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Peripheral IV Catheter (PIVC) Excellence

User guide/navigational tips

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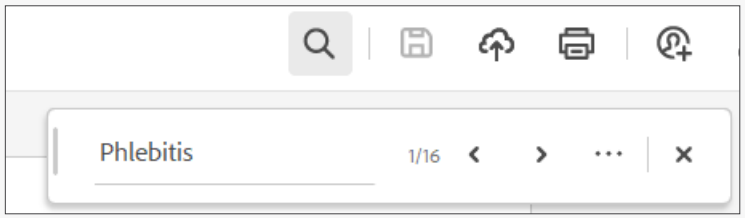
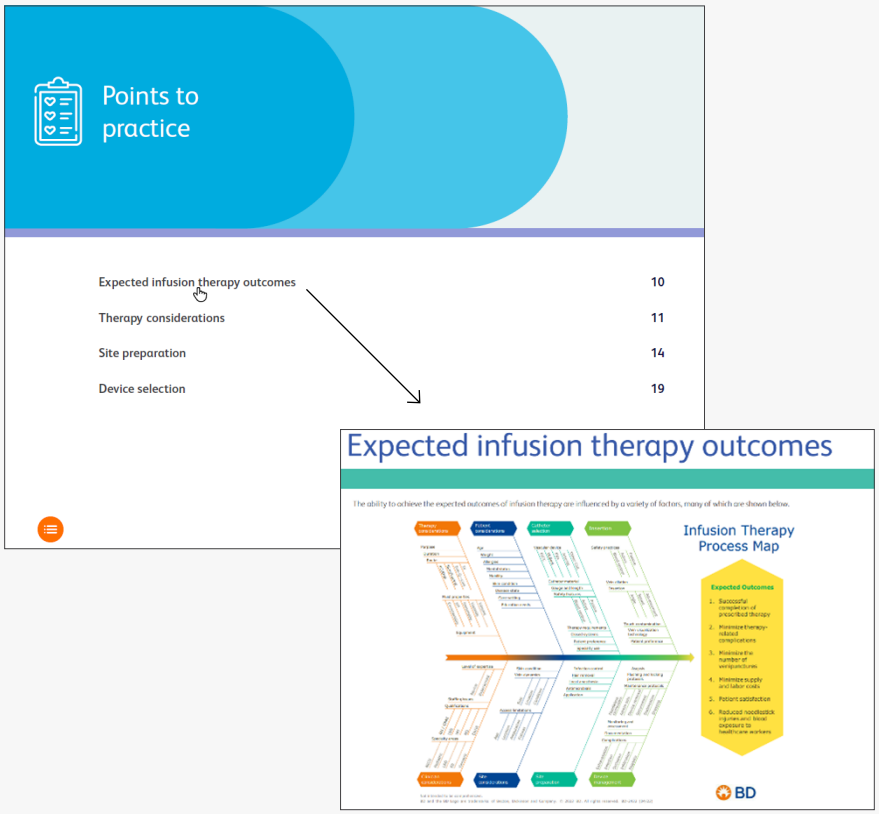
That means that searching for the information you need has never been easier!

You can use key word searches to target topics for quick reference (ex. Phlebitis – Infusate – Hemodilution – Securement – Infiltration – Extravasation – Irritant – Vesicant – Venipuncture – Flush – Occlusion – Dislodgement – CABSI – Infection).



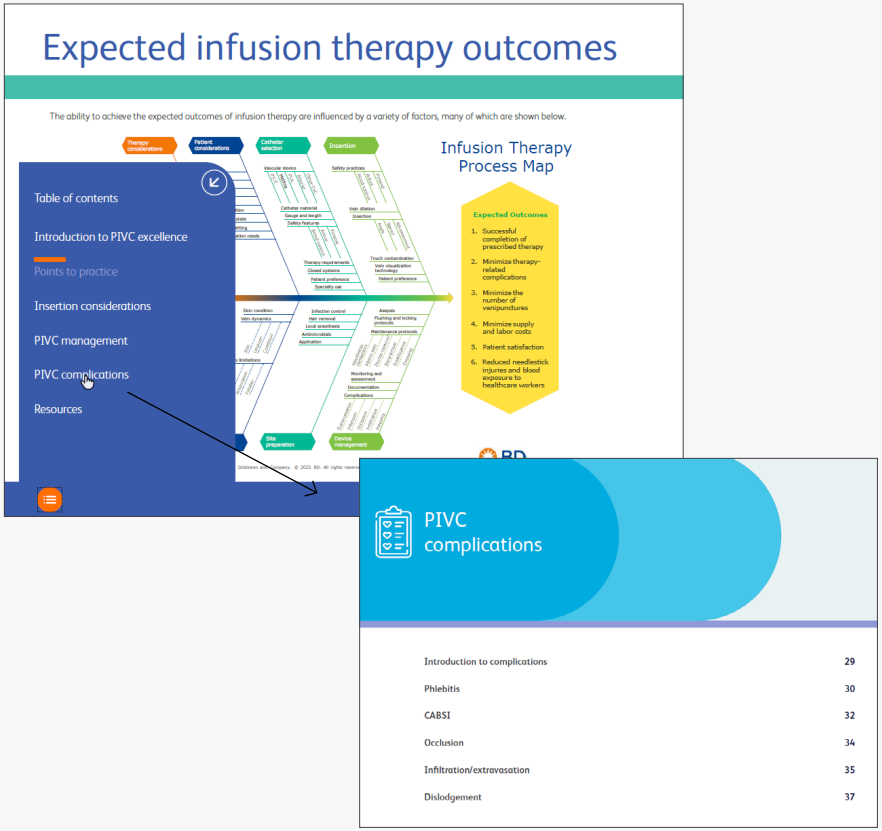
You can also jump to scroll through the table of contents and jump into each section for additional information about the topics there.

The index of each section will allow you to hone your search by digging into individual topics that are covered in the section.



User guide/navigational tips (cont'd)

Navigate to other sections of the **PIVC Excellence PDF** at any time through the table of contents by opening this menu in the lower left-hand corner of the page you're on.



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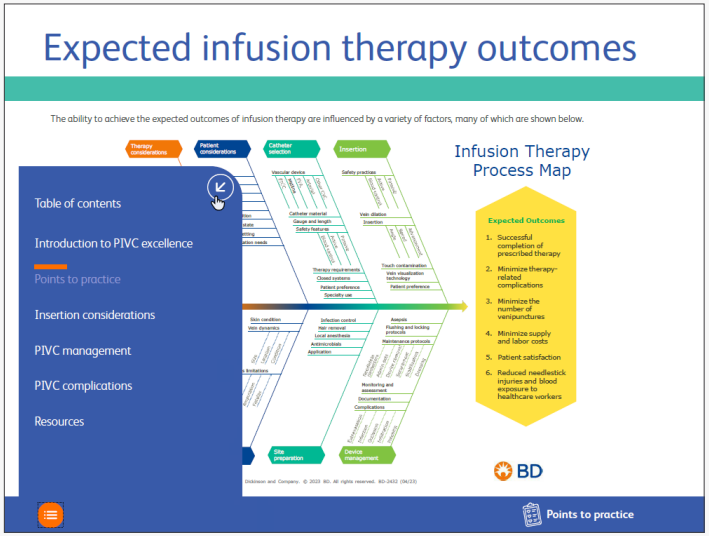

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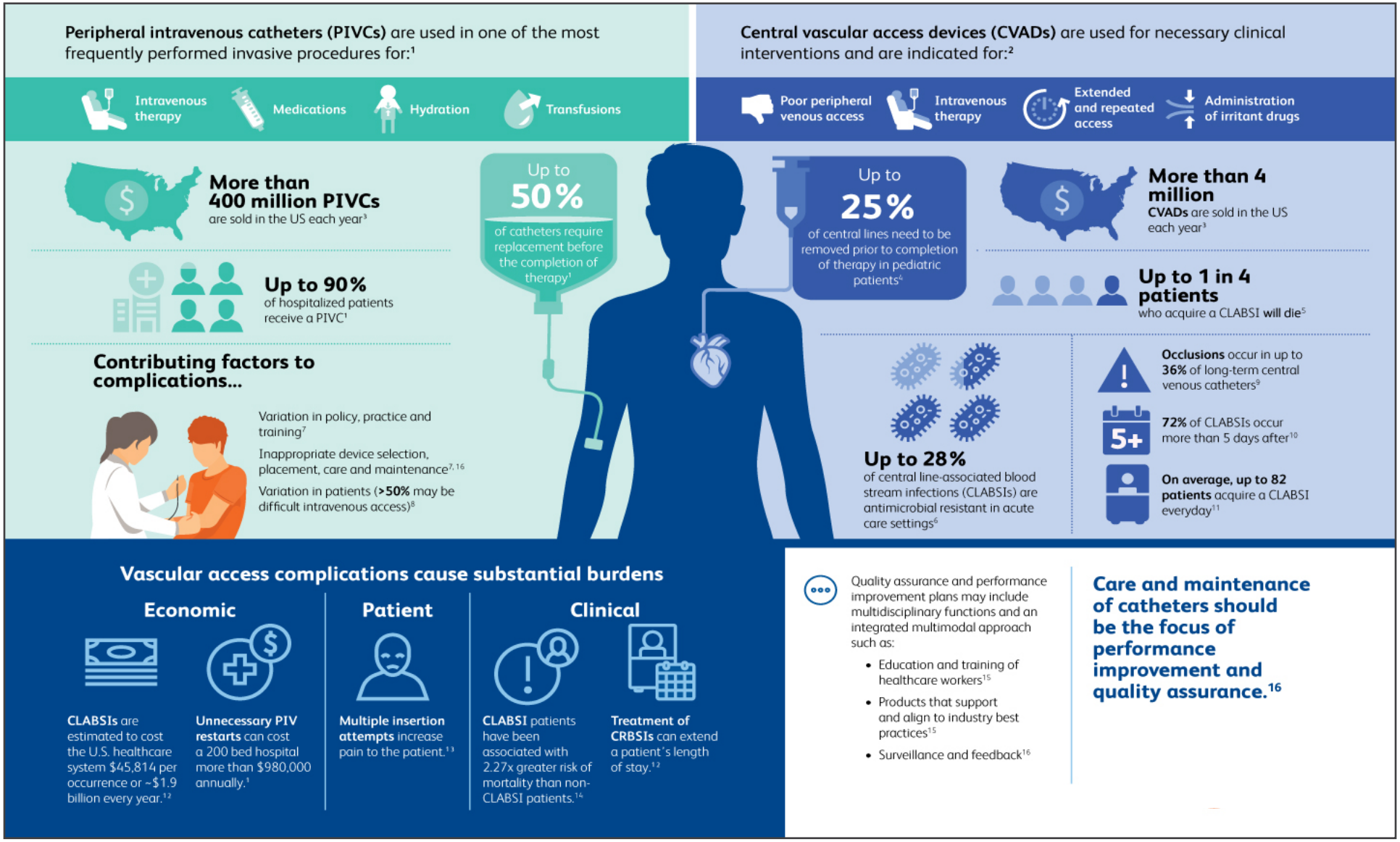
Challenges of vascular access



The burden of PIVC insertion failure

Risk factors

contributing to PIVC insertion failure in adult and pediatric populations include:

- **Patient** — Age, skin/vein characteristics
- **Procedural** — Insertion site and catheter gauge
- **Clinician/Operator expertise**[17]

Repeated PIVC insertion attempts can negatively impact **three key areas** of the healthcare system: clinical, economic and patient experience.

Three areas of impact

1 Clinical Impact

First-attempt insertion failure occus up to:

- **26%** adults[17]
- **54%** pediatrics[17]
- **55%** neonatal[18]

Attempts per successful IV insertion occurs up to:

- **1.6** adults[19]
- **2.1** pediatrics[20]

Repeated attempts can lead to:

- Vessel trauma[21]
- Venous depletion[21]
- Increased risk of catheter failure[21]

Less experienced/confident nurses and clinicians can:

- Be fearful of the risks of puncturing arteries or nerves[22]
- Lead to first time insertion failure[23]

2 Economic impact

First-attempt insertion failure can lead to increased costs.

- **$28-$35** per adult insertion[21]
- **$43-$47** per pediatric insertion[20]

Failure to insert a PIVC on the first attempt increases procedural time.[24]

3 Patient impact

Adult patients and caregivers of pediatric patients report that inadequate insertion competency impacted patient well-being, especially with multiple insertion attempts.[25]

Each IV insertion can result in:

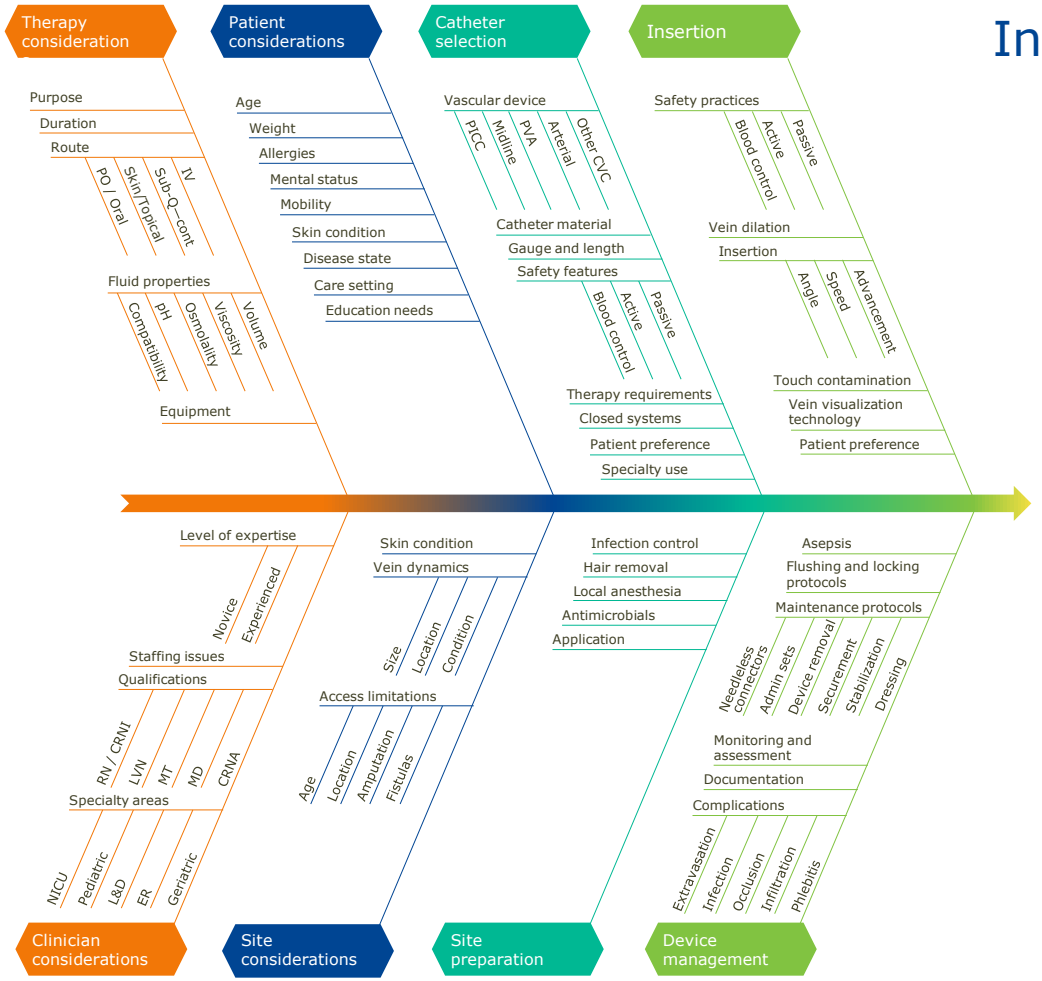
- Heightened anxiety[26–29]
- A sense of vulnerability[26]
- Great pain[27–30]

Reducing PIVC insertion attempts through proper strategies and techniques is paramount to PIVC success rates and patient care.

Points to practice

Expected infusion therapy outcomes

The ability to achieve the expected outcomes of infusion therapy are influenced by a variety of factors, many of which are shown below.



Infusion Therapy Process Map

Expected Outcomes

1. Successful completion of prescribed therapy
2. Minimize therapy-related complications
3. Minimize the number of venipunctures
4. Minimize supply and labor costs
5. Patient satisfaction
6. Reduced needlestick injuries and blood exposure to healthcare workers

Not intended to be comprehensive.

Therapy considerations

Infusate considerations

Knowledge regarding medications and solutions to be administered through the PIVC, their purpose, properties, duration and potential complications can lead to informed decisions and influence expected outcomes.

When considering the therapies to be administered through a PIVC, clinicians should ask:

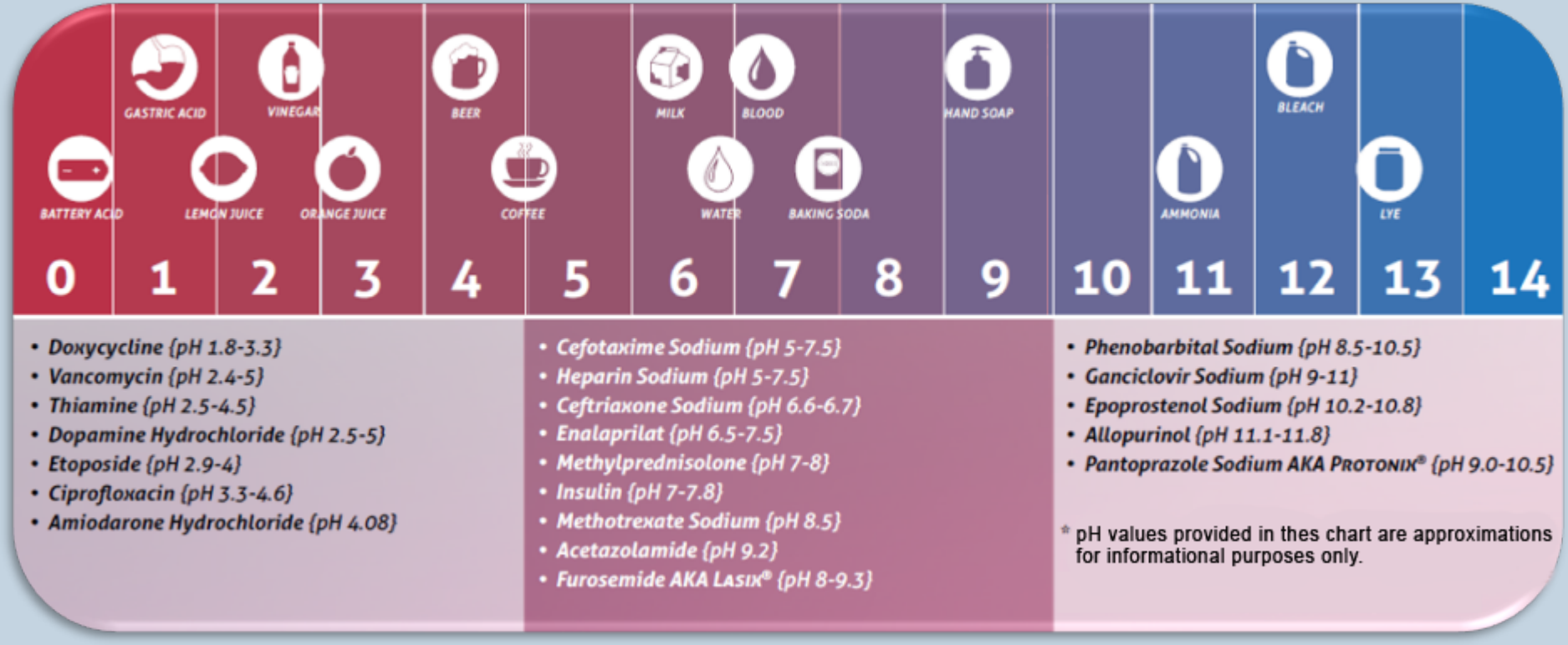
- How many medications and solutions are prescribed?
- Are they compatible with one another?
- What are the chemical properties of the infusates (pH and osmolarity)?
- How often will they be administered? How quickly do they need to be administered?
- Do they require any special equipment (e.g., power injector, filter, etc.)?

Consider the pH of an infusion therapy:

- Normal serum pH falls between 7.35–7.45.[35]
- pH of infusates can vary widely between very acidic and very basic. [35]
- The farther the pH of an infusate is from normal serum pH, the greater the risk of complications when that infusate is administered through a PIVC.[31]

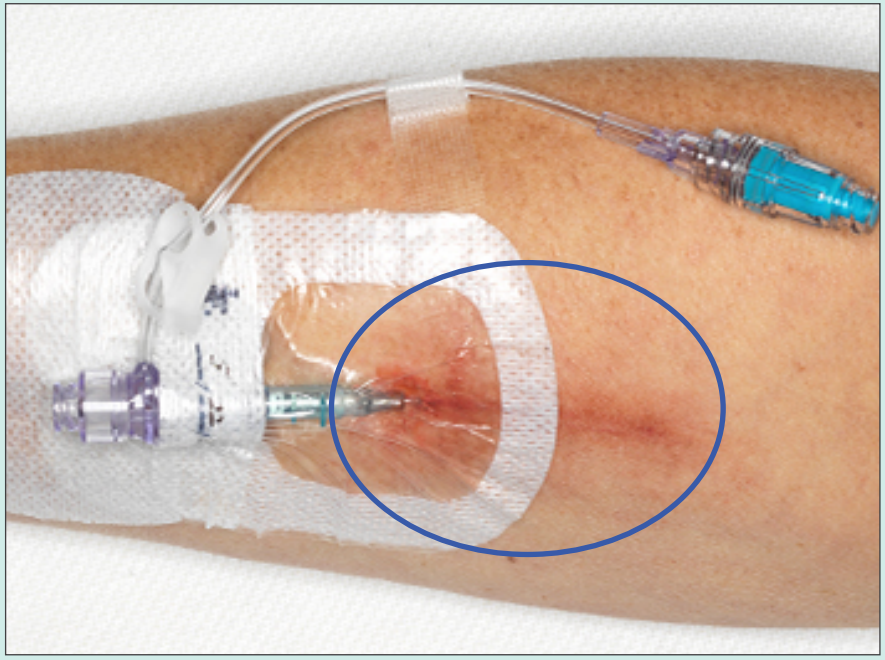
Consider the osmolarity of an infusion therapy:

- The concentration of solutes in solution is written as mOsm/L.
- Normal serum osmolarity (use osmolarity when describing fluids within the body) is 280–295 mOsm/L.[35]
  - A perfect isotonic solution will be 280–295 mOsm/L.
  - A near isotonic solution is between 240 and 450 mOsm/L.
- The farther the osmolarity of an infusate is from normal serum osmolarity, the greater the risk of complications when that infusate is administered through a PIVC.[32]



Many drugs and solutions can be damaging to the venous endothelium irrespective of their osmolarity or pH.

Irritant drugs and solutions can cause itching, phlebitis, or reaction along the vessel.[33]



Vesicant drugs can cause blistering, tissue sloughing, or necrosis when they escape from the normal vascular pathway.[34]

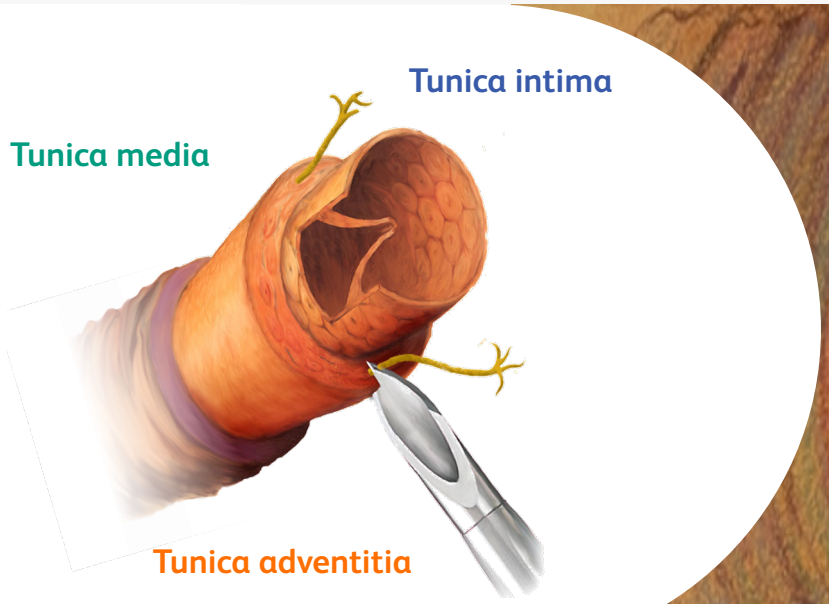
Site selection

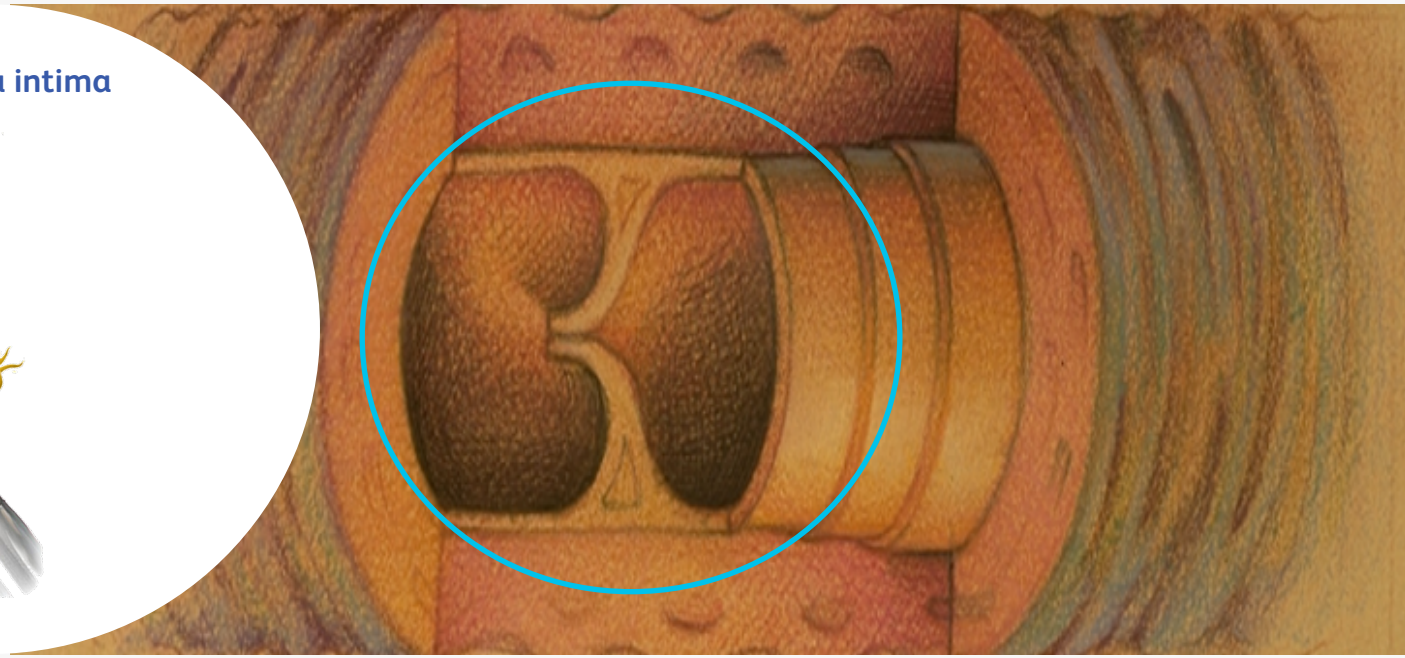
Anatomy of the vein

The vein is made up of three layers of tissues and fibers:

- The **tunica intima**, or inner layer, has a **smooth, elastic endothelial lining**, **allowing blood to easily flow** through the vein.
- The **tunica media**, or middle layer, is comprised of **smooth muscle and elastic tissue, allowing the vein to get wider or narrower** as blood passes through.
- The **tunica adventitia**, or outer layer, which is made up of **fibrous connective tissue, provides structure to the vein** and helps shape it.

The **valves** prevent the backward flow of blood and are formed by the tunica intima. They can prevent catheter advancement and may prevent blood withdrawal. Damage to the valves increases risk of thrombus formation.

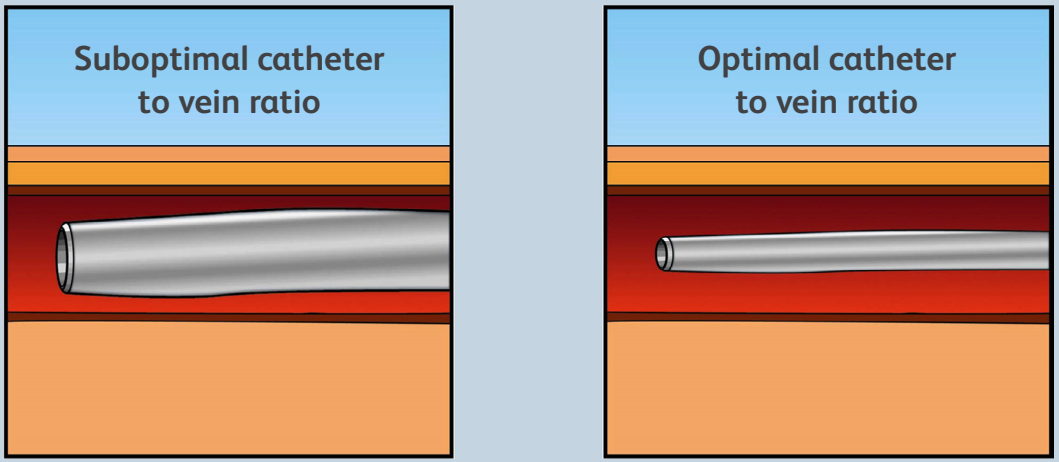


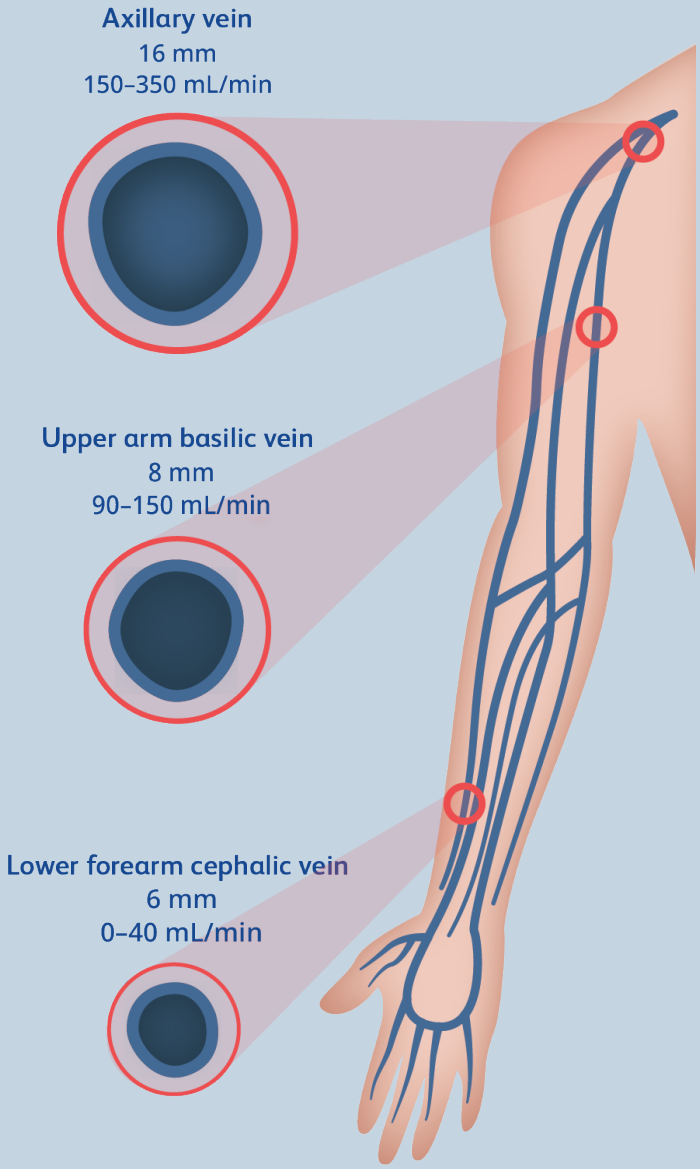


Hemodilution

Hemodilution refers to the ability of blood to flow around the catheter at a sufficient rate to disperse infusates quickly and to prevent venous stasis. The larger the catheter diameter or the smaller the vein diameter, the less blood will be able to flow around it. This can cause complications due to the increased risk for coagulation and clot formation as well as the potential for caustic infusates to stay in one place for longer and cause irritation or degradation of the vessel wall.

You can help prevent these complications by selecting a vessel large enough to accommodate the device required for therapy, and by choosing a device with a small enough gauge to allow appropriate hemodilution in the target vein, as shown in the second image below.[35]





Peripheral vasculature[36]

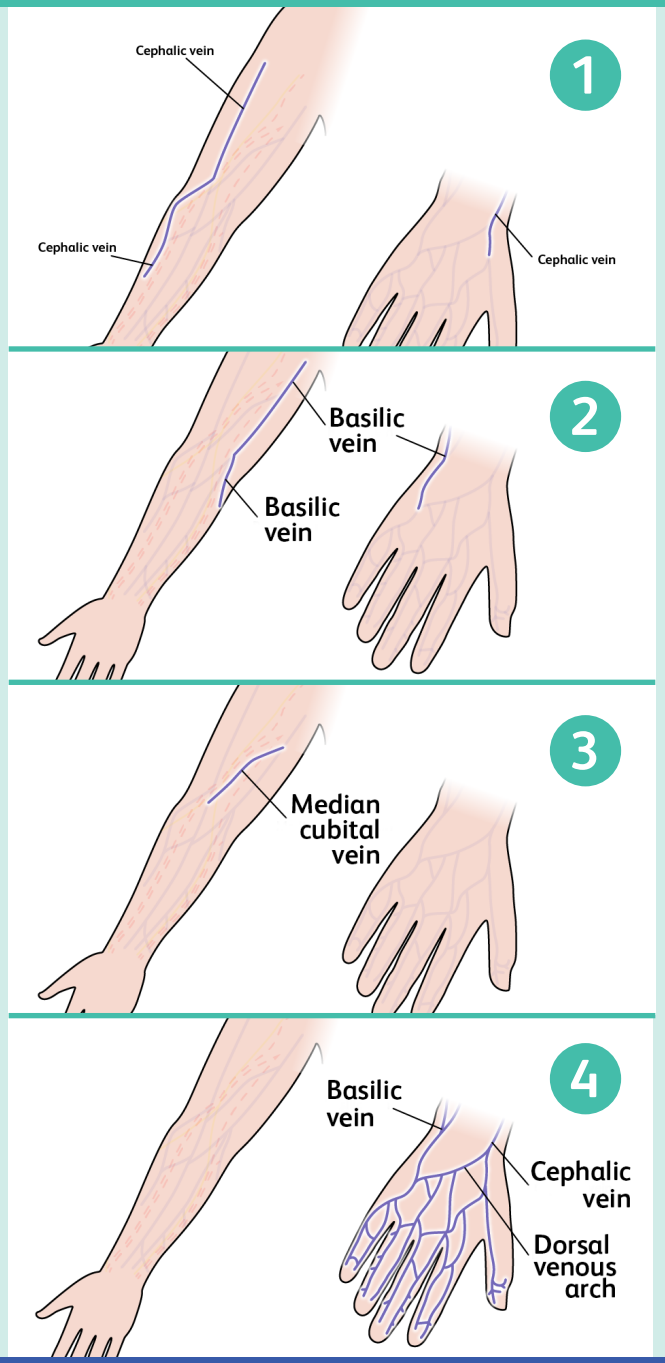
The veins of the hand and arm are generally used for peripheral IV catheter insertion. The forearm has increased likelihood of lasting the full length of therapy. Review the following commonly used insertion sites.

1. **Cephalic vein:** The cephalic vein is a superficial vein that begins in the hand and ascends the outer side of the arm. Use caution at the radial wrist and at or above the antecubital fossa to avoid the risk of nerve damage.

2. **Basilic vein:** The basilic vein begins in the hand and ascends the inner side of the arm. It is superficial up to halfway through the upper arm, where it becomes a deep vein. Use caution at or above the antecubital fossa to avoid the risk of nerve damage.

3. **Median cubital vein:** The median cubital vein is often used for infusion therapies because it is easily accessible. **However,** it is also located at an area of high flexion, so stabilization is especially important. Use caution at or above the antecubital fossa to avoid the risk of nerve damage.

4. **Hand:** Although easily accessible, the metacarpal, cephalic and basilic veins of the hand are associated with high rates of failure over time. Consider these veins for therapies less than 24 hours.



Optimal vein conditions for an insertion site include the following qualities:[39]

- Soft, straight and elastic
- Springy, easily palpated
- No visible valves
- Supported by intact, elastic skin
- Easily stabilized

Avoid the following:[40]

- Dominant extremity
- Areas of flexion, including antecubital space and wrist
- Compromised areas
- Sites below recent venipunctures
- Areas where restraints are being used
- Lower extremities

Vascular visualization technology

There are various devices that use sound or light waves to allow for the location and identification of blood vessels and guide device insertion.[41]

1. **Visible light devices:** These devices function by providing transillumination of the peripheral veins. These devices aid in locating superficial veins in neonates. However, their usefulness in infants, older children and adults is limited due to the thickness of subcutaneous tissue and size of the arm circumference.[42]

2. **Near infrared (nIR) light technology:** Near infrared works by shining a frequency of light onto the patient that is absorbed by blood but reflected by surrounding tissue. The reflected light forms an image, either on the patient's skin or on a screen, that shows the path of fluid-filled vessels. nIR light technology can aid in locating superficial veins and helping assess their pathway, including to identify bifurcations and valves.[43]

3. **Ultrasound:** Ultrasound technology transmits sound waves through tissue. These waves bounce off of tissue in different ways depending on its density, and the image the reflected waves creates can be used to visualize anatomical structures under the skin. Ultrasound provides real-time guidance for catheter placement, unlike visible light devices and near infrared technology, which only identify the venous pathway.[44]

Device selection

Size considerations

Different catheters work best for different infusion therapies. Choosing the right catheter accomplishes the following:[45]

- Has the **greatest** likelihood of **remaining intact** throughout the anticipated **length of therapy**
- Accommodates the **requirements** of the therapy
- Is the **least invasive** option possible
- Utilizes the **fewest number of catheters** over the **course of the therapy**
- Meets a **benefit versus risk** assessment

Catheter gauge	INS recommendation for use[46]
20–24 gauge	Most infusion therapies*
22–26 gauge	Neonates, pediatric patients, older adults and patients with limited venous options
large (>20)–gauge catheters	Consider when rapid fluid replacement is required
Fenestrated catheters	Consider for a contrast-based radiographic study

*Catheters larger than 20-gauge are more likely to cause phlebitis

Follow your facility policy for specific procedures regarding catheter size requirements.

Insertion considerations

Vein distention and stabilization

Vein distention:

Remember the following when applying a tourniquet:[47]

- Apply 5–6 inches above the intended insertion site.
- It should be tight enough to impede venous flow while maintaining arterial circulation.
- Apply loosely or consider not using with patients at risk for bleeding, who have fragile skin/veins or have compromised circulation.

Additional methods to promote venous distention include the following:

1. Position the extremity lower than the heart for a minute or two.
2. Have the patient open and close their fist repeatedly.
3. Lightly stroke the vein downward or lightly tap on it.
4. Apply a controlled heat source to the extremity.

Vein stabilization:

- Anchors the vein
- Minimizes rolling
- Straightens curvy veins
- Facilitates catheter advancement

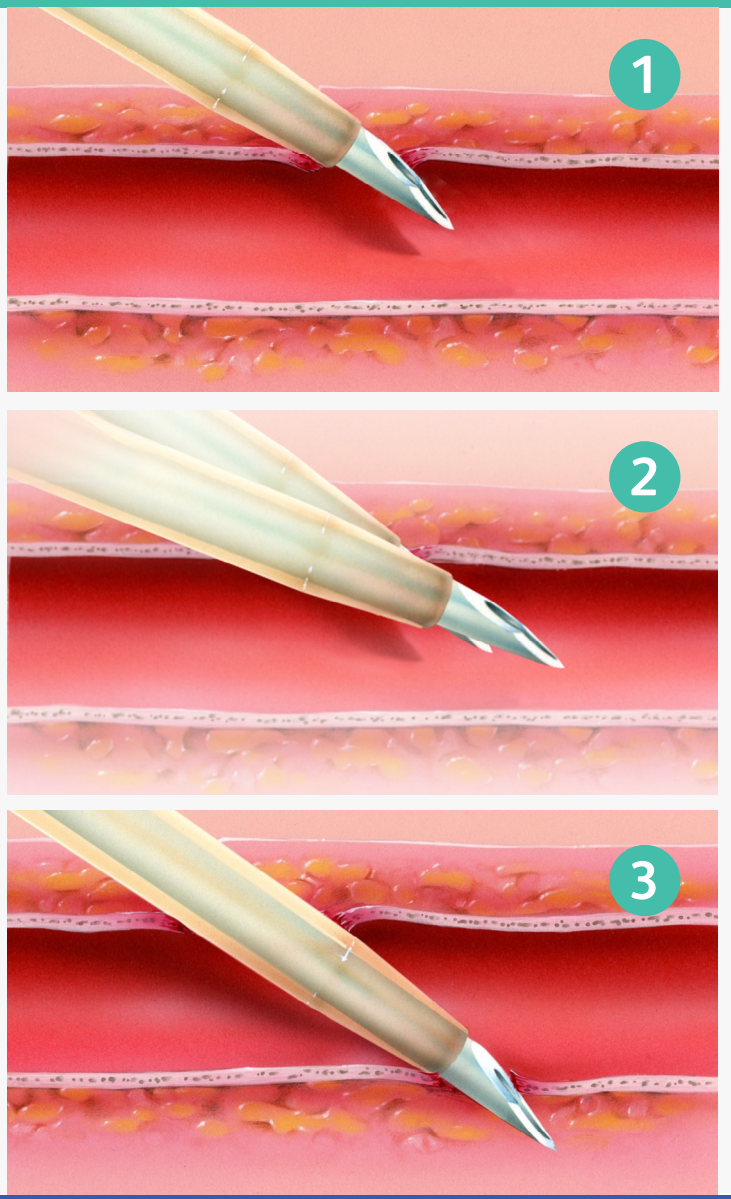
Stabilize by gently pulling the skin down and away from the insertion site. Maintain vein stabilization while advancing the catheter. Avoid contamination of the insertion site by re-palpating or when applying skin traction.

Venipuncture considerations

1. **Blood return** indicates the **needle tip has entered the vein**, but the **catheter tip may not be in the vein**.

2. Once **blood return is seen**, **lower the insertion angle** and **advance the needle and catheter as a unit**, slightly. This **helps ensure that the catheter tip is also within the vein** and **helps prevent puncturing** through the **back wall of the vein**.

3. **Puncture of the back wall** of the vein (also known as through puncture or backwalling) occurs when the **catheter/needle unit is inserted too far** or at **too great of an angle**.



Tips for success:

- Use only one catheter for each venipuncture attempt.
- Make no more than two insertion attempts per clinician.
- Release the tourniquet after the catheter is advanced off of the needle.

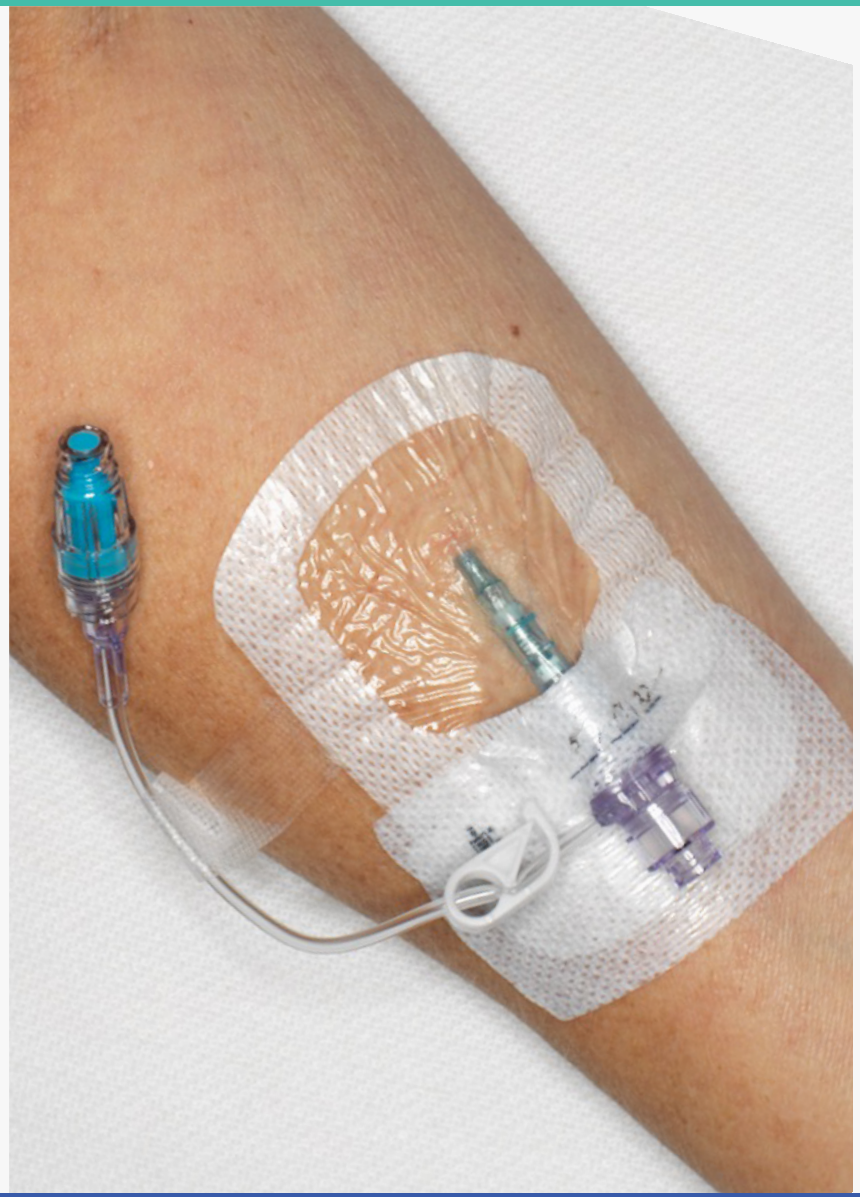
Securement

Proper securement is essential to the device's longevity. Effective securement provides the following benefits:[48]

- Preserves the integrity of the PIVC.
- Minimizes catheter movement at the hub.
- Helps prevent catheter dislodgement and loss of access.

Points to practice:

- The insertion site should be readily visible for routine assessment and monitoring.[49]
- The securement method should not impede vascular circulation.[49]
- Avoid the use of rolled bandages, with or without elastic properties, as the primary securement method.[50]
- Secure extensions, tubings and other add-on devices that could get caught and dislodge the PIVC.



PIVC management

Flushing

Appropriate catheter flushing is important to decreasing complications and maintaining the patency of PIVCs.[51]

When should a catheter be flushed?

1. Prior to each infusion to assess catheter function.
2. After each infusion to clear the infused medication.

Refer to your institutional policy and manufacturer instructions for use for more information.

Tips for catheter flushing:[42]

Use prefilled **single-use saline syringes** with preservative-free **0.9% sodium chloride** to reduce contamination risk and save time.

Use a minimum flush volume of **2x** the internal volume of the catheter system. **Larger volumes** may also remove more **fibrin**, **drug precipitate**, and **debris** from the lumen.

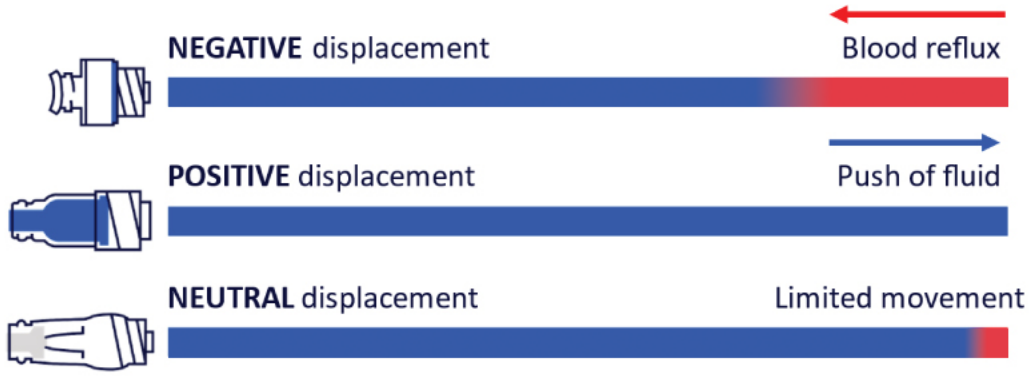
Consider using a **pulsatile technique**: Multiple short **1 mL boluses** with **brief pauses** may more effectively **remove solid deposits** from the lumen.

Use **positive pressure** techniques to **minimize blood reflux** upon disconnect.

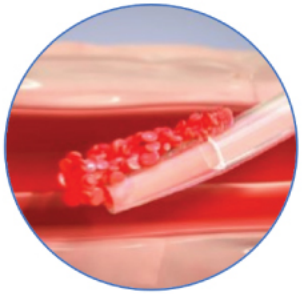
Flushing

Fluid displacement

Fluid displacement is the movement of fluid upon disconnection when no clamping is performed.



Blood reflux can play a significant role in thrombotic catheter occlusions.[54]



"**Understanding NFC design and the appropriate clamping and disconnecting sequence** for the various device types is necessary to ensure the best outcomes and prevent catheter-related complications.[53]"

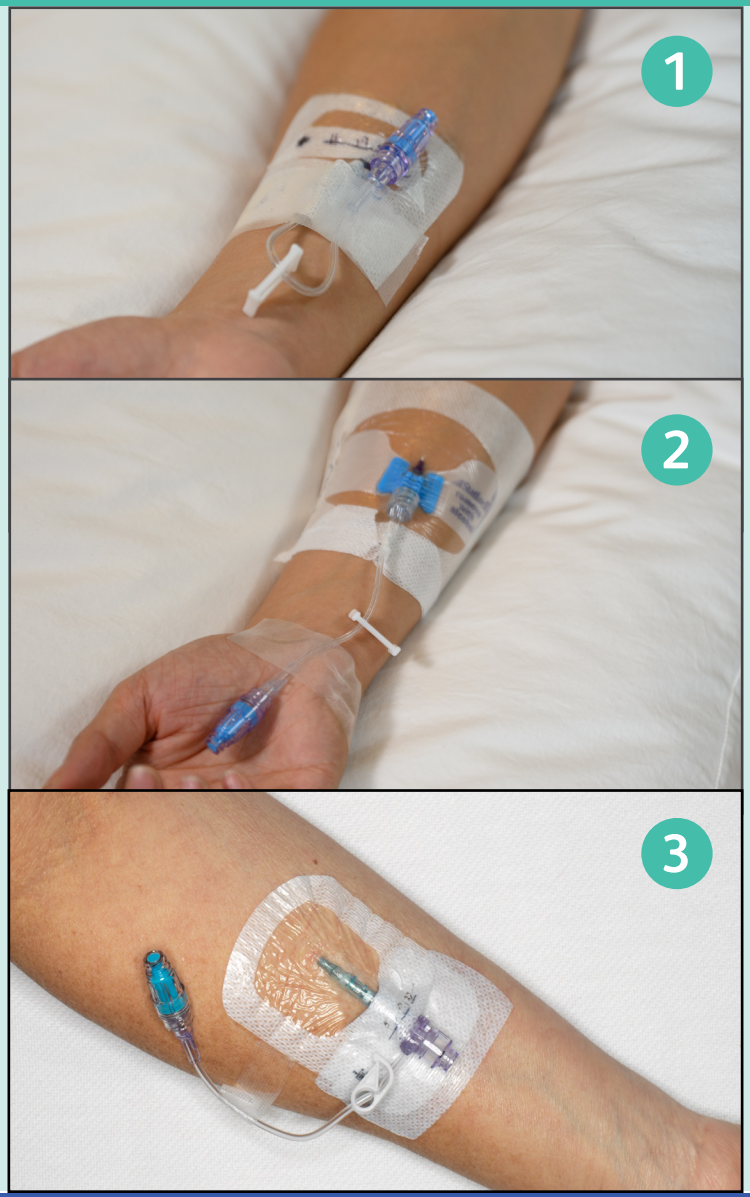
Dressing management

It's essential to secure the catheter in a way that will minimize catheter movement. If the catheter is moving constantly, it can cause mechanical phlebitis or create a risk for dislodgement. Consider the potential impacts for each of the following examples:

1. The label is covering the insertion site which could interfere with site assessment.

2. The extension tubing crosses the wrist joint, increasing the risk of dislodgement and impeding the patient's use of their hand.

3. The catheter and extension tubing are well secured. The needle-free connector can be easily accessed, and the insertion site is visible.



PIVC complications

Intro to complications

This tab will introduce common complications that may affect PIVCs:

- **Phlebitis**
- **CABSI**
- **Occlusion**
- **Infiltration/extravasation**
- **Dislodgement**

As you read through each complication, you'll see links allowing you to quickly find and review the relevant best practices.

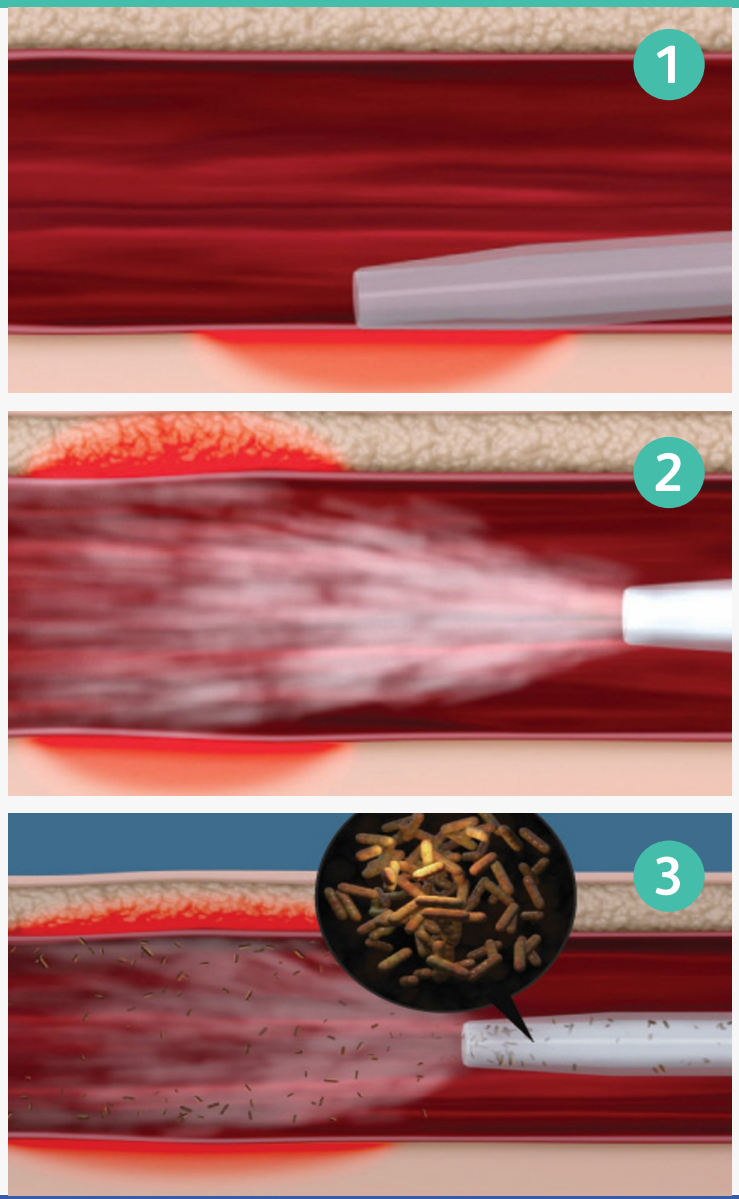
Most vascular access complications can be prevented, and it starts by learning to recognize them early.

Phlebitis

Phlebitis is inflammation of the intimal lining of the vessel.[55] This irritation can have several causes:[56]

1. **Mechanical:** manipulation during insertion, improper catheter stabilization, catheter size and tip location.
2. **Chemical:** irritating solutions, inadequate hemodilution, skin antisepsis not allowed to dry prior to insertion.
3. **Infectious:** breaks in aseptic technique, poor hand washing, inadequate cleaning for connectors, non-occlusive dressing.

- **Select appropriate device for intended therapy.[57]**
- **Manage vein/catheter ratio to allow adequate hemodilution.[57]**
- **Stabilize catheter.[57]**
- **Practice proper aseptic technique during insertion, access and maintenance.[57]**



Identification and progression[58]

Phlebitis follows a grading system which is used to assess the severity of the symptoms.

Grade 1 phlebitis presents as erythema at the insertion site with or without pain.

Grade 2 phlebitis may look similar to grade 1 phlebitis, but consists of pain at the access site with erythema and/or edema.

Grade 3 phlebitis consists of pain at the access site with erythema, streak formation, or a palpable venous cord.

Grade 4 phlebitis includes pain at the access site, erythema, streak formation, a palpable venous cord greater than 1 inch in length, and/or purulent drainage.

Intervention[59]

When you identify phlebitis:

- Remove the catheter.
- Elevate the extremity.
- Apply a warm compress to the site.
- Provide analgesics as needed.
- Consider other pharmacologic interventions such as anti-inflammatory agents.

CABSI

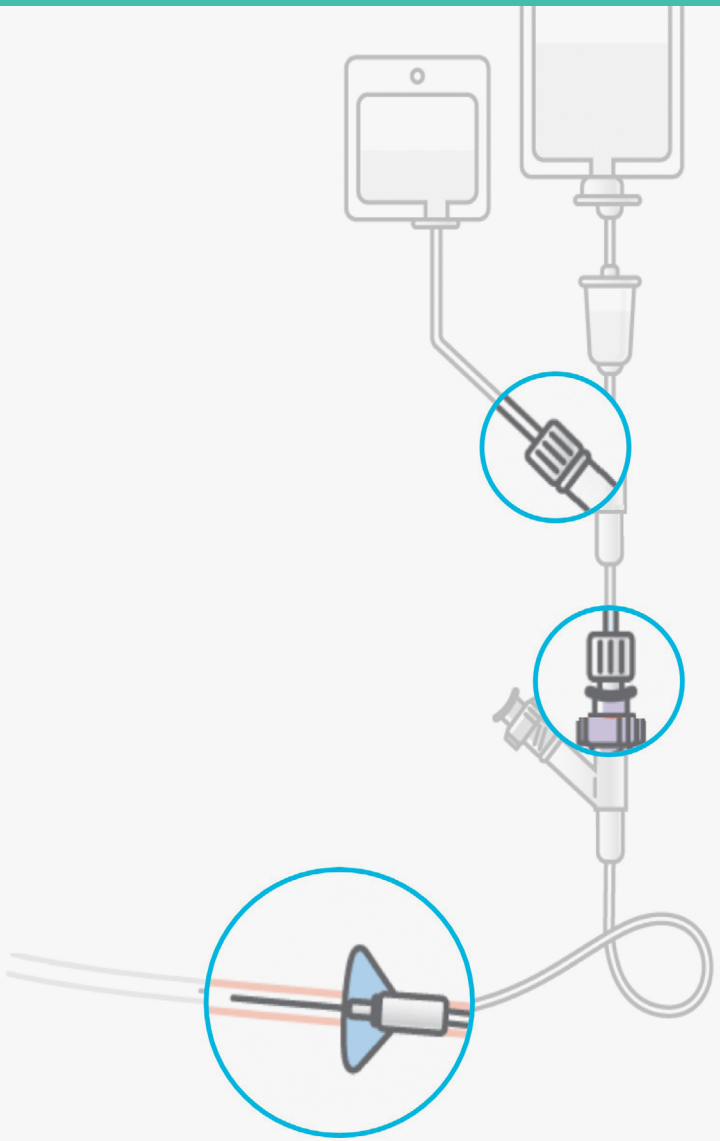
Catheter-associated bloodstream infection (CABSI) is the presence and growth of a pathogenic microorganism in the bloodstream originating from the catheter.[60]

Extraluminal:[61]

- Seeding from a distant site
- Contaminated device
- Ingress of bacteria at the insertion site

Intraluminal:[61]

- Caused by the patient or healthcare worker
- Contaminated infusate (fluids infused through the catheter), caused by the manufacturer, pharmacy or other healthcare workers



- **Continue education[62]**
- **Practice proper aseptic technique during insertion, access and maintenance[62]**
- **Disinfect skin properly[62]**
- **Select site properly[62]**
- **Remove VAD promptly when no longer needed[62]**

Identification

Common **signs** and **symptoms of infection** include:[63]

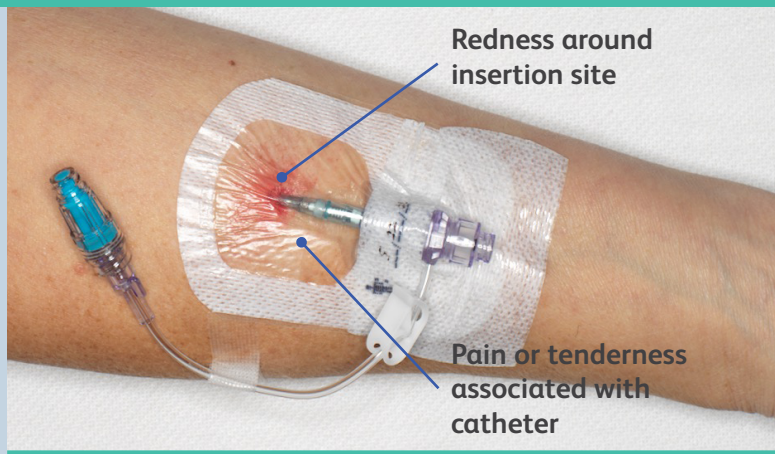
- Fever
- Increased white blood cell count
- Redness around the insertion site
- Drainage from the insertion site
- Pain or tenderness associated with the catheter

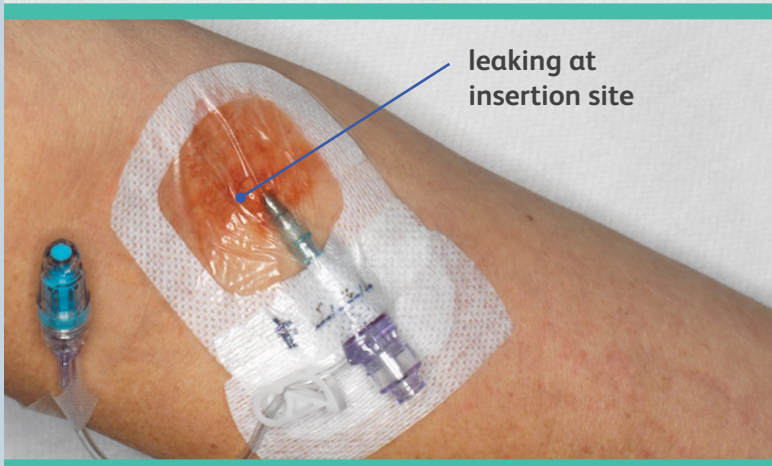
Intervention[64]

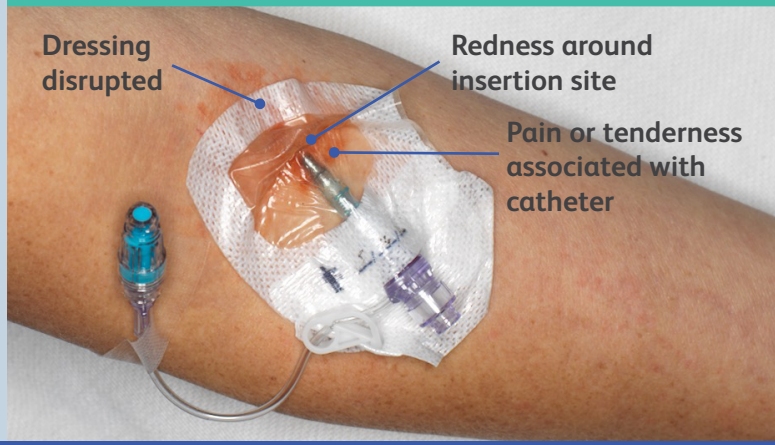
Remove a PIVC when:

Patient **develops symptoms of complication** and **failure** such as **infection** (e.g., erythema extending at least 1 cm from the insertion site, induration, exudate, fever with no other obvious source of infection).

Patient **reports any pain or tenderness** associated with the **catheter**.







Occlusion

Occlusion is the obstruction of the catheter lumen, preventing or limiting the ability to flush and/or administer solutions or withdraw blood.[65]

Occlusion may be caused by:[66]

1. Improper **flushing** and **locking** procedures
2. Infusion of **incompatible** medications
3. Mechanical causes, such as having the **clamp engaged** or **tubing kinked**

- **Use vigorous pulsatile flush technique[67]**
- **Disallow reflux of blood or fluid after flush[67]**
- **Use adequate flush volumes[67]**
- **Flush before or after each use or at least once every 24 hours[67]**

Identification

Common **signs** and **symptoms** of occlusion include:[68]

- Frequent pump occlusion alarm
- Swelling/leaking from the insertion site
- Inability to withdraw blood or sluggish blood return
- Sluggish flow: resistance or inability to infuse or flush the catheter

Intervention[69]

If occlusion is suspected, start by straightening any kinks in the catheter tubing and ensuring that the clamp is not engaged. If occlusion persists, remove catheter.

Infiltration and extravasation

Infiltration: Nonvesicant solution or medication is inadvertently administered into surrounding tissue.[70]

Extravasation: Vesicant solution or medication inadvertently infiltrates into surrounding tissue.[71]

Risk factors for infiltration/extravasation:[72]

Inappropriate insertion site	Irritants/vesicants get infused
Inadequate stabilization	Difficult access history
Medications that alter pain sensation	Diseases that produce change in vasculature
Use of deep veins with insufficient catheter length	Inability of patient to report symptoms

Also note that **early identification is essential** to limiting the **potential impact of infiltration** and **extravasation**. Monitor the **insertion site closely** if **risk factors** for **infiltration or extravasation** are present.

Select an appropriate vein for insertion[73, 74]

Use ultrasound-guidance for deep and/or difficult to visualize veins[73, 74]

Select appropriate catheter (based on type, gauge, length, etc.)[73, 74]

Stabilize catheter adequately[73, 74]

Assess site routinely to recognize infiltration early[73, 74]

Identification

The following are symptoms of infiltration or extravasation:[75]

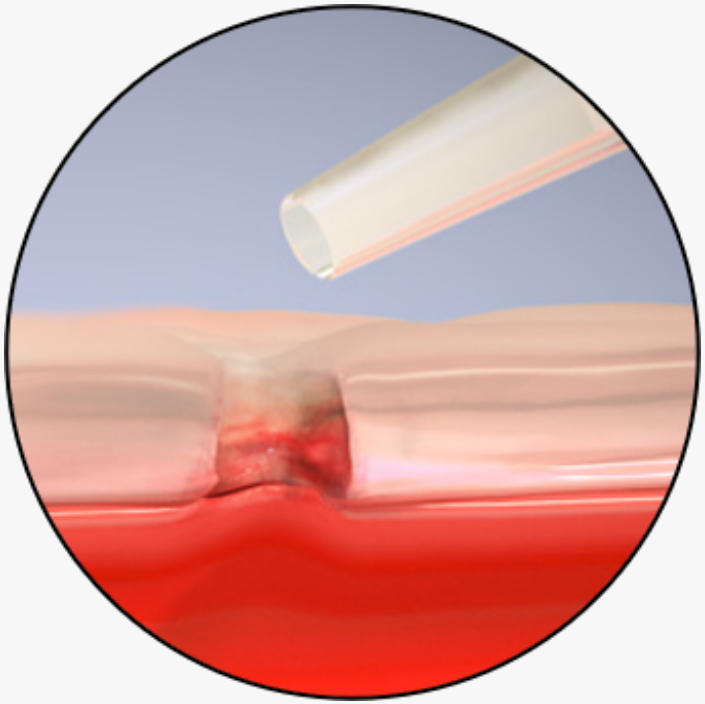
- Swelling of the extremity at or around the insertion site.
- Blanching and taut skin.
- Patient complaint of pain, burning, tightness or discomfort.

Intervention[76]

- Immediately stop the infusion upon identification of infiltration/ extravasation injury and initiate appropriate interventions.
- Aspirate for blood return from the peripheral catheter.
- Do not flush the VAD, as this will inject additional medication into the tissue.
- Disconnect the administration set and aspirate from the catheter, even though a very small amount of fluid may be retrieved.
- Remove the peripheral catheter.
- Avoid application of pressure.
- Elevate the extremity.

Dislodgement

Dislodgement occurs when the catheter becomes dislodged from the vein. Dislodgement may be **incomplete** (meaning that the catheter tip is no longer in the vessel but is still in the patient) or **complete** (meaning that the catheter falls out entirely). [77]



Dislodgement may be caused by:[78, 79]

1. **Patient manipulation:** body habitus or arm movement causing VAD dislodgement
2. **Loosening:** due to inadequate stabilization and lack of proper securement
3. **Poor site selection**

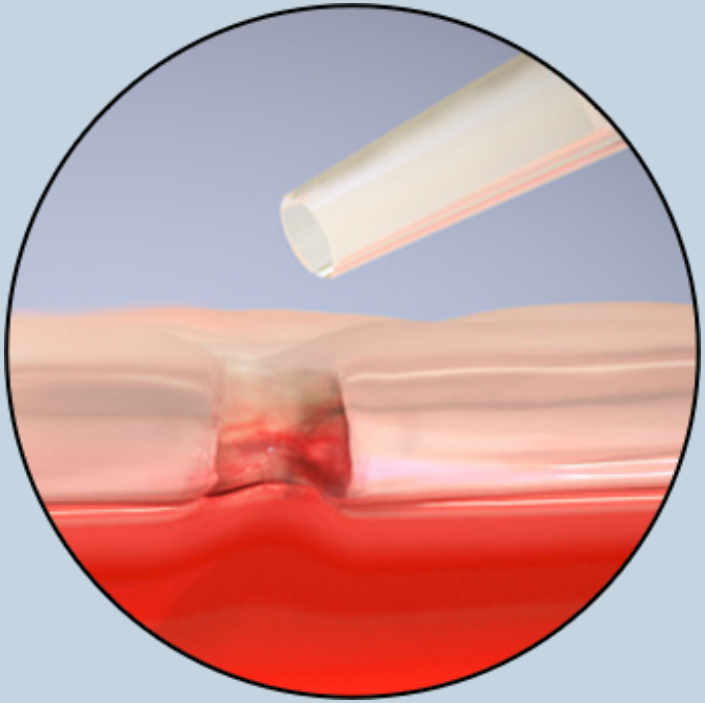
- **Avoid areas of flexion while selecting insertion sites.[80, 81]**
- **Use a securement device ISD, SASS, TA or ASD, in addition to primary dressing to stabilize and secure VADs.[80, 81]**
- **Use ISD, SSAS, TA or ASD for peripherally inserted catheters (PICCs) as an alternative to sutures.[80, 81]**

ISD - integrated securement device
SASS - subcutaneous anchor securement system
TA - tissue adhesion
ASD - adhesive securement device

Identification[82]

The following are signs and symptoms of dislodgement:

- Inability to continue infusion
- Increased external catheter length since last assessment
- Leakage at the insertion site
- If catheter moves out of the vein but not the skin, it can also result in:
  - Edema
  - Pain
  - Changes in skin color
  - Progress to blistering ulceration



Intervention[83]

Remove the peripheral catheter.

Never re-advance a vascular access device that has been pulled out back into the vein as it could introduce bacteria.

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