventions
			<ul style="list-style-type: none"> • Thrombotic: the most common occlusion type due to fibrin buildup, thrombosis within the catheter lumen or surrounding catheter tip (intraluminal occlusion or fibrin sheath/tail) • Manage/treat the occlusion. • Instill the appropriate catheter-clearance agent (precipitate clearing or de clotting agent) for nonthrombotic and thrombotic occlusions. • Correct mechanical occlusions by changing filters, removing catheter kinks, unclamping catheter, or removing sutures and replacing with an engineered catheter-stabilization device.
Site infection	<ul style="list-style-type: none"> • Poor hand hygiene • Break in aseptic technique during dressing change • Use of contaminated equipment • Inappropriate catheter securement 	<ul style="list-style-type: none"> • Pain, swelling, and/or inflammation at insertion site • Discolored tissue of surrounding area; purulent drainage may be present 	<p>Prevention:</p> <ul style="list-style-type: none"> • Perform hand hygiene as directed in organization's policy. • Maintain a clean, dry, and intact CVAD dressing. • Maintain aseptic technique during dressing change. • Maintain a closed infusion system. • Assess the CVAD site regularly for warmth, redness, drainage, and pain. • Assess the patient for signs of infection, such as elevated temperature. <p>Interventions:</p> <ul style="list-style-type: none"> • Notify the provider if infection is suspected. • If ordered, remove the catheter and culture it to determine if it's the source of the infection. • If there's drainage at the site, obtain a culture before removing the catheter. • Initiate anti-infective therapy as ordered.
Infiltration/extravasation	<ul style="list-style-type: none"> • Failure to stabilize CVAD adequately • Large-gauge catheter • Patient age (very young or very old), medical condition, and acuity • Administration of irritating infusate • Inadequate CVAD insertion technique • Inadequate care and maintenance practices • Multiple manipulations of infusion delivery system • Extravascular catheter tip location • Damage to intima of the vein • Erosion of vessel by catheter • Thrombus formation around catheter • Catheter migration out of vessel 	<ul style="list-style-type: none"> • Swelling in chest, neck, or extremity with CVAD • Pain, burning, stinging during infusion • Changes in skin color, blanching, bruising, or redness on extremity with CVAD • Tight feeling, taut skin • Changes in skin temperature on extremity with CVAD • Numbness, tingling • Fluid leaking from insertion site • Slow capillary refill • Impaired ability to move fingers, hand, or extremity • Blisters 	<p>Prevention:</p> <ul style="list-style-type: none"> • Stabilize catheter to prevent movement at the insertion site. • Assess the catheter patency before and during medication administration. • Compare the insertion site extremity size with the same area on the opposite side. • Assess the patient for pain. • Use the smallest catheter possible to accomplish the intended therapy. <p>Interventions:</p> <ul style="list-style-type: none"> • Stop infusion immediately if infiltration/extravasation is suspected. • Aspirate fluid from the catheter with a small syringe. • Remove the catheter as directed. • Elevate the extremity and apply heat as appropriate. • Instill an antidote (sodium thiosulphate, dexrazoxane, phentolamine, hyaluronidase) when warranted and as ordered by the provider. • Observe and assess the site for other complications, such as compartment syndrome, nerve injury, blisters, and tissue necrosis.
Loss of skin integrity	<ul style="list-style-type: none"> • Patient has fragile skin due to age (very young or very old), disease state, or medication regimen • Patient is sensitive or allergic to glue or skin-preparation agents used during vascular access and dressing 	<ul style="list-style-type: none"> • Redness • Excoriation • Blisters • Weeping 	<p>Prevention:</p> <ul style="list-style-type: none"> • Allow antiseptic and skin-preparation agents to dry completely before placing dressings. • Follow the manufacturer's instructions on all dressing supplies. • Check for allergies or sensitivities to dressing and skin-preparation agents before use. • Use a skin-barrier solution to reduce the risk of medical-adhesive-related skin injury. <p>Interventions:</p> <ul style="list-style-type: none"> • Consult the provider and/or wound and skin care specialist. • Consider using dressing supplies manufactured for sensitive skin.
Phlebitis: Mechanical, chemical, bacterial	<p>Mechanical</p> <ul style="list-style-type: none"> • Inappropriate site selection (area of flexion) • Inadequate vein size for catheter gauge • Inadequate securement • Traumatic insertion <p>Chemical</p> <ul style="list-style-type: none"> • Rapid rate infusion • Particulate matter • Extended catheter dwell time 	<ul style="list-style-type: none"> • Erythema at access site with or without pain • Pain at access site with erythema or edema • Streak formation • Palpable venous cord • Purulent drainage 	<p>Prevention:</p> <ul style="list-style-type: none"> • Don't place CVAD in an area of flexion without joint stabilization. • Select a catheter gauge appropriate for the vein diameter. • Adhere to aseptic techniques for insertion, care, use, and maintenance. • Secure the catheter with an engineered stabilization device. • Use caution with infusion rates and potential irritants. • Administer properly diluted medications. <p>Interventions:</p> <ul style="list-style-type: none"> • Initiate prompt removal of the CVAD as ordered if the vessel is warm to the touch, painful, or red or has a palpable cord. • Use a standardized phlebitis assessment tool.

Care, use, and maintenance complications

Complication	Risk factors	Signs and symptoms	Prevention and interventions
	<ul style="list-style-type: none"> Irritating medications and solutions Medications improperly mixed or diluted <p>Bacterial</p> <ul style="list-style-type: none"> Poor hand hygiene Poor aseptic technique when preparing venipuncture site Poor catheter insertion technique Inadequate catheter securement 		<ul style="list-style-type: none"> Consult the provider if phlebitis is suspected. Apply a thermal compress to the phlebotic area for 20 minutes three to four times per day with a provider's order. Chemical: Evaluate the infusion therapy and the need for different vascular access or a slower rate of infusion; determine if catheter removal is needed. Mechanical: Stabilize the catheter, apply heat, elevate the extremity, and monitor for 24 to 48 hours; if signs and symptoms persist after 48 hours, consider removing the catheter. Bacterial: If bacterial infection is suspected, remove the catheter as ordered.
Venous thrombosis	<ul style="list-style-type: none"> History of deep vein thrombosis Presence of chronic diseases associated with hypercoagulable state Surgical and trauma patients Critical care patients Fluid volume deficit History of multiple CVADs 	<ul style="list-style-type: none"> Pain in extremity with CVAD, shoulder, neck, or chest Edema in the extremity, shoulder, neck, or chest Erythema in extremity Engorged peripheral veins on the extremity, shoulder, neck, or chest wall Difficult movement of neck or extremity 	<p>Prevention:</p> <ul style="list-style-type: none"> Ensure the catheter tip is in the superior vena cava at the cavoatrial junction for adults and pediatric patients with upper-body insertion sites. For lower-body insertion sites (pediatric patients and adults, when applicable), the catheter tip should be located in the inferior vena cava above the level of the diaphragm. Use the smallest-diameter catheter possible to accomplish the intended therapy. <p>Interventions:</p> <ul style="list-style-type: none"> Notify the provider if thrombus is suspected. Obtain radiographic studies to confirm catheter placement and the presence of a thrombus. Initiate anticoagulant or thrombolytic therapy as ordered.

Source: Alexander et al. 2014

blood as identified by positive blood cultures) is considered catheter-related when the same organisms are isolated from both the catheter and the blood. Most catheter-related bloodstream infections are considered preventable. Prevention measures include performing hand hygiene before and after conducting interventions; disinfecting needleless connectors with alcohol wipes, alcohol chlorhexidine wipes, or alcohol caps before accessing; maintaining aseptic technique during all infusion therapy administrations and during all CVAD dressing changes; changing administration sets and add-on devices at appropriate intervals; maintaining a closed infusion system; and discontinuing CVADs when they're no longer necessary.

Occlusion

CVAD occlusions, which may increase the risk of catheter-related infection, are defined as partial or complete obstructions of the catheter lumens that restrict blood aspiration or fluid injection into the catheter. Occlusions may occur in response to catheter twisting or kinking, medication precipitate, the

presence of a fibrin sheath, thrombus at the catheter tip, or positioning against the vessel wall. Interventions for catheter clearance should be performed as soon as possible when an occlusion is detected.

Venous thrombus

Although the CVAD is the primary contributing factor in catheter-related venous thrombosis, other multifactorial conditions may contribute, including the presence of a chronic disease that creates a hypercoagulable state, genetic abnormalities affecting coagulation factors, immobility, pregnancy, surgery, a history of multiple CVAD use, and age-related factors associated with the very young or very old.

Phlebitis

Phlebitis may be accompanied by pain, erythema, edema, streak formation, and/or a palpable cord. It's caused by endothelial cell inflammation of the vessel and classified as chemical (chemicals in the infusate), mechanical (presence of the catheter in the vessel, catheter movement, inadequate vein-to-

catheter ratio, or traumatic insertion), or bacterial (infection and inflammation affecting the vein wall).

Catheter malposition

As previously noted, CVAD malposition is the unintended placement of the catheter tip either internal or external to the vascular system. In CVADs, if the catheter tip doesn't terminate in the lower third of the superior vena cava, the catheter is considered malpositioned. Extravascular malposition may cause infiltration/extravasation of the infusate in the mediastinum, hemothorax or pleural effusion if in the pleura, or pericardial effusion or cardiac tamponade if in the pericardium. Catheter malpositioning may occur during insertion but can occur during the care, use, and maintenance phase as well.

Discontinuation complications

Primary complications associated with CVAD discontinuation are air embolism, excessive bleeding, insertion site infection, and catheter embolism (catheter embolism can occur when a portion of the catheter separates or breaks off and re-

Discontinuation complications

During central venous access device (CVAD) discontinuation, nurses must recognize the risk factors, signs, and symptoms of complications and apply prevention and intervention measures.

Complication	Risk factors (or causes)	Signs and symptoms	Prevention and interventions
Air embolism	<ul style="list-style-type: none"> • Inability to place patient in supine position during CVAD removal • Patient unable to perform Valsalva maneuver during CVAD removal • Failure to immediately place occlusive dressing after CVAD removal • Patient unable to lie flat for 30 minutes after CVAD removal 	<ul style="list-style-type: none"> • Sudden onset of dyspnea • Coughing • Chest pain • Hypotension • Tachyarrhythmias • Wheezing • Tachypnea • Altered mental status • Altered speech • Changes in facial appearance • Numbness • Paralysis • A loud continuous churning sound heard over precordium during auscultation 	<p>Prevention:</p> <ul style="list-style-type: none"> • Place patient in the supine position to ensure that the CVAD is at or below the level of the heart. • Have the patient perform the Valsalva maneuver unless contraindicated. • Apply digital pressure to the exit site until hemostasis is achieved. • Use an occlusive dressing. Apply a sterile gauze dressing with petroleum-based ointment to the exit site to seal the skin-to-vein tract. • Instruct the patient to lie flat for 30 minutes after removal. <p>Interventions:</p> <ul style="list-style-type: none"> • Immediately place the patient on his or her left side with the head lower than the heart. • Prevent additional air from entering the circulation by applying a sterile gauze dressing with petroleum-based ointment to the exit site to seal the skin-to-vein tract. • Immediately notify the provider. • Administer oxygen. • Check the patient's vital signs, oxygen saturation, and cardiac rhythm.
Catheter embolism (due to damage)	<ul style="list-style-type: none"> • Defective catheter • Reinsertion of needle during placement of over-the-needle catheter • Pinch-off syndrome* • Power injection in CVAD that isn't labeled for this use 	<ul style="list-style-type: none"> • Symptoms vary depending on location of catheter fragment, but may include palpitations, arrhythmias, dyspnea, cough, thoracic pain • Upon removal of the CVAD, tip fragmentation noted or entire catheter not intact 	<p>Prevention:</p> <ul style="list-style-type: none"> • Inspect the catheter upon removal and verify that the length is the same as at the time of insertion. • Prohibit reinsertion of over-the-needle catheters (pulled backward then advanced forward), which can pierce or sever the catheter. • Don't forcibly remove the CVAD against resistance. <p>Interventions:</p> <ul style="list-style-type: none"> • Immediately notify the provider if an embolism is suspected. • Place a tourniquet above the insertion site if the catheter breaks during removal. • Monitor the patient for distress.

*Pinch-off syndrome, although rare, occurs when the CVAD enters the costoclavicular space medial to the subclavian vein and is positioned outside the lumen of the subclavian vein in the narrow area bounded by the clavicle, first rib, and costoclavicular ligament. Catheter compression causes intermittent or permanent catheter occlusion and, because of the "scissoring" effect of catheter compression between the bones, can result in catheter tearing, transection, and catheter embolism.

Source: Alexander et al. 2014

mains in the patient after the CVAD is removed). Air and catheter embolism present the greatest risk for mortality or significant injury. Clinicians must be prepared to initiate emergency measures if necessary. Standard nursing protocol for all CVAD discontinuation must be followed to ensure patient safety. (See *Discontinuation complications*.)

Diligent nursing care

CVAD-associated complications are serious patient safety events that can prolong illness, cause permanent physical damage, increase healthcare costs, extend length of

stay, or lead to death. Diligent nursing assessment and intervention is instrumental at CVAD insertion, care, use, maintenance, and discontinuation to prevent and detect the onset of CVAD-associated complications and to initiate corrective action and therapeutic management when complications occur. ★

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1. When a peripherally inserted central catheter (PICC) is placed in an upper-body position, the tip should be located

- a. at the subclavian/ventricle junction.
- b. in the subclavian vein.
- c. at the cavoventricular junction.
- d. in the superior or inferior vena cava.

2. Which of the following vascular access devices (VADs) is accessed with a noncorriging needle?

- a. PICC
- b. Implanted vascular access port
- c. Nontunneled central VAD
- d. Tunneled, cuffed VAD

3. Which statement about the duration of a CVAD is correct?

- a. CVADs should be changed every 48 hours.
- b. CVADs should be changed every 72 hours.
- c. CVADs aren’t removed based solely on length of dwell time.
- d. CVADs are removed when the dressing needs to be changed.

4. Before a CVAD is inserted, skin antiseptics should be performed with

- a. povidone-iodine for patients between 12 and 18 years old.
- b. povidone-iodine for adult patients.
- c. > 0.25% chlorhexidine in alcohol solution for premature infants.
- d. > 0.5% chlorhexidine in alcohol solution for adults.

5. Which statement about nerve injury related to CVAD insertion is correct?

- a. The antecubital fossa is associated with a risk for nerve injury.
- b. If nerve injury is suspected, the catheter should be left in place for assessment.
- c. Probing to ensure proper vein location reduces the risk of nerve injury.
- d. Interventions for nerve injury may include elevation and/or cold compresses.

6. Use of administration sets or add-on devices with Luer lock connectors is a risk factor for

- a. catheter embolism.
- b. air embolism.
- c. occlusion.
- d. infiltration.

7. Appropriate management of mechanical phlebitis includes

- a. stabilizing the catheter.
- b. applying a cold compress.
- c. placing the extremity in a dependent position.
- d. monitoring for 72 to 96 hours.

8. Which statement about discontinuing a CVAD is correct?

- a. The patient should perform the Valsalva maneuver unless contraindicated.
- b. Apply a nonocclusive dressing after the catheter is removed.
- c. Be sure to have the CVAD above the level of the heart before removal.
- d. Have the patient lie flat for 10 minutes after removal.

9. If the CVAD catheter breaks when it’s being removed, you should

- a. apply a nonocclusive dressing to the insertion site.
- b. apply a warm compress to the insertion site.
- c. place a tourniquet below the insertion site.
- d. place a tourniquet above the insertion site.

10. After CVAD is removed, your patient experiences signs and symptoms of air embolism. Fortunately, you know that you should immediately place the patient

- a. on his or her right side with the head lower than the heart.
- b. on his or her left side with the head lower than the heart.
- c. on his or her left side with the head higher than the heart.
- d. on his or her back with the head lower than the heart.

11. All of the following interventions for suspected infiltration/extravasation are correct except:

- a. Elevate the extremity.
- b. Stop the infusion immediately.
- c. Aspirate fluid from the catheter with a large syringe.
- d. Instill an antidote when warranted and ordered by the provider.

12. A risk factor for chemical phlebitis is

- a. poor catheter insertion technique.
- b. irritating medications and solutions.
- c. inadequate securement of the device.
- d. inadequate vein size for catheter gauge.