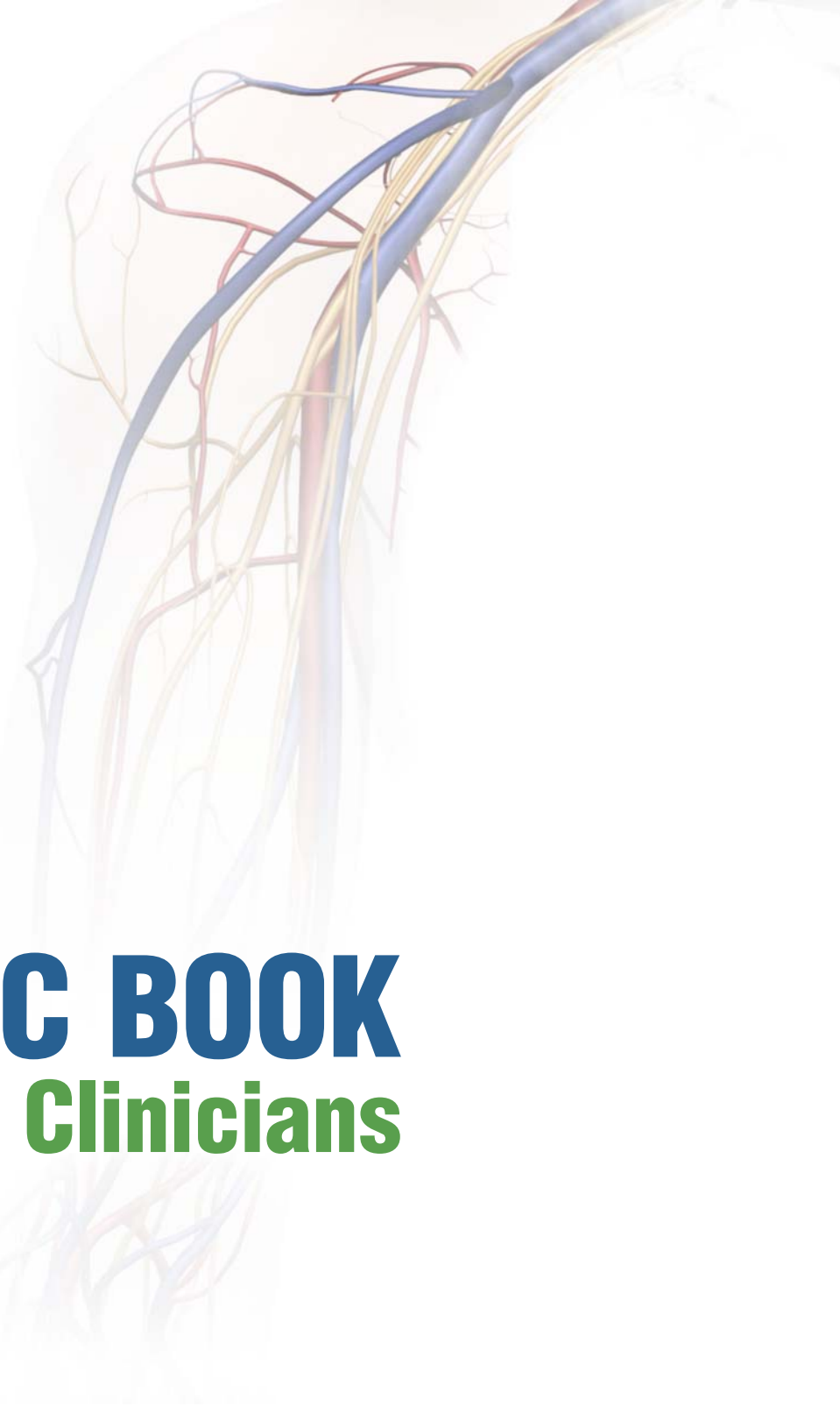
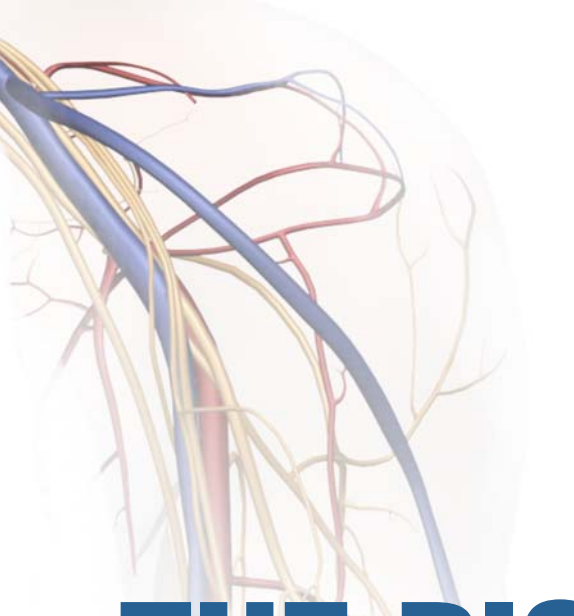


THE PICC BOOK

A Guide for Clinicians



THE PICC BOOK
A Guide for Clinicians

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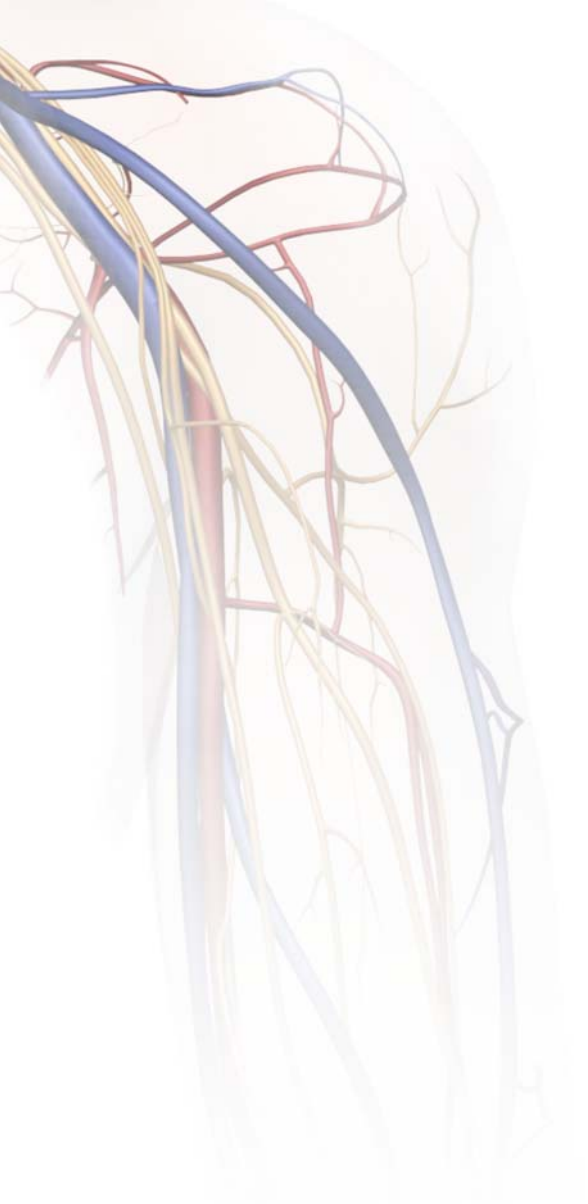


Introduction

It is estimated that over 90% of hospitalized patients will receive some form of vascular access. The purpose of vascular access is to hydrate the patient, administer medication, take blood samples, and/or perform blood transfusions. These things are done with a vascular access device (VAD), such as a peripheral intravenous device (commonly called a peripheral IV or PIV), midline catheter, centrally inserted central catheter (CICC), or a peripherally inserted central catheter (PICC). This manual focuses on PICCs.

As a designer and manufacturer of PICCs, Bard Access Systems strives to educate clinicians on proper PICC insertion and maintenance. Since PICC insertion is an advanced skill that is not covered in basic nursing studies, clinicians should complete an eight-hour class, participate in hands-on training, and engage other resources as appropriate. This manual can be used as a reference guide to supplement such training. This manual is not intended to replace such training or clinical judgment.

The goal of clinicians inserting PICCs should be to administer the appropriate therapy to the patient via safe and successful vascular access. In addition to providing guidance for PICC insertion, this manual will discuss various complications and how they can be prevented, detected, documented, and managed. Techniques for routine care and maintenance of a PICC and the patient are also discussed. We at Bard Access Systems hope the information provided in this manual will help you, the clinician, provide quality care for each patient.

Understanding Vascular Anatomy

OVERVIEW [9,12,18,21,22]

The circulatory system is a complex circuit of the heart and blood vessels. Understanding the typical vascular anatomy of veins and arteries is necessary prior to placing a peripherally inserted central catheter (PICC). To insert a PICC, a needle is typically inserted through the skin and three layers of a vein in the arm. After access is established, the PICC is threaded into the axillary vein (near the shoulder), through the subclavian vein (above the clavicle), continuing through the brachiocephalic vein (leading downward toward the heart) and into the superior vena cava (SVC). Ideally, the PICC tip will terminate in the distal SVC or cavoatrial junction (CAJ). The increased blood flow in the SVC/CAJ (2,000 mL/min compared to 20–40 mL/min in forearm vessels) facilitates hemodilution and mitigates vein irritation caused by infusates. Inserting a PICC requires that clinicians understand the relevant anatomy and physiology of the vascular system and that they know the best techniques to mitigate any complications. This chapter will discuss this information.

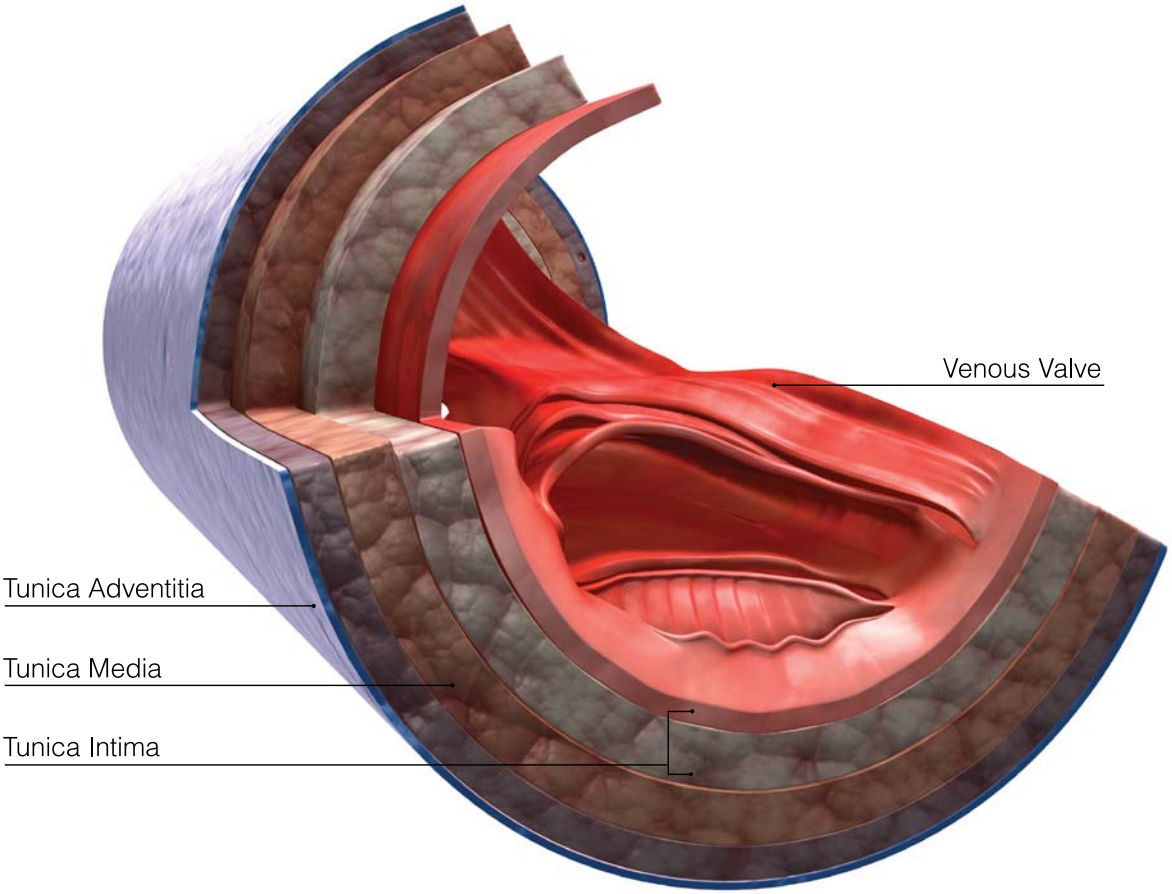
OBJECTIVES

- Identify vessel-wall structure.
- Identify and locate the vessels used for insertion of a PICC.
- Correlate the anatomy and physiology of the venous structures of the arms, axillary, neck, and thorax in relation to the placement of a PICC.
- Identify the anatomic location of arteries and nerves in close proximity to the veins of the upper extremeties.

This section is intended to provide a general overview of anatomy and physiology of the circulatory system and does not replace clinical training or judgment. Users should refer to product Instructions for Use as well as applicable facility protocols.

VESSEL WALL STRUCTURE [20]

There are three layers in veins: the tunica adventitia, tunica media, and tunica intima (also known as the endothelium).

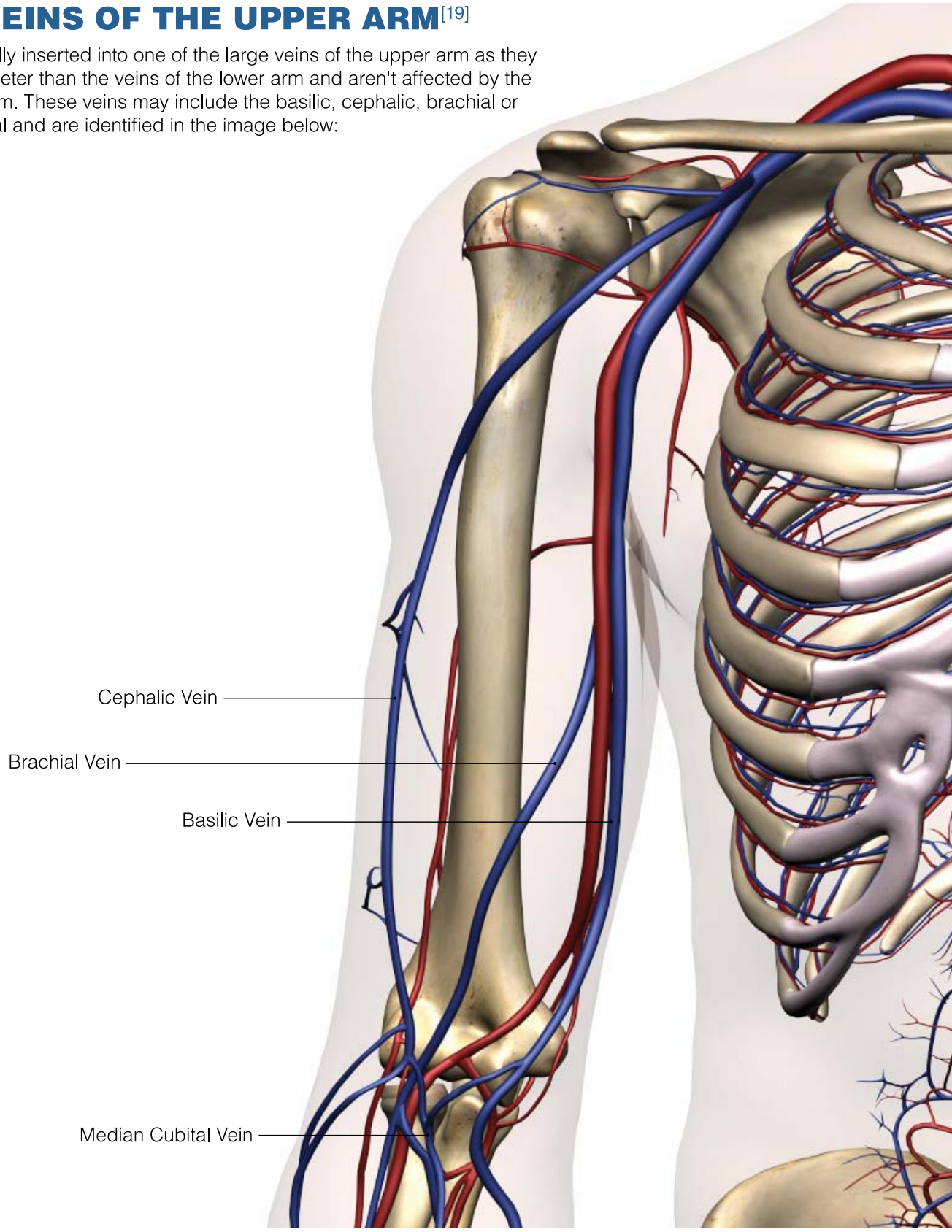


VASCULAR CHARACTERISTICS

	Veins	Arteries
Characteristics [1,5,13,14,15,16]	• Carry deoxygenated blood toward the heart. • Thin walls. • Contain valves to prevent back flow of blood. • Three types: superficial, deep, and perforating (which connect superficial with deep). • Muscular, allowing veins to contract and expand. • Collapse with pressure. • Not pulsatile.	• Carry oxygenated blood away from the heart. • Thick walls. • Do not contain valves. • Elastic tissue in walls. • The smooth muscle allows arteries to constrict or dilate. • More difficult to collapse than veins. • Usually lie deep in the tissues and are protected by muscle. • Pulsatile.
Tunica Intima [2,3]	• Innermost layer. • Endothelial lining is identical to that found in arteries. • Made up of a single layer of smooth, flat endothelial cells that span the length of each vessel. • Any trauma that roughens the endothelial lining encourages thrombin formation. • Damage to these cells initiates the inflammatory process of phlebitis.	• Innermost layer. • Endothelial lining is identical to that found in veins. • Made up of a single layer of smooth, flat endothelial cells that span the length of each vessel. • Any trauma that roughens the endothelial lining encourages thrombin formation. • Damage to these cells initiates the inflammatory process of phlebitis.
Tunica Media [2,3]	• Middle layer. • Consists of muscular and elastic tissue. • Nerve fibers, both vasoconstrictors and vasodilators, are located in this middle layer. • Stimulation by a change in temperature or by mechanical or chemical irritation may produce spasms of the vein or artery.	• Middle layer. • Consists of muscular and elastic tissue. • Nerve fibers, both vasoconstrictors and vasodilators, are located in this middle layer. • Stimulation by a change in temperature or by mechanical or chemical irritation may produce spasms of the vein or artery. • Capable of controlling blood flow by constriction and dilation.
Tunica Adventitia [2,3]	• Outermost layer. • Connective tissue that surrounds and supports a vessel. • Sympathetic nerves are located in the adventitia of larger veins.	• Outermost layer. • A layer of connective tissue thicker than that in veins that surrounds and supports a vessel. • Sympathetic nerves are located in larger arteries.

LARGE VEINS OF THE UPPER ARM[19]

A PICC is generally inserted into one of the large veins of the upper arm as they are larger in diameter than the veins of the lower arm and aren't affected by the bending of the arm. These veins may include the basilic, cephalic, brachial or median anticubital and are identified in the image below:



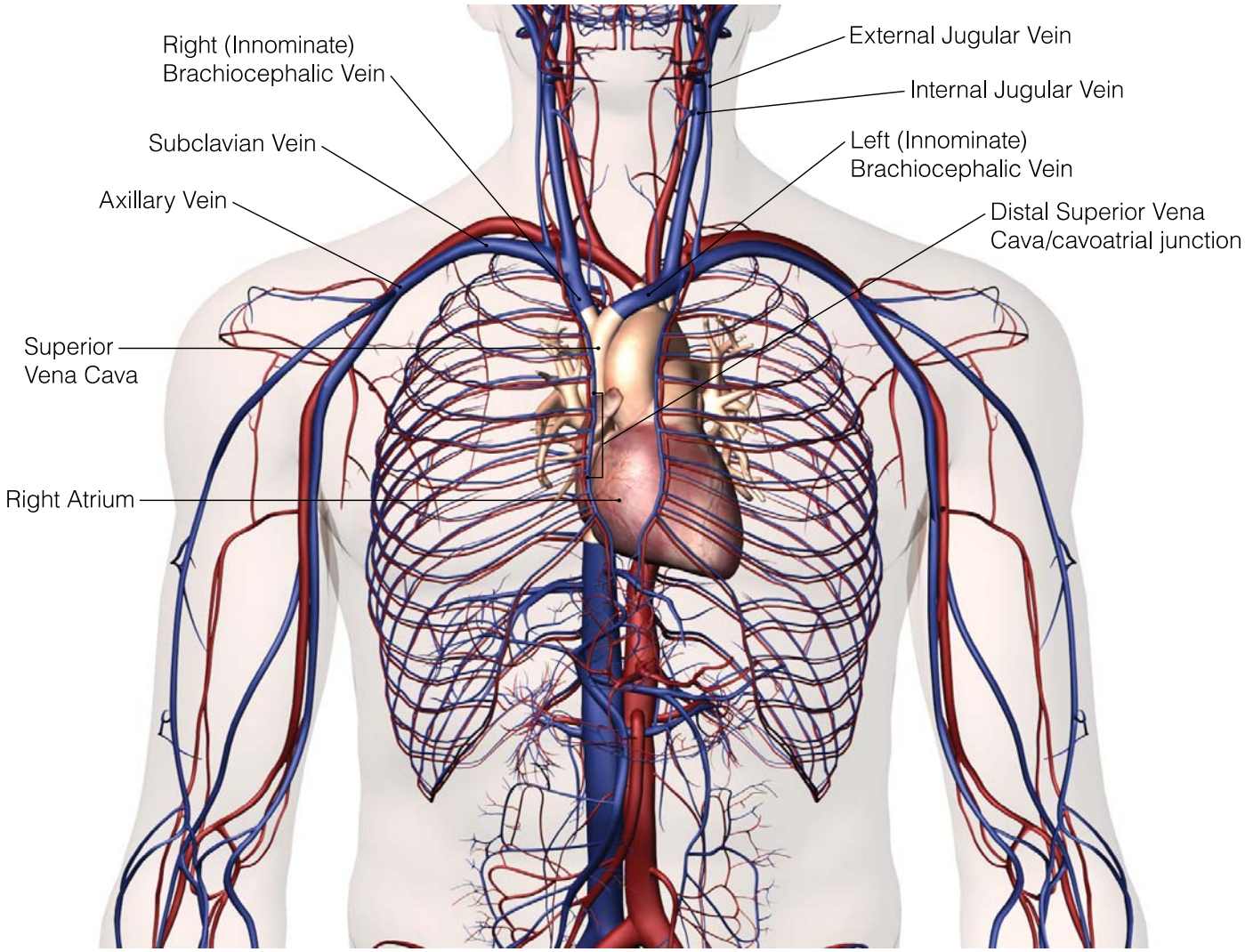
VEINS USED FOR PICC INSERTION [11]

Preferred veins for PICC insertion are the basilic, cephalic, brachial, and median cubital.

Vessel Name	Anatomical Location	Advantages	Disadvantages
Basilic Vein [3,4,5]	Courses upward in a direct path along the inner side of the bicep muscle and terminates in the axillary vein.	• Often the vein of choice for PICC placement. • Typically large in size. • Follows a straight path.	May be more difficult to access or perform care and maintenance related to its location.
Cephalic Vein [4,5,6]	Courses down the arm, lateral to the bicep muscle, and then down the lateral forearm.	• Superficial. • Possible to enter at the antecubital fossa. • Vein of choice for patients on crutches. • Often used for obese patients due to the vein's superficial nature.	• Difficulty may be encountered with catheter threading due to the sharp angle where it joins the axillary vein. • The cephalic vein is often the smallest of the arm veins. • The location of the cephalic vein over the bicep muscle may result in excessive movement of the catheter during arm flexion and extension, causing discomfort and limiting arm motion.
Brachial Vein [6,17,19]	The paired brachial veins are located deep in the arm and paired within the same sheath as the brachial artery.	Typically large in size.	• Lies deep in the upper arm and cannot be visualized or palpated without ultrasound guidance. • Lies in close proximity to the brachial nerve and artery.
Median Cubital Vein [4,5,6,16]	This vein joins the cephalic and basilic veins at about the level of the antecubital fossa.	• Often visible without ultrasound. • Often readily accessible for venipuncture. • Well supported by muscular and connective tissue.	• May limit movement. • Cannulation in an area of flexion may lead to dislodgement or mechanical phlebitis. • The caudal turn at the shoulder may result in the catheter entering the axillary vein in a peripheral direction rather than a central location.

VESSELS OF THE THORAX [12,19]

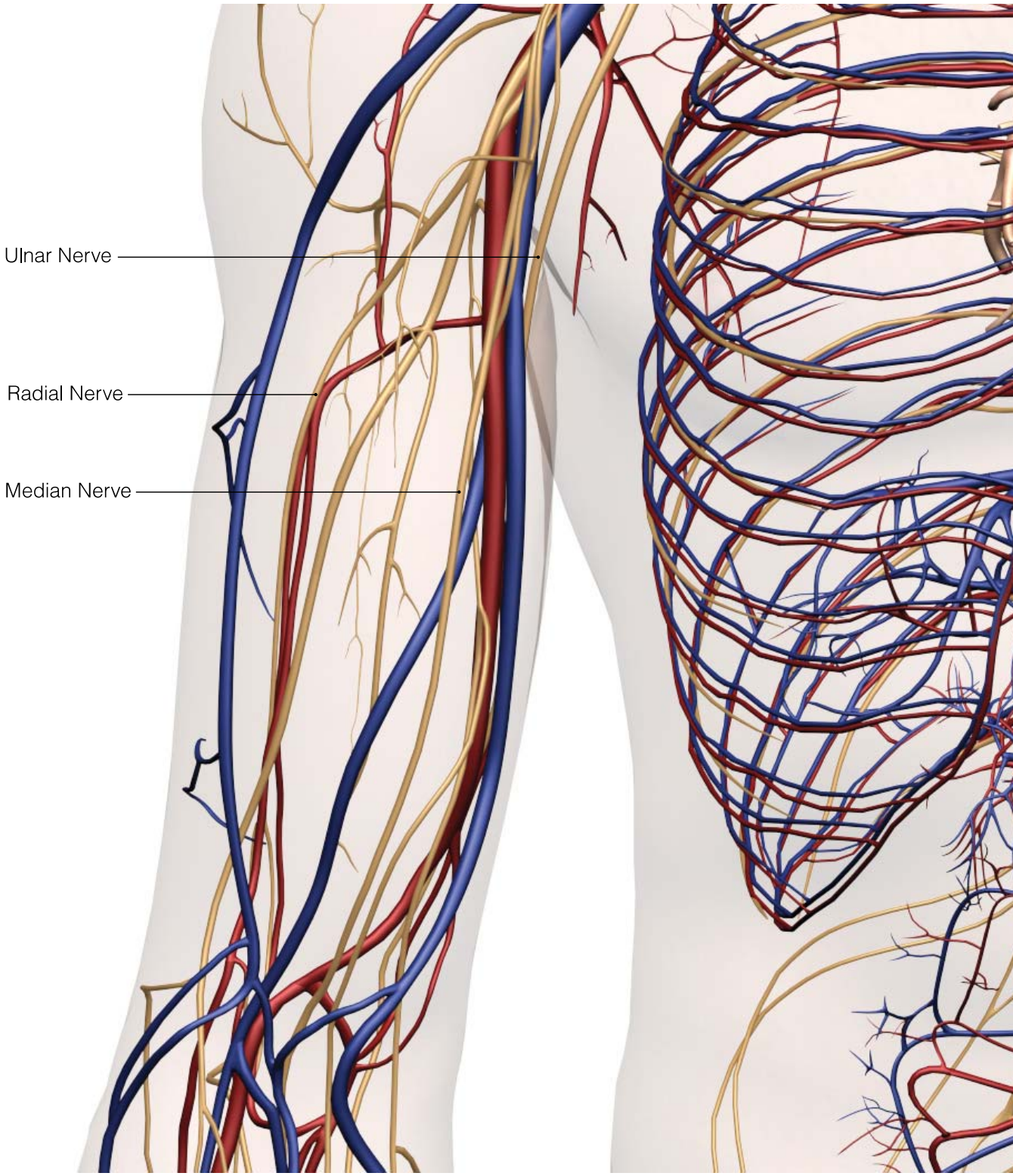
The PICC tip should reside in the lower one-third of the SVC, or the CAJ.



Vessel Name	Anatomical Location
Axillary Vein [3]	The axillary vein is classified as a deep vein, which extends from the lateral aspect of the chest to the lateral border of the first rib. It receives the brachial vein at its midpoint and the cephalic vein near the border of the rib. There are 3 suprascapular veins and several other veins joining the axillary vein in this area and as many as 40 valves can be documented in this region.
Subclavian Vein [3]	The continuation of the axillary vein is the subclavian vein from the lateral edge of the first rib to the sternal edge of the clavicle. This vein angles upwards as it arches over the first rib and passes under the clavicle.
Internal and External Jugular Veins [3]	The jugular veins drain the head and face. The external jugular vein is superficial and lies on the outer border of the neck. The external jugular vein joins the subclavian vein at its midpoint. The internal jugular vein is a deep vein covered by the muscles of the neck. It joins the subclavian vein at its proximal end.
Brachiocephalic (Innominate) Veins [3]	At the top of the thoracic inlet, the internal jugular and subclavian veins join to create the brachiocephalic vein, also called the innominate vein. This junction contains the last venous valve before the heart. The left brachiocephalic vein, which is approximately 6 cm in length, is approximately twice as long as the right brachiocephalic vein.
Tributaries [3]	Tributaries unite with the great thoracic veins and have been documented as aberrant locations for central venous catheters (CVCs). The internal thoracic (mammary) vein joins the SVC at the superior end. The left and right inferior thyroid veins join the respective brachiocephalic veins, the esophageal, tracheal, and laryngeal areas. The left superior intercostal vein joins the left brachiocephalic vein. The azygos vein drains the blood from the veins of the spinal column and enters the posterior side of the SVC.
Superior Vena Cava [3]	The SVC begins at the confluence of the left and right brachiocephalic veins. It is about 7 cm long, extending from the inferior border of the first costal cartilage behind the sternum to the level of the third costal cartilage, where it joins the right atrium. The lower half of the SVC is inside the fibrous pericardium at the level of the second intercostal cartilage. Variation of the anatomy of the SVC can lead to the creation of a right and left location, leaving the SVC exclusively on the left side of the mediastinum. This is known as persistent left superior vena cava (PLSVC). This congenital anomaly occurs in 0.3% of healthy individuals and in 2%–4% of those with other cardiac anomalies.
Right Atrium [3]	The SVC and inferior vena cava (IVC) join the atrium of the right side of the heart on the posterior aspect. The SVC returns blood from the upper part of the body and has no valve. The IVC returns blood from the lower part of the body, is larger than the SVC, and has a semilunar valve near the opening into the atrium.

NERVES OF THE UPPER ARM

Nerve Name	Anatomical Location
Median Ulnar and Radial Nerves [3]	Branches off the brachial plexus. The median nerve passes laterally to the brachial artery, crosses the artery, descends medially into the antecubial fossa, and descends into the forearm and palm of the hand.



PHYSIOLOGY OF THE VENOUS SYSTEM

Blood-Flow Dynamics [3]

The cardiac output of blood in the average resting adult is about 5 liters per minute. Blood circulates in a closed system and is dependent upon multiple factors. Factors related to the venous system include: viscosity, vein diameter, vessel flow rates, pressure, velocity, and flow.

Viscosity [3]

The viscosity of any fluid is defined as the degree of resistance to flow when pressure is applied. Viscosity of blood is primarily determined by the percentage of cells in blood (hematocrit). Friction from a high concentration of cells increases viscosity.

Viscosity is affected by vessel diameter. In larger vessels, the most rapid flow is in the center of the vessel; the slowest flow is closest to the vessel wall. As velocity of flow decreases, the viscosity increases; therefore, blood flowing through small vessels and capillaries has the highest viscosity. For that reason it's important to use the smallest catheter in the largest possible vessel.

Vessel Flow Rates and Vein Diameters [1,9,10,18,24]

Vein	Flow Rate	Approximate Diameter
Metacarpal	10 ml/min.	2–5 mm
Forearm	20–40 ml/min.	6 mm
Basilic Upper Arm Vein	90–150 ml/min.	8 mm
Axillary Vein	15–350 ml/min.	16 mm
Subclavian	350–500 ml/min.	6–19 mm
Superior Vena Cava	2000 ml/min.	20–30 mm

The presence of numerous venous valves in the peripheral veins creates turbulent flow, while the absence of valves streamlines the flow in the SVC.

Volume in relation to flow rate is dependent on diameter, length, and resistance within the vessel. As the data in the table demonstrates, the blood-flow rate in peripheral veins is significantly less than the rate in the SVC.

The rate of blood flow at the SVC is 2000 ml/min. compared to 20–40 ml/min. in the vessels in the forearm. The increased blood flow in the SVC offers greater hemodilution and less irritation to the vein by infusates.

Pressure [3,37]

The greatest pressure is found in the aorta because of the pumping action of the heart.

Velocity [3]

Velocity is the distance blood moves in a specific period of time.

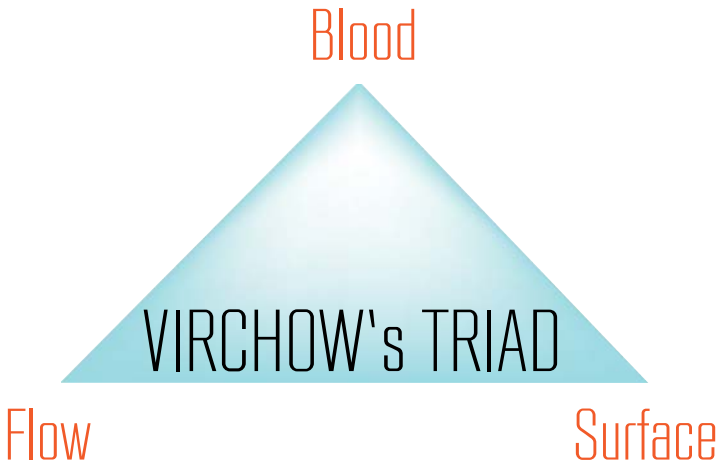
Flow [3]

- All other factors being equal, flow through a single vessel is most affected by the diameter of the vessel. When the diameter doubles, the flow rate increases 16 times; with a fourfold increase in lumen diameter, the flow rate increases 256 times.
- Flow can be in two types of patterns: laminar or turbulent.
  - In laminar flow, the blood moves in layers or concentric circles through the vessels. As blood moves through the vessels, the layer touching the vessel wall is slowed because of adherence to the wall. The next layer slides easily over the outer one, and the innermost layer moves easiest.
  - Turbulent flow is in all directions, flowing crosswise and lengthwise along the vessel. This type of flow is created when the vessel's inner surface is rough, when there is an obstruction or a sharp turn in the vessel, or when the amount of flow has increased greatly.

VIRCHOW'S TRIAD [3,11,25,26]

A deep vein thrombosis (DVT) is a potential complication associated with PICC insertion. When selecting a VAD, the clinician should select the smallest gauge with the least number of lumens to manage the patient's prescribed therapy.

Virchow's Triad traditionally describes the 3 key components of clot formation: endothelial injury, circulatory stasis, and hypercoagulable states.



Flow
- Disturbed bloodflow
- Stasis of flow

Surface
- Foreign body (catheter)
  - Thrombus (including platelets and fibr n) can accumulate on the external catheter surface.
- Vascular wall (Endothelium)
  - PICC can cause persistent irritation resulting in a thrombus developing on a vein wall (DVT)

Blood
- Hypercoagulability of patient – varies by individual
- Disease state
- Individual genetics
- Lifestyle (diet, smoking, etc.)

DVT may be reduced by improved selection of patients and catheter size.
Larger catheters have been found to have an increased risk of DVT.

SUMMARY [2,12,19,21,22,24]

This chapter has identified the veins and arteries typically involved in PICC insertion. Venous and arterial characteristics and physiology have also been discussed. Understanding the body's vasculature and how it works is essential for clinicians who insert PICCs. The next chapter will discuss the different vascular access devices (VADs) and how to decide when each one should be used.

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Selecting a Vascular Access Device

OVERVIEW [3,8,9,10,13]

When a patient needs infusion therapy, the clinician should select the appropriate vascular access device (VAD) based on several criteria. These criteria include: patient characteristics, patient preferences, therapy time, infusion characteristics, and catheter characteristics. This chapter will discuss each of these and help clinicians understand when and why a PICC is selected as the appropriate VAD. Although different VADs (PICCs, peripheral IVs, midlines, and implanted ports) are discussed in this chapter, the focus of the entire book is the PICC.

OBJECTIVES

- Review vascular access devices (VADs).
- Understand device selection in relation to length of therapy, infusate properties, and duration of therapy.
- Understand device selection as it relates to the effects of pH and osmolality on the vascular system.

This document is intended as a general educational overview. Indications and/or contraindications for any of the devices should be followed and may vary per manufacturer.

COMMON VASCULAR ACCESS DEVICES[1,2,5,9,14,15]

Device	Definition	Description
Peripheral Intravenous Catheter (PIV)	A catheter that begins and terminates in an extremity.	• Made of polyurethane or silicone with a rigid hub. • Less than 3 inches in length. • Available in a variety of gauge sizes (from 14 to 27). • Winged and nonwinged, single and double lumen.
Midline Catheter	A peripheral infusion device with the tip terminating distal to the shoulder in either the basilic, cephalic, or brachial vein.	• Made of polyurethane or silicone. • 3–8 inches in length. • Available in a variety of French and gauge sizes. • Various catheter styles and insertion techniques. • Not a central catheter.
Peripherally Inserted Central Catheter (PICC)	A central vascular access device (CVAD) inserted into a vein of the extremity. The catheter tip terminates in the central vasculature.	• Made of polyurethane or silicone. • Available in single, double, or triple lumen. • Available in a variety of French and gauge sizes. • Inserted percutaneously through the veins of the upper arm (or legs in the case of pediatric) and terminating in the central vasculature. • Arm veins that should be considered for PICC cannulation are the basilic, median cubital, cephalic, and brachial veins.
Non-Tunneled Central Vascular Catheter (CVC)/ Tunneled CVC	A CVAD inserted into a vein of the neck, chest, or groin. The catheter tip terminates in the central vasculature.	• Made of polyurethane. • A subclavian site, rather than a jugular or a femoral site, is used in adult patients to minimize the infection risk. • Inserted though a central vein. Avoid the subclavian site in hemodialysis patients and patients with advanced kidney disease.
Implanted Venous Port	A CVC attached to a small dome-shaped housing, or port, with a silicone septum.	• Catheter or port constructed of polyurethane or silicone. Portal housing constructed of titanium, plastic, or stainless steel with a silicone septum. • The entire device is placed subcutaneously inside a surgically created pocket. The septum serves as a reservoir that empties into the catheter. • A non-coring needle is used to access the port.

Device	Tip Location	Length of Therapy	Types of Infusates
Peripheral Intravenous Catheter (PIV)	Peripheral vein.	Usually for treatments of less than 1 week.	• Recommended pH between 5 and 9 • Recommended osmolality less than 600 • Not for continuous infusion of vesicants • Not for parenteral nutrition
Midline Catheter	• Below the axillary vein. • Midline catheters inserted via a scalp vein in neonates and pediatric patients should have the tip terminating in the external jugular vein.	1–4 weeks	• Recommended pH between 5 and 9 • Recommended osmolality less than 600 • Not for continuous infusion of vesicants • Not for parenteral nutrition
Peripherally Inserted Central Catheter (PICC)	The catheter tip terminates in the central vasculature, such as the superior or inferior vena cava near the junction with the right atrium.	Short or long term	Continuous or intermittent infusion of all infusions appropriate for both PIV and midline as well as antineoplastics, vesicants, known irritants, parenteral nutrition, antibiotics, and medications with a pH of less than 5 or greater than 9 and osmolarity of greater than 600mOsm/L.
Non-Tunneled Central Vascular Catheter (CVC)/ Tunneled CVC	The catheter tip terminates in the central vasculature, such as the superior or inferior vena cava near the junction with the right atrium.	Short term up to 30 days	All infusates as above, including continuous or intermittent infusion of antineoplastics, vesicants, known irritants, parenteral nutrition, antibiotics, and medications with a pH less than 5 or greater than 9 and osmolarity greater than 600mOsm/L.
Implanted Venous Port	The catheter tip terminates in the central vasculature, such as the superior or inferior vena cava near the junction with the right atrium.	Long term	All infusates as above, including continuous or intermittent infusion of antineoplastics, vesicants, known irritants, parenteral nutrition, antibiotics, and medications with a pH less than 5 or greater than 9 and osmolarity greater than 600mOsm/L. Recommended for patients for whom more than 6 weeks of vascular access is anticipated and for whom a PICC may not be the appropriate means of chemotherapy.

CONSIDERATIONS FOR DEVICE SELECTION [1]

The use of a structured approach, or algorithm, may assist in determining the most appropriate VAD for a patient. The clinician needs to be knowledgeable of and consider the following factors:

- Prescribed therapy
- Length of therapy
- Physical assessment
- Patient health history
- Support-systems resources
- Device availability, indications, limitations, precautions, and placement techniques
- Patient preferences
- Accomodations for the patient's vasculature, duration of dwell, and vascular integrity

PICCs

Indications [3]

Typically, PICCs can be indicated for both short-and long-term access to the central venous system for intravenous therapy, power injection of contrast media, central venous pressure monitoring, and blood sampling. (Check manufacturer's Indications for Use for specific catheter capabilities.)

Contraindications [3,4]

Typically, PICC's are contraindicated whenever:

- The patient is known or is suspected to be allergic to materials contained in the device.
- Past irradiation of prospective insertion site is noted.
- Previous episodes of venous thrombosis or vascular surgical procedures at the placement site occured.
- There is local tissue disturbance at the insertion site, such as dematitis, cellulitis, or burns. Caution should be taken and careful assessment completed prior to PICC placement in patients with contractures, mastectomy, existing thrombophlebitis, radiation therapy, pacemaker wires, crutch walking, and potential use of limb for AV fistula.
- The patient's body size is insufficient to accommodate the size of the implanted device.
- The presence of device-related infection, bacteremia or septicemia is known or suspected.

Check manufacturer's Indications for Use for specific catheter capabilities.

Vascular Access Device Selection *Evaluate Prescribed I.V. Therapy*

This is for informational purposes only and is not meant to replace clinical judgement.

- Length of therapy
- Number of lumens required
- Flow rates required
- Need for blood draws
- Patient preference, ability to cope/care for device
- Will patient be discharged on therapy

→ **DETERMINE pH/OSMOLALITY**

Consider

- *Risk for insertion compications*
- *Risk for post insertion complications*
- *Potential for change in therapy*
- *Current and potential activity level of patient*
- *Costs: device/ insertion/ maintenance*
- *Past medical history*
- *Current medical condition*

pH in range of 5-9
Osmolality < 600 mOsm/L
PERIPHERAL

Determine length of therapy

Short Term	Intermediate Term	Long Term
< 10 days	*> 10 days but < 4 weeks*	*> 4 weeks*

Venous Assessment

Good peripheral Veins	*Accessible Upper Arm Veins*	*Accessible Upper Arm Veins*	*Accessible Upper Arm Veins*	*Accessible Upper Arm Veins*
Yes	**Yes**	**Yes**	**Yes**	**Yes**
Short Peripheral I.V.	Midline or PICC	PICC	PICC	PICC
No	**No**	**No**	**No**	**No**
Midline	CVC	Tunneled CVC	CVC	Tunneled CVC or Port

pH< 5 or >9
Osmolality > 600 mOsm/L
CENTRAL

Determine length of therapy

Short Term	< 1 year	Long Term

Venous Assessment

[1,5,9,15]

Please consult the particular products Indications for Use for additional safety information including warnings, precautions, and additional contraindications.

INFUSATE CHARACTERISTICS [5]

It is estimated that ninety percent of all hospitalized patients receive some type of intravenous therapy; consequently, it is essential to consider infusate characteristics when selecting the appropriate vascular access device.

Irritant: An agent capable of causing itching, phlebitis, or reaction along the vessel or at the injection site.

Vesicant: An agent capable of causing blistering, tissue sloughing, or necrosis when it escapes from the intended vascular pathway.

This is for reference only and it is not meant to replace clinical judgment.
This list may not include all medications with irritant or vesicant properties. Consult your pharmacist.

Medications with Potential Vesicant Properties [6]

acyclovir
calcium chloride
calcium gluconate
carboplatin
carmustine
chlorothiazide
cyclophosphamide
dacarbazine
dactinomycin
daunorubicin
dextrose over 10%
dobutamine
docetaxel
dopamine
doxorubicin
edetate disodium
epinephrine
epirubicin
esmolol
etoposide
idarubicin
lorazepam
mannitol 10%–20%
mechlorethamine
methocarbamol
methotrexate
mitomycin
mitoxantrone
nafcillin
norepinephrine
oxaliplatin
paclitaxel
phenergan
pentamidine
pentobarbital
phenobarbital
phenylephrine
phenytoin
promethazine hydrocloride
sodium bicarbonate
streptozotocin
teniposide
tobramycin
TPN
vancomycin
vasopressin

Medications with Potential Irritant Properties [6]

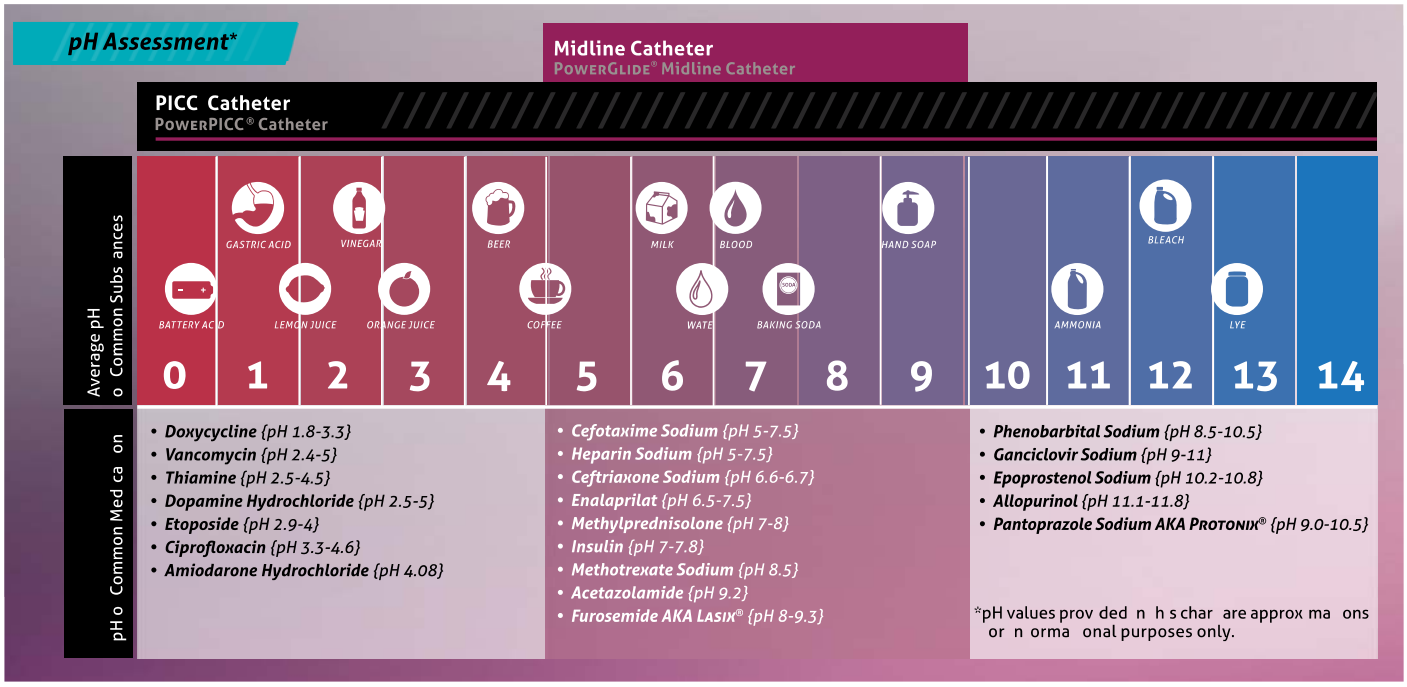
amiodarone
amobarbital
amphotericin b
ampicillin sodium
azithromycin
aztreonam
bleomycin
bortezomib
cefepime
cefotetan
cefoxitin
ceftriaxone
cefuroxime
ciprofloxacin
cisplatin
clindamycin
dantrolene
diazepam
dolasetron
doxapram
doxycline
erythromycin
foscarnet
ganciclovir
hemin
hydromorphone
ifosfamide
imipenem-cilistastin
immune globulin over 10%
indomethacin
irinotecan
iron dextran
octreotide
ondansetron
oxacillin
paclitaxel
pantoprazole
penicillin
pentostatin
piperacillin
PPN
polymyxin
potassium chloride
propofol
quinupristin-dalfopristin
levofloxacin
minocycline
meperidine
meropenem
metronidazole
midazolam
milrinone
nicardipine
nitroprusside
rifampin
rocuronium
sulbactam sodium
sulfamethazole
topotecan

Infusate pH [8,9,10,17]

The pH of an infusate can contribute to potential complications and can be a determining factor regarding the type of access device the patient requires.

The pH scale extends from 0 to 14, a value of 7 being neutral. Values lower than 7 are acidic; values higher than 7 are alkaline (base). Pure water has a pH of 7. The normal pH of blood is between 7.35 and 7.45. Intravenous fluids and medications can fall anywhere on the pH scale.

The image below shows the pH scale 1-14 (acid to base) with common substances by pH. Common medications are listed in their respective pH categories for reference.



[6]

Fluids within the body are contained in two basic compartments: intracellular and extracellular. Movement of fluids and electrolytes across these compartments play a vital role in maintaining homeostasis. Changes in the levels of concentration of solutes, expressed in a unit of measure called osmol (osm), influence the movement of water in and out of the cells.

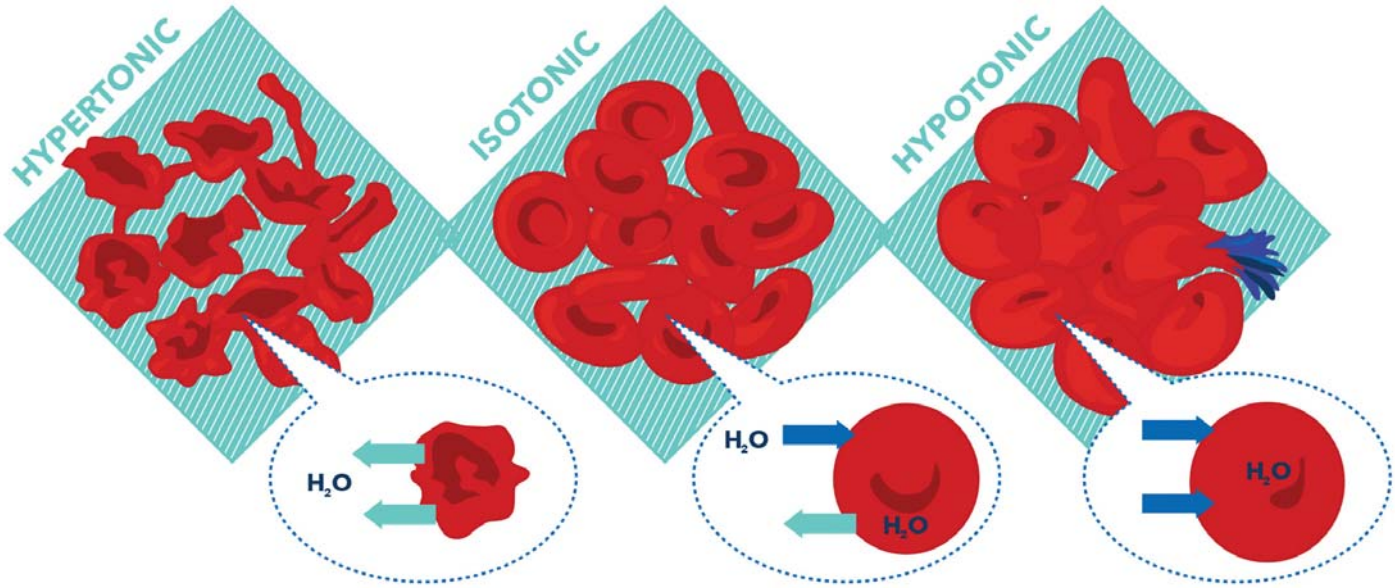
Osmolarity and Osmolality [9,10,15]

Osmolality refers to the concentration of solutes in a solution by weight. It is expressed as the number of miliosmols (mOsm) per kilogram (kg) of solution. The term osmolality is used when describing fluids within the body.

Osmolarity describes the concentration of solutes in a solution by number and is expressed as osm/L.

Tonicity [9,11,12,14]

Tonicity refers to the concentration of dissolved molecules held within a solution which affects the osmotic pressure of a solution. Osmotic pressure influences the movement of water across the cell membrane.



Hypertonic Solutions [10,19]

Hypertonic solutions cause the water from within a cell to move to the extra cellular fluid (ECF) compartment, where the concentration of salt is greater, causing the cell to shrink. Hypertonic solutions have an osmolarity of 375 mOsm/L or greater. These solutions are used to replace electrolytes. When hypertonic dextrose solutions are used alone, they are also used to shift ECF from interstitial tissue to plasma. Solutions with osmolarity of >600 are recommended to be infused through a central line. For example, hypertonic solutions, such as 3% NaCL, are used as volume expanders.

Isotonic Solutions [10,19]

Isotonic solutions have the same osmolarity as that of normal body fluids. Solutions that have an osmolarity of 250–375 mOsm/L are considered isotonic solutions and have minimal effect on the volume of fluid within the cell; the solution remains within the ECF space. Isotonic solutions are used to expand the ECF compartment. For example, isotonic solutions, such as normal saline, are used in cases of trauma to replenish fluid volume.

Hypotonic Solutions [10,17,19]

Hypotonic solutions contain less salt than the intracellular space and when infused have an osmolarity below 250 mOsm/L. Water moves into the cell, causing the cell to swell and possibly burst. By lowering the serum osmolarity, the body fluids shift out of the blood vessels into the interstitial tissue and cells. Hypotonic solutions hydrate cells and can deplete the circulatory system. For example, hypotonic solutions such as .45% NaCL could be used in diabetic ketoacidosis to shift fluids into the cell.

Infusates with pH of less than 5, greater than 9, or mOsmol greater than 600 may cause damage to the tunica intima if infused through a PIV and should be considered for infusion through a central line.

CATHETER FEATURES

Catheter Materials [9,12]

Most vascular access devices are constructed of silicone elastomers or thermoplastic urethane (polyurethane). The most common engineering characteristics used to describe the properties of both polyurethanes and silicone are tensile strength, ultimate elongation (stretchability), durometer (hardness), and flexible modulus (bendability without kinking).

All catheters, whether they are used for short- or long-term access, should have a radiopaque lateral strip or a radiopaque distal end for radiographic visualization of the tip location and for identification in the event of catheter fracture or embolus.

Material	Advantages	Disadvantages
Silicone	• High degree of flexibility. • Resistant to many chemicals (e.g.,alcohols). • Biocompatible.	• Thicker walls reduces flow rates.
Polyurethane	• Softens within the body after catheter insertion. • Biocompatible. • Thinner walls mean higher flow rates. • Less thrombogenic than silicone. • Lower infection rates for candida.	• Exposure to alcohol or ethanol may weaken the catheter.

Catheter Size and Lumen Configuration [5,9,13]

The CDC guidelines recommend the use of a CVC with the minimum number of lumens which are essential for the prescribed therapy.

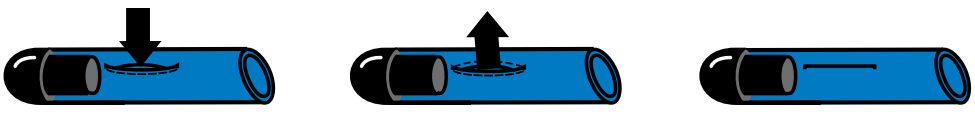
PICCs are available in single-, dual-, and triple-lumen configurations making them more versatile, particularly in patients requiring multiple simultaneous infusions.

Reverse taper PICCs are graduated in size from the catheter tip to the hub, which supports superior kink resistance and may help prevent bleeding at the insertion site.

Valved vs. Non-Valved Technology [9]

PICCs are constructed to be valved or non-valved. A valved catheter has (an) intricate valve(s) within the catheter, either at the distal tip or at the proximal end of the catheter. When the catheter is not in use, the valve reduces reflux of blood into the catheter and reduces the risk of air embolism by remaining closed. Clamping is not required with valved catheters because the valve remains closed except during infusion and aspiration.

Distal Valved Catheter



Proximal Valve

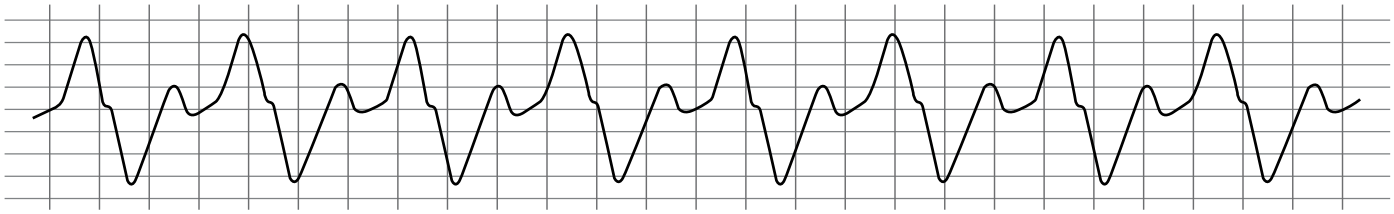
Power-Injectable PICCs [13]

The recent demand for power-injectable devices has brought about the technological advancement of power-injectable PICCs. It should be noted that only PICC products that are indicated for power injection, as determined by the manufacturer's Indications for Use (IFU), should be used for this application. Subjecting conventional PICCs to power injection is typically contraindicated and could result in catheter fracture, catheter embolus, and extravasation. Catheters indicated for power injection should be labeled as such by the manufacturer.

Hemodynamic Monitoring [13]

Obtaining reliable central venous pressure (CVP) data from open-ended catheters requires a continuous, patent column of fluid from the catheter tip to the pressure transducer, allowing the signal to travel like a wave. The catheter lumen should be at least 18 to 20 gauge in size as larger lumens provide the best fidelity.

Occurences such as kinks, air, or intraluminal occlusions can disrupt the signal transmission and dampen the wave form. Utilizing a continuous-pressure infusion device connected directly to the hub of the catheter helps to maintain a patent fluid column and improves signal transmission. The presence of needleless injection caps or valves may interfere with the signal, and an adapter may be necessary to provide an open channel. Brisk catheter flushing immediately prior to obtaining data may improve catheter patency and enhance signal transmission.



SUMMARY [1,3,5,7,9,15,16]

This chapter has described common vascular access devices (VADs) and criteria for determining when each one should be used. It has also discussed infusate characteristics. It is important that clinicians be knowledgeable about the available VADs, their different Indications for Use, and infusate characteristics to select the most appropriate VAD for each patient. Even though different VADs have been discussed in this chapter, the remainder of the training manual will focus exclusively on PICCs. The following chapter will discuss how to prepare for PICC placement.

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Preparing for PICC Insertion

OVERVIEW [1,2,7,8,9,10,12,13,14,18,19]

Prior to inserting a PICC, it is important that clinicians understand and perform certain preparation steps. These steps include evaluating the patient, his/her medical history, and his/her vascular condition; educating the patient about the medical care and treatment; obtaining a physician's order and informed consent; complying with requirements for a maximal sterile barrier (MSB) to mitigate the risks for infection; and verifying through a "time-out" that the correct data is on file and the procedure is still the appropriate thing to do. This chapter will discuss all of these preparation steps.

OBJECTIVES

- Identify required elements of informed consent.
- Understand patient and vessel assessment required for PICC insertion.
- Understand how to educate patients and caregivers about PICC insertion.
- Understand measurement techniques related to PICC insertion.
- Identify universal precautions, sterile technique, and maximum barrier precautions pertaining to PICC insertion.
- Discuss patient verification and universal time-out.

This section is intended to provide a general overview of basic techniques and procedures, and does not replace clinical training or judgement. Users should refer to product Instructions for Use, manufacturers' indications and/or contraindications for any device as well as applicable facility protocols.

INFORMED CONSENT

A patient's right to informed consent includes knowing and understanding what health-care treatment is being undertaken.

Clinical elements of informed consent [10]

- The patient's diagnosis and name of the treatment, procedure, or medication.
- An explanation of the treatment, procedure, medication, and intended purpose.
- The hoped-for benefits of the proposed regiment (with no guarantee as to the outcome).
- The material risks, if any, of the treatment, procedure, or medication.
- Alternative treatments, if any.
- The prognosis if the recommended care, procedure, or medication is refused.

Documentation of informed consent [8,10]

The manner most often used to denote informed consent is the consent form. The consent form is used as a supplement to the dialogue required between the patient and the health-care provider in obtaining consent.

Once informed consent is given and the form is signed, the consent is typically valid unless or until it is retracted by the patient or a change in condition renders the informed consent invalid.

The health-care provider shall confirm that the patient's informed consent was obtained for the defined procedure as identified in facility protocols and/or practice guidelines and in accordance with local, state, and federal regulations.

The health-care provider should ensure that informed consent includes, among other requirements, the following elements:

- Documents written at or below the 5th-grade reading level and provided in the primary language of the patient.
- Provision of a qualified medical interpreter or reader to assist patients with limited language proficiency, limited health literacy, and visual or hearing impairments.
- Patient-centered information that is adequate and meaningful to the individual.
- A dialogue with the patient and, as appropriate, the family or other decision makers about the nature and scope of the procedure.

Who obtains consent [10]

The physician is the one who has the primary duty to obtain the informed consent of the patient for medical care and treatment. Other independent health-care providers, such as nurse anesthetists or surgeons, are responsible for obtaining informed consent for their particular procedures. For procedures performed by a nurse, the nurse would be the appropriate provider to obtain the consent. Refer to your own facility's policies with respect to obtaining informed consent.

PRE-INSERTION ASSESSMENT

After a physician order and consent are obtained, assessment of the patient should be performed. This may include reviewing the patient history, diagnosis, renal function, infusates, and duration of therapy. These factors may determine if the patient is suitable for PICC placement.

Patient Assessment [1,2,3,5,7,8,12]

Thorough pre-insertion patient assessment should include, but is not limited to, the following:

- Obtain and review the physician order for the PICC.
- Verify the patient's identity using two independent identifiers. (For more information on this refer to section entitled "Verification and Time-Out.")
- Medical diagnosis and prognosis.
- Patient condition, such as medication profile, coagulation status, and renal function.
  Note: *In patients with CKD stage 4 or 5, forearm and upper-arm veins suitable for placement of VADs should not be used for venipuncture or for placement of intravenous (IV) catheters, subclavian catheters, or PICCs.*
- Past medical/surgical history.
- Co-morbidities, such as diabetes, steroid use, edema, lymphedema, vein harvesting, intravenous stent placement, and the presence of other devices, such as defibrillators or pacemakers.
- Relevant radiographic studies, including a recent frontal-chest radiograph, provide valuable information concerning existing intrathoracic devices (e.g., pacemaker, automatic internal cardiac defibrillator (AICD), CVC, presence of intrathoracic mass, etc.), as well as in the determination of appropriate catheter length for achieving optimal catheter-tip position. Venogram studies, computed tomography (CT), and magnetic resonance imaging (MRI) may provide valuable information concerning aberrant vascular anatomy and/or vascular thrombosis/stenosis.
  Note: *The presence of a pacemaker requires careful evaluation and thorough assessment to select the appropriate catheter and insertion site. The contralateral side is preferred for placement of a central vascular access device (CVAD), but if the ipsilateral side is selected, a PICC may be the safest choice.*
- Previous history of infusion therapy (peripheral or central), including devices, therapies, and outcomes.
- History of intravenous drug use.
- Patient age—older patients may experience diminished renal function and cardiovascular changes.
- Allergies.
- Type and duration of infusion therapy.
- Patient preference.
- Mentation (e.g., level of cooperation or mental status).
- Hydration status—dehydration may result in poor venous filling.
- Activity and/or mobility level (e.g., the use of crutches, walkers, or transfer aids).
- Language and/or cultural barriers.

Vessel Assessment

The site chosen for inserting a PICC will depend on the patient's vasculature. The skin surrounding the intended insertion site should be visually assessed. Vessel assessment via ultrasound should be performed when possible.

Insertion-site selection should include consideration of the following: [2,8,9,21]

- Vessel size (recommended size is 3 times that of the catheter).
- Vessel location and path.
- Vessel health.
- Vessel compression—veins should compress easily with light to moderate pressure and be nonpulsatile.
- Condition of the skin at the intended insertion site.
- Condition of the vasculature at the insertion site and proximal to the insertion site.
- Avoid areas of pain on palpation and veins that are compromised (e.g., bruised, infiltrated, phlebitis, sclerosed, or corded).
- Circulatory status (e.g., impaired circulation, lymphedema, post-operative swelling).
  Note: *Veins in an upper extremity should be avoided on the side of breast surgery with axillary-node dissection, after radiation therapy to that side, with lymphedema or the affected extremity from a cerebrovascular accident.*
- An insertion site above the antecubital fossa to prevent mechanical irritation or kinking of the catheter when the arm is in movement.

PATIENT AND CLINICIAN EDUCATION [8,22]

Patient and/or caregiver education should begin with an assessment of their baseline knowledge and include expectations of placement, verification, potential complications, and care and maintenance of the PICC.

Education may include, but is not limited to the following:

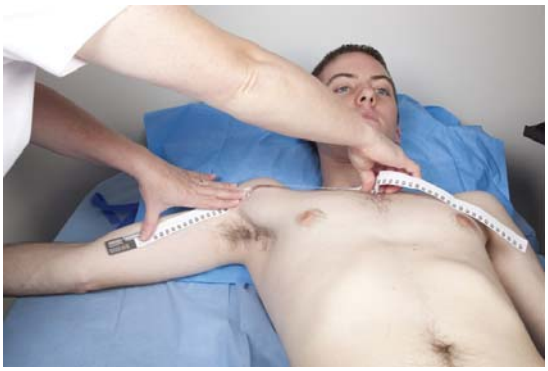
- Expectations of the procedure for inserting a PICC and verifying its placement.
- Proper hand hygiene and aseptic technique to prevent infection.
- How to care for and maintain the PICC, including flushing and dressing changes.
- How to safely store, maintain, and dispose of PICC supplies.
- Prevention and identification of potential complications.
- Prevention and identification of infection.
- How and when to report issues with the PICC.
- Limitations to and management of activities pertaining to activities of daily living with a PICC.

POSITIONING AND MEASURING TECHNIQUES [1,18,19]

Prior to PICC insertion, the patient should be in bed and lying flat, if possible, to facilitate the procedure. Measuring the approximate length of catheter required can ensure the appropriate length catheter is selected.

- Perform hand hygiene per facility protocol.
- The patient should be positioned supine with arm at a 90-degree angle, when possible, to assist with accurate measurement and prevention of possible complications.
- Identify the proposed PICC-insertion site as determined by pre-insertion assessment.
- Measure the distance from the intended insertion site to the desired terminal tip location. When possible, measure directly on the patient's skin. In centimeters (cm) measure the path from the planned insertion site, using the following external landmarks:

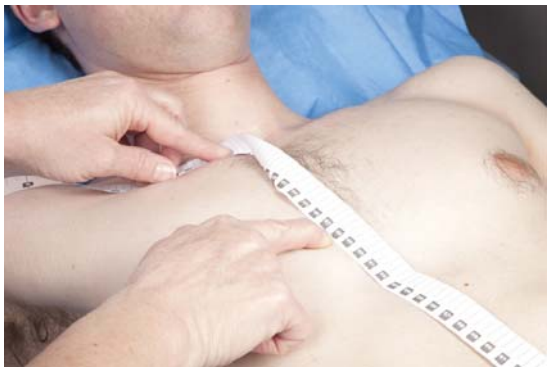
Measuring



[14]

1. Measure from the insertion site to the axillary crease.

2. Measure from the axillary crease to the right clavicular head. This applies to both right-and left-sided insertions.



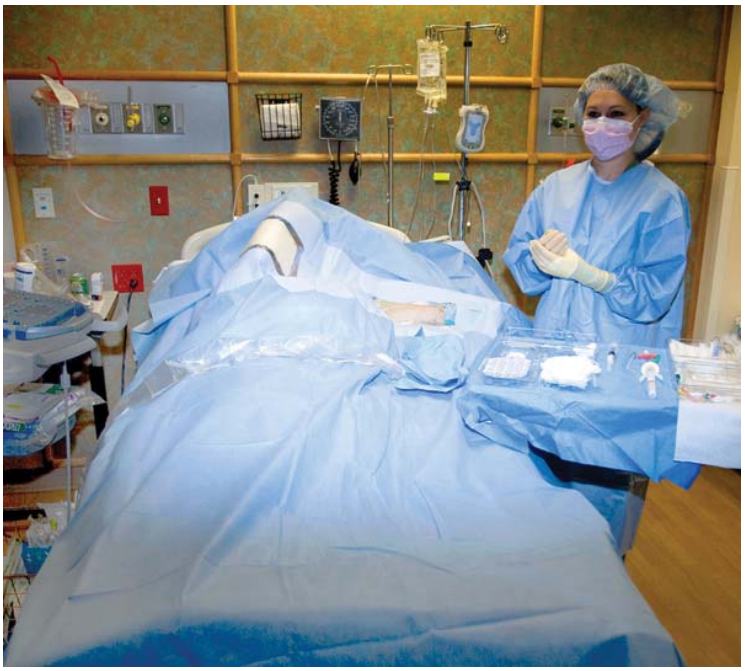
[14]

3. Measure from the right clavicular head to the right sternal border of the third intercostal space.

Note: *The external measurement can never exactly duplicate the internal venous anatomy.*

MAXIMAL STERILE BARRIER (MSB) PRECAUTIONS [13,14]

For the clinician placing the PICC and for those assisting in the procedure, maximal barrier precautions means strict compliance with hand hygiene and wearing cap, mask, sterile gown, sterile gloves, and utilizing a maximum-barrier patient drape.



Hand hygiene [12,23]

Hand hygiene is a standard precaution and should be performed prior to contact with the patient, whenever contamination occurs, and after the procedure.

Procedure [12,23]

1. Remove all jewelry and ensure sleeves are above the wrists.

2. Adjust water to a warm temperature.

3. Wet the hands thoroughly with water.

4. Follow the manufacturer's directions for application of soap.

5. Lather soap and rub the hands together, including between fingers, palms, and backs of hands.

6. Keep the hands lower than the elbows.

7. Wash the hands for at least 15 seconds.

8. Rinse the hands to remove all soap.

9. Dry the hands thoroughly with a disposable towel.

10. Use a disposable towel to turn the water off.

Cap [12,15]

All personnel in the procedure room should cover their head, even bald heads, and facial hair, including sideburns and the nape of the neck.

The following should be considered:

- A clean, low-lint surgical head cover or hood that confines all hair and covers the scalp should be worn. The head cover or hood should be designed to minimize microbial dispersion.
- Reusable head coverings should be laundered in a health-care-accredited laundry facility after each daily use.
- A cap or hood should be put on before the gown to protect the garment from contamination by hair.

Procedure [23]

1. Secure hair.

2. Put the cap over head.

3. Ensure all hair is inside the cap.

Mask [12,15,23]

A single-use mask should be worn during PICC insertion to protect the inserter from sprays of blood and body fluids and to protect the patient from infectious agents carried in the inserter's mouth or nose.

Consider the following:

- The mask should cover the mouth and nose and allow pinching to secure it at the nose.
- The mask should be tied securely above the ears and at the neck to prevent contamination of the sterile field.
- A new mask should be worn for each procedure.
- Masks should be worn before and during the PICC procedure.

Procedure

1. Locate the top of the mask (usually has a metal strip along edge).

2. Ensure the mask is over the bridge of the nose and tie the top two strings above the ears and at the back of head.

3. Ensure the mask is under the chin and tie the bottom two strings at the nape of the neck.

Sterile Gown [14,15,16,23]

A sterile gown is worn to maintain sterility between the wearer and the sterile field.

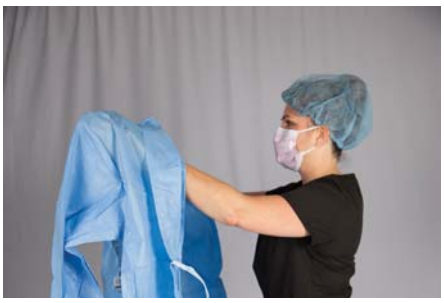
The following points should be remembered:

- Sterile gowns should be donned away from the sterile field.
- Sterile gowns should be sufficient in size to cover all of the clothing under the gown. The front of the gown is considered sterile from the chest to the level of the sterile field. Gown sleeves are considered sterile from 2 inches above the elbow to the cuff.
- The neckline, shoulders, underarms, sleeve cuffs, and gown back are considered nonsterile.
- Sterile gloves must cover the cuffs of the gown completely to prevent contamination of the sterile surface.
- The cuffs of the gown are considered contaminated.
- The sleeves should be long enough so the cuffs cover the wrists.
- The sleeves should not be pulled up.
- Sterile gowns should be fluid resistant to prevent blood and body fluids from permeating.

Gowning Procedure [14,15,23]

The following is the procedure for donning a wrap-around, sterile surgical gown:

1. Pick up the gown from the sterile wrapper, touching only the inside near the collar by the shoulders.



2. Locate the arm holes. With the gown away from you, allow the gown to unfold.

3. With the arms at eye level, allow the arms to slip in the sleeves but not through the cuff.

4. An assistant should be standing behind the wearer to tie the gown at the waist.

5. The assistant shall tie the gown at the neckline.

6. After donning sterile gloves, the wearer should remove the left short tie from the tag.

7. Holding the left tie, the tag should remain attached to the right tie.

8. Hand the tag with the right tie attached to it to the assistant. The assistant will bring the tag with the tie behind the wearer to their left. The wearer can then pull the tie from the paper tag.

9. The wearer then ties the long right tie to the short left tie at the side of the gown.

Gloving [14]

PICC insertion is an invasive procedure requiring sterile technique. After donning a sterile gown, the clinician should apply sterile gloves. There are two techniques for sterile gloving, which include open and closed gloving.

Open-Gloving Technique [14,15]

Gowning for the open-gloving method is the same as it is for the closed-gloving method; the only difference is that the scrubbed person extends the hands all the way through the cuffs and sleeves, leaving the hands totally exposed outside the cuffs. This method is not recommended for the person establishing the sterile field, but is helpful when changing a contaminated glove. Either hand can be gloved first.

The open-gloving method uses a skin-to-skin, glove-to-glove technique. The hand, although scrubbed, is not sterile and must not contact the exterior of the sterile gloves. The folded cuff on the gloves exposes the inner surfaces. The first glove is put on with the skin-to-skin technique, bare hand to inside cuff. The sterile fingers of that gloved hand then may touch the sterile exterior of the second glove (i.e., glove-to-glove technique).

1. With the right or left hand, grasp the inner edge of the cuff of the opposite glove and lift the glove from the wrapper. Take care not to touch the inner aspect of the wrapper or the sterile exterior portions of the glove.

2. Insert a hand into the glove, pulling the glove on and leaving the cuff turned down well over the hand. Be sure to keep the thumb adducted into the palm of the hand until it is well inside the confines of the glove. Do not adjust the cuff; this will be done as a last step.

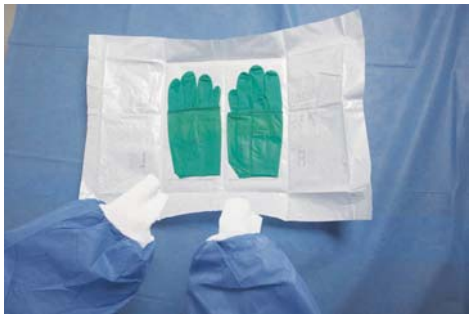
3. Slip the fingers of the sterile-gloved hand under the other everted cuff on the sterile side of the glove. Pick up the glove and step back.

4. Align the fingers of the non-gloved hand and insert the hand into the glove, keeping the thumb adducted until all fingers are well inside the glove. Pull the glove on all the way, unfolding the cuff and enclosing the knitted cuff at the wrist.

5. Pull the cuff of the other glove up and over the knitted cuff of the sleeve. Avoid touching the bare wrist; sterile surfaces should touch only sterile surfaces.

Closed-Gloving Technique [14,15]

During the closed-gloving process the scrub person should keep his/her hands inside the cuffs of the sterile gown. Either hand can be gloved first when establishing the sterile field.



1. If the gloves are still in the folded inner-paper wrapper, they need to be opened. Using the cuff-covered hands, place the wrapper in front of you like a book on a sterile surface. Open the two sides. There is an inner fold to the glove wrapper. With the two cuff-covered hands grasp the lower inner corners of the bottom fold. Lift both corners open and fold under at the same time. When this method is used, the wrapper will remain open during the gloving process.

2. With the cuff-covered hand, pick up a glove from the inner wrap of the glove package by grasping the glove fingers, lifting the glove straight up, and placing the glove on the palm thumb-side down. The glove fingers should be pointing toward the body.

3. Grasp the edges of the glove cuff with the cuff-covered hand and the opposite edge with the other hand. Peel the glove over the cuff-covered hand and over the end of the sleeve and wiggle the fingers to extend them into the glove-covered hand.

4. The cuff of the glove is now over the stockinette cuff of the gown with the hand still inside the sleeve. Grasp the cuff of the glove and underlying gown sleeve with the covered other hand. Pull the glove on over the extended fingers until the glove is completely on and the glove cuff completely covers the stockinette cuff of the gown.

5. Reversing hands, glove the other hand in the same manner.

Draping [14,15]

Draping is the procedure of covering the patient and surrounding areas to create a sterile barrier. An effective barrier may eliminate the passage of microorganisms between nonsterile and sterile areas.

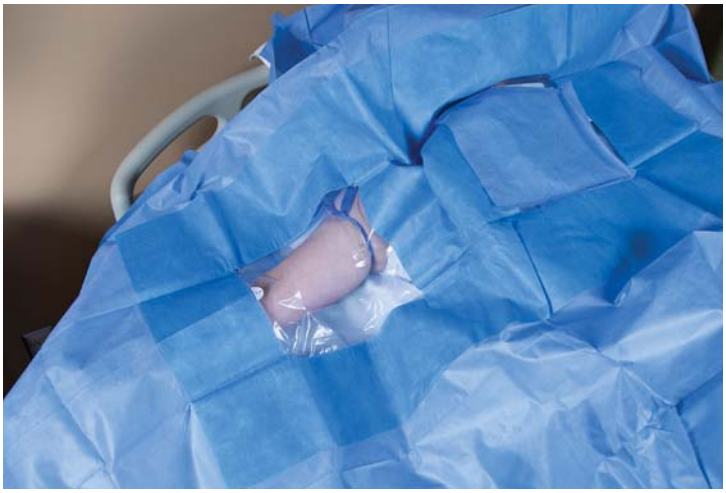
Drapes should be:

- Blood and fluid resistant to keep drapes dry and prevent migration of microorganisms between nonsterile and sterile areas. Material should be impermeable to moist microbial penetration (i.e., resistant to strike-through).
- Resistant to tearing, puncture, or abrasion that causes fiber breakdown and thus permits microbial penetration.
- Lint-free to reduce airborne contaminants and shedding onto the surgical site.

Fenestrated sheets [14,15,16]

The drape sheet has an opening (fenestration) that is placed to expose the anatomic area where the insertion will be made. The size, direction, and shape of the fenestration vary to give adequate exposure of the surgical site. Fenestrated sheets are usually marked to indicate the direction in which they should be unfolded. This may be an arrow or label designating the top/head and bottom/foot.

Most fenestrated sheets are fan-folded toward the opening from the top and the bottom, and the folds are rolled or fanned toward the center of the opening. The edges of the top and bottom folds of the sheet are fanned to provide a cuff under which the scrubbed person may place his or her gloved hands. The top and lower sections should be identified by markings to facilitate easy handling.



The following should be considered: [15,16]

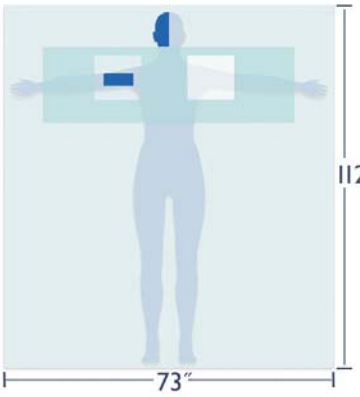
- Place drapes on a dry area. The area around or under the patient may become damp from solutions used in skin preparation. Remove damp items or cover the area to provide a dry field on which to lay sterile drapes.
- Allow sufficient time to permit careful application.
- Allow sufficient space to observe sterile technique. Do not reach across a nonsterile surface.
- Handle sterile drapes as little as possible; movement of draping materials creates air currents through which dust, lint, and other particles can migrate.
- Never reach across the bed to drape the opposite side.
- Hold sterile drapes above waist level until they are properly placed on the patient or device being draped. If the end of a drape falls below waist level, it should not be retrieved because the area below waist level is considered unsterile.

- Carry folded drapes to the bed. Watch the front of the sterile gown; it may bulge and touch the nonsterile bed. Stand well back from the nonsterile bed.
  - Hold a drape high enough to avoid touching nonsterile areas.
  - Hold a drape high until it is directly over the proper area and then lay it down where it is to remain.
  - Once a sheet is placed, do not adjust it. Be careful not to slide the sheet out of place when opening the folds.
  - Protect gloved hands by cuffing the end of the sheet over them. Do not let gloved hands touch the skin of the patient.
  - Control all parts of the drape at all times during placement, using precise and direct motions.
- When unfolding a sheet from the prepped area toward the foot or head of the bed, protect the gloved hand by enclosing it in a turned-back cuff of a sheet provided for this purpose. Keep hands at table level.
  - Do not flip, fan, or shake drapes. Shaking a drape results in uncontrolled motion of the drape, which may cause it to come into contact with an unsterile surface or object. A drape should be carefully unfolded and allowed to fall gently into position by gravity.
- Drape the procedural area first and then the periphery. Always drape from a sterile area to an unsterile area by draping the near side first.
- If a drape becomes contaminated, do not handle it further. Drop it and use another drape. Discard it without contaminating gloves or other items.
  - If the end of a sheet falls below waist level, do not handle it further. Drop it and use another sheet.
  - If in doubt as to the sterility, consider a drape contaminated.
  - If a drape is incorrectly placed, discard it.
- If a hole is found in the drape after it is laid down, the hole must be covered with another piece of draping material. Use judgment in considering whether covering or discarding the drape is appropriate. Discarding the drape is ideal if at all possible.
- A hair found on the drape must be removed and the area covered immediately.

Procedure for draping the patient: [17]

1. Remove full body fenestrated drape from the PICC-insertion kit.

2. Determine whether the patient will need a left- or right-side placement. Remove the appropriate liner to reveal the fenestration.
  - For left-sided placements, remove the liner “LEFT.”
  - For right-sided PICC placements, remove the liner “RIGHT.”



3. Place the exposed fenestration securely on the patient’s arm over the planned insertion site (press firmly to ensure adhesion to the arm).

4. Ensure the drape is properly aligned, that is, “Head” points to the head of the bed and “Foot” points to the foot of bed.

5. Unfold the drape to each side of the patient.

6. Unfold the drape to the feet of the patient. Ensure that the drape is fully extended, covering the patient’s feet.

7. Unfold the drape to cover the patient’s head.

8. If necessary, perforate the drape to reveal the patient’s head.

9. Continue preparation for the PICC insertion as determined by hospital protocol.

VERIFICATION AND TIME-OUT [20]

The purpose of pre-procedure verification is to correctly identify the patient and ensure the correct procedure is being performed. The following points should be remembered:

- Prior to PICC insertion the patient should be identified using a minimum of two identifiers. Examples of identifiers include the patients name, medical number, and date of birth.
- Relevant documents and information related to the PICC insertion should be:
  - Available prior to starting the procedure.
  - Labeled with the patient's identifier.
  - Reviewed prior to the procedure.
- A time-out should be performed immediately before starting the PICC insertion. The purpose of the time-out is to conduct a final assessment on whether the correct patient, site, and procedure were identified.
- During the time-out, the team members should agree, at a minimum, on the following:
  - Correct patient identity.
  - Correct site.
  - Procedure to be done.
- Document the completion of the time-out.
  Note: *The hospital determines the amount and type of documentation.*

SUMMARY [1,2,10,21,24]

This chapter has discussed patients' right to know what PICC insertion entails. Also discussed were recommendations for both clinicians and patients on how to mitigate any complications, such as insertion-related bloodstream infections. Finally, the chapter explained patient verification and time-out so that clinicians can be sure the appropriate procedure is performed on the correct patient. The next chapter will discuss PICC placement.

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Inserting a PICC

OVERVIEW

There are different techniques and technologies for inserting a PICC. This chapter discusses the peel-away sheath technique, modified Seldinger technique (MST), Seldinger technique, landmark approach, ultrasound guidance, and magnetic tip tracking. Clinicians should be familiar with each of these, as they have varying rates of success. This chapter provides the basic steps to insert a PICC using these different techniques.

OBJECTIVES

Understand techniques for PICC insertion including:

- Peel away and Break-Away Needle
- Modified Seldinger Technique
- Seldinger
- Landmark approach
- Ultrasound guidance
- Magnetic tip tracking

Understand PICC insertion procedures including:

- Basic
- Utilizing guidance
- Utilizing ECG
- Understanding different methods of inserting a PICC

This section is intended to provide a general overview of basic techniques and procedures, and does not replace clinical training or judgement. Users should refer to product Instructions for Use as well as applicable facility protocols. Manufacturers' indications and/or contraindications for any device should be followed and may vary per manufacturer.

TECHNIQUES FOR PICC INSERTION

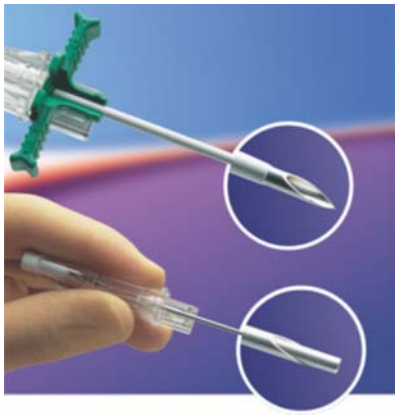
Peel-Away Sheath Technique [7,21]

INDICATIONS: The Safety Excalibur™ Introducer is intended for access of peripheral veins for the placement of PICC and Midline catheters.

The traditional peel-away cannula is similar to those of IV catheters with a needle safety mechanism. The venipuncture is done in a visible or palpable vein. The blood return is seen in the flashback chamber. The needle is blunted as it is removed from the introducer catheter. The catheter is then inserted and advanced and the introducer is removed.

Note: *Not all peel-away cannula incorporate needle safety mechanisms.*

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.



Excalibur Needle

Modified Seldinger Technique (MST) [7,8,9,22]

This Microintroducer Kit is an introducer system designed for access of peripheral veins using minimal insertion techniques for the placement of PICC and Midline catheters.

Modified Seldinger Technique (MST), is a minimally invasive approach to PICC placement. It has been shown to increase the likelihood of success, particularly in target sites above the antecubital fossa. It also minimizes local tissue and vessel trauma and the risk of artery or nerve injury. The essential components of the micro-introducer technique include a needle, guidewire, dilator-introducer sheath, and scalpel.

MST involves establishing initial venous access with a relatively small needle, followed by guidewire insertion. The needle is removed and a small skin nick is made to facilite insertion of the dilator/introducer sheath which is threaded over the guidewire. The guidewire and dilator are then removed. Next, the catheter is advanced through the introducer and the introducer is then removed.

Access can be established with a small bore peripheral IV cannula or the micro-introducer needle.

MST Kit

PEEL-AWAY SHEATH TECHNIQUE [8,10,21,26,33]

Conventional PICC introducer as large as 14 gauge.

Does not use a guidewire.

May have a needle equipped with a self-activating anti-stick mechanism.

Avoid sharp or acute angles during implantion that could compromise the patency of the catheter lumen(s).

A review of the literature shows insertion success rates using the peel-away needle method to range from 60-70% success rates (AVA Position Statement 2011.)

vs.

MODIFIED SELDINGER TECHNIQUE [8,11]

A small needle is utilized to access a vein regardless of the size of the catheter.

Utilizes a guidewire. It protects vessel patency. The wire will not advance easily in a stenosed or thrombosed vessel.

Insertion of PICCs using the micro-introducer technique may improve the practitioner's ability to access veins above the antecubital fossa, particularly when paired with imaging technology, such as ultrasound.

Same size access needle or IV cannula can be utilized to insert catheter sizes 3 French and larger.

Patients may find placement higher in the arm more comfortable, allowing for full range of motion.

Increased success rates of PICC insertion and less venous trauma.

Avoid sharp or acute angles during implantion that could compromise the patency of the catheter lumen(s).

Seldinger Technique [9,8,22]

The Seldinger technique is a method of inserting a vascular-access catheter percutaneously into a blood vessel. The vessel is accessed with a needle, and a guidewire is placed through the needle. The needle is then removed, and a catheter is placed over the guidewire and advanced to the desired location. The guidewire is then removed, leaving the catheter in place.

When utilizing the Seldinger technique for PICC insertion, observe the following precautions:

- Never advance a PICC over a wire that is shorter than the PICC. The wire should be at least 30 cm longer than the PICC.
- Do not advance wire past the axilla without fluoroscopic guidance.

Landmark Approach[1]

- Puncture of a palpable vessel based upon anatomical structures.
- Does not require extensive additional equipment
- Limitations of this technique
  - Placing VADs using anatomical landmarks can be problematic due to significant anatomic variation.
  - Puncture-related complications are higher overall using the landmark technique.
  - Complications increase as the number of attempts increase.

USING ULTRASOUND GUIDANCE [1,23,24]

Ultrasound technology utilizes a probe that transmits sound waves through the tissues. Depending on the density of the tissue, fluid, or bone, sound waves are bounced back to the probe. These sound waves are converted to an image displayed on the ultrasound screen. The denser the structure, the darker the image viewed on the ultrasound screen. Veins and arteries can be identified.

Real-time ultrasound-guidance technique involves using ultrasound to guide a small gauged needle into the selected vein. Veins can be accessed that cannot be felt or seen by the naked eye.

Ultrasound Guidance Technique

Advantages [1,4,5]

- Portable (assuming use of portable ultrasound machine)
- Provides real-time imaging of veins, arteries, needles, and wires
- Assess patency of the vessel
- Doppler mode on some machines may be used to assess blood flow
- Decreases potential for arterial puncture
- Increases success on insertion
- Decreased trauma
- More patients are potential PICC candidates.
- Allows access to larger, deeper veins of the upper arms
- Fewer referrals to Interventional Radiology
- Decrease in mechanical phlebitis
- Increased patient satisfaction and comfort
- Provides non-invasive, non-ionizing imaging, reducing radiation exposure

Disadvantages [1,5]

- Initial capital investment
- Disposable equipment is required
- Requires new hand-eye coordination
- Requires experience for proficiency

Terminology Applicable to Ultrasound [2,3,7]

The ultrasound wave emitted from a transducer.

Depth and Gain

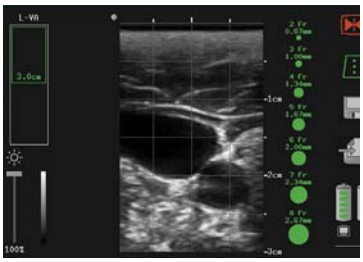
Two basic functions to optimize image on the ultrasound screen. The gain should be adjusted until there is a slight fill-in with echos or white flecks in the vein. The depth should be adjusted so that the view of the target structures is maximized while allowing structures posterior to the target to also be seen.

Brightness/Contrast

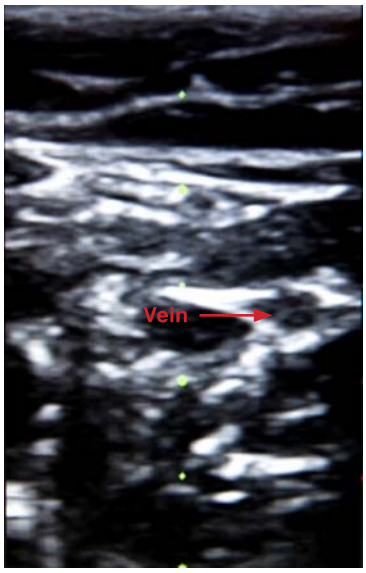
Adjust brightness/contrast to assist with visualization in different environments.

Features

The standard ultrasound screen may display hash marks or dots that are placed at 0.5 cm intervals. Using these markings, one can determine the depth of the image vessel from the skin surface.

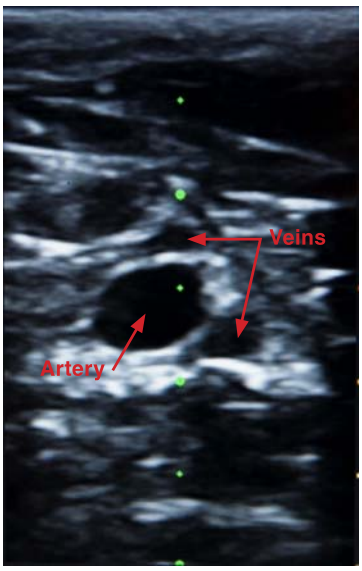


Differentiating Veins from Arteries using Ultrasound [1,3,7]



Veins

- Applying pressure to the tissue under the transducer normally causes veins to compress.
- Fluid-filled structures, such as veins, should appear black or anechoic.
- A vein should compress easily. If it doesn't compress, compresses unevenly, or appears opaque, it may be a sign of thrombosis.



Arteries

Arteries may compress with pressure, but they will generally pulsate with minimal compression.

Longitudinal View[7]

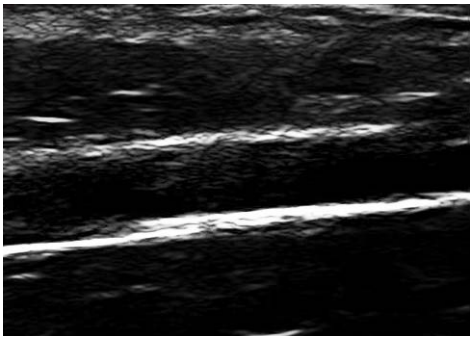
The transducer is parallel along the long axis of the vein to facilitate imaging of the device and guidewire advancement.

Advantages

- Entire needle can be visualized as it advances and enters the vein.
- Depth orientation is better with this approach.

Disadvantages

- Poor lateral resolution.
- Needle located just to the side of the vessel can appear to be in the same plane.



Transverse View[7]

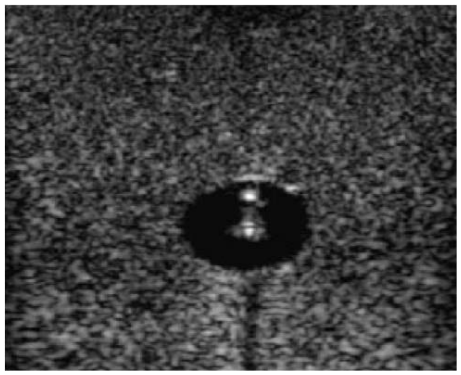
The transducer is perpendicular to the vein to facilitate imaging of the needle and guidewire as they enter the vein.

Advantages

Better lateral resolution, which results in higher success rate.

Disadvantage

- Challenge of not losing sight of needle tip.



CATHETER-TIP NAVIGATION [7,8,9,10]

INDICATIONS: Catheter stylets provide internal reinforcement to aid in catheter placement. The Sherlock™ II TLS Stylet contains passive magnets that generate a magnetic field. This field can be detected by the Sherlock™ II TLS Detector to provide the placer rapid feedback on catheter tip location.

The Sherlock™ II Tip Location System (TLS) detector quickly locates the position of specially designed, magnet-tipped Peripherally inserted Central Catheters (PICCS) and Central Venous Catheters (CVCs) during and after initial placement. This device may be used by appropriate caregivers in hospitals, long-term care facilities or home-care settings. The Sherlock™ II TLS detector provides rapid feedback to the caregiver but was not designed to replace conventional methods of placement verification. Users are urged to confirm correct placement according to their established facility protocol and clinical judgment.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Some catheter navigation systems use a stylet in the catheter that is magnetic, allowing it to be tracked externally by a sensor. The navigation systems can be portable, hand held, battery operated, and provide audible and visual indicators. Some devices may be compatible with or integrated into ultrasound systems. The navigation systems provide real-time directional guidance of the catheter-tip as it is advanced, allowing the inserter to detect obvious catheter malpositions. Navigation systems are generally unable to determine the exact location of the catheter-tip within the anatomy and are not designed to replace conventional methods of verification.

To reduce potential interference with the magnetic tip-location equipment, cell phones, watches, pagers, name tags, jewelry, and motor-driven equipment must be removed or placed at least 5 feet away from the patient.

INSERTING A PICC

Preparing for insertion [7]

1. Perform hand hygiene per facility protocol.

2. Verify the patient's identity using two independent identifiers. *(refer to section entitled "Verification and Time-Out.")*

3. Perform pre-procedural patient assessment, education, and consent per facility protocol.

4. Gather supplies, which may include, but are not limited to, the following:

- PICC kit (verify package integrity and expiration date)
- Ultrasound machine and coupling gel
- Needleguide kit (optional) and sterile ultrasound probe sheath and coupling gel
- *If* not included in catheter kit:
  - Extra antiseptic applicators
  - Catheter stabilization device
  - Catheter dressing
  - Sterile 4x4's, 2x2's and sterile surgical adhesive strips
  - Chlorhexidine-impregnated sponge as per facility protocol
  - Needleless connector and/or add-on device
  - Sterile 10 mL syringes and preservative-free 0.9% sodium chloride (USP)
  - Intradermal anesthetic agent with sterile small-bore needle and syringe
  - Disposable tourniquet and tape measure
  - Maximal sterile barrier precautions: mask, sterile gown, cap, sterile gloves, protective eyewear, and large full body drape

  Note: *Sterile non-latex, powder-free gloves*

Patient positioning and measurement [7,12,16,20,27]

1. Place the patient in recumbent position (as tolerated) and adjust the appropriate arm to the proper position from the body at a 90-degree angle.

2. Use ultrasound to identify proposed PICC-insertion site.

3. Assess skin integrity at the potential insertion site and all vessels in the upper arm for size, pathway, compressability, and proximity to artery and nerves.

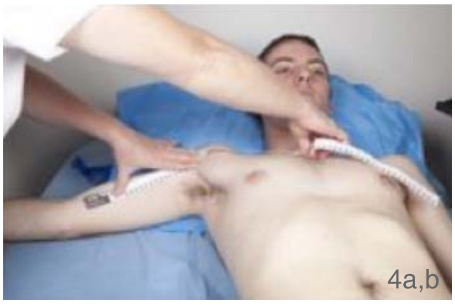
4. Measure the distance from the intended insertion site to the desired terminal tip location.

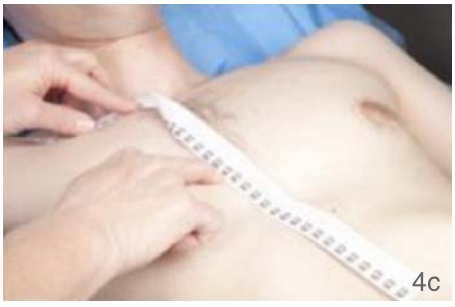
a. Insertion site to axillary crease.

b. Axillary crease to right clavicular head. Measure to the right clavicular head for left or right-sided placements.

c. Right clavicular head to the right sternal border of the third intercostal space.

Note: *The external measurement can never exactly duplicate the internal venous anatomy.*





5. Close the door to the room and post "Sterile Procedure in Progress—Do Not Enter."

6. Apply ultrasound coupling gel to the acoustic window of the probe head and place the probe in the designated area on the ultrasound machine.

Consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and instructions for use.

Equipment setup and patient preparation
[7,9,12,13,14,15,16,19,20,22]

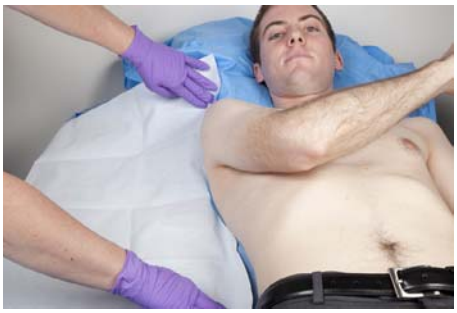
1. Perform hand hygiene per facility protocol.

2. Apply non-sterile prep gloves.

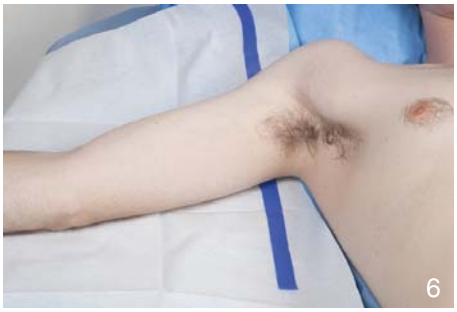
3. Disinfect the work area with antimicrobial solution and allow it to dry completely.

4. Open the PICC kit outer package and place it on the bedside table or work area.

5. Place the absorbent drape under the patient's arm and shoulder area.



6. Loosely place a tourniquet under the area high on the upper arm close to the axilla. The tourniquet can be tightened before the patient is draped.



7. Prepare the insertion site and surrounding skin with the skin antiseptic applicator or according to institutional policy. If the intended insertion site is visibly soiled, cleanse it with antiseptic soap and water prior to application of antiseptic solution(s).

Note: *Chlorhexidine solution is preferred for skin antisepsis. One percent to two percent tincture of iodine, iodophor (povidone-iodine), and 70% alcohol may also be used. Chlorhexidine is not recommended for infants under 2 months of age.*

a. If using a winged chlorhexidine gluconate applicator, pinch the wings of the applicator to break the ampule and release the antiseptic solution.

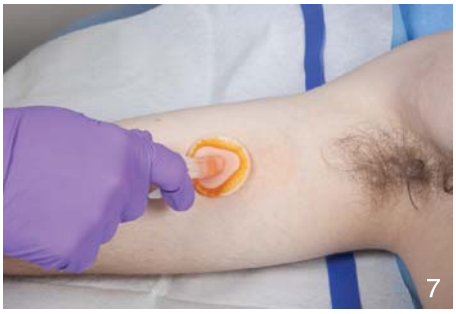
Note: *Do not touch the sponge.*

b. Wet the sponge by repeatedly pressing and releasing the sponge against the treatment area until fluid is visible on the skin. Use repeated back-and-forth and up-and-down strokes of the sponge for approximately 30 seconds. Completely wet the treatment area with antiseptic.

c. Allow the area to dry completely. Do not blot or wipe away the antiseptic.

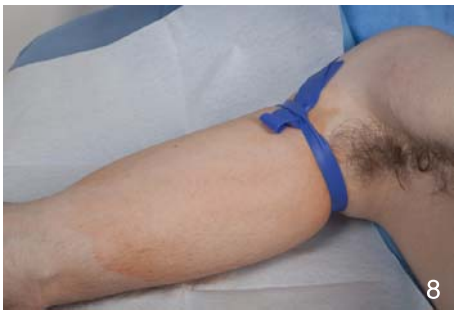
d. If alcohol and/or betadine are used as skin prep, it must be allowed to completely air dry before the insertion procedure is started.

e. Antiseptic solutions in a single unit configuration shall be used.



8. Apply the tourniquet above the intended insertion site to distend the vessel.

9. Remove and discard gloves.



10. Open wrapped sterile supplies by opening the wrapper flap furthest away first to prevent contamination from passing an unsterile arm over a sterile item. Next, open each of the side flaps. The nearest wrapper flap should be opened last.

Note: *The sterile field should be prepared in the location in which it will be used. Moving tables stirs air currents that can contaminate the sterile field.*

Note: *A sterile field should be maintained and monitored constantly.*

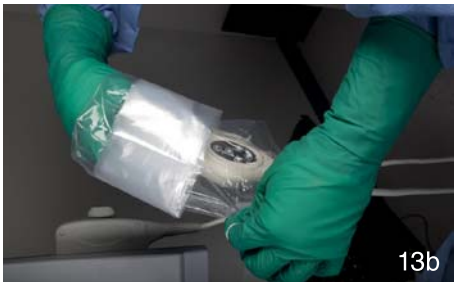
Note: *Sterile fields should not be covered.*


11


12b


12f


13


13b


13d

11. Don a sterile gown and gloves.

Note: *Prepare supplies on the sterile field in order of use. This allows the inserter to have an organized approach with each step of the placement procedure.*

12. Drape the patient.

a. Ensure that the drape is properly aligned, that is, "Head" pointing to the patient's head and "Foot" pointing to the patient's feet.

b. Determine whether the patient will need a left-or right-sided placement. Remove the appropriate liner to reveal the fenestration (for left-sided PICC placements, remove the liner "LEFT," and for right-sided PICC placements, remove the liner "RIGHT").

c. Place the exposed fenestration securely on the patient's arm over the planned insertion site and just below the level of the tourniquet. Press firmly to ensure adhesion to the arm.

d. Unfold the drape to each side of the patient. The drape should unfold over the patient's chest, away from the insertion site.

e. Unfold the drape to the feet of the patient. Ensure that the drape is fully extended covering the patient's feet.

f. Unfold the drape to cover the head of the patient. If necessary, aseptically perforate the drape to reveal the patient's head.

13. Prepare the ultrasound system probe.

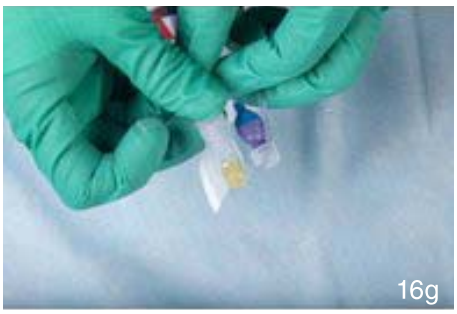
a. Place the probe cover over the probe head, being careful not to wipe off the coupling gel.

b. Cover the probe and probe cable with the probe cover, maintaining sterile technique.

c. Smooth the probe cover over the acoustic window of the probe head to remove any air bubbles or folds in the sheath.

d. Be sure no air is trapped between the ultrasound probe and the skin, which can obstruct vessel visualization.

e. Secure the probe cover with provided fasteners.



14. Draw up anesthetic agent and 0.9% sodium chloride (USP) in 10 mL syringes, maintaining sterile technique. Label the syringes and place them on the field in ready to use fashion with small-bore needle on anesthetic agent.

15. Pre-flush all the lumens of the catheter with normal sterile saline to wet the hydrophilic stylet. Follow the manufacturer's instructions for use and facility protocol.

Note: *Follow manufacturer's instructions for use to determine the catheter length modification.*

16. Trim the catheter.

a. Measure the distance from the zero mark on the catheter to the pre-determined catheter measurement.

Note: *Catheter markings are in centimeters.*

b. Loosen the T-lock connector/stylet assembly.

Note: *Ensure that all lumens of the catheter have been pre-flushed with sterile normal saline to wet the hydrophilic stylet.*

c. Retract the entire T-lock connector/stylet assembly as one unit until the stylet is well behind the location where the catheter is to be cut.

d. Using a sterile scalpel or scissors, carefully cut the catheter.

Caution: *The stylet or stiffening wire needs to be well behind the point the catheter is to be cut. NEVER cut the stylet or stiffening wire. Inspect the cut surface to ensure there is no loose material.*

e. Re-advance the T-lock connector/stylet assembly locking the connector to the catheter hub. Ensure the stylet tip is intact.

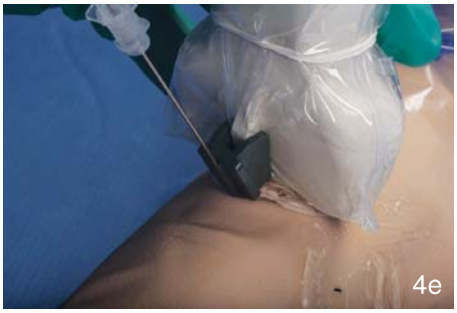
f. Gently retract the stylet through the locked T-lock connector until the stylet tip is contained inside the catheter.

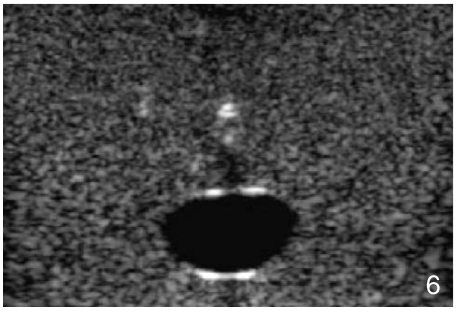
g. Assure proper alignment of the stylet to the distal end of the trimmed catheter.

Caution: *Follow manufacturer's instructions for use and facility policy when modifying catheter length.*

Note: *Prior to catheter insertion, ensure that the stylet tip is contained inside and within the catheter but not more than 1 cm from the trimmed end of the catheter. Failure to do so could result in degraded magnetic navigation.*

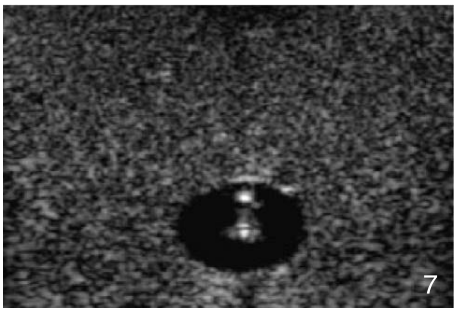
Warning: *Ensure that the stylet tip does not extend beyond the trimmed end of the catheter. Extension of the stylet tip beyond the catheter end, combined with kinking and excessive forces, may result in vessel damage, stylet damage, difficult removal, stylet tip separation, potential embolism and risk of patient injury.*

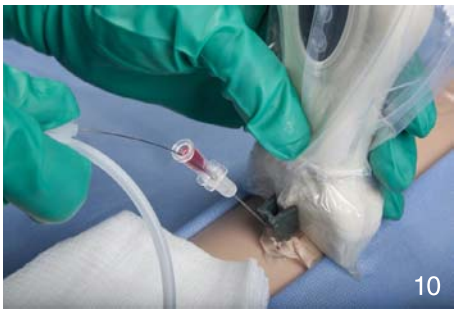


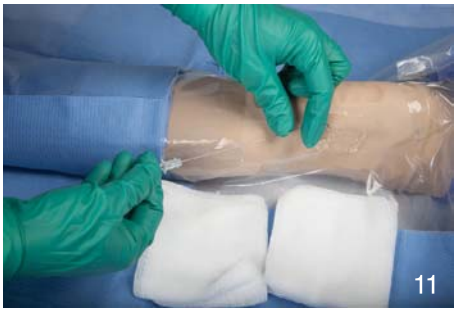


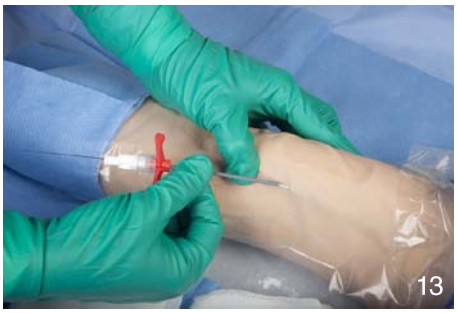
Catheter Insertion [7,9,12,13,16,21,24,25]

1. Conduct a time-out immediately before starting the invasive procedure. During the time-out, the team members should agree, at a minimum, on the following:
   a. Correct patient identity,
   b. Correct site,
   c. Correct procedure to be done (Refer to section entitled "Patient Verification and Time-Out").
2. Apply a layer of sterile coupling gel to the covered acoustic window of the ultrasound probe.
3. Using ultrasound, locate the target vessel, as well as an adjacent artery and nerve. Center the dot markers on the target vessel. The dot markers are displayed on the ultrasound screen.
4. Optional: choose the appropriate needle guide based on the needle gauge and the depth of the target structure.
   a. Ensure that a sterile probe cover has been placed over the probe.
   b. Clip the short end of the needle guide to the end of the needle guide hook closest to the top of the probe.
   c. Push the larger end of the needle guide toward the probe until the needle guide snaps onto the needle guide hook. Do not slide.
      Caution: *Always snap the needle guide on to the needle guide hook. Do not slide the needle guide on to the needle guide hook, as the sterile sheath may tear.*
   d. Slide the appropriately sized needle, beveled edge facing the probe, into the channel on the guide.
   e. Place the probe against the skin, perpendicular to the target structure.
   f. Hold the probe so that the needle guide points away from the heart.
   g. Center the dot markers on the target vessel.
5. Administer local anesthetic at the intended venipuncture site while keeping the dot markers centered on the target vessel.
6. While keeping the dot markers centered on the target vessel, slowly advance the needle while looking at the ultrasound screen. When the needle approaches the target vessel, you should see the anterior wall indenting.









7. Once venipuncture occurs, the vessel returns to it's normal shape.

8. Observe venous blood return.

9. Hold the needle and gently rock the probe away from the needle for a smooth separation. The needle guide channel should open, and the needle should smoothly disengage from the guide.

10. Remove the guidewire tip protector from the guidewire hoop and insert the flexible end of the guidewire into the introducer needle or catheter and into the vein. Advance the guidewire to the desired depth.

Caution: *Do not advance the guidewire past the axilla without fluoroscopic guidance or other tip location methods. Do not advance the guidewire against resistance.*

11. Gently withdraw and remove the introducer needle or catheter while holding the guidewire in position.

Caution: *If the guidewire must be withdrawn while the needle is inserted, remove both the needle and wire as a unit to prevent the needle from damaging or shearing the guidewire.*

12. Remove the tourniquet.

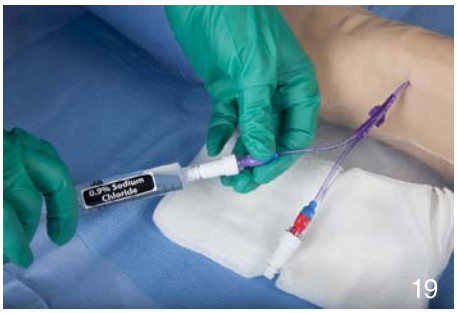
13. Advance the dilator and introducer sheath together as a unit over the guidewire, using a slight rotational motion. If necessary, a small incision may be made adjacent to the guidewire to facilitate insertion of the dilator and introducer sheath.

Note: *Verify facility guidelines concerning the use of a scalpel prior to making incision. To avoid potential damage to the vessel and guidewire, the scalpel blade should be bevel side-up.*

Warning: *To avoid guidewire embolism, maintain control and position of the guidewire at all times.*

14. Remove the guidewire and dilator from the introducer sheath and per the manufacturer's instructions for use and facility policy. Withdraw the dilator and guidewire, leaving the introducer sheath in place.

Warning: *Place a finger over the orifice of the sheath to minimize blood loss and risk of air aspiration. The risk of air embolism is reduced by performing this part of the procedure with the patient performing the Valsalva maneuver.*



15. Insert the catheter into the introducer sheath. Advance the catheter slowly. When the catheter tip has been advanced to the shoulder, have the patient turn his/her head (with chin on shoulder) toward the insertion side to prevent possible insertion into the jugular vein. Complete catheter advancement to the desired position.

Note: *PICCs should be positioned with the catheter tip in the lower 1/3 of the SVC.*

16. Continue to *slowly* advance the catheter until it is inserted to the pre-insertion external measurement.

17. Withdraw the introducer sheath from the vein and away from the site.

a. Stabilize the catheter position by applying light pressure to the vein distal to the insertion site.

b. Withdraw the introducer sheath from the vein and away from the site. Split the introducer sheath and peel it away from the catheter.

18. Disconnect the T-lock and stylet funnel from the catheter luer connector. Slowly remove the T-lock, stylet funnel, and stylet as a unit. Do not remove the stylet through the T-lock.

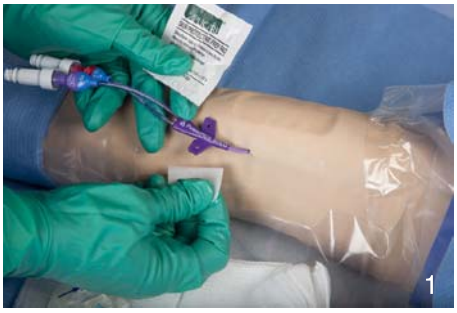
Caution: *Never use force to remove the stylet. Resistance can damage the catheter. If resistance or bunching of the catheter is observed, stop stylet removal and allow catheter to return to its normal shape. Withdraw both catheter and stylet together approximately 2 cm and reattempt stylet removal. Repeat this procedure until the stylet is easily removed. Once the stylet is out, advance the catheter into the desired position.*

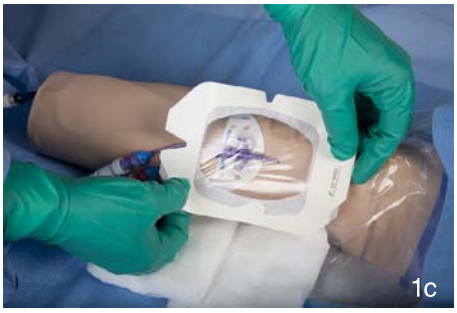
19. Aspirate for adequate blood return.

20. Flush the catheter with preservative-free 0.9% sodium chloride (USP), observing for complications.

21. Attach the needleless connector(s).

22. Lock the catheter per the manufacturer's guidelines or facility protocol.





Catheter Securement and Dressing Application [7,9,12,13,16]

1. To minimize the risk of catheter breakage, embolization, and migration, the catheter must be secured in place.

a. Secure the catheter per the manufacturer's instructions for use and facility protocol.

Note: *The use of a catheter stabilization device should be considered the preferred alternative to tape or sutures when feasible.*

b. The use of a chlorhexidine-impregnated sponge with short-term central vascular access devices should be considered in patients older than 2 months of age as an additional measure to prevent catheter-related blood stream infection.

c. Cover the insertion site and the PICC stabilization device with a transparent dressing or per institutional policy.

2. Perform hand hygiene per institutional policy.

3. Label the PICC dressing with

a. Date and time of insertion,

b. Gauge and length of PICC, and

c. Initials of inserter.

4. Clean and disinfect the ultrasound probe.

5. Dispose of used supplies in appropriate receptacles.

6. Remove and dispose of personal protective equipment.

7. Using chest X-ray, verify the correct catheter-tip position.

INSERTING A PICC USING THE SHERLOCK™ II TIP-LOCATION SYSTEM (TLS) [12,13,9,22,14,19,20,15,16]

INDICATIONS: Catheter stylets provide internal reinforcement to aid in catheter placement. The Sherlock™ II TLS Stylet contains passive magnets that generate a magnetic field. This field can be detected by the Sherlock™ II TLS Detector to provide the placer rapid feedback on catheter tip location.

The Sherlock™ II Tip Location System (TLS) detector quickly locates the position of specially designed, magnet-tipped Peripherally inserted Central Catheters (PICCS) and Central Venous Catheters (CVCs) during and after initial placement. This device may be used by appropriate caregivers in hospitals, long-term care facilities or home-care settings. The Sherlock™ II TLS detector provides rapid feedback to the caregiver but was not designed to replace conventional methods of placement verification. Users are urged to confirm correct placement according to their established facility protocol and clinical judgment.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Preparing for Insertion[7]

1. Perform hand hygiene per facility protocol.

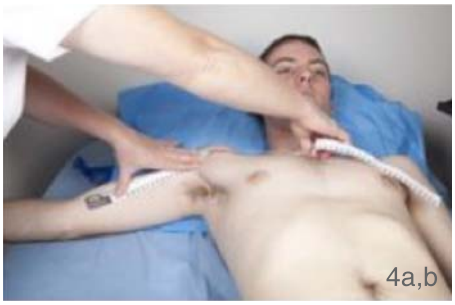
2. Verify the patient's identity using two independent identifiers. (Refer to section entitled "Verification and Time Out").

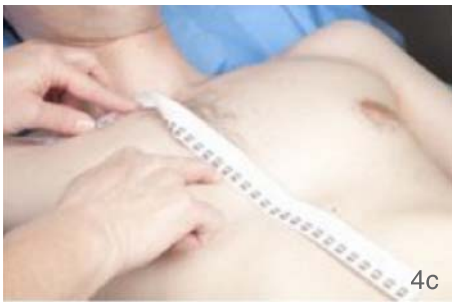
3. Perform pre-procedural patient assessment, education, and consent as per facility protocol.

4. Gather supplies which may include, but are not limited to, the following:

- PICC kit (verify package integrity and expiration date)
- Ultrasound machine and coupling gel
- Needleguide kit (optional) and sterile US probe sheath and coupling gel
- *If* not included in catheter kit:
  - Extra antiseptic applicators
  - Catheter stabilization device
  - Catheter dressing
  - Sterile 4x4's, 2x2's and sterile surgical adhesive strips
  - Chlorhexidine-impregnated sponge as per facility protocol
  - Needleless connector and/or add-on device
  - Sterile 10 mL syringes and preservative-free 0.9% sodium chloride (USP)
  - Intradermal anesthetic agent with sterile small-bore needle and syringe
  - Disposable tourniquet and tape measure
  - Maximal sterile barrier precautions: mask, sterile gown, cap, sterile gloves, protective eyewear, and large full-body drape

    Note: *Sterile non-latex, powder-free gloves*





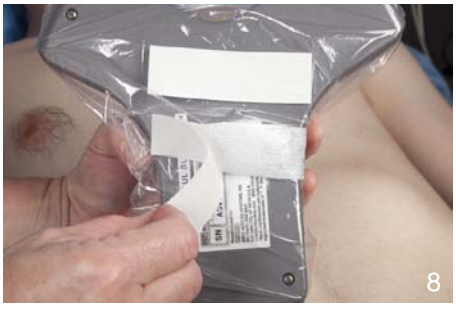
Patient positioning and measurement [7,12,16,20,27]

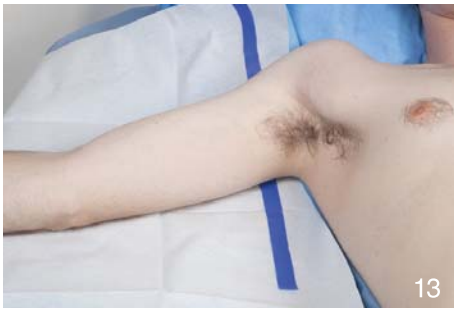
1. Place the patient in a recumbent position (as tolerated) and adjust the appropriate arm to the proper position from the body at a 90-degree angle.
2. Use ultrasound to identify the proposed PICC-insertion site.
3. Assess skin integrity at the potential insertion site and all vessels in the upper arm for size, pathway, compressability, and proximity to artery and nerves.
4. Measure the distance from the intended insertion site to the desired terminal tip location.
   a. Insertion site to axillary crease.
   b. Axillary crease to right clavicular head. Measure to the right clavicular head for left or right-sided placements.
   c. Right clavicular head to the right sternal border of the third intercostal space.
   Note: *The external measurement can never exactly duplicate the internal venous anatomy.*
5. Close the door to the room and post "Sterile Procedure in Progress— Do Not Enter."
6. Apply ultrasound coupling gel to the acoustic window of the probe head and place the probe in the designated area on the ultrasound machine.

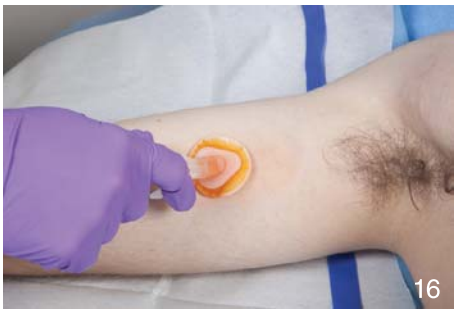
Consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and instructions for use.

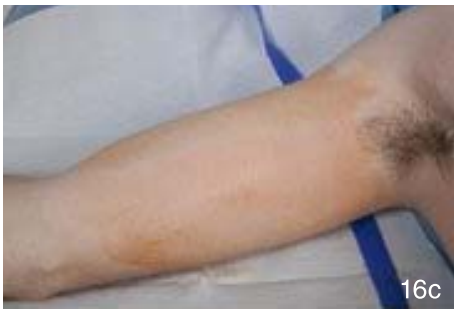
Equipment setup and patient preparation [7,9,12,13,14,15,16,19,20,22]

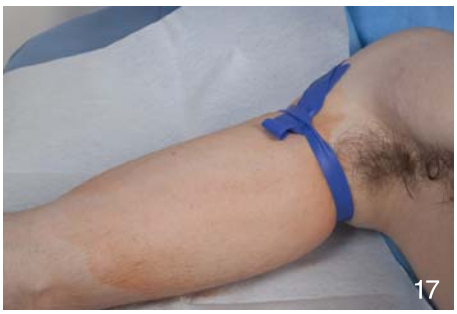
1. Perform hand hygiene per facility protocol.
2. Lower the bed rails.
3. Calibrate the system prior to setting up the sterile field to ensure there is no environmental interference.
4. Don non-sterile prep gloves.
5. Disinfect the work area with antimicrobial solution, and allow it to dry completely.
6. Open the PICC kit outer package and place it on the bedside table or work area.
7. Place the magnetic catheter-tip-location sensor in the sensor holder and tighten the cinch ring.
8. Remove the tape over the adhesive backing from the sensor holder.
   Note: *Ensure no metal is in the area where the sensor will be placed (monitor leads, necklace, etc.).*
9. Place the sensor adhesive-side down directly on the skin and as flat as possible for best results.
   Note: *The sensor should be placed the same for left-or right-side placements.*











10. Place the sensor high on the patient's chest touching the neck, if possible. The manufacturer's logo should face upward. The sensor cord should be routed towards the patient's feet.

11. Do not move the sensor after it is secure. Best results will be achieved if the patient remains still and the sensor is not placed on open wounds, over bandages, drapes, gowns, or other coverings.

12. Remove metal objects, such as watches, cell phones, pagers, name tags, jewelry, etc. that may move during the procedure and place them at least five feet (1.5 m) away.

13. Place an absorbent drape under the patient's arm and shoulder area.

14. Loosely place a tourniquet under the area high on the upper arm, close to the axilla. The tourniquet can be tightened prior to draping the patient.

15. Don head covering, mask, and either a face shield or goggles.

a. Anyone assisting with device insertion must wear full personal protective equipment.

b. Anyone remaining in the procedure area must wear a mask.

16. Prepare the insertion site and surrounding skin with the skin antiseptic applicator or according to facility protocol. If the intended insertion site is visibly soiled, cleanse with antiseptic soap and water prior to applying antiseptic solution(s).

Note: *Chlorhexidine solution is preferred for skin antisepsis. One percent to two percent tincture of iodine, iodophor (povidone-iodine), and 70% alcohol may also be used. Chlorhexidine is not recommended for infants under 2 months of age.*

a. If using a winged chlorhexidine gluconate applicator, pinch the wings of the applicator to break the ampule and release the antiseptic solution.

Note: *Do not touch the sponge.*

b. Wet the sponge by repeatedly pressing and releasing it against the treatment area until fluid is visible on the skin. Use repeated back-and-forth and up-and-down strokes of the sponge for approximately 30 seconds. Completely wet the treatment area with antiseptic.

c. Allow the area to dry completely. Do not blot or wipe away the antiseptic.

d. If alcohol and/or betadine are used as skin prep, they/it must be allowed to completely air dry before the insertion procedure is started.

e. Antiseptic solutions in a single-unit configuration shall be used.

17. Apply the tourniquet above the intended insertion site to distend the vessel.

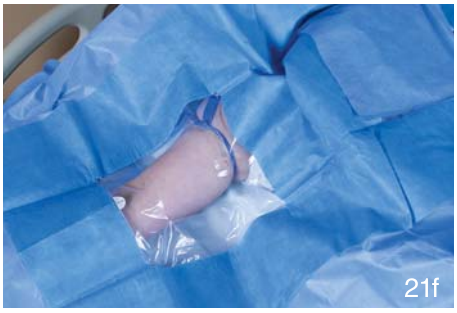
18. Remove and discard gloves.

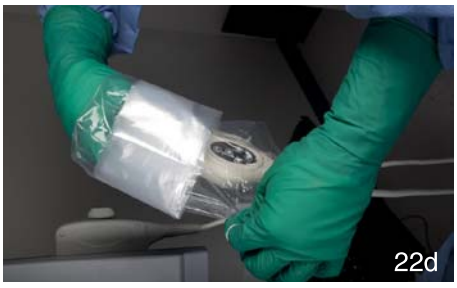
19. Open wrapped sterile supplies by opening the wrapper flap furthest away first to prevent contamination from passing an unsterile arm over a sterile item. Next, open each of the side flaps. The nearest wrapper flap should be opened last.

Note: *The sterile field should be prepared in the location in which it will be used. Moving tables stirs air currents that can contaminate the sterile field.*

Note: *A sterile field should be maintained and monitored constantly.*

Note: *Sterile fields should not be covered.*





20. Don a sterile gown and gloves.

Note: *Prepare supplies on the sterile field in order of use. This allows the inserter to have an organized approach with each step of the placement procedure.*

21. Drape the patient.

a. Ensure that the drape is properly aligned, that is, “Head” pointing to the patient’s head and “Foot” pointing to the patient’s feet.

b. Determine whether the patient will need a left-or right-side placement. Remove the appropriate liner to reveal the fenestration (for left-sided PICC placements, remove the liner, “LEFT,” and for right-sided PICC placements, remove the liner “RIGHT”).

c. Place the exposed fenestration securely on the patient’s arm over the planned insertion site and just below the level of the tourniquet. Press firmly to ensure adhesion to the arm.

d. Unfold the drape to each side of the patient. Drape should unfold over the patient’s chest away from the insertion site first.

e. Unfold drape to the feet of the patient. Ensure that the drape is fully extended, covering the patient’s feet.

f. Unfold the drape to cover the head of the patient. If necessary, aseptically perforate the drape to reveal the patient’s head.

22. Prepare the ultrasound system probe.

a. Place the probe cover over the probe head, being careful not to wipe off the coupling gel.

b. Cover the probe and probe cable with the probe cover, maintaining sterile technique.

c. Smooth the probe cover over the acoustic window of the probe head to remove any air bubbles or folds in the sheath.

d. Be sure no air is trapped between the ultrasound probe and the skin, which can obstruct vessel visualization.

e. Secure the probe cover with provided fasteners.

23. Draw up anesthetic agent and 0.9% sodium chloride (USP) in 10 mL syringes maintaining sterile technique. Label the syringes and place them on the field in ready-to-use fashion with a small-bore needle on the anesthetic agent.

24. Pre-flush all the lumens of the catheter with normal sterile saline to wet the hydrophilic stylet. Follow the manufacturer's instructions for use and facility protocol.

Note: *Follow the manufacturer's instructions for use to determine the catheter length modification.*

25. Trim the catheter.

a. Measure the distance from the zero mark on the catheter to the pre-determined catheter measurement.

Note: *Catheter markings are in centimeters.*

b. Loosen the T-lock connector/stylet assembly.

Note: *Ensure that all lumens of the catheter have been pre-flushed with normal sterile saline to wet the hydrophilic stylet.*

c. Retract the entire T-lock connector/stylet assembly as one unit until the stylet is well behind the location where the catheter is to be cut.

d. Using a sterile scalpel or scissors, carefully cut the catheter.

Caution: *The stylet or stiffening wire needs to be well behind the point the catheter is to be cut. NEVER cut the stylet or stiffening wire. Inspect the cut surface to ensure there is no loose material.*

e. Re-advance the T-lock connector/stylet assembly locking the connector to the catheter end cap. Ensure the stylet tip is intact.

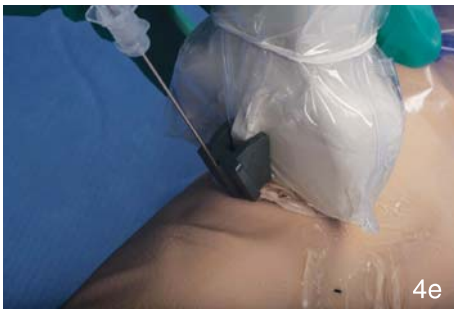
f. Gently retract the stylet through the locked T-lock connector until the stylet tip is contained inside the catheter.

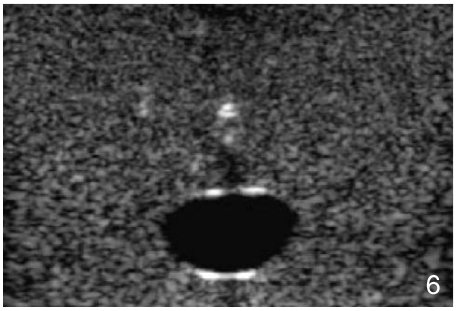
g. Assure proper alignment of the stylet to the distal end of the trimmed catheter.

Caution: *Follow the manufacturer's instructions for use and facility protocol when modifying catheter length.*

Note: *Prior to catheter insertion, ensure that the stylet tip is contained inside and within the catheter but not more than 1 cm from the trimmed end of the catheter. Failure to do so could result in degraded magnetic navigation.*

Warning: *Ensure that the stylet tip does not extend beyond the trimmed end of the catheter. Extension of the stylet tip beyond the catheter end, combined with kinking and excessive forces, may result in vessel damage, stylet damage, difficult removal, stylet tip separation, potential embolism, and risk of patient injury.*





Catheter Insertion [7,9,12,13,16,21,24,25]

1. Conduct a time-out immediately before starting the invasive procedure. During the time-out, the team members agree, at a minimum, on the following:

a. Correct patient identity,

b. Correct site, and

c. Correct procedure to be done (Refer to the section "Verification and Time-Out").

2. Apply a layer of sterile coupling gel to the covered acoustic window of the ultrasound probe.

3. Using ultrasound, locate the target vessel, as well as an adjacent artery and nerve. Center the dot markers on the target vessel. The dot markers are displayed on the ultrasound screen.

4. Optional: Choose the appropriate needle guide based on the needle gauge and the depth of the target structure.

a. Ensure that a sterile probe cover has been placed over the probe.

b. Clip the short end of the needle guide to the end of the needle guide hook closest to the top of the probe.

c. Push the larger end of the needle guide toward the probe until the needle guide snaps onto the needle guide hook.

Caution: *Always snap the needle guide onto the needle guide hook. Do not slide the needle guide onto the needle guide hook, as the sterile sheath may tear.*

d. Slide the appropriately sized needle, beveled edge facing the probe, into the channel on the guide.

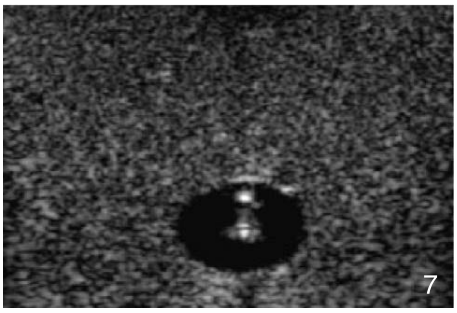
e. Place the probe against the skin, perpendicular to the target structure.

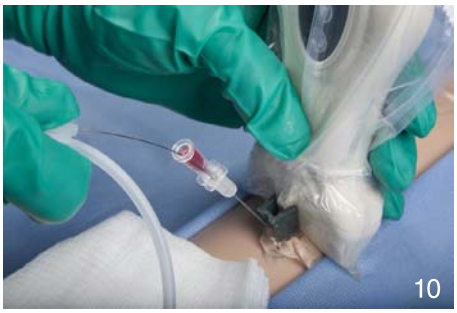
f. Hold the probe so that the needle guide points away from the heart.

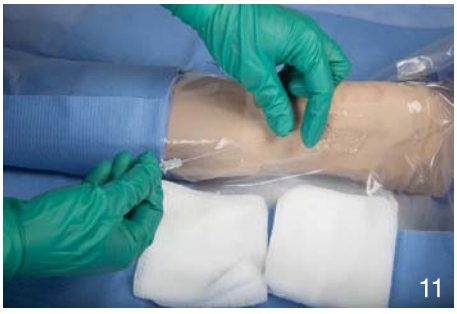
g. Center the dot markers on the target vessel.

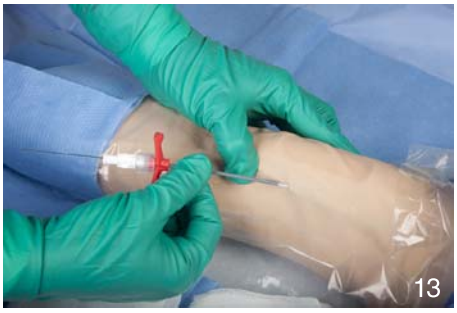
5. Administer local anesthetic at the intended venipuncture site.

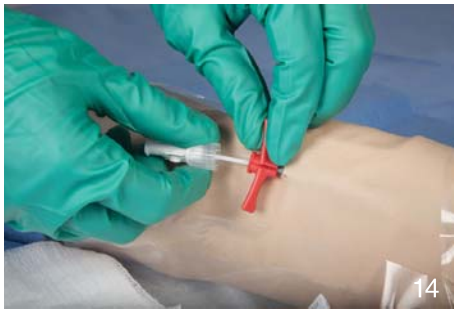
6. While keeping the dot markers centered on the target vessel, slowly advance the needle while looking at the ultrasound screen. When the needle approaches the target vessel, you should see the anterior wall indenting.











7. Once venipuncture occurs, the vessel returns to normal shape.

8. Observe venous blood return.

9. Hold the needle and gently rock the probe away from the needle for a smooth separation. The needle guide channel should open and the needle should smoothly disengage from the guide.

10. Remove the guidewire tip protector from the guidewire hoop and insert the flexible end of the guidewire into the introducer needle or catheter and into the vein. Advance the guidewire to the desired depth.

Caution: *Do not advance the guidewire past the axilla without fluoroscopic guidance or other tip-location methods. Do not advance the guidewire against resistance.*

11. Gently withdraw and remove the introducer needle or catheter while holding the guidewire in position.

Caution: *If the guidewire must be withdrawn while the needle is inserted, remove both the needle and wire as a unit to prevent the needle from damaging or shearing the guidewire.*

12. Remove the tourniquet.

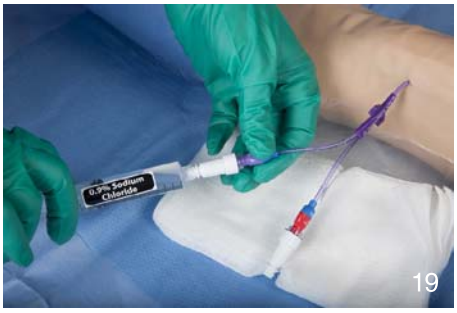
13. Advance the dilator and introducer sheath together as a unit over the guidewire, using a slight rotational motion. If necessary, a small incision may be made adjacent to the guidewire to facilitate insertion of the dilator and introducer sheath.

Note: *Verify facility guidelines concerning the use of a scalpel prior to making incision. To avoid potential damage to the vessel and guidewire, the scalpel blade should be bevel-side up.*

Warning: *To avoid guidewire embolism, maintain control and position of the guidewire at all times.*

14. Remove the guidewire and dilator from the introducer sheath and per the manufacturer's instructions for use and facility protocol. Withdraw the dilator and guidewire, leaving the introducer sheath in place.

Warning: *Place a finger over the hole of the sheath to minimize blood loss and risk of air aspiration. The risk of air embolism is reduced by performing this part of the procedure with the patient performing the Valsalva maneuver.*



15. Insert the catheter slowly until the magnetic navigation shows the stylet icon moving consistently downward.

16. While watching the stylet icon moving consistantly downward on the navigation display screen, continue to *slowly* advance the catheter until it is inserted to the pre-insertion external measurement.

17. Withdraw the introducer sheath from the vein and away from the site.

a. Stabilize the catheter position by applying light pressure to the vein distal to the insertion site.

b. Withdraw the introducer sheath from the vein and away from the site. Split the introducer sheath and peel it away from the catheter.

18. Disconnect the T-lock and stylet funnel from the catheter luer connector. Slowly remove the T-lock, stylet funnel, and stylet as a unit. Do not remove the stylet through the T-lock.

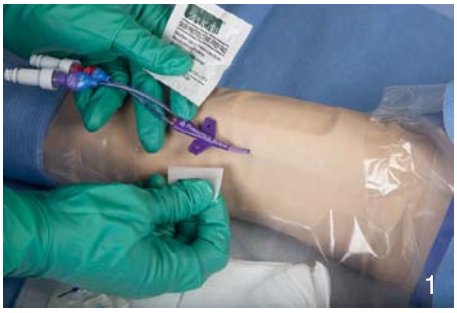
Caution: *Never use force to remove the stylet. Resistance can damage the catheter. If resistance or bunching of the catheter is observed, stop stylet removal and allow the catheter to return to its normal shape. Withdraw both catheter and stylet together approximately 2 cm and reattempt stylet removal. Repeat this procedure until the stylet is easily removed. Once the stylet is out, advance the catheter into the desired position.*

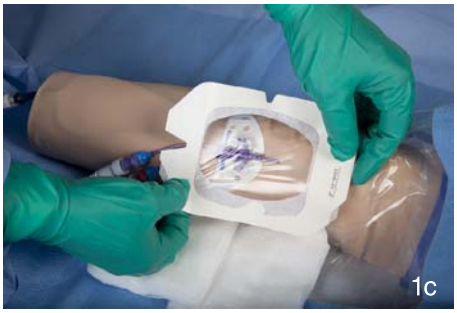
19. Aspirate for adequate blood return.

20. Flush the catheter with preservative-free 0.9% sodium chloride (USP), observing for complications.

21. Attach the needleless connector(s).

22. Lock the catheter per the manufacturer's guidelines or facility protocol.





Catheter securement and dressing application [7,9,12,13,16]

1. To minimize the risk of catheter breakage, embolization, and migration, the catheter must be secured in place.

a. Secure the catheter per the manufacturer's instructions for use and facility protocol.

Note: *The use of a catheter stabilization device should be considered the preferred alternative to tape or sutures when feasible.*

b. The use of a chlorhexidine-impregnated sponge with short-term CVADs should be considered as an additional measure to prevent catheter-related bloodstream infection in patients older than 2 months of age.

c. Cover the insertion site and the PICC stabilization device with a transparent dressing or per facility protocol.

2. Perform hand hygiene per facility protocol.

3. Label the PICC dressing with

a. Date and time of insertion,

b. Gauge and length of PICC, and

c. Initials of the inserter.

4. Clean and disinfect the ultrasound probe.

5. Dispose of used supplies in appropriate receptacles.

6. Remove and dispose of personal protective equipment.

7. Using chest X-ray, verify the correct catheter-tip position.

INSERTING A PICC USING THE SHERLOCK 3CG™ TIP-CONFIRMATION SYSTEM (TCS)[6,7,9,12]

INDICATIONS: The Sherlock 3CG™ Tip Confirmation System (TCS) is indicated for guidance and positioning of Peripherally Inserted Central Catheters (PICCs). The Sherlock 3CG™ TCS provides real-time PICC tip location information by using passive magnets and the patient's cardiac electrical activity (ECG). When relying on the patient's ECG signal, the Sherlock 3CG™ TCS is indicated for use as an alternative method to chest X-ray and fluoroscopy for PICC tip placement confirmation in adult patients.

Limiting but not contraindicated for this technique are in patients where alterations of cardiac rhythm change the presentation of the P-wave as in atrial fibrillation, atrial flutter, severe tachycardia, and pacemaker driven rhythm. In such patients, who are easily identifiable prior to PICC insertion, the use of an additional method is required to confirm PICC tip location.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Preparing for Insertion

1. Perform hand hygiene per facility protocol

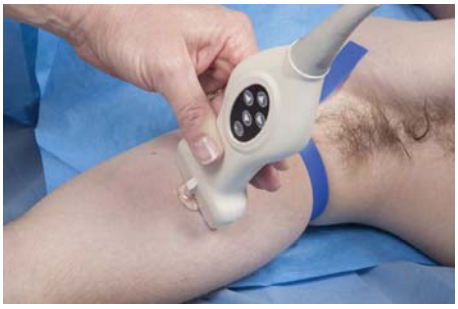
a. Verify the patient's identity using two independent identifiers. (Refer to section entitled "Verification and Time-Out.")

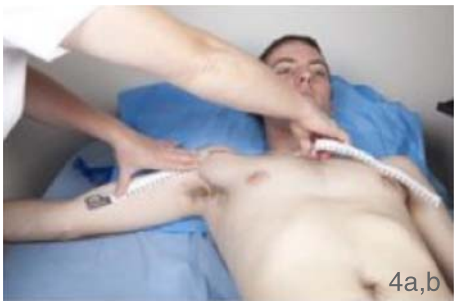
2. Perform pre-procedural patient assessment, education, and consent per facility protocol.

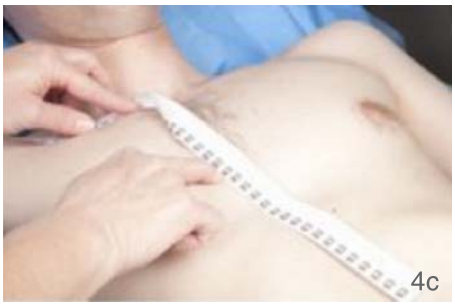
3. Gather supplies, which may include, but are not limited to the following:

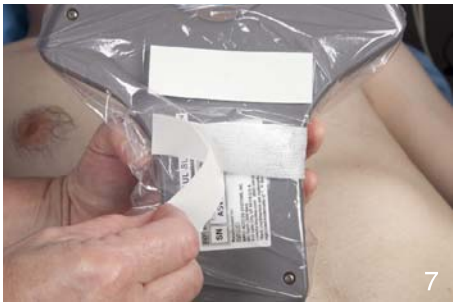
- PICC kit (verify package integrity and expiration date)
- Ultrasound machine and coupling gel
- Needleguide kit (optional) and sterile ultrasound probe sheath and coupling gel
- *If* not included in catheter kit:
  - Extra antiseptic applicators
  - Catheter stabilization device
  - Catheter dressing
  - Sterile 4x4's, 2x2's and sterile surgical adhesive strips
  - Chlorhexidine-impregnated sponge as per facility protocol
  - Needleless connector and/or add-on device
  - Sterile 10 mL syringes and preservative-free 0.9% sodium chloride (USP)
  - Intradermal anesthetic agent with sterile small-bore needle and syringe
  - Disposable tourniquet and tape measure
  - Maximal sterile barrier precautions: mask, sterile gown, cap, sterile gloves, protective eyewear, and large full body drape

    Note: *Sterile non-latex, powder-free gloves*









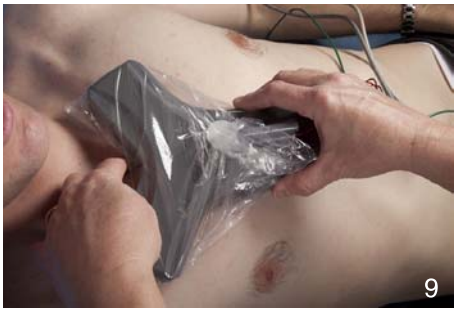
Patient positioning and measurement [7,12,27,20,16]

1. Place the patient in a recumbent position (as tolerated) and adjust the appropriate arm to the proper position from the body at a 90-degree angle.
2. Use ultrasound to identify the proposed PICC-insertion site.
3. Assess skin integrity at the potential insertion site and all vessels in the upper arm for size, pathway, compressability, and proximity to artery and nerves.
4. Measure the distance from the intended insertion site to the desired terminal tip location.
   a. Insertion site to axillary crease.
   b. Axillary crease to right clavicular head. Measure to the right clavicular head for left or right-sided placements.
   c. Right clavicular head to the right sternal border of the third intercostal space.
   Note: *The external measurement can never exactly duplicate the internal venous anatomy.*
5. Close the door to the room and mark "Sterile Procedure in Progress— Do Not Enter."
6. Apply ultrasound coupling gel to the acoustic window of the probe head and place the probe in the designated area on the ultrasound machine.

Consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and instructions for use.

Equipment setup and patient preparation [7,9,12,13,14,15,16,19,20,22]

1. Lower the bed rails.
2. Calibrate the system prior to setting up the sterile field to ensure there is no environmental interference.
3. Don non-sterile prep gloves.
4. Disinfect the work area (i.e., over-bed table) with antimicrobial solution and allow it to dry completely.
5. Open the PICC kit outer package and place it on the bedside table or work area.
6. Place the magnetic catheter-tip-location sensor in the sensor holder and tighten the cinch ring.
7. Remove the tape over the adhesive backing from the sensor holder.
   Note: *Ensure no metal is in the area where the sensor will be placed (monitor leads, necklace, etc.).*
8. Place the sensor adhesive-side down directly on the skin and as flat as possible for best results.
   Note: *The sensor should be placed the same for left or right side placements.*



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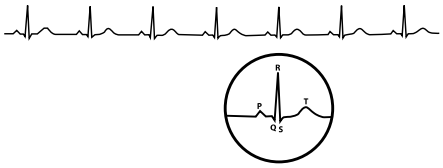


9. Place the sensor high on the patient's chest touching the neck, if possible. The manufacturer's logo should face upward. The sensor cord should be routed towards the patient's feet.

10. Do not move the sensor after it is secure. Best results will be achieved if the patient remains still and the sensor is not placed on open wounds, over bandages, drapes, gowns, or other coverings.

11. Remove metal objects, such as watches, cell phones, pagers, name tags, jewelry, etc. that may move during the procedure and place them at least five feet (1.5 m) away.

12. Prepare and attach external ECG electrodes. Ensure electrode locations are oil-free and completely dry.

Caution: *Electrodes should be applied only to intact, clean skin (e.g., not over open wounds, lesions, infected or inflamed areas)*

Note: *Vigorous cleaning with an alcohol prep pad will help ensure good skin-electrode contact.*

13. Attach the electrodes to the lead wires. Remove the backing and press the electrodes firmly onto skin at the specified locations. Place the black electrode on the patient's right shoulder. Place the red electrode on the patient's lower left side, inferior to the umbilicus and laterally along the mid-axillary line.

Caution: *Placement of the red electrode outside of this region may result in reduced ECG performance. If applicable, place the green electrode on the patient's lower right side.*

Warning: *Place skin electrodes carefully at locations indicated and ensure good skin-electrode contact. Failure to do so may cause unstable ECG waveforms and/ or ECG waveforms that are not described in the manufacturer's instructions for use. In such case, rely on magnetic navigation and external measurement for tip positioning and use chest X-ray or fluoroscopy to confirm catheter tip location, as indicated by the facility guidelines and clinical judgment.*

Caution: *Discontinue electrode use immediately if skin irritation occurs.*

14. Evaluate baseline ECG waveform. The external ECG waveform should be visible and stable at this time.

15. Verify that the P-wave is present, identifiable, and consistent.

Note: *Difficulty in interpretation of the ECG waveform may be due to procedural issues such as improper connection of the fin assembly to the sensor, poor skin-electrode contact or electrode positioning outside of the recommended locations. Check the security of the fin assembly to sensor connection, as well as the placement and security of the electrodes.*

16. Adjust ECG waveform, as needed, during placement to ensure that the entire ECG waveforms are visible in the ECG window.

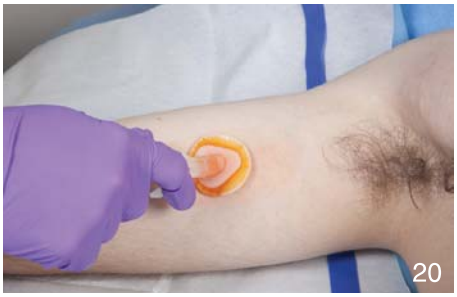
17. Place an absorbent drape under the patient's arm and shoulder area.

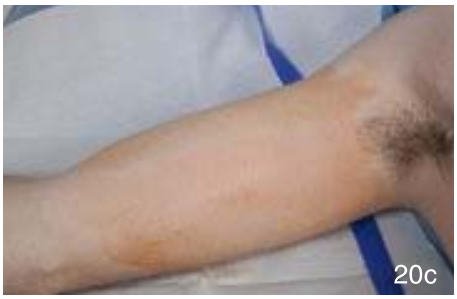
18. Loosely place a tourniquet under the area high on the upper arm close to the axilla. The tourniquet can be tightened prior to draping the patient.

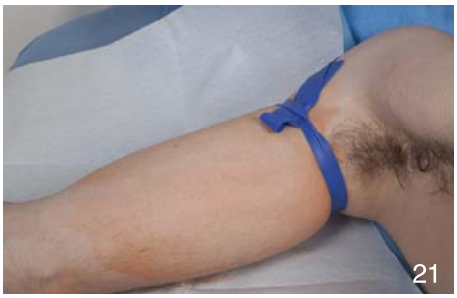
19. Don head covering, mask and either a face shield or goggles.

a. Anyone assisting with device insertion must wear full personal protective equipment.

b. Anyone remaining in the procedure area must wear a mask.







20. Prepare the insertion site and surrounding skin with the skin antiseptic applicator or according to facility protocol. If the intended insertion site is visibly soiled, cleanse it with antiseptic soap and water prior to applying antiseptic solution(s).

Note: *Chlorhexidine solution is preferred for skin antisepsis. One percent to two percent tincture of iodine, iodophor (povidone-iodine), and 70% alcohol may also be used. Chlorhexidine is not recommended for infants under 2 months of age.*

a. If using a winged chlorhexidine gluconate applicator, pinch the wings of the applicator to break the ampule and release the antiseptic solution.

Note: *Do not touch the sponge.*

b. Wet the sponge by repeatedly pressing and releasing it against the treatment area until fluid is visible on the skin. Use repeated back-and-forth and up-and-down strokes of the sponge for approximately 30 seconds. Completely wet the treatment area with antiseptic.

c. Allow the area to dry completely. Do not blot or wipe away the antiseptic.

d. If alcohol and/or betadine are used as skin prep, it/they must be allowed to completely air dry before the insertion procedure is started.

e. Antiseptic solutions in a single-unit configuration shall be used.

21. Apply the tourniquet above the intended insertion site to distend the vessel.

22. Remove and discard gloves.

23. Open wrapped sterile supplies by opening the wrapper flap furthest away first to prevent contamination from passing an unsterile arm over a sterile item. Next, open each of the side flaps. The nearest wrapper flap should be opened last.

Note: *The sterile field should be prepared in the location in which it will be used. Moving tables stirs air currents that can contaminate the sterile field.*

Note: *A sterile field should be maintained and monitored constantly.*

Note: *Sterile fields should not be covered.*

24. Don a sterile gown and gloves.

Note: *Prepare supplies on the sterile field in order of use. This allows the inserter to have an organized approach with each step of the placement procedure.*

25. Drape the patient

a. Ensure that the drape is properly aligned, that is, “Head” pointing to the patient’s head and “Foot” pointing to the patient’s feet.

b. Determine whether the patient will need a left-or right-side placement. Remove the appropriate liner to reveal the fenestration (for left-sided PICC placements, remove the liner “LEFT,” and for right-sided PICC placements, remove the liner “RIGHT”).

c. Place the exposed fenestration securely on the patient’s arm over the planned insertion site and just below the level of the tourniquet. Press firmly to ensure adhesion to the arm.

d. Unfold the drape to each side of the patient. The drape should unfold over the patient’s chest away from the insertion site.

e. Unfold the drape to the feet of the patient. Ensure that the drape is fully extended, covering the patient’s feet.

f. Unfold the drape to cover the head of the patient. If necessary, aseptically perforate the drape to reveal the patient’s head.

26. Prepare ultrasound system probe.

a. Place the probe cover over the probe head, being careful not to wipe off the coupling gel.

b. Cover the probe and probe cable with the probe cover, maintaining sterile technique.

c. Smooth the probe cover over the acoustic window of the probe head to remove any air bubbles or folds in the sheath.

d. Be sure no air is trapped between the ultrasound probe and the skin, which can obstruct vessel visualization.

e. Secure the probe cover with provided fasteners.

27. Draw up anesthetic agent and 0.9% sodium chloride (USP) in 10 mL syringes, maintaining sterile technique. Label the syringes and place them on the field in ready-to-use fashion with a small-bore needle on the anesthetic agent.

Note: *Follow manufacturer's instructions for use to determine the catheter length modification.*

28. Trim the catheter

a. Measure the distance from the zero mark on the catheter to the pre-determined catheter measurement.

Note: *Catheter markings are in centimeters.*

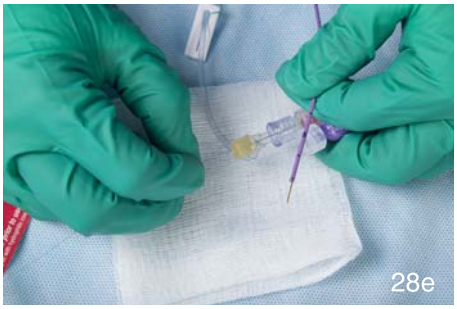
b. Loosen the T-lock connector/stylet assembly.

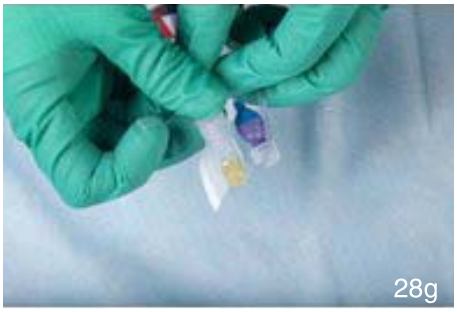
Note: *Ensure that all lumens of the catheter have been pre-flushed with sterile normal saline to wet the hydrophilic stylet.*

c. Retract the entire T-lock connector/stylet assembly as one unit until the stylet is well behind the location where the catheter is to be cut.

d. Using a sterile scalpel or scissors, carefully cut the catheter.

Caution: *The stylet or stiffening wire needs to be well behind the point the catheter is to be cut. NEVER cut the stylet or stiffening wire. Inspect the cut surface to ensure there is no loose material.*





e. Re-advance the T-lock connector/stylet assembly locking the connector to the catheter needleless connector. Ensure the stylet tip is intact.

f. Gently retract the stylet through the locked T-lock connector until the stylet tip is contained inside the catheter.

g. Assure proper alignment of the stylet to the distal end of the trimmed catheter.

Caution: *Follow the manufacturer's instructions for use and facility protocol when modifying catheter length.*

Note: *To ensure adequate catheter length to reach maximum P-wave amplitude, it is recommended that up to 5 cm be added to the pre-insertion measurement. Catheter length should be based on clinician measurement technique and experience.*

Note: *Prior to catheter insertion, ensure that the stylet tip is contained inside and within the catheter but not more than 1 cm from the trimmed end of the catheter. Failure to do so could result in degraded magnetic navigation.*

Warning: *Ensure that the stylet tip does not extend beyond the trimmed end of the catheter. Extension of the stylet tip beyond the catheter end, combined with kinking and excessive forces, may result in vessel damage, stylet damage, difficult removal, stylet tip separation, potential embolism, and risk of patient injury.*

Catheter Insertion [7,9,12,13,16,21,24,25]

1. Conduct a time-out immediately before starting the invasive procedure. During the time-out, the team members should agree on the following:

a. Correct patient identity,

b. Correct site, and

c. Correct procedure to be done (Refer to the section "Verification and Time Out").

2. Apply a layer of sterile coupling gel to the covered acoustic window of the ultrasound probe.

3. Using ultrasound, locate the target vessel, as well as an adjacent artery and nerve. Center the dot markers on the target vessel. The dot markers are displayed on the ultrasound screen.

4. Optional: Choose the appropriate needle guide based on the needle gauge and the depth of the target structure.

a. Ensure that a sterile probe cover has been placed over the probe.

b. Clip the short end of the needle guide to the end of the needle guide hook closest to the top of the probe.

c. Push the larger end of the needle guide toward the probe until the needle guide snaps onto the needle guide hook.

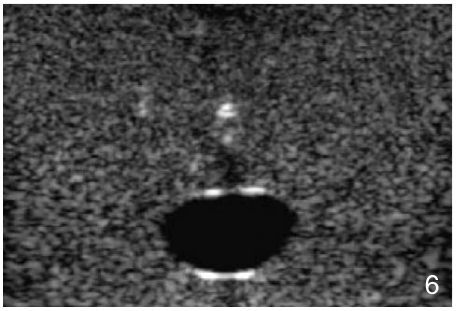
Caution: *Always snap the needle guide onto the needle guide hook. Do not slide the needle guide onto the needle guide hook, as the sterile sheath may tear.*

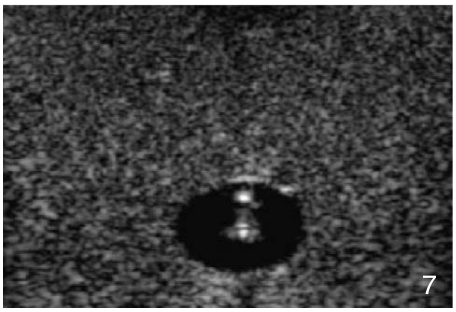
e. Slide the appropriately sized needle, beveled edge facing the probe, into the channel on the guide.

f. Place the probe against the skin, perpendicular to the target structure.

g. Hold the probe so that the needle guide points away from the heart.

h. Center the dot markers on the target vessel.





5. Administer local anesthetic at intended venipuncture site.

6. While keeping the dot markers centered on the target vessel, slowly advance the needle while looking at the ultrasound screen. When the needle approaches the target vessel, you should see the anterior wall indenting.

7. Once venipuncture occurs, the vessel should return to its normal shape.

8. Observe venous blood return.

9. Hold the needle and gently rock the probe away from the needle for a smooth separation. The needle guide channel should open, and the needle should smoothly disengage from the guide.

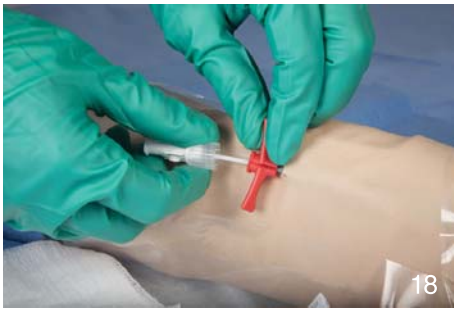
10. Remove the guidewire tip protector from the guidewire hoop and insert the flexible end of the guidewire into the introducer needle or catheter and into the vein. Advance the guidewire to the desired depth.

Caution: *Do not advance the guidewire past the axilla without fluoroscopic guidance or other tip-location methods. Do not advance the guidewire against resistance.*

11. Gently withdraw and remove the introducer needle or catheter while holding the guidewire in position.

Caution: *If the guidewire must be withdrawn while the needle is inserted, remove both the needle and wire as a unit to prevent the needle from damaging or shearing the guidewire.*

12. Remove the tourniquet.



13. Advance the dilator and introducer sheath together as a unit over the guidewire, using a slight rotational motion. If necessary, a small incision may be made adjacent to the guidewire to facilitate insertion of the dilator and introducer sheath.

Note: *Verify facility guidelines concerning the use of a scalpel prior to making incision. To avoid potential damage to the vessel and guidewire, the scalpel blade should be bevel-side up.*

Warning: *To avoid guidewire embolism, maintain control and position of the guidewire at all times.*

14. Attach the catheter stylet to the fin assembly.

15. Palpate the fin assembly through the sterile drape. Form and pinch the drape around the fin assembly to conform the drape to the fin assembly.

16. Place the stylet connector on the bottom end of the fin assembly and slide the connector forward until it is fully seated.

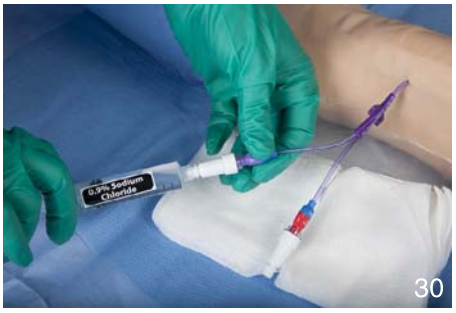
17. Uncoil the catheter stylet lead.

18. Remove the guidewire and dilator from the introducer sheath per the manufacturer's instructions for use and facility protocol. Withdraw the dilator and guidewire, leaving the introducer sheath in place.

Warning: *Place a finger over the orifice of the sheath to minimize blood loss and risk of air aspiration. The risk of air embolism is reduced by performing this part of the procedure with the patient performing the Valsalva maneuver.*

19. Insert the catheter slowly until the navigation display screen shows the stylet icon moving consistently downward.

20. At this point, the catheter may need to be flushed to stabilize the waveform. If necessary, attach a saline-filled syringe. Flush the catheter with saline and wait for the intravascular ECG waveform to stabilize.



22. Verify that the P-wave on the intravascular ECG waveform is present, identifiable, and consistent.

Warning: *Do not rely on ECG signal detection for catheter tip positioning when interpretation of the intravascular ECG waveform is difficult (e.g., P-wave is not present when it is unidentifiable, or when it is intermittent).*

23. Slowly adjust the catheter tip position to obtain maximum P-wave amplitude. Compare the main screen intravascular ECG waveform to the reference screen intravascular ECG waveform while monitoring for P-wave negative deflection.

Note: *P-wave may continue to increase in amplitude when initial negative defection is observed. In this case, adjust the catheter tip position to maximum P-wave amplitude with no negative deflection.*

Warning: *Do not rely on ECG signal detection for catheter tip positioning when there are no observable changes in the intravascular ECG P-wave. In these cases, rely on magnetic navigation and external measurement for tip positioning and use chest X-ray or fluoroscopy to confirm catheter tip location, as indicated by facility guidelines and clinical judgment.*

24. Once the final tip position is determined by evaluation of the P-wave, select “Freeze” on the system to save the current ECG waveforms on the reference screen, add the exit site marking, and select print.

25. Withdraw the introducer sheath from the vein and away from the site.

a. Stabilize the catheter position by applying light pressure to the vein distal to the insertion site.

b. Withdraw the introducer sheath from the vein and away from the site. Split the introducer sheath and peel it away from the catheter.

26. Disconnect the T-lock and stylet funnel from the catheter luer connector. Slowly remove the T-lock, stylet funnel, and stylet as a unit. Do not remove the stylet through the T-lock.

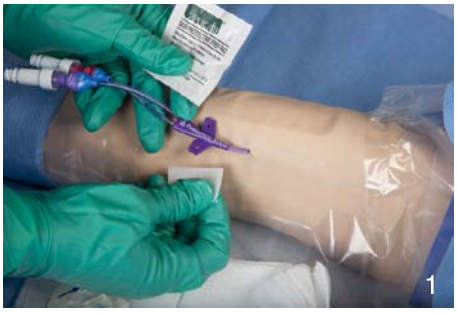
Caution: *Never use force to remove the stylet. Resistance can damage the catheter. If resistance or bunching of the catheter is observed, stop stylet removal and allow the catheter to return to its normal shape. Withdraw both catheter and stylet together approximately 2 cm and reattempt stylet removal. Repeat this procedure until the stylet is easily removed. Once the stylet is out, advance the catheter into the desired position.*

27. Aspirate for adequate blood return.

28. Flush the catheter with preservative-free 0.9% sodium chloride (USP), observing for complications.

29. Attach the needleless connector(s).

30. Lock catheter per the manufacturer’s guidelines or facility protocol.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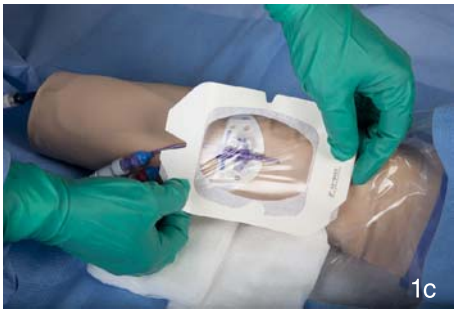
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Catheter securement and dressing application [7,9,12,13,16]

1. To minimize the risk of catheter breakage, embolization, and migration, the catheter must be secured in place.

a. Secure the catheter per the manufacturer's instructions for use and facility protocol.

Note: *The use of a catheter stabilization device should be considered the preferred alternative to tape or sutures when feasible.*

b. The use of a chlorhexidine-impregnated sponge with short-term CVADs should be considered in patients older than 2 months of age as an additional measure to prevent catheter-related bloodstream infection.

c. Cover the site and the PICC stabilization device with a transparent dressing or per facility protocol.

2. Perform hand hygiene per facility protocol.

3. Label the PICC dressing with the following:

a. Date and time of the insertion,

b. Gauge and length of the PICC, and

c. Initials of the inserter

4. Clean and disinfect the ultrasound probe.

5. Dispose of used supplies in appropriate receptacles.

6. Remove and dispose of personal protective equipment.

SUMMARY [1-4]

This chapter has discussed different techniques and equipment used to insert a PICC. All techniques and equipment are associated with varying rates of success. It is, therefore, essential that clinicians know the success rates related to each technique and technology. "For example, Naylor found the malposition rate with TLS to be 2.5%, and without the use of TLS to be 13.4%." This chapter has also provided detailed instructions for inserting a PICC. The next chapter will discuss ways PICC placement can be confirmed.

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Confirming PICC Placement

OVERVIEW [1,2,3,4,14,16,21]

PICCs should be placed with the tip in the distal region of the superior vena cava (SVC) and the cavoatrial junction (CAJ). Before each PICC is released for use, an acceptable tip location must be confirmed by officially approved methods. Traditionally, these methods have been X-ray and fluoroscopy. However, alternative methods, such as ECG confirmation, are increasingly being used due to high success rates reducing X-ray exposure. Using ECG does require that the patient have a P-wave that is identifiable and consistent and that clinicians be adept at interpreting ECG. This chapter discusses both radiography and ECG as methods for confirming the PICC tip location.

OBJECTIVES

- Understand the optimal location for a catheter tip.
- Understand elements of electrocardiographic (ECG) systems, such as basic interpretation of normal ECG waveform.
- Identify criteria for excluding patients from ECG-guided PICC placement.
- Understand uses of radiography for PICC confirmation.

This section is intended to provide a general overview of basic techniques and procedures, and does not replace clinical training or judgement. Users should refer to product Instructions for Use as well as applicable facility protocols.

PICC TIP PLACEMENT [1,2,3,4,6,23]

When a PICC is placed, proper tip position must be confirmed prior to the initiation of therapy. Multiple professional organizations have made statements regarding where the tip should reside.

According to the Infusion Nursing Society (INS) Standards of Practice, "Central venous access devices (CVADs) shall have the tip dwelling within the superior vena cava (SVC) near its junction with the right atrium." Furthermore, the "tip location of a CVAD shall be determined radiographically or by other approved technologies prior to initiation of infusion therapy." The Association for Vascular Access (AVA) states, "The most appropriate location for the tip of peripherally inserted central catheters (PICCs) is the lower one-third of the SVC close to the junction of the SVC and the right atrium."

The recommendations for PICCs to be placed with the tip in the region of the CAJ are based on a desire to improve patient outcomes and optimize hemo-dilution of the infusate. PICC-tip placement should be proximal to the CAJ, which improves blood flow and allows the tip to lie parallel to the SVC. PICC tips residing in the upper SVC may lie against the vessel wall, exposing the endothelial lining to mechanical injury, which could contribute to the development of a catheter-related thrombosis. Additional chemical injury may occur with the infusion of irritants, vesicants, or solutions greater than 600 mOsmol. Catheters inserted into a patient's left side have been found to have an increased occurrence of vascular injury resulting in thrombosis. Catheter tips lying at the merger of the left brachiocephalic vein and the SVC have a higher risk of endothelial damage from catheter impingement and chemical irritation. Figure 1 shows a right-sided centrally inserted central catheter (CICC) and a left-sided PICC in place with the tip abutting the lateral wall of the upper SVC. Figure 2 shows a PICC with the tip in optimal position within the lower portion of the SVC at the region of the CAJ.

Another advantage of PICCs terminating at the SVC/CAJ is the increased blood flow, which may alleviate accumulation of thrombus on the catheter tip. The constant motion of the catheter tip (as shown in figure 3) caused by cardiac pulsatility may reduce platelet aggregation and fibrin-sleeve formation, thereby diminishing the incidence catheter- related thrombosis and catheter malfunction. Petersen et al found that "catheter-tip location was the only factor statistically predictive of catheter malfunction." They state, "A significant increase in malfunction was observed when the catheter tip was located greater than 4 cm superior to the CAJ."

Central catheters positioned high in the SVC may migrate with increased intrathoracic pressure from coughing, sneezing, or vomiting into the ipsilateral or contralateral brachiocephalic, subclavian, or jugular veins.

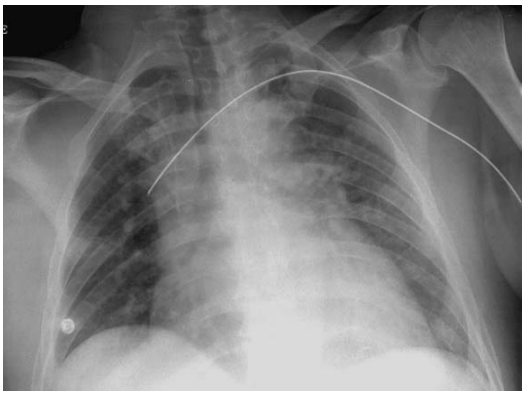


Figure 1. A right-sided CICC and a left-sided PICC with the tip in the abbutting the wall of the upper SVC. [8]

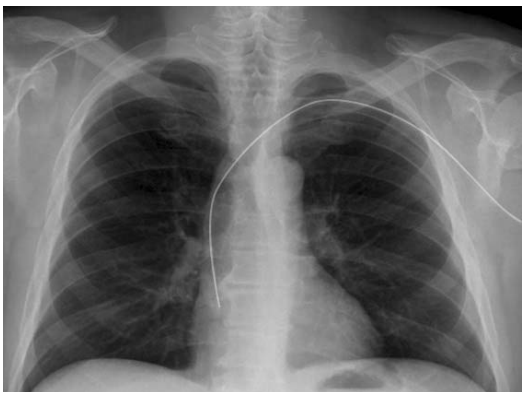


Figure 2. A left-sided PICC with the tip positioned at the CAJ. Note that the catheter-tip is lying parallel to the lower SVC. [8]

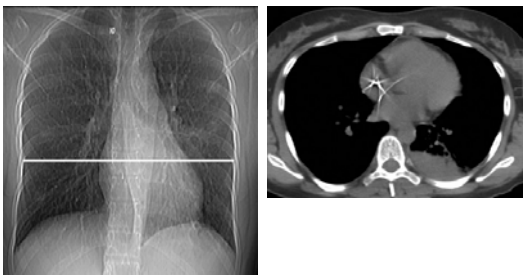


Figure 3. A chest radiograph with a correlating cross-sectional CT image of a patient with a left-sided PICC. The PICC tip terminates at the CAJ, as seen on the frontal-chest radiograph. The star-like image on CT depicts catheter-tip motion. [8]

USING RADIOGRAPHY TO CONFIRM PICC PLACEMENT

Radiography, whether it be fluoroscopy or post-procedural chest X-ray, is the standard for verifying catheter-tip position and identifying malpositions. Portable X-ray generally uses the anterior-posterior (A-P) view to verify catheter-tip position. Variations in interpretation can occur and are dependent on multiple factors, including exposure time, respiratory cycle, patient positioning, anatomic aberrations, motion, artifact, arterial placement, and obesity. Additionally, it is difficult to identify anotomic landmarks on two-dimensional X-rays.

Education and Training [21,22]

Depending on the scope of practice in a particular state, clinicians may be able to evaluate a chest X-ray for proper PICC-tip location and release the line for use. In order to establish uniform competency among vascular access clinicians for the release of PICCs for use, it is recommended that educational programs include didactic teaching and validation of competency, including both knowledge and skill in the assessment of vascular-catheter position on chest radiographs. According to the INS position paper, "To be qualified, an RN must attend and successfully complete an educational program that contains theoretical and anatomical content, as well as didactic sessions. A competency checklist will be completed and signed by a qualified instructor."

Evaluating the Chest Radiograph [20]

When a clinician evaluates a chest radiograph, they should first verify the patient's name, medical record number, date, and time of exam. Next, they should assess the quality of the exam (e.g., portable, exposure, motion artifact, degree of inspiration, lung compliance, extraneous support equipment, body habitus, etc.). Upon completing the aforementioned steps, they need to identify the following anatomy:

- Right mediastinal border (superior to inferior), which includes
  - Right brachiocephalic vein (BCV)
  - SVC
  - Right pulmonary arteries and veins
  - Right atrial appendage (RAA)
  - Right atrium (RA)
- Left mediastinal border (superior to inferior), which includes
  - Left brachiocephalic vein
  - Aortic arch (AA)
  - Left pulmonary arteries and veins
  - Left atrial appendage (LAA)
  - Left ventricle (LV)
  - Left SVC, if present, may form portion of upper left mediastinal border

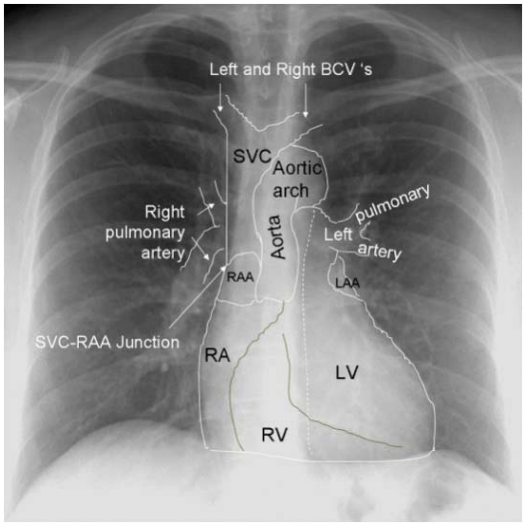


Figure 4. Right and left mediastinal borders, as seen on the frontal chest radiograph

After anatomical identification of the above structures, the clinician should locate the lower SVC and confirm that the RAA junction is approximately 2 cm above the CAJ and that the lower SVC 4 cm landing zone will be approximately 2 cm above or below the SVC-RAA junction.

Radiographic Localization Methods [5,20]

Radiographic localization methods for central line tip termination include either indirect or direct evaluation of a chest film. The indirect method utilizes non-vascular structures to identify the central venous catheter tip location and can be used alone or along with the direct method which utilizes vascular structures and can provide improved accuracy compared to the indirect method.

Indirect method: Utilizes skeletal and airway structures; parameters for correct tip termination are as follows:

- Ribs/intercostals spaces(ICS)- between the 3rd and 4th ICS
- Carina- 5cm below the superior vena cava (SVC)-right atrial appendage(RAA)
- Right tracheobronchial angle- 3cm below
- Vertebral bodies- two vertebral bodies below the carina (assuming the average adult vertebral body height is 2 cm)

Direct method: Utilizes vascular structures including the SVC, heart silhouette, and right-atrial appendage. Parameters for correct tip termination are as follows:

- By locating the SVC and the heart silhouette the RAA can be identified.
- Ideally the central vascular access device tip will terminate in the “landing zone”, which is 2 cm above or below the RAA.

Considerations and Suggestions

Inadvertent intra-arterial placement, although rare, may be seen as:

- The PICC coursing above the clavicle

A right-sided PICC would cross the midline to the left side, while a left-sided PICC does not cross the midline to the right side and does not curve toward the RA inferiorly(as a left SVC draining into the coronary sinus would, see figures 21-22).

A tight catheter turn may also suggest a malposition

To improve PICC visualization:

- Avoid portable radiographs unless a grid is utilized
- Have Radiologic Technologist assist with patient positioning
- Remove extraneous equipment from image area
- Assess prior films as needed
- Utilize digital imaging tools (eg. Invert, magnify, window/level, etc.)
- The preferred image is a shallow right posterior oblique (RPO)
- Use contrast or fluoroscopy as needed

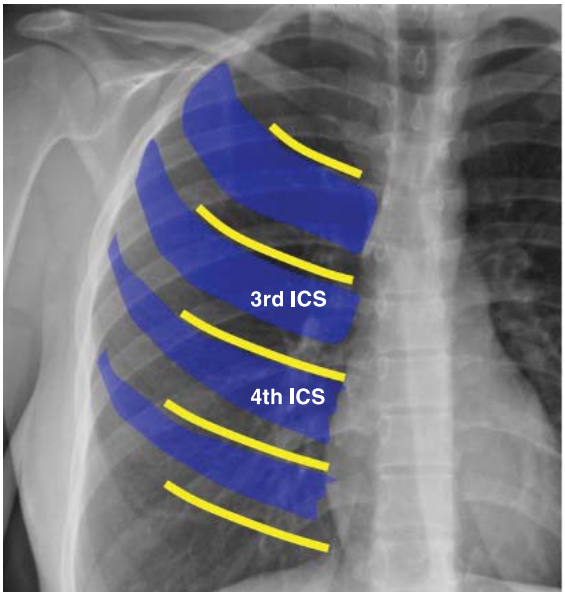


Figure 5. Intercostal space method

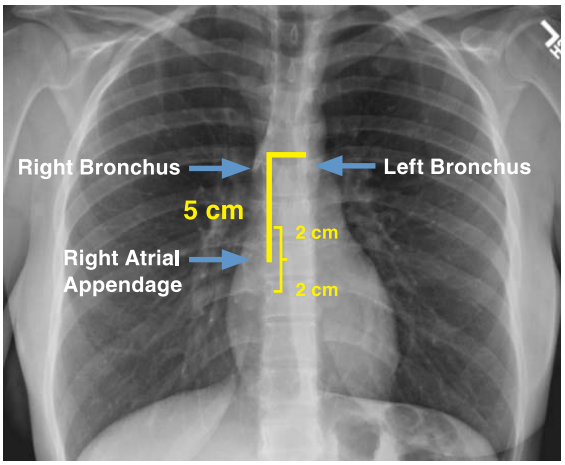


Figure 6. Carina method

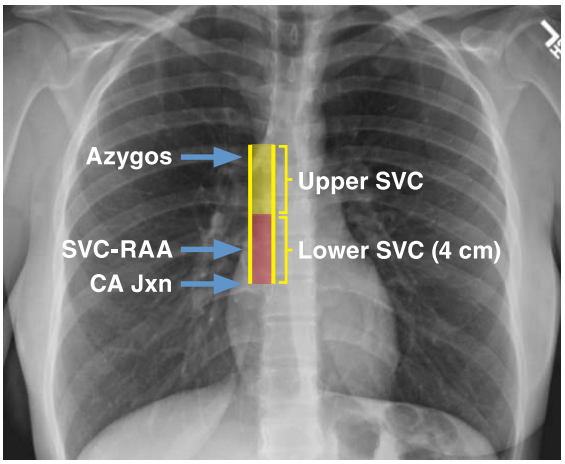


Figure 7. Direct method

Radiographic Images[19]

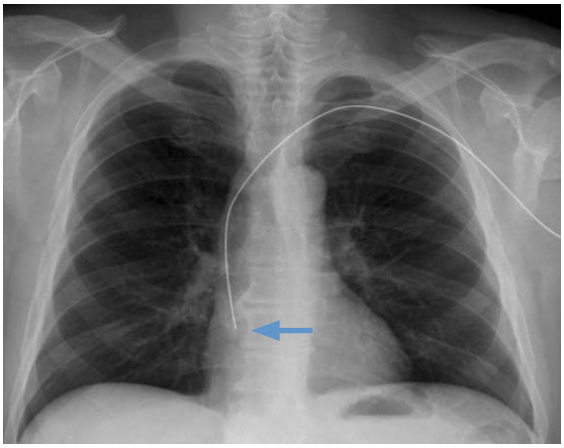


Figure 8. A left-sided PICC with the catheter-tip at the CAJ.

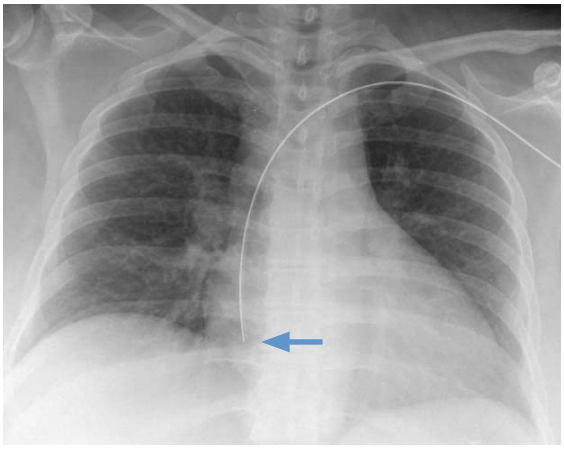


Figure 11. A left-sided PICC with the tip in RA.

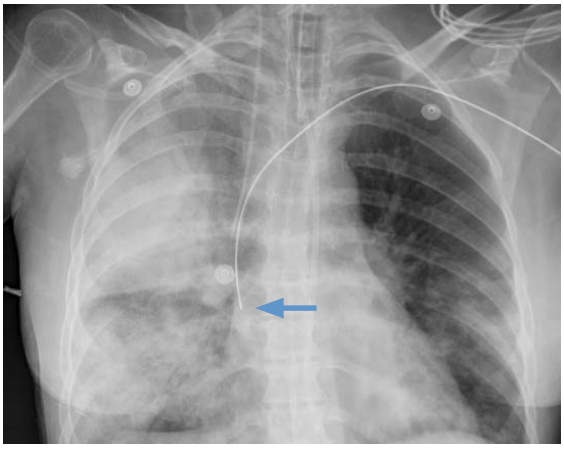


Figure 9. A left-sided PICC with the tip in the lower SVC. There is also a right-sided internal jugular (IJ) CVC in place.

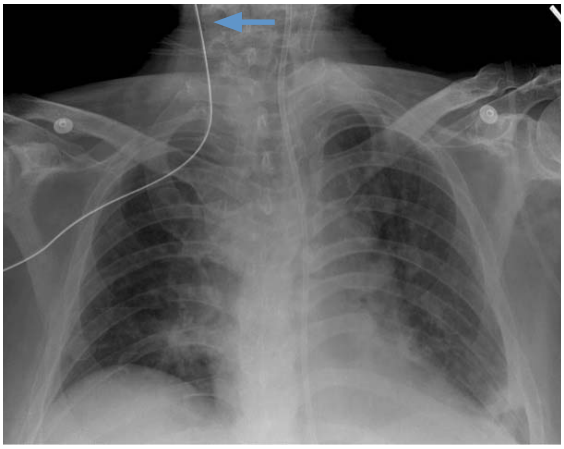


Figure 12. A right-sided PICC with the tip malpositioned in the ipsilateral IJ vein.

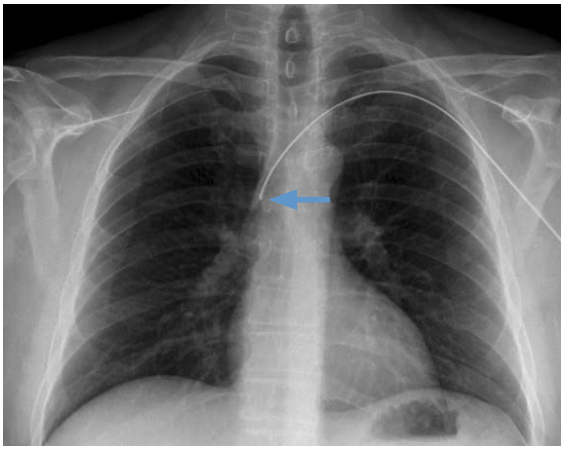


Figure 10. A left-sided PICC with the tip in the upper SVC.

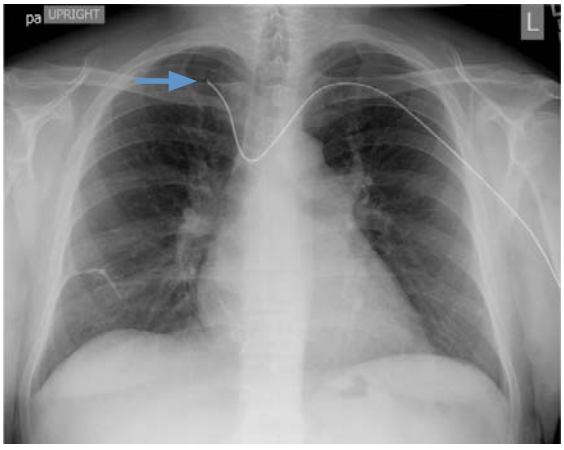


Figure 13. A left-sided PICC malpositioned in the contralateral subclavian vein.

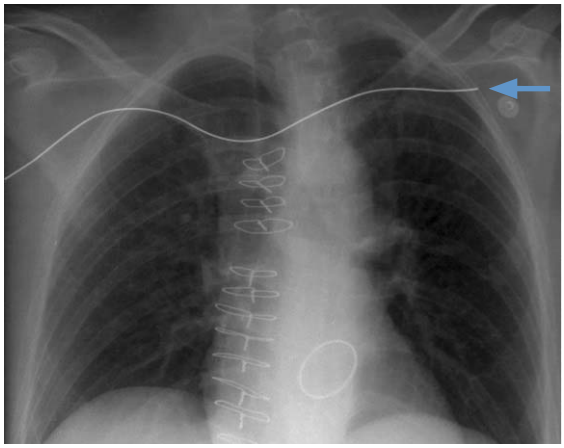


Figure 14. A right-sided PICC malpositioned in the contralateral axillary vein.

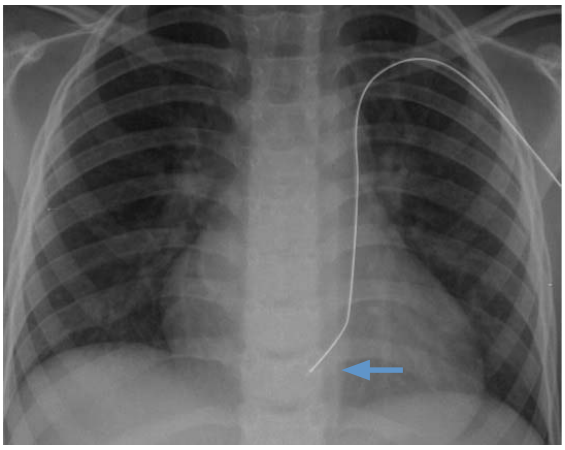


Figure 17. A left-sided PICC with the tip overinserted in the persistent left SVC. Note: *The catheter-tip is coursing medially into the coronary sinus.*

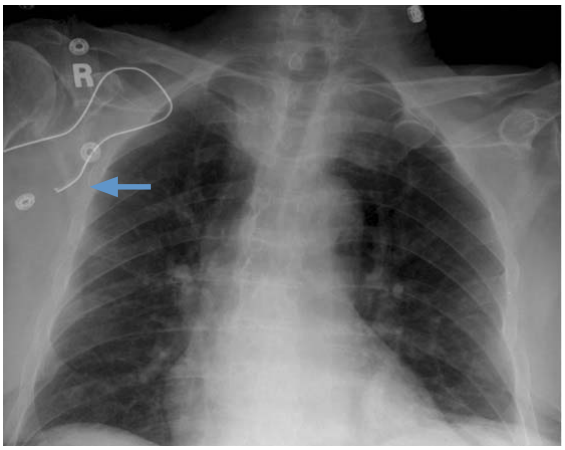


Figure 15. A right-sided cephalic-vein PICC insertion with the catheter-tip malpositioned in the ipsilateral basilic vein.

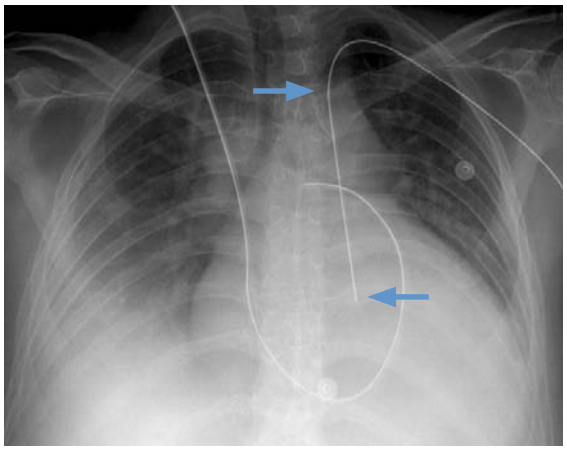


Figure 18. A left-sided intra-arterial PICC placement. Note: *The PICC is coursing above the clavicle and to the left of the mediastinum. There is a pulmonary artery catheter in place as well.*

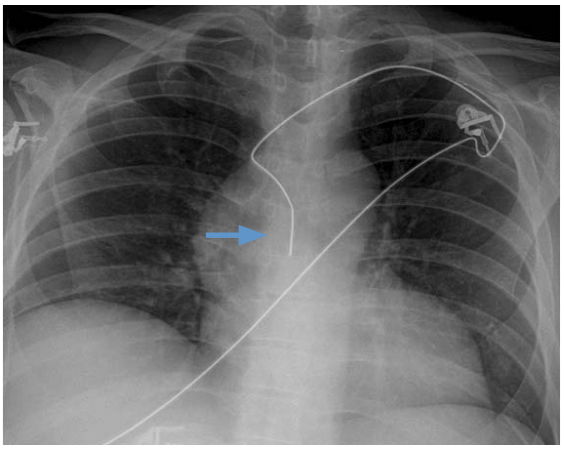


Figure 16. A left-sided PICC malpositioned in the azygos vein.

USING ELECTROCARDIOGRAPHY (ECG) TO CONFIRM PICC PLACEMENT [14,15,16,17,18]

Intravascular ECG as a modality for confirming tip location was introduced in Europe over twenty years ago for CVCs, and thousands of catheters have been successfully inserted utilizing this method.

The ECG method uses a conductive stylet or saline column as an internal electrode to detect the proximity of the catheter tip to the sinoatrial (SA) node.

ECG guidance allows final catheter-tip confirmation to be performed by the clinician immediately upon placement. Infusion therapy can then be initiated without a confirmatory chest X-ray.

INDICATIONS: The Sherlock 3CG™ Tip Confirmation System (TCS) is indicated for guidance and positioning of PICCs. The Sherlock 3CG™ TCS provides real-time PICC-tip location information by using passive magnets and the patient's cardiac electrical activity. When relying on the patient's ECG signal, the Sherlock 3CG™ TCS is indicated for use as an alternative method to chest X-ray and fluoroscopy for confirmation of PICC- tip placement in adult patients.

Limiting, but not contraindicated for this technique, are patients where alterations of cardiac rhythm change the presentation of the P-wave, such as in atrial fibrillation, atrial flutter, severe tachycardia, and pacemaker-driven rhythm. In such patients, who are easily identifiable prior to PICC insertion, the use of an additional method is required to confirm PICC-tip location.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Electrophysiology of the Heart [12,13]

The heart is a pump that circulates blood throughout the body. It is comprised of cardiac muscle tissue that is stimulated to contract by electrical impulses. These electrical impulses are generated and conducted by a network of innervated tissue comprising the SA node, atrioventricular (AV) node, right-and left-bundle branches, and the Purkinje fibers.

The SA node is located in the upper right atrium near the entrance of the SVC. It sets the pace for the heart, which is generally between 60–100 beats per minute under normal conditions. It is known as the heart's pacemaker. The electrical stimulus created by the SA node travels through the right and left atria, causing the atria to contract, and continues to the AV node, where it stops briefly, allowing the atria to complete their contraction before the ventricles contract. The electrical impulse then continues down the conduction pathways to the bundle of His into the ventricles.

Interpretation of the Normal electrocardiogram (ECG) Waveform [12,13]

The electrical activity of the heart can be detected through ECG, which is a graphic record of the heart's electrical activity detected by electrodes placed on the body. These electrodes transmit a signal, which is translated into a graphic recording (see Figure 1) made up of various waveforms, or deflections, which are named alphabetically. The primary components of the ECG cycle, or complex, are the P-wave, QRS complex, and T-wave. The electrical activity resulting in a contraction is called depolarization, and the resting and recovery phase is called repolarization. The electrical activity initiated by the SA node results in the depolarization of the atria and is represented by the P-wave. The QRS complex is a result of ventricular depolarization, and the T-wave represents ventricular repolarization.

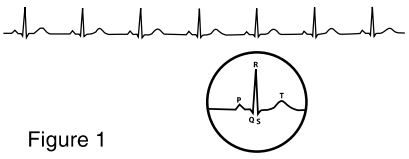


Figure 1

The P-Wave for ECG verification [12,13,14,15]

ECG guidance for positioning a PICC tip relies on identifying changes in the P-wave, which represents the depolarization of the atria, resulting in atrial contraction. When the ECG monitor is connected to the internal catheter electrode, the size of the P-wave will change as the position of the catheter tip changes in relation to the SA node. The location of the catheter tip as it travels through the SVC, cavoatrial junction, and right atrium can be determined by monitoring the P-wave height and deflection. (See Figure 2).

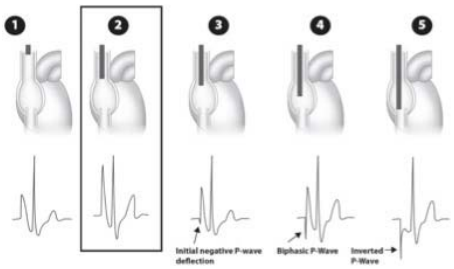


Figure 2

Figure 2 illustrates approximate catheter-tip positions and respective intravascular ECG waveforms:

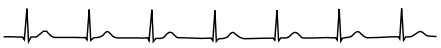
- P-wave increasing as catheter-tip approaches the CAJ.
- P-wave at maximum amplitude indicating the catheter-tip is proximal to P-wave with small negative deflection indicating the catheter-tip is in the proximal right atrium.
  Note: *Negative deflection of the P-wave is a small downward spike immediately before the P-wave.*
- Biphasic P-wave indicates that the catheter-tip is in the mid right atrium.
  Note: *Biphasic P-wave contains a negative deflection of the P-wave that is a least one-half the amplitude of the later positive deflection.*

Inverted P-wave, indicating the catheter-tip is approaching the right ventricle.

Warnings [14]

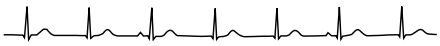
- Facility protocols and clinical judgement should be utilized prior to implementing the use of an ECG-guidance system as an alternative to chest X-ray and/or fluoroscopy.
  - Do not rely on ECG-signal detection for catheter-tip positioning when there are no observable changes in the intravascular ECG P-wave.

P-wave is not present



P-wave is not identifiable

P-wave is intermittent



SUMMARY [4,5,15,24]

This chapter has discussed the importance of the PICC tip residing near the CAJ, as advised by various professional organizations. Also discussed were the primary technologies used to verify the location of the catheter tip. These technologies are radiography and ECG. ECG, in particular, has some wonderful benefits: It reduces the time between PICC placement and infusion therapy, and it reduces the amount of radiation exposure because it nullifies chest X-ray and fluoroscopy. But even when the PICC is placed accurately, complications at times arise. The next chapter focuses on managing common complications.

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Managing Complications

OVERVIEW [1,2,3]

The process of inserting a PICC and its presence in the human body exposes the patient to a wide range of potential complications, ranging from minor things like discomfort, anxiety, or delayed therapy to life-threatening occurrences, such as vessel perforation, sepsis, or embolism. Clinicians placing and caring for PICCs should know how to prevent, detect, intervene, and document such complications, with the primary goal being prevention. Nevertheless, even early recognition of complications can prevent further complications. This chapter will discuss various complications and how to prevent, detect, manage and document them.

OBJECTIVES

- Identify potential complications, including those related to PICC insertion and post insertion.
- Describe strategies for preventing, detecting, and intervening in the event of a PICC related complication.
- Understand the recommendations for documenting complications.

This chapter is for informational and educational purposes only. It is intended to familiarize clinicians and other health professionals with some of the potential complications associated with vascular access devices. Complete diagnosis and management of complications are outside of the scope of this document. Clinicians should consider collaboration with a treating physician, and compliance with hospital protocols for addressing complications. Users should refer to product manufacturers' Instructions for Use. This section is intended to provide a general overview of basic techniques and procedures, and does not replace clinical training or judgement. Users should refer to product Instructions for Use as well as applicable facility protocols.

COMPLICATIONS [1,2]

Vascular access devices have potential complications which should be weighed prior to selecting a device. Complications can vary from mild to life threatening.

It is important for the clinician inserting and caring for these devices to be educated regarding complications and methods to prevent, detect, manage, and document their occurrence. The primary goal is to prevent complications when possible.

Complications can be broken down in relation to their time of occurrence. For example, insertion-related complications may include arterial puncture, bleeding, or nerve injury and post-insertion may include vessel thrombosis, catheter occlusion, sepsis or phlebitis. In addition,there are some complications which may occur at any time, such as air embolism, cardiac arrhythmias, or vascular perforation.

Potential complications related to Peripherally Inserted Central Catheters (PICC) may include the following: [3]

Insertion related

- Arterial puncture
- Bleeding and hematoma
- Nerve irritation or injury
- Laceration/perforation of vessels or viscus
- Risks normally associated with local or general anesthesia

Post insertion

- Vessel thrombosis/ thromboembolism
- Catheter-related infection and/or sepsis and/or exit-site infection
- Catheter erosion through the skin
- Phlebitis
- Difficult catheter removal
- Endocarditis
- Catheter occlusion/fibrin-sheath formation
- Myocardial erosion

Complications which may occur

- Air embolism
- Allergic/hypersensitivity reactions/intolerance reaction to implanted device
- Cardiac arrhythmias
- Catheter and/or wire fracture and embolism
- Catheter malposition or migration
- Exit-site necrosis
- Extravasation
- Vascular erosion, perforation, cardiac tamponade
- Spontaneous catheter-tip malposition or retraction
- Vessel erosion

INSERTION RELATED COMPLICATIONS

ARTERIAL PUNCTURE: Inadvertent puncture of an artery.

Prevention [4,5]

Careful assessment of vessels utilizing ultrasound prior to insertion of the PICC. Locate the brachial artery prior to accessing the vessels of the upper arm.

Detection [1]

Inadvertent arterial puncture caused by the introducer needle is often evident to the clinician immediately. Blood return from an arterial puncture is usually bright red and pulsating. Sometimes, with lower blood pressure, it may not become evident until the dilator removed from the sheath.

Intervention [1,6]

Release the tourniquet and withdraw the needle from the artery. Apply pressure for 3–5 minutes.

In most cases arterial puncture will resolve with pressure. The area should be monitored for the rare possibility of pseudoaneurysm or arteriovenous fistula formation.

Documentation [7]

- Assessment of the patient's conditions
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.
- Nursing interventions that were performed.
- Patient's response to the interventions.

BLEEDING AND/OR HEMATOMA: Puncturing a vein with a needle has the potential of causing bleeding at the insertion site. Patients that receive antiocoagulants or steroids are at increased risk for bleeding. If bleeding is uncontrolled, it may form a hard, painful lump under the skin, called a hematoma. [28,29]

Prevention [29]

The clinician should perform thorough assessment prior to insertion. Do not penetrate through the vein but ensure the needle is in the vein.

Detection [29]

Hematomas may be detected by patient complaints of pain and rapid swelling at or near the insertion site.

Intervention [8,29]

If a hematoma continues to increase during venipuncture, the needle should be withdrawn and pressure applied to the site. When there is post-insertion bleeding, a gauze dressing should be applied for the first 24 hours. Ice can also be applied for the first 24 hours of bleeding and/or hematoma.

Documentation [7,29]

- Assessment of the patient's condition.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.
- Observable ecchymotic areas.

NERVE IRRITATION OR INJURY: Inadvertently hitting a nerve with a needle or introducer during insertion. [29]

Prevention [9,10,29]

- Use ultrasound technology when inserting PICCs.
- The arm in which the catheter is being inserted should be well supported during the insertion procedure.
- Avoid PICC placement in the antecubital fossa.
- Minimize probing with the needle during insertion.

Detection [10,11,29]

- Sharp, shooting, or radiating pain at the insertion site.
- Weakness of the affected nerve.
- The patient experiences an electric shock sensation
- Numbness, tingling, weakness of the area innervated by the involved nerve.

Intervention [8,29]

- If nerve injury is suspected, remove the needle or catheter immediately.
- Apply pressure to the affected area.
- Elevate the extremity to the level of the heart.

Documentation [7,8,13,29]

- Assessment of the patients condition.
- Nursing interventions that were performed.
- Patient response to interventions.
- Removal of the device.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

POST-INSERTION COMPLICATIONS

VESSEL THROMBOSIS: A formation of a blood clot in the vein. [30]

Prevention [9,29]

- Thorough patient assessment to determine the size and patency of a suitable target vessel.
- When selecting a vascular access device, the clinician should select the smallest gauge with the least number of lumens to manage the patient's prescribed therapy.
- Patients should be encouraged to resume their normal activities of daily living, limit their exercises to those that are gentle, and stay hydrated.

Detection [8,9,12,30]

- Clinical signs and symptoms may be absent.
- Swelling in the neck, supraclavicular area, or arms.
- Dilated collateral veins over the arm, neck, or chest.
- Arm pain in the patient and/or or discoloration.
- Pulmonary embolism (PE) will be apparent.
- The patient will experience post-thrombotic syndrome.
- Assess for catheter malfunction (e.g., poor or absent blood return, resistance when attempting to flush the catheter, leakage of infusate at insertion site, persistent high-pressure-infusion-pump alarm).
- Perform a color Doppler.

Intervention [8,12]

- Notify the physician.
- Treatment may consist of thrombolysis and/or anticoagulation.
- The American College of Chest Physicians (ACCP) guidelines for upper-extremity-related deep vein thrombosis (DVT) include:
  - Systemic anticoagulants to prevent extension of the thrombus and PE are recommended.
  - Initial treatment with low-molecular weight heparin, unfractionated heparin, or fondaparinux is recommended.
  - Long-term treatment should include at least 3 months with a vitamin K antagonist (e.g., warfarin).
  - The CVAD does not need to be removed if it is functioning and necessary.
  - If the CVAD is removed, the guidelines do not recommend that long-term anticoagulation therapy be shortened to less than 3 months.

Documentation [7,13]

- Assessment of the patient's condition.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

CATHETER OCCLUSION: A partial or complete blockage of the catheter, which may limit the functional ability of the PICC for blood draws, flushing, and/or administration of fluids or medications.[8]

Prevention [8]

- Routine flushing per facility protocol and the manufacturers' Instructions for Use.
- Flush the catheter, using positive pressure and a push-pause technique to increase turbulence and prevent reflux.
- Valved catheters, neutral connectors, or needleless connectors may assist in preventing reflux.

Detection [29]

- Infusion-pump alarms
- Low infusion rates
- Inability to aspirate blood
- Inability or resistance with flushing the catheter
- Fluid leaking from the insertion site
- Resistance to flushing may be experienced for several days before complete occlusion.

Intervention [8,9]

- Assess the PICC for potential causes of occlusion and catheter clearance, as indicated, to preserve the PICC.
- Occlusions thought to be thrombotic in nature can be treated with a thrombolytic agent, such as low- dose alteplase, which may clear the line.
- A catheter occlusion from a high-pH drug precipitate may be dissolved with sodium bicarbonate.
- A catheter occlusion from a low-pH precipitate may be dissolved with 0.1N hydrocloric acid.
- A catheter occlusion from a fat-emulsion buildup may be dissolved with ethanol, ethyl alcohol, or sodium hydroxide.

Documentation [7,13]

- Assessment of the catheter occlusion, which may include inability to draw blood, difficulty or inability to flush the catheter, or sluggish flow.
- Nursing interventions that were performed to obtain catheter clearance.
- Outcome of the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

CATHETER RELATED INFECTION AND/OR SEPSIS: Central line-associated bloodstream infection (CLABSI) is the term used by the CDC to define a primary bloodstream infection that has no other identifiable source in a patient that has had a central line within the 48-hour period before onset of the bloodstream infection. [14]

Prevention [9,14,15,16]

- Implement Institute for Health Improvement (IHI) Central Line Bundle, including
  - Hand hygiene
  - Maximal barrier precautions
  - Chlorhexidine skin antisepsis
  - Optimal catheter-site selection
  - Daily review of line necessity with prompt removal of unnecessary lines
- Utilize a central-line insertion checklist to ensure compliance.
- Select a device with the minimum number of lumens necessary for the management of the patient.
- Replace the PICC dressing if it becomes damp, loose, or soiled.
- In patients 2 months and older, the use of a chlorhexidine-impregnated sponge should be considered if the CLABSI rate is not decreasing, despite compliance with basic preventative measures.
- Secure the device with a sutureless securement device.
- Disinfect the needeless connector prior to accessing the line.

Detection [8,9,16]

- Monitor the patient for signs and symptoms of infection.
- Patient assessment should include ongoing monitoring of the catheter- insertion site and signs and symptoms of infection.
- Regularly inspect and/or palpate the insertion site through the dressing. If the patient expresses pain with palpation or has fever or if other conditions suggest an infection, the dressing should be removed to allow you to see the insertion site.
- Ongoing surveillance and reporting of CLABSIs is recommended. The goal is a 0% infection rate. A standard formula should be used to measure the incidence of CLABSI. For example,

$$\frac{\textit{Number of BSIs in patients with central lines}}{\textit{Total number of central line days multiplied by 1000}} \; X \; 1000 = \textit{CLASBI Rate}$$

Intervention [9]

- Notify the physician about signs and symptoms of an infection, including, but not limited to, erythema, edema, induration, or drainage at the insertion site, and/or fever.
- Obtain blood cultures prior to administration of anti-infective agents if they have been ordered.
- Obtain new IV access as ordered.

Documentation [7,13,29]

- Assessment of the patient.
- Nursing interventions that were performed.
- Outcome of interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

PHLEBITIS: Inflammation of the intima of the vein, which may cause pain, tenderness, erythema, edema, streak formation, or warmth at the site.[8]

Prevention [8,9,29]

- Use ultrasound technology when inserting PICCs to increase success rates and decrease insertion-related complications.
- Seldinger or modified Seldingers technique (MST) are the preferred methods for decreasing vein trauma during PICC insertion.
- Avoid placing a PICC in the antecubital fossa.
- Prior to inserting a PICC, thoroughly assess the patient for proper catheter gauge in relation to the vessel.
- Stabilize the catheter.

Detection [29]

- Pain or tenderness
- Erythema
- Warmth
- Swelling
- Purulent drainage
- Palpable cord
- Fever

Intervention [9,29]

- Application of a warm compress.
- Assess the site and rate the severity using a standardized scale.
- Remove the device if clinically indicated.
- Determine if the cause of the phlebitis is chemical, mechanical, or bacterial.
- Treatment should begin immediately after observing the first symptom of phlebitis and should continue until inflammation completely subsides.
- Monitor the site for 48 hours.

Documentation [7,13]

- Assessment of the patient's condition.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

DIFFICULT CATHETER REMOVAL: Irritation of the lining of the vein, causing venospasm or presence of a thrombosis that results in an inablitiy to remove the catheter.[8]

Prevention [8,9]

When removing a catheter, use a gentle, slow pace to prevent venospasm. Avoid pressure at or above the insertion site and along the path of the vein.

Detection [8]

When attempting to remove the catheter you would encounter resistance or be unable to remove it.

Intervention [8,29]

- If resistance is met, avoid pulling.
- If resistance is met, stop the procedure and apply a sterile dressing.
- To dilate the vein during removal, a warm compress may be applied proximal to the insertion site.
- Removal may be reattempted after an established time period has passed, per facility protocol.
- The patient may need to be sent to interventional radiology for evaluation and catheter removal.
- When the catheter is removed, it should be inspected to ensure no damage has occured.

Documentation [7,8,25]

- Assessment of the patient's condition.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Length and integrity of the catheter.
- Dressing that was applied.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

COMPLICATIONS OCCURRING ANYTIME

These are potential complications that may occur during or after insertion.

AIR EMBOLISM: Can occur when air enters the venous system. [17,20]

Prevention [1,8,18, 20]

- Position the patient with the arm in which the catheter is being inserted below the level of the heart during insertion.
- The catheter should be inserted promptly after the dilator is removed from the sheath.
- Place a finger over the opening of the sheath.
- Use luer-locking connections on catheter junctions.
- All syringes, administration sets, and connectors should be flushed with saline to remove the air prior to connecting to the patient.
- A non-valved catheter should be clamped during changes of needleless connector and administration sets.
- Prior to insertion and thereafter, routinely inspect devices for integrity.

Detection [19,20]

- Patient may experience a sudden onset of dyspnea, lightheadedness, nausea, shoulder pain, or chest pain.
- The patient may feel anxious, agitated, irritable, or feel a sense of impending doom.
- Physiologic symptoms may include tachypnea, tachycardia, and/or hypotension.
- Neurologic symptoms may be similar to those of a stroke.
- When auscultating heart sounds, it is rare, but possible, to hear a mill-wheel murmur, which is indicative of a large right-ventricular embolism.

Intervention [8,19,20]

- Notify the physician
- Put the patient on his/her left side in trendelenburg unless that is contraindicated.
- Administer oxygen at 100%.
- Attempt to occlude the opening if the entry site is known.
- If the external portion of the catheter is visibly damaged, a non-serrated clamp should be applied proximal to the damaged area.
- Attempting to remove the air from the CVAD may provide some relief from symptoms.
- Monitor vital signs. Emergency equipment should be available.

Documentation [7,13,19]

- Assessment of the patient's condition, including vital signs.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

ALLERGIC/HYPERSENSITIVITY REACTIONS: The bodies physiologic response to a foreign object. [20]

Prevention [20]

- Evaluate the patient's history for any known allergies.
- Ensure accurate patient identification and allergy status.
- Prior to PICC insertion, identify patients with allergies to lidocaine, heparin, skin prep, or tape.
- Prior to insertion identify patients with a latex allergy.

Detection [20]

- Allergic reactions can range from moderate to severe and from localized to systemic.
- Symptoms may include, but are not limited to, edema, hypotension, tachycardia, itching, rash, hives, anxiety, agitation, wheezing, respiratory difficulty, respiratory arrest, and/or cardiac arrest.

Intervention [20]

- If the reaction is infusion related, the infusion should be stopped.

Monitor vital signs. [25]

- Notify the physician.
- Stay with the patient.
- Emergency equipment should be available.

Documentation [7,13,20]

- Assessment of the patient's condition, including vital signs.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

CARDIAC ARRHYTHMIAS: May be caused by stimulation of the myocardium caused by over-insertion of the PICC or post-insertion migration.[6]

Prevention [1,8,10,21]

- Review cardiovascular history, including presence of cardiac arrhythmias.
- Assess the patient for cardiac devices, such as pacemakers and implantable defibrillators, which may indicate a hypersensitive myocardium.
- Anthropometric measurment of the expected PICC pathway should be performed to determine approximate catheter length.
- The guidewire should not extend past the tip of the catheter.
- Secure the catheter to help prevent catheter migration.
- The catheter tip should be verified in the correct position prior to using the PICC and routinely thereafter.

Detection [1,2,11,21]

- Alteration in cardiac rhythms, such as ectopy or tachycardia.
- Cardiac monitoring showing arrythmias during insertion.
- Routinely verify external catheter length has not changed, per facility protocol.
- The patient complains of palpitations.

Intervention [1,2,6 22]

- Over-inserted wires or catheters should be retracted.
- Persistent arrhythmias should be promptly treated.
- Cardiology should see the patient.
- Perform a 12-lead ECG.
- Pull the PICC back 2–3 cm to see if the arrhythmias resolve.

Documentation [1,2,7,13]

- Assessment of the patient's condition, including vital signs and cardiac rhythm.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

CATHETER AND/OR WIRE EMBOLISM OR CATHETER FRACTURE: When a portion of a catheter or wire fractures, it can cause an embolism.

Prevention [8,9,18,22]

- Do not remove a catheter through a needle.
- Maintain control of the guidewire.
- Do not force the guidewire in or out to prevent sheering.
- Prior to inserting a guidewire, check it's integrity.
- If the guidewire must be withdrawn while the needle is inserted, remove both the needle and the wire as a unit to prevent the needle from damaging or shearing the guidewire.
- Once removed, the stylet should not be reinserted into the catheter.
- Power injection should only be done through power-injectable devices.
- The size of the syringe used for flushing should follow the catheter manufacturer's Indications for Use.
- Avoid using excessive force or sharp instruments near the catheter.
- If resistance is met when removing the PICC, stop to avoid breaking the catheter.

Detection [8,9,20,22]

- When an incomplete catheter is removed from the patient, embolism should be suspected.
- Signs and symptoms are dependent on the location of the catheter or wire fragment, but may include cyanosis, dyspnea, hypotension, chest pain, respiratory arrest, or cardiac arrest.
- The guidewire is visually transected when it is withdrawn from the needle.
- When removing a PICC, examine it for damage or possible fracture.
- If embolism is suspected, a chest radiograph may be necessary.
- If catheter removal is difficult, the patient and catheter should be assessed for signs or symptoms of embolism.
- Routinely inspect the catheter's integrity.

Intervention [20]

- Notify the physician.
- Intervene, as necessary, to manage symptoms.
- The patient should remain on bed rest.
- Monitor the patient's vital signs.
- Perform radiographic studies to determine the location of the fragment.

Documentation [7,13,25]

- Assessment of the patient's condition, including vital signs.
- Signs and symptoms of catheter embolism.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

CATHETER MALPOSITION OR MIGRATION: A malposition can be defined as the catheter tip lying outside of the distal SVC, or CAJ.

Prevention [1,8,9,10,21]

- Intrathoracic changes, such as coughing, sneezing, and vomiting may cause catheter malposition or migration.
- Assess radiographic images and ultrasound or CT studies to assist in identifying anatomical abnormalities, which may alter the length of the catheter required.
- Advance the catheter slowly and steadily.
- Perform a pre-insertion anthropometric measurement.
- Turn and abduct head toward the side of insertion while advancing the catheter.
- Navigation may decrease insertion-related malpositions.
- After insertion use a catheter stabilization device.

Detection [8,9,10,20,21]

- Atrial and ventricular tachyarrhythmias.
- During insertion, ultrasound may assist in ruling out catheter placement in the internal jugular vein.
- Difficulty advancing the catheter during insertion.
- Pain, edema, or errythema in the arm, shoulder, or neck.
- Difficulty flushing or aspirating blood from the catheter.
- Prior to initiation of therapy the location of the catheter tip should be confirmed either radiographically or by other approved technologies.
- Change in external catheter measurement.
- If it is suspected that the catheter is malpositioned, a chest X-ray or fluoroscopy should be performed.
- Patient may complain of hearing a flushing or gurgling sound during catheter flushing.

Intervention [8,9,23,24]

- Catheters should not be advanced after initial insertion is complete.
- Consider repositioning the patient to allow the catheter to float into the SVC.
- Catheter exchange or removal may be required.
- The patient may require repositioning in Interventional Radiology.
- Notify the physician.
- Stop the infusions.

Documentation [7,13,25]

- Assessment of the patient's condition, including vital signs and cardiac rhythm.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.
- Radiographic-verification results.

VASCULAR EROSION, PERFORATION, AND CARDIAC TAMPONADE:

Vascular erosion can occur from malpositions, which may lead to perforation, and cardiac perforation of the right atrium may result in cardiac tamponade.[21,31]

Prevention [8,9,21,26]

- The PICC tip should reside in the lower third of the SVC or the CAJ.
- PICC- tip confirmation should be done after PICC insertion and before the catheter is used. Tip position should be routinely reassessed per facility guidelines.
- Avoid over-insertion of the guidewire and catheter.
- Ensure the catheter is securely dressed to prevent migration.
- The use of manufactured catheter-stabilization or securement devices are preferred over other methods, such as sterile tapes and/or surgical strips.
- Routinely verify that the length of the catheter out of the body has not changed.

Detection [21,22,27]

- Cardiac and respiratory compromise are immediately present and may include dyspnea, tachycardia, bradycardia, muffled heart tones, hypotension, pulsus paradoxus, pulseless electrical activity (PEA), and pallor.
- On a chest radiograph the cardiac silhouette and mediastinum will appear enlarged.

Intervention [21,27,31]

- Stop infusions and attempt to aspirate from the catheter.
- Perform a chest radiograph.
- Perform an echocardiogram.
- Notify the physician.
- Monitor the patient's vital signs.
- Have emergency equipment available.

Documentation [7,13]

- Assessment of the patient's condition, including vital signs and cardiac rhythm.
- Nursing interventions that were performed.
- Patient's response to the interventions.
- Name of the physician that was notified and any new orders that were given.
- Date and time the physician was notified.

SUMMARY [1,2,3]

This chapter has discussed complications that vary in severity from mild to life threatening. Preventing complications should be a clinician's primary objective, but complications will sometimes arise. It is, therefore, essential that clinicians know how to recognize and deal with complications to improve the quality of care for the patient. The next chapter will discuss how to care for and maintain the PICC.

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PICC Care and Maintenance

OVERVIEW [3,6]

Routine care and maintenance of a PICC are essential for preventing common complications, such as dislodgement, infection, and malfunction. It is imperative that the clinician possess the skill, knowledge, and judgment to perform the tasks necessary to care for the PICC. The techniques discussed in this chapter include disinfecting and dressing the insertion site, stabilizing the PICC, flushing and locking the PICC, taking blood samples, repairing a malfunctioning PICC, and removing a PICC.

OBJECTIVES

- Identify different skin asepsis solutions, application techniques, and dry times.
- Identify different types of stabilization devices.
- Understand the types of dressings, the procedure for changing them, and the frequency at which they should be changed.
- Identify types of needleless connectors.
- Understand proper technique for flushing, locking, drawing blood, and doing power injection.
- Understand the procedures for catheter clearance, repair, and removal.

This section is intended to provide a general overview of basic techniques and procedures, and does not replace clinical training or judgement. Users should refer to applicable Instructions for Use and facility protocols.

SKIN ANTISEPSIS [2,4,6,20,22,23,24]

Skin antisepsis should occur prior to PICC insertion and during dressing changes. Prior to inserting the line, it is recommended that the skin be cleaned and not contain any organic matter. The 2011 CDC guidelines recommend prepping the skin with >0.5% chlorhexidine before PICC insertion and during dressing changes. If there is a contraindication to chlorhexidine, alternatives include povidone-iodine and 70% isopropyl alcohol.

Solution	Application	Recommendations for dry time.
2% Chlorhexidine gluconate with alcohol	Completely wet the area, using a back-and-forth stroke for approximately 30 seconds.	30 Seconds
Povidone-iodine	Scrub the site for 3-5 minutes, using a concentric circle beginning at the insertion site.	2 minutes
70% isopropyl alcohol	Scrub the site using a back-and-forth stroke for 1 minute.	1.5 minutes

Consult manufacturer's Instructions for Use and facility protocols for specific products.

PICC STABILIZATION [3,4,26]

The use of a stabilization device can help minimize catheter movement, risk of phlebitis, risk of infection, catheter migration, and dislodgement. There are different types of stabilization methods, including the use of manufactured stabilization devices, tape, and sutures.

Manufactured Stabilization Device*

A manufactured stabilization device is recommended over tape or sutures, when possible.

INDICATIONS FOR USE: The StatLock® stabilization device is a stabilization device for compatible medical tubes and catheters. Multiple pad and retainer designs are available.

Choose the StatLock® stabilization device indicated for the tube or catheter to be secured.

CONTRAINDICATIONS: Known tape or adhesive allergies.

WARNINGS AND PRECAUTIONS: Do not alter the StatLock® stabilization device or components. Procedure must be performed by trained personnel with knowledge of anatomical landmarks, safe technique, and potential complications.

Do not use the StatLock® stabilization device where loss of adherence could occur, such as with a confused patient or nonadherent skin.

Observe universal blood and body fluid precautions and infection control procedures, during application and removal of the StatLock® stabilization device.

Suture the StatLock® stabilization device pad to skin if desired or deemed necessary.

Avoid contact with alcohol or acetone, as both can weaken bonding of components and adherence of the StatLock® stabilization device pad adherence.

Minimize catheter/tube manipulation during application and removal of the StatLock® stabilization device.

A StatLock® stabilization device luer-lock connector must be used to secure central venous and arterial catheters.

Always apply adhesive strip to central venous and arterial catheters at or near insertion site when using StatLock® stabilization device.

Remove oil and moisturizer from targeted skin area.

Orient the StatLock® stabilization device so arrow points toward catheter tip (if applicable).

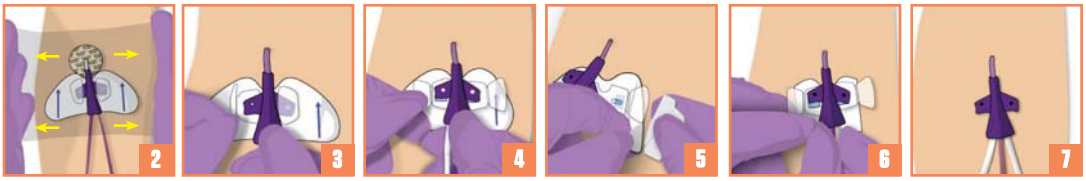
The StatLock® stabilization device should be monitored and replaced in accordance with facility protocol.

The StatLock® stabilization device should be replaced at least every 7 days.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

REMOVAL TECHNIQUE



Procedural Considerations

Set Up

1. Open Statlock® PICC/CVC stabilization device dressing change kit and prepare the field per facility protocol and procedure.

Disengage

2. Wearing sterile gloves, mask, and sterile drape under the arm, use the stretch technique to remove the transparent dressing from the Statlock® stabilization device anchor pad. Remove chlorhexidine disc, if applicable.

Note: *Dab alcohol over the transparent dressing if difficult to remove. Continue to stretch off the skin.*

3. Stabilize the catheter while holding the Statlock® stabilization device. Use the thumb of the opposite hand to gently lift the lower tab of the retainer door. Reposition your hands and repeat the process to open the second retainer door.

4. Carefully remove the catheter from the retainer.

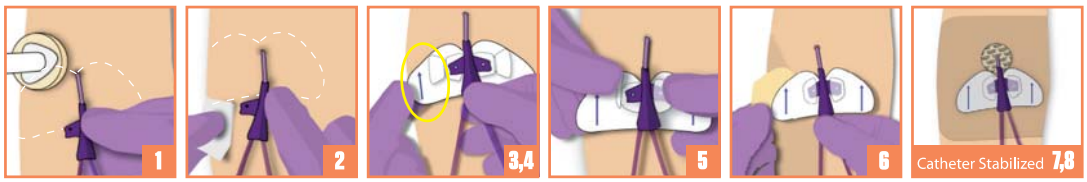
Dissolve

5. Use 3–4 alcohol pads to lift the corner edge of the anchor pad, then continue to stroke under the surface of the pad with generous amounts of alcohol to remove the anchor pad from the skin.

6. Fold the anchor pad under itself and repeat on the opposite side. Do not pull or use force to remove the pad. The more alcohol used, the easier the removal.

7. Complete dressing change per facility protocol or discontinue the catheter.

APPLICATION TECHNIQUE



Prep

1. Cleanse and degrease insertion and stabilization sites using alcohol or a chlorhexidine solution. Extend on both sides to an area larger than where the anchor pad will be placed. Allow to dry completely.

2. Apply skin protectant provided to the stabilization site. Extend the protectant to both sides of the stabilization site, covering an area larger than where the Statlock® stabilization device anchor pad will be placed. Allow skin protectant to dry completely (for 10 to 15 seconds) until the skin is smooth to the touch.

Press

3. Orient the Statlock® stabilization device anchor pad so the directional arrows point toward the insertion site.

4. Place the catheter wing holes over the Statlock® stabilization device posts one side at a time

5. Add support underneath the anchor pad and catheter while closing the retainer doors.

Place and Peel

6. Hold the Statlock® stabilization device retainer securely as you peel away the paper backing from the Statlock® stabilization device anchor pad one side at a time. Place on the skin.

7. Apply a chlorhexidine disc per the manufacturer's instructions for use, if indicated.

8. Apply transparent dressing per facility protocol.

9. Record the date and time the dressing was applied per facility protocol.

Tape*: The catheter hub may also be secured with tape or sterile surgical strips. The tape should not be applied directly to the catheter skin junction. [6]

Sutures*: Sutures may also be used, when applicable, to secure the device. They may, however, allow small movements, which could lead to additional complications. Sutures have the potential for needle stick injuries and should be avoided, if possible. [3,6]

CHLORHEXIDINE SPONGES* [3,4,6,27]

The 2011 CDC guidelines state, "Use a chlorhexidine-impregnated sponge dressing for temporary short-term catheters in patients older than 2 months of age if the CLABSI rate is not decreasing despite adherence to basic prevention measures, including education and training, appropriate use of chlorhexidine for skin antisepsis, and MSB [93, 96-98]. Category IB".

Purpose

To prevent external infection of the PICC.

Frequency

Change the dressing, as necessary, according to facility protocol. Dressing can be left in place for up to 7 days. For highly exuding wounds, more frequent changes may be needed.

GUARDIVA™ DRESSING INDICATIONS FOR USE*:
The Bard® GuardIVa™ Antimicrobial Hemostatic IV Dressing is intended for use as a hydrophilic wound dressing to absorb exudate, cover, and protect catheter sites. Common applications include IV catheters, other intravenous catheters, and percutaneous devices. It is also indicated for control of surface bleeding from percutaneous catheters and vascular access sites.

GUARDIVA™ DRESSING WARNINGS:

- **Do not use the GuardIVa™ dressing on patients with a known sensitivity to chlorhexidine gluconate. The use of chlorhexidine gluconate containing products has been reported to cause irritation, sensitization, and generalized allergic reactions. If any such reactions occur, discontinue use of the dressing immediately, and if severe, contact a physician.**
- **For external use only. Do not allow this product to contact ears, eyes, mouth, or mucous membranes.**
- **Intended for single use. DO NOT REUSE. Reuse and/or repackaging may create a risk of patient or user infection, compromise the structural integrity and/or essential material and design characteristics of the device, which may lead to device failure, and/or lead to injury, illness, or death of the patient.**
- **See outer label to determine status and method of sterilization.**
- **The Bard® GuardIVa™ Antimicrobial Hemostatic IV Dressing is not intended to treat infection.**

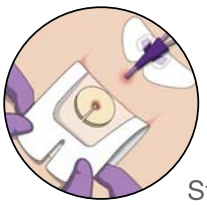
Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Procedural Considerations

1. Prepare the skin surrounding the percutaneous device according to facility protocol.
2. Remove the GuardIVa™ dressing from the sterile package, using an aseptic technique.
3. Place the GuardIVa™ dressing around the catheter with the printed side facing up.
4. Position the GuardIVa™ dressing around the catheter/pin site so the catheter rests on the slit portion of the GuardIVa™ dressing. The slit edges should come in contact with one another to assure best efficacy.
5. Secure the catheter and GuardIVa™ dressing to the skin with a transparent dressing. Assure complete contact between the skin and GuardIVa™ dressing.
6. To remove GuardIVa™, hold the catheter and pick up the corner of the transparent dressing. In a slow and low motion pull the dressing away from the catheter. The GuardIVa™ dressing will lift off with the transparent dressing.


Step 4


Step 5


Step 6

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

PICC DRESSINGS* [2,3,4,5,7,20,25]

Insertion sites should be assessed regularly and with dressing changes. Site care should be performed to clean the skin and reduce the presence of microorganisms. A sterile dressing should be applied to cover the insertion site. The dressing can be sterile gauze with the edges secured by an occlusive material or a transparent semipermeable membrane (TSM). In addition, dressings should be changed if they become visibly loose, damp or soiled.

Purpose

To prevent external infection of the central venous catheter.

Frequency

Assess the dressing in the first 24 hours for accumulation of blood, fluid, or moisture beneath the dressing. During all dressing changes, assess the external length of the catheter to determine if catheter migration has occurred. Periodically confirm catheter placement, tip location, patency, and dressing security.

According to the 2011 INS standards, dressings should be changed every 5 to 7 days and PRN if dressing is loose or damp. A gauze dressing may also be used at the insertion site if there is bleeding or oozing and should be changed every 48 hours or sooner, as needed. Gauze may be used by itself or under a TSM. If the gauze is under a TSM, it still should be changed every 48 hours or sooner. Chlorhexidine gluconate is the suggested antiseptic to use. Acetone and tincture of iodine should not be used. Swabsticks with 2% Chlorhexidine gluconate and 70% isopropyl alcohol may be used for dressing changes. Povidone iodine may also be used as an antiseptic.

Supplies

A central line dressing kit is recommended. If one is not used, the following are recommended:

- Nonsterile gloves
- Sterile gloves
- Chlorhexidine gluconate 2% with alcohol, Povidone-iodine or 70% alcohol
- Stabilization device
- Chlorhexidine-impregnated sponge (recommended),
- Transparent semipermeable membrane (TSM) dressing
- Mask
- Surgical strips or sterile tape
- Sterile drape
- Single-use measuring tape

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

Procedural Considerations

1. Perform hand hygiene.

2. Don a mask.

3. Put on non-sterile gloves.

4. Carefully remove the old dressing and discard it. Avoid tugging on the catheter and using scissors or other sharp objects.

5. Remove the stabilization device.

6. Inspect the catheter exit site for swelling, redness, or exudate. Notify the physician if a problem is observed.

7. Verify the external catheter length.

8. Remove non-sterile gloves.

9. Put on sterile gloves.

10. Perform skin antisepsis.

11. Apply a new manufactured stabilization device, surgical strips, or sterile tape per facility protocol.

12. Apply a chlorhexidine impregnated sponge per the facility protocol.

13. Apply a new TSM over the exit site and catheter tubing.

14. Attach additional securement per facility protocol. Avoid placing tape directly on the polyurethane catheter material.

15. Discard used supplies.

16. Remove gloves and discard them.

17. Perform hand hygiene.

18. Label the dressing.

19. Document the procedure.

FLUSHING AND LOCKING* [3,7,16,20]

Purpose

Flushing should be performed before and after each infusion to clear the line of infusates, maintain line patency, prevent mixing of incompatible medications, and ensure patency. Flushing should be done with preservative-free 0.9% sodium chloride.

Frequency

Non-valved catheters should be flushed every 12 hours when they are not in use. Valved catheters should be flushed at least weekly. Locking should be performed after the final flush solution to decrease the potential for occlusion.

Supplies

- Isopropyl alcohol, povidone-iodine wipes, or CHG swab stick
- Appropriately sized syringe filled with preservative-free 0.9% sodium chloride (normal saline)
- Heparin-lock prefilled syringe (per facility protocol)

Procedural Considerations

1. Perform hand hygiene.

2. Identify the needleless connector type (positive, negative, neutral, or split septum).

3. Using friction, scrub the top of the needleless connector with alcohol, povidone-iodine wipes, or CHG swab per the manufacturer's Instructions for Use.

4. Attach syringe of preservative-free 0.9% sodium chloride to the needleless connector.

5. Pull back on the syringe until you are able to aspirate blood.

6. Flush the catheter with a minimum of 10ml of saline, using a pulse or stop-start technique.

7. Disconnect the syringe using the appropriate clamping sequence for the connector described below.

8. Lock with heparin* (per facility protocol)

For non-valved catheters

Negative-displacement connectors: Flush the solution and maintain force on the syringe plunger as the clamp is closed. Then disconnect the syringe. (Figure 4)

(Figure 4)

Positive-displacement connectors: Flush the solution, disconnect the syringe, and close the clamp. (Figure 5)

(Figure 5)

Neutral-displacement connectors: Flush the solution. The clamp may be closed before or after the syringe removal. (Figure 6)

(Figure 6)

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

WITHDRAWING BLOOD / ASPIRATING* [16,20]

Purpose

To obtain blood samples for laboratory evaluation, eliminate the need for peripheral vein punctures, or verify venous placement.

Supplies

- 3 appropriately sized syringes
- 2–3 sterile appropriately sized preservative-free 0.9% sodium chloride (normal saline)
- Isopropyl alcohol wipes, povidone-iodine wipes, or CHG swabstick
- Blood specimen tubes
- Needleless connector
  - Heparin-lock solution prefilled syringe* (per facility protocol)
  - Transfer device

Procedural Considerations

1. Perform hand hygiene.

2. Gather supplies.

3. Apply gloves.

4. Stop any IV fluids infusing through all lumens of the catheter.

5. Using friction, scrub the top of the needleless connector with alcohol, povidone-iodine wipes, or a CHG swab per the manufacturer's guidelines.

6. Gently aspirate blood.

7. Pull back the syringe plunger, pausing for 2 seconds to allow blood to come into catheter. Slowly continue to aspirate blood.

Note: *If unable to obtain blood return: have patient change position, cough, move arm or take a deep breath and hold. Attempt to flush with 0.9% normal saline.*

8. Disconnect the syringe and discard it. (Saline in a catheter dilutes the specimen and may alter lab values.)

9. Attach an appropriately sized empty syringe and aspirate per step 6 to withdraw the amount of blood needed for testing.

10. Disconnect the syringe and attach the saline-filled syringe.

11. Change needleless connector.

12. Flush the catheter with a minimum of 20 ml normal saline, using the stop-start" technique.

13. Transfer to blood collection tubes per facility protocol.

14. Dispose of used supplies in a biohazard container.

15. Remove gloves.

16. Perform hand hygiene.

17. Document the procedure per facility protocol.

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

POWER INJECTION*

Purpose

To inject contrast media per facility protocol.

Supplies

Appropriately sized syringes containing 0.9% normal saline, alcohol, povidone-iodine wipes, or CHG swab, and needleless connectors.

Procedural Considerations

1. Perform hand hygiene.

2. Gather supplies.

3. Apply gloves.

4. Remove the injection/needleless cap from the catheter. Using friction, scrub the hub with alcohol, povidone-iodine wipes, or CHG swab per the manufacturer's guidelines.

5. Attach a syringe filled with sterile 0.9% normal saline.

6. Aspirate for adequate blood return and vigorously flush the catheter with the full 10 ml of normal sterile saline.

Warning: *Failure to ensure patency of the catheter prior to power-injection studies may result in catheter failure.*

7. Detach the syringe.

8. Attach the power injection device to the PICC per the manufacturer's recommendations.

9. Contrast media should be warmed to body temperature prior to power injection.

Warning: *Failure to warm contrast media to body temperature prior to power injection may result in catheter failure.*

10. Use only lumens marked "power injectable" to power-inject contrast media.

Warning: *Use of lumens not marked "power injectable" for power injection of contrast media may cause failure of the catheter.*

11. Complete the power injection study, being careful not to exceed the flow-rate limits. Do not exceed the maximum flow rate of the catheter*.

Warning: *Exceeding the maximum flow rate = or the maximum pressure of power injectors may result in catheter failure and/or catheter tip displacement.*

Warning: *Power-injector machine pressure limiting feature may not prevent over-pressurization of an occluded catheter, which may cause catheter failure.*

12. Disconnect the power-injection device.

13. Replace the injection/needleless cap on the catheter.

14. Flush each lumen of the catheter with 10 ml of sterile normal saline, using an appropriately sized syringe. Using heparinized* saline to lock each lumen of the catheter, per facility protocol, is optional for valved catheters.

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

CHANGING NEEDLELESS CONNECTORS* [16]

Needleless Connectors are placed on the end of the catheter to allow access with a syringe or IV tubing without the use of a needle. There are different types of connectors. Simple (split septum) and complex (positive, neutral, and negative).

Purpose

To minimize potential for infection from overuse of a needleless connector.

Frequency

- Every 7 days or per facility protocol agency policy
- When the needleless connector has been removed for any reason
- Anytime the needleless connector appears to be damaged or leaking or when blood is seen in the catheter without explanation or when blood residue is observed in the needleless connector
- After blood has been withdrawn through the needleless connector (per facility protocol)

Supplies

- New sterile needleless connector
- Alcohol wipes, povidone-iodine wipe, CHG swabstick
- Appropriately sized syringe filled with 5 ml of sterile 0.9% sodium chloride (normal saline)
- Gloves

Procedural Considerations

1. Perform hand hygiene.

2. Apply gloves.

3. Using aseptic technique, open the needleless connector package and prefill the needleless connector with normal saline.

4. Hold the hub of the catheter below the level of the patient's heart and remove the old needleless connector.

5. Clean the outside of the catheter hub with an alcohol wipe, povidone-iodine wipe, or CHG swabstick.

6. Remove the tip protector from the new needleless connector and twist it clockwise onto the catheter hub.

7. Irrigate the catheter with 5 ml of sterile 0.9% sodium chloride.

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

Needleless Connectors

This is not an all inclusive list and is not meant to replace the manufacturers' Indications for Use.

MANUFACTURER	BRAND NAME	CAP	DISPLACEMENT TYPE
Covidien	Kendall™ Cap		Neutral
ICU Medical, Inc.	MicroClave™ Cap		Neutral
ICU Medical, Inc.	MicroClave™ Clear Cap		Neutral
ICU Medical, Inc.	Antimicrobial MicroClave™ Cap		Neutral
ICU Medical, Inc.	Clave™ Cap		Negative
ICU Medical, Inc.	Antimicrobial Clave™		Negative
ICU Medical, Inc.	CLC 2000™ Cap		Positive
ICU Medical, Inc.	NanoClave™ Cap		Neutral
ICU Medical, Inc.	Neutron™ Cap		Neutral
RyMed Technologies, Inc.	InVision-Plus™ Cap		Neutral
RyMed Technologies, Inc.	InVision-Plus CS™ Cap		Neutral
RyMed Technologies, Inc.	InVision-Plus Junior™ Cap		Neutral

MANUFACTURER	BRAND NAME	CAP	DISPLACEMENT TYPE
B Braun	CARESITE™ Cap		Positive
B Braun	ULTRASITE Ag Antibacterial™ Cap		Positive
B Braun	ULTRASITE™ Cap		Positive
B Braun	SAFELINE Split Septum™ Cap		Negative
Baxter	INTERLINK Split Septum™ Cap		Negative
Baxter	CLEARLINK™ Cap		Negative
Baxter	ONE-LINK™ Cap		Neutral
Baxter	V-LINK Antimicrobial™ Cap		Negative
BD	Q-Syte™ Cap		Negative
CareFusion, Corp.	MaxPlus Clear™ Cap		Positive
CareFusion, Corp.	MaxGuard Antimicrobial™ Cap		Positive
CareFusion, Corp.	SmartSite™ Cap		Negative
CareFusion, Corp.	VersaSafe Split Septum™ Cap		Negative

CLEARING OCCLUDED PICCS* [16]

A catheter may become occluded from an improper flushing technique or lack of flushing after infusions and blood draws. A catheter may be occluded if it is difficult or not possible to flush.

Purpose

To restore patency to an occluded catheter.

Supplies

- Sterile needleless connector (1)
- Thrombolytic solution
- Appropriately sized syringe (1)
- Appropriately sized syringe filled with 10 ml normal saline (1)
- Isopropyl alcohol wipes
- Gloves

Procedural Considerations

1. Perform hand hygiene.

2. Put on gloves.

3. Remove the needleless connector, attach appropriately sized empty syringe and attempt to aspirate. If aspiration is successful, withdraw clots and flush the catheter with 10 ml normal saline. Replace the needleless connector. If aspiration is unsuccessful, proceed to step 4.

4. Obtain the physician's order for the use of thrombolytic solution to declot the catheter. The packaging insert should be observed.

Note: *Cautions are contained in the medication packaging.*

5. Draw up thrombolytic solution* into an appropriately sized syringe.

6. Using friction, scrub the hub with alcohol, providone-iodine or CHG. Aseptically attach the thrombolytic-solutio n filled syringe to the catheter hub. Slowly and gently inject the thrombolytic solution into the catheter using a push-pull motion to achieve maximum mixing. To avoid catheter rupture, do not force entire amount into catheter if strong resistance is felt.

7. Leave an appropriately sized syringe attached to catheter. Do not attempt to aspirate for 30–60 minutes.

8. After 30 minutes, attempt to aspirate the drug and residual clot. If unsuccessful, repeat thrombolytic instillation.

9. When patency is restored, aspirate 5 ml of blood to assure the removal of all drug and clots.

10. Remove the blood-filled syringe and replace it with an appropriately sized syringe filled with normal saline.

11. Attach the sterile, saline-filled needleless connector.

12. Attach an additional securement per facility protocol, avoiding the placement of tape directly on the polyurethane catheter material.

Note: *For suspected calcium and phosphate precipitation when thrombolytic solution does not clear blockage, a sterile 0.1% N hydrocholoric acid solution may be instilled in the catheter and left in place for one hour. The solution should then be aspirated and the catheter flushed with normal saline.*

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

REPAIRING GROSHONG® PICCS* [17, 20]

Catheter damage may occur from excessive pressure during flushing, accidental cutting, or from the catheter clamp. Currently the only product repairable is a catheter with a distal valve (i.e., the Groshong® PICC).

GROSHONG® INDICATIONS: The Groshong® PICC catheter is designed for use when central venous catheterization is prescribed. The Groshong® Midline catheter is used for peripheral placement for delivery of selected infusates (See Contraindications). For blood therapy, it is recommended that a 4 French or larger catheter be used.

WARNINGS: Intended for Single Patient Use. DO NOT REUSE. Bard Access Systems products are single use devices and should never be reimplanted. Reuse carries with it the attendant concern of cross-infection regardless of the cleaning or sterilization method. Resterilization of incompletely cleaned devices may not be effective. Any device that has been contaminated by blood should not be reused or resterilized.

After use, this product may be a potential biohazard. Handle and dispose of in accordance with accepted medical practice and applicable local, state and federal laws and regulations.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Purpose

To repair a damaged or loose connector.

Note: *The catheter should have been clamped with an atraumatic non-toothed clamp or kinked and taped between the catheter exit site and the damaged area when damage or connector separation occurred and must remain clamped or kinked and taped during repair.*

Supplies [16]

- One replacement connector
- Antiseptic agent
- Sterile scissors
- Sterile gloves
- 0.9% saline
- 10 ml syringe with 0.9%
- Mask
- Needleless connector
- Sterile drape
- Stabilization device
- TSM dressing

Repairing Connectors on Dual-Lumen Catheters

1. Perform hand hygiene.
2. Don a mask.
3. Apply non-sterile gloves.
4. Remove the old dressing/stabilization device and discard it.
5. Determine where the damaged extension leg should be cut off. Be sure to retain as much of the original extension segment as possible. At least 2 inches (5 cm) of intact catheter beyond the Y-site joint is needed to be able to repair the catheter.
6. Remove non-sterile gloves.
7. Apply sterile gloves.
8. Place a sterile drape under the patient's arm.
9. Thoroughly clean the catheter with antiseptic agent at the point where it is to be cut.
10. Using sterile scissors, cut the extension leg off at a 90-degree angle, half an inch distal to the location of the previous connector, to remove any damaged catheter material.
11. Transfer the white or red sleeve onto the catheter from the connector.
12. Firmly push without twisting the catheter onto the adapter using the pre-inserted hub stylet as a guide.
13. Slide the white/red oversleeve over the catheter and hub. If the catheter starts to bunch up, remove the oversleeve and swab the catheter with an alcohol wipe before sliding the sleeve over it.
14. Remove and discard the stylet.
15. Attach the needleless connector and flush the catheter with normal saline or flush the catheter with normal saline and attach IV tubing.
16. Apply a new manufactured stabilization device, surgical strips, or sterile tape per facility protocol.
17. Apply a chlorhexidine-impregnated sponge per facility protocol.
18. Apply a new TSM dressing over the exit site and catheter tubing.
19. Attach additional securement per facility protocol, avoiding the placement of tape directly on the catheter material.
20. Discard used supplies.
21. Remove and discard gloves.
22. Perform hand hygiene.
23. Label the dressing.
24. Document the procedure.

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

Connecting the Hub

Repairing Connectors on Single-Lumen Catheters*

1. Perform hand hygiene.

2. Don a mask.

3. Apply non-sterile gloves.

4. Remove the old dressing/stabilization device and discard it.

5. Determine where the damaged extension leg is to be cut off. Be sure to retain as much of the original external segment as possible. At least 2 inches (5 cm) of intact catheter is needed in order to repair the catheter.

6. Remove non-sterile gloves.

7. Apply sterile gloves.

8. Place a sterile drape under the patient's arm.

9. Thoroughly clean the catheter with antiseptic agent at the point where it is to be cut.

10. Using sterile scissors, cut the catheter half an inch distal to the location of the tear to remove any damaged catheter material.

11. Retrieve the oversleeve portion of the connector and with a straight motion (do not twist it), slide the oversleeve portion of the connector onto the adapter, aligning the grooves on the oversleeve portion of the connector with the barbs on the adaptor.

Note: *Connector portions must be gripped on plastic areas for proper assembly. Do not grip on the distal portion of oversleeve.*

12. Advance the oversleeve completely until the connector barbs are fully attached. A tactile, locking sensation will confirm that the two pieces are properly engaged. There may be a small gap between the oversleeve and the stabilization device-compatible connector with the extension leg.

13. Attach the needleless connector and flush the catheter with normal saline, or flush the catheter with normal saline and attach IV tubing.

14. Apply a new manufactured stabilization device, surgical strips, or sterile tape per facility protocol.

15. Apply a chlorhexidine-impregnated sponge per hospital policy.

16. Apply a new TSM dressing over the exit site and catheter tubing.

17. Attach additional securement per facility protocol. Don't place tape directly on the polyurethane catheter material.

18. Discard used supplies.

19. Remove and discard gloves.

20. Perform hand hygiene.

21. Label the dressing.

22. Document the procedure.

* This information is intended as a supplement to and not as a replacement for the manufacturers' Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

REMOVING PICCS* [16]

Removal of a PICC should be based on the patient's condition, completion of therapy, presence of infection, inflammatory process, malposition, or dysfunction and is subject to a physician's order. Clinicians should exercise their best clinical judgment in assesing the need to perform this or other clinical actions.

Purpose

A PICC should be removed when it is no longer needed or has a complication indicating removal.

Supplies

- Gloves
- Sterile gauze
- Tape or TSM dressing
- Antiseptic

Procedure

1. Make sure the patient is in a supine position.

2. Turn off any infusions and flush with 10 ml of preservativ-free 0.9% normal saline.

3. Perform hand hygiene.

4. Apply gloves.

5. Remove the old dressing and securement devices (or sutures).

6. Cleanse the insertion site (per facility protocol).

7. Grasp the catheter at the insertion site.

8. Have the patient take a deep breath and hold it.

9. Remove the catheter by pulling it straight with gentle, constant traction.

If resistance is met, stop. Apply a warm pack to the area proximal to the insertion site, wait 30 minutes, and reattempt catheter removal.

10. Apply sterile gauze over the exit site and hold pressure for 1–5 minutes.

11. Apply sterile dressing.

12. Discard used supplies.

13. Remove gloves and discard them.

14. Perform hand hygiene.

15. Label the dressing.

16. Document the procedure.

TROUBLESHOOTING* [16]

Air in the Line [16]

Possible Causes

- There is a hole in the catheter IV tubing.
- The needless connector is not prefilled with normal saline.
- There are loose connections (e.g., needless connector, IV tubing).
- "Manometer Effect"– Holding the catheter connector end above the level of the heart while it is open to the air creates a manometer effect. Air will not enter the bloodstream unless the valve has been propped open.

Possible Solutions

- Check the catheter for leakage by flushing it well with normal saline.
- Prefill the catheter and IV tubing needless connector with normal saline before attaching it to the catheter.
- Check for loose connections (e.g., needless connector, IV tubing).
- Perform procedures requiring the catheter to be opened to the air with the connector end below the level of the patient's heart or the catheter clamped.

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Aspiration Difficulties

Possible Causes

- Failure to flush according to the PICC flushing procedure, Irrigation Procedure, may result in lumen obstruction.
- The opening may be against a vein wall.
- A blood clot, fibrin sheath, or particulate matter is obstructing the catheter.
  - A clot or other obstruction in the catheter lumen can produce a one-way-valve effect. During infusion, the catheter wall expands slightly and allows fluid to flow around the obstruction. During aspiration, the catheter wall contracts slightly, tightening around the obstruction and preventing aspiration.
- The catheter is kinked.
  - There is securement constriction at the catheter-skin exit site.
  - The catheter may be curled or kinked within the vessel or under the dressing.
- Malposition of catheter tip (e.g. jugular vein, or outside the vein).

Possible Solutions

- Visually check the catheter for any exterior kinks or constricting sutures. Remove the dressing, if necessary. If sutures are present, removing them may release the constriction and allow aspiration.
- Move the patient's arm, shoulder, and head to see if a change in position allows aspiration.
- If you don't feel resistance to infusion is felt, attempt to flush with 10 ml normal saline. Then pull back 0.5 ml gently on the syringe plunger, pause, and proceed with aspiration.
- If you feel resistance to infusion is felt, check for signs of extravasation or infiltration. If present, notify the physician of the possibility of catheter leakage.
- If you still feel resistance to aspiration, obtain a physician's order for a chest X-ray or dye study to determine the catheter position and status.
- If studies indicate that occlusion is due to a blood clot or drug precipitate, obtain a physician's order regarding the use of thrombolytic or other solution to clear the catheter.
  - If the catheter tip is not in the SVC, it should be repositioned.
  - If the catheter tip is out of the vein, it should be replaced.

Catheter Occlusion[16]

Possible Causes

- A blood clot is completely obstructing a lumen.
- Drug precipitate or lipid precipitate is completely obstructing a lumen.
- The catheter may be kinked, coiled, or damaged.
- The catheter tip may not be inside the vein.
- If sutures were used during the placement of the catheter, they can tighten and restrict flow.

Possible Solutions

- Attempt to aspirate the blood clot.
- Inspect the patient for presence of sutures around the catheter. If sutures are present, they should be removed.
- Move the patient's arm, shoulder, and head to see if a position change affects the ability to infuse.
- Obtain a physician's order and instill thrombolytic solution or per facility protocol.
- Obtain a physician's order for a chest X-ray or dye study to determine the position of the catheter.

Catheter Damage[16]

Possible Causes

- The catheter has made contact with a sharp object.
- Rupture from an attempt to irrigate an occluded catheter with a small syringe (e.g. 1 or 3 ml syringe)
  - Small syringes generate very high internal pressures with very little force. The back pressure from an occlusion may not be felt when a small syringe is used until damage to the catheter has occurred.
- There has been a rupture from attempts to power inject through an occluded catheter or a non-power injectable-catheter.

Possible Solutions

- When repairing a catheter, always hold it between the patient, and the damaged area. Follow manufacturers Instructions For Use.
- Remove and exchange/replace the catheter

Fluid Leakage from Catheter Exit Site[16]

Possible Causes

- The catheter has been punctured by sharp object (e.g. scalpel, suture, needle, or scissors) just prior to placement.
- Catheter ruptured from an attempt to irrigate an occluded catheter with a small syringe (e.g. a 1 ml or 3 ml syringe).
  - Small syringes can generate very high internal pressures with very little manual force. The back pressure from an occlusion may not be felt when a small syringe is used until the damage to the catheter has occurred.
- The catheter may have become encapsulated by a fibrin sheath, which prevents infused fluid from entering the venous system. The fluid will then take the path of least resistance, flowing back along the outside of the catheter to the skin exit site.
- There has been a rupture from attempts to power inject through an occluded catheter.
- Central-vein thrombosis has occured, occluding the vein and causing infused fluid to flow back along the outside of the catheter to the skin exit site.

Possible Solutions

- Slowly infuse 10 ml of normal saline and observe for signs of fluid extravasation under the skin.
- Obtain a physician's order for a dye study through the catheter to determine the path of fluid flow.
- Remove the catheter if a leak is discovered inside or outside the body.

SUMMARY

This chapter has discussed ways to care for and maintain the PICC. The methods discussed in this chapter focus on preventing infection at the insertion site, stabilizing the PICC, flushing and locking the line, withdrawing blood, power injecting contrast media, changing needleless connectors, clearing occluded catheters, and repairing Groshong® PICCs. A short troubleshooting guide is also included at the end of the chapter to address common problems. This manual has covered the essential information that clinicians need to know to insert and maintain a PICC and also to manage any complications that may arise. Additional reference material can be found in the appendixes.

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Appendix A: Organizations

This list of resources is provided as a reference only, and is not an endorsement by Bard Access Systems of any of these organizations or publications.

The descriptions included are based on information obtained from these organizations.

ORGANIZATIONS

Association for Professionals in Infection Control and Epidemiology (APIC)
- http://www.apic.org
- Members are multi-disciplinary.
- Provides educational programs.
- Holds annual conferences.
- Publishes the *American Journal of Infection Control (AJIC).*

Association for Vascular Access (AVA)
- http://www.avainfo.org
- Publishes the *Journal of the Association for Vascular Access.*
- Publishes guidelines and position papers related to vascular access.
- Holds annual conferences.

Centers for Disease Control and Prevention (CDC)
- http://www.cdc.gov
- Responsible for providing guidance in the form of recommendations, which are considered voluntary standards.
- Publish the "Guidelines for the Prevention of Intravascular Catheter-Related Infections".

Centers for Medicare and Medicaid Services (CMS)
- http://www.cms.gov
- Sets the standards for health-care providers receiving a Medicare-Medicaid reimbursement.

Food and Drug Administration (FDA)
- http://www.fda.gov
- Regulates products such as food, cosmetics, and over-the-counter medications, and biological agents to ensure that they are safe and effective for their intended purposes.
- Safe Medical Devices Act of 1990 (SMDA); device-user facilities, such as hospitals, ambulatory surgery centers, nursing homes, and outpatient treatment facilities are legally required to report to the FDA and the manufacturer, if known, incidents in which a medical device may have contributed to a serious injury, serious illness, or death of a patient.
- The FDA MedWatch program allows clinicians to report significant adverse events, product problems, or product-use errors.

GAVeCeLT
- www.gavecelt.info.html
- Offers educational courses.

Infectious Diseases Society of America (IDSA)
- http://www.idsociety.org/Index.aspx
- Represents physicians, scientists, and other health-care professionals who specialize in infectious diseases.
- Its purpose is to improve the health of individuals, communities, and society by promoting excellence in patient care, education, research, public health, and prevention relating to infectious diseases.
- Publishes clinical-practice guidelines.
- Publishes the *Clinical Infectious Diseases Journal.*
- Publishes the J*ournal of Infectious Diseases.*

Infusion Nurses Society (INS)
- http://www.ins1.org
- Published the first standards for specialty practice of infusion nursing in 1980.
- Publishes the Infusion Nursing Standards of Practice.
- Publishes the Journal of Infusion Nursing (JIN).
- Holds bi-annual conferences.

National Institute for Health and Clinical Excellence (NICE)
- http://www.nice.org.uk
- Independent organization to provide guidance, set quality standards, and manage a national database of evidence to improve people's health and prevent and treat ill health.

National Kidney Foundation (NKF)
- https://www.kidney.org
- Published the KDOQI Clinical Practice Guidelines and recommendations for Diabetes; Update 2012.

National Council of State Boards of Nursing (NCSBN)
- https://www.ncsbn.org/1455.htm
- Most contain similar provisions, such as scope of practice, definitions, description of the composition of the boards of nursing, and requirements for initial license and license renewal.
- May be general or specific in their guidance for a particular procedure or action.
- Some states may have specific position statements allowing or limiting the inclusion of activities within the state's scope of practice.
- In some states a decision tree may be used to assist in determining whether an act is within the scope of practice.

Occupational Safety and Health Administration (OSHA)
- https://www.osha.gov
- Promotes job safety and protects health-care workers' "right-to-know" law, which requires that employees be informed of the potential of certain hazards that could be encountered in the workplace (2001).
- Occupational Exposure to Bloodborne Pathogens; Needlesticks and other Sharps Injuries, which expands on standard precautions and addresses the risk of occupational exposure to bloodborne pathogens.

Registered Nurses' Association of Ontario (RNAO)
- http://rnao.ca
- The professional association representing registered nurses in Ontario.
- Clinical practice guidelines and programs are accessible.
- Publishes the Assessment and Device-Selection guidelines.
- Publishes the Care and Maintenance guidelines.

Royal College of Nursing (RCN)
- http://www.rcn.org.uk
- Publishes the Standards of Infusion Therapy.
- Represents nurses and nursing, promotes excellence in practice, and shapes health policies.

Society for Healthcare Epidemiology of America (SHEA)
- http://www.shea-online.org
- Its mission is to prevent and control health-care-associated infections and advance the field of health-care epidemiology.
- Prepares evidence-based practical guidelines, white papers, and other resources on infection prevention.

Society of Interventional Radiology (SIR)
- http://www.sirweb.org
- A national organization of physicians, scientists, and allied health professionals dedicated to improving public health through disease management and minimally invasive, image-guided therapeutic interventions.
- Publishes the Journal of Vascular Interventional Radiology (JVIR).

The Joint Commission (TJC)
- http://www.jointcommission.org
- Private not-for-profit organization and accrediting body that defines optimal, achievable standard for health-care organizations, such as hospitals, home-care services, nursing homes, and ambulatory care centers.

Vascular Access Society (VAS)
- http://www.vascularaccesssociety.com
- Publishes the Journal of Vascular Access.
- Provides organizational guidelines.

WoCoVA (World Congress Vascular Access)
- http://www.wocova.com
- Holds conferences every other year.
- Offers scientific and educational sessions.

Appendix B: Standards, Guidelines, and Recommendations

Below is a partial selection of standards, guidelines and recommendations from the organizations listed in Appendix A with respect to the topics discussed in these materials.

CONSIDERATIONS FOR DEVICE AND PATIENT SELECTIONS

DEVICE-INFUSATE RECOMMENDATIONS:

Alexander, M., ed. Infusion Nursing Standards of Practice. Journal of Infusion Nursing. 315 Norwood Park South Norwood, MA. 2011;34(1):37.

DEVICE SELECTION RELATED TO DWELL TIME:

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INSERTING A PICC

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Appendix C: Clinician Observation Checklists

CLINICIAN OBSERVATION *checklist*

ACCESS·U™ | BARD ACCESS SYSTEMS

PICC Insertion with
Sherlock 3CG™ Tip Confirmation System (TCS)

Clinician Name _____ *Facility Name* _____

Observer Name and Title _____ *Observation Date(s)* _____

Indications: The Sherlock 3CG™ Tip Confirmation System (TCS) is indicated for guidance and positioning of Peripherally Inserted Central Catheters (PICCs). The Sherlock 3CG™ TCS provides real-time PICC tip location information by using passive magnet tracking and the patient's cardiac electrical activity (ECG). When relying on the patient's ECG signal, the Sherlock 3CG™ TCS is indicated for use as an alternative method to chest X-ray and fluoroscopy for PICC tip placement confirmation in adult patients.

Limiting but not contraindicated situations for this technique are in patients where alterations of cardiac rhythm change the presentation of the P wave as in atrial fibrillation, atrial flutter, severe tachycardia, and pacemaker driven rhythm. In such patients, who are easily identifiable prior to PICC insertion, the use of an additional method is required to confirm PICC tip location.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Observation: This documentation of observation of Sherlock 3CG™ Tip Confirmation System (TCS) is intended to verify the knowledge and skills required to place, track, and confirm PICC tip position in accordance with Bard Access Systems Instructions for Use. This observation checklist is not intended as a supplement and not as a replacement for the Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

Training Component	*Date:*	*Requirements Met*
Has completed online training, documentation provided. Has completed on-site didactic review and hands-on practice.		
Demonstrates an understanding of the INS, CDC, and other nationally accepted standards or guidelines relatingto use of PICC lines.		
Demonstrates an understanding of proper vascular access device selection. Factors include: anatomy/physiology of the upper extremities, drug composition considerations (pH and osmolarity, etc), duration of therapy, etc.		
Demonstrates an understanding of Bard Access Systems' device related collateral, specifically the care and maintenance of the catheter, and the risks, safety information, indications, contraindications, warnings and precautions delineated in the Instructions for Use.		

The following observations will be completed for actual patient insertions.

Performance Criteria	*Date:*	*Date:*	*Date:*	*Comments*
Prior to PICC catheter insertion, clinician demonstrates: • Obtain and review order for PICC insertion. • Obtain informed consent per institutional protocol. • Review patient allergies. • Review patient contraindications to vascular access device placement. • Review patient's labs and medical history.				

Performance Criteria	*Date:*	*Date:*	*Date:*	*Comments*
Gather supplies/imaging/Sherlock 3CG™ TCS equipment • Enter patient information as needed.				
Patient Preparation: • Position patient for procedure and perform ultrasound pre-scan. • Select and mark the vein based on patient assessment.				
Patient Preparation: • Measure patient from planned insertion site to axillary crease, then to right clavicular head, then down to third intercostal space for catheter tip location in the lower 1/3 of superior vena cava. Additional length may be added in cases where vessel depth is significant or as desired to determine final catheter length. • Ensure no metal is in the area where the sensor will be placed. • Attach fin assembly to sensor. • Place Sherlock 3CG™ TCS sensor in sensor holder and tighten the cinch ring. • Remove adhesive backing from sensor holder and place in desired location in accordance with device IFU. • Prepare and attach external ECG leads. • Prepare environment as described in Sherlock 3CG™ TCS IFU and perform pre-calibration. • Evaluate baseline ECG waveform and verify that P-wave is present, identifiable, and consistent.				
Skin Preparation, clinician will: • Perform hand hygiene and don prep gloves. • Apply underdrape. • Prepare site with antiseptic solution according to institutional policy. • Remove and discard gloves.				
Sterile Field Preparation, clinician will: • Don mask and cap. • Apply tourniquet. • Perform hand hygiene. • Don sterile gown and gloves. • Apply fenestrated drape and complete sterile field preparation.				
Catheter Preparation, clinician will: • Pre-flush catheter. • Trim catheter to desired length by withdrawing stiffening stylet well beyond trim point to prevent accidental stylet trimming (option: trim catheter after cannulation depending on clinician preference). • Ensure the tip of the Sherlock 3CG™ TCS stylet is within 1 cm of the end of the catheter prior to catheter insertion.				
Perform Venipuncture, clinician will: • Anesthetize with local anesthesia as required. • Cannulate vein using ultrasound guidance. • Release the tourniquet. • Insert the flexible end of the guidewire into the introducer needle and advance the desired length into the vein. • Gently withdraw and remove the introducer needle while holding the guidewire in place. • Advance the small sheath and dilator together as a unit over the guidewire. A small incision may be made adjacent to the guidewire to facilitate insertion. • Withdraw the dilator and guidewire leaving the small sheath in place.				
Insert and Advance Catheter, clinician will: • Attach catheter stylet to fin assembly and uncoil stylet lead. • Insert catheter into introducer sheath. • Switch from ultrasound to Sherlock 3CG™ TCS mode. • Perform calibration before advancing the catheter ensuring the catheter is at least 12 inches away from the sensor.				

Performance Criteria	*Date:*	*Date:*	*Date:*	*Comments*
Insert and Advance Catheter, clinician will: • Continue to advance catheter using a slow steady motion while observing the Sherlock 3CG™ TCS display. • Identify and correct malpositions appropriately.				
Determine Terminal Tip Position using Sherlock 3CG™ TCS • Insert catheter until magnetic navigation shows stylet icon moving consistently downward. • Continue to SLOWLY advance catheter until the catheter is inserted to the external measurement (may need to withdraw and peel away introducer sheath). • Verify P-wave on intravascular waveform is present, identifiable, and consistent. • Select freeze to save current ECG waveform to the reference screen as desired. • Slowly adjust catheter to maximum P-wave amplitude comparing the intravascular waveform to the reference screen and monitor for initial negative deflection. • Record ECG waveform at final catheter tip position, noting exit site marking. • Save or print final ECG waveform.				
Complete Catheter Insertion, clinician will: • Withdraw and peel away introducer sheath. • Disconnect t-lock assembly and cap catheter. • Aspirate for blood return and flush per institutional protocol. • Apply catheter stabilization device. • Apply dressing per institutional protocol.				
Post Procedure, clinician will: • Perform hand hygiene. • Confirm catheter tip location per institutional protocol. • Document procedure per institutional protocol.				
General Device Knowledge • Able to verbalize catheter care and maintenance in accordance with Bard Access Systems' Instructions for Use.				

Comments:

Clinician Signature _____

Observer(s) Signature _____

MC-MM-911-03

CLINICIAN OBSERVATION *checklist*

ACCESS·U™ | BARD ACCESS SYSTEMS

PICC Insertion with
Sherlock™ II Tip Location System (TLS)

Clinician Name _____ *Facility Name* _____

Observer Name and Title _____ *Observation Date(s)* _____

Indications: The Sherlock™ II Tip Location System (TLS) detector quickly locates the position of specially designed, magnet-tipped Peripherally Inserted Central Catheters (PICCs) and Central Venous Catheters (CVCs) during initial placement. This device may be used by appropriate caregivers in hospitals, long-term care facilities or home-care settings. The Sherlock™ II TLS detector provides rapid feedback to the caregiver but was not designed to replace conventional methods of placement verification. Users are urged to confirm correct placement according to their established institutional protocol and clinical judgment.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Observation: This documentation of observation of PICC insertion is intended to verify the knowledge and skills required to safely insert a PICC using Site-Rite® Ultrasound System and Sherlock™ II Tip Location System (TLS) in accordance with Bard Access Systems Instructions for Use. This observation checklist is intended as a supplement to and not as a replacement for the Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, instructions, contraindications, warning and precautions, etc.

Training Component	*Date:*	*Requirements Met*
Has completed online training, documentation provided. Has completed on-site didactic review and hands-on practice.		
Demonstrates an understanding of the INS, CDC, and other nationally accepted standards or guidelines relating to use of PICC lines.		
Demonstrates an understanding of proper vascular access device selection. Factors include: anatomy/physiology of the upper extremities, drug composition considerations (pH and osmolarity, etc), duration of therapy, etc.		
Demonstrates an understanding of Bard Access Systems' device related collateral, specifically the care and maintenance of the catheter, and the risks, safety information, indications, contraindications, warnings and precautions delineated in the Instructions for Use.		

The following observations will be completed for actual patient insertions.

Performance Criteria	*Date:*	*Date:*	*Date:*	*Comments*
Prior to PICC catheter insertion, clinician demonstrates: • Obtain and review order for PICC insertion. • Obtain informed consent per institutional protocol. • Review patient allergies. • Review patient contraindications to vascular access device placement. • Review patient's labs and medical history for appropriateness of PICC line.				
Gather supplies/imaging equipment • Enter patient information as needed.				
Patient Preparation: • Position patient for procedure and perform ultrasound pre-scan. • Select and mark the vein based on patient assessment.				

Performance Criteria	*Date:*	*Date:*	*Date:*	*Comments*
Patient Preparation: • Measure patient from planned insertion site to axillary crease, then to right clavicular head, then down to third intercostal space for catheter tip location in the lower 1/3 of superior vena cava. • Ensure no metal is in the area where sensor will be placed. • Place Sherlock™ II TLS sensor in sensor holder and tighten the cinch ring. • Remove adhesive backing from sensor holder and place in desired location in accordance with device IFU. • Prepare environment as described in Sherlock™ II TLS IFU and perform pre-calibration.				
Skin Preparation, clinician will: • Perform hand hygiene and don prep gloves. • Apply underdrape. • Prepare site with antiseptic solution according to institutional policy. • Remove and discard gloves.				
Sterile Field Preparation, clinician will: • Don mask and cap. • Apply tourniquet. • Perform hand hygiene. • Don sterile gown and gloves. • Apply fenestrated drape and complete sterile field preparation.				
Catheter Preparation, clinician will: • Pre-flush catheter. • Trim catheter to desired length by withdrawing stiffening stylet well beyond trim point to prevent accidental stylet trimming (option: trim catheter after cannulation depending on clinician preference). • Ensure the tip of the Sherlock™ II TLS stylet is within 1 cm of the end of the catheter prior to catheter insertion.				
Perform Venipuncture, clinician will: • Anesthetize with local anesthesia as required. • Cannulate vein using ultrasound guidance. • Release the tourniquet. • Insert the flexible end of the guidewire into the introducer needle and advance the desired length into the vein. • Gently withdraw and remove the introducer needle while holding the guidewire in place. • Advance the small sheath and dilator together as one unit over the guidewire. A small incision may be made adjacent to the guidewire to facilitate insertion. • Withdraw the dilator and guidewire leaving the small sheath in place.				
Insert and Advance Catheter, clinician will: • Insert catheter into introducer sheath. • Switch from ultrasound to Sherlock™ TLS mode. • Perform calibration before advancing the catheter ensuring the catheter is at least 12 inches away from the sensor. • Continue to advance catheter using a slow, steady motion while observing the Sherlock™ TLS display. • Identify and correct malpositions appropriately.				
Complete Catheter Insertion, clinician will: • Withdraw and peel away introducer sheath. • Remove the stiffening stylet, stylet funnel (if applicable) and t-lock assembly and cap catheter. • Aspirate for blood return and flush per institutional protocol. • Apply catheter stabilization device. • Apply dressing per institutional protocol.				

Performance Criteria	*Date:*	*Date:*	*Date:*	*Comments*
Post Procedure, clinician will: • Perform hand hygiene. • Confirm catheter tip location per institutional protocol. • Document procedure per institutional protocol.				
General Device Knowledge • Able to verbalize catheter care and maintenance in accordance with Bard Access Systems' Instructions for Use.				

Comments:

Clinician Signature _____

Observer(s) Signature _____

MC-MM-934-03

CLINICIAN OBSERVATION *checklist*

ACCESS·U™ | BARD ACCESS SYSTEMS

GuardIVa®
Antimicrobial Hemostatic Dressing

Clinician Name _____ *Facility Name* _____

Observer Name and Title _____ *Observation Date(s)* _____

Indications: The Bard® GuardIVa® Antimicrobial Hemostatic IV Dressing is intended for use as a hydrophilic wound dressing to absorb exudate, cover and protect catheter sites. Common applications include IV catheters, other intravenous catheters and percutaneous devices. It is also indicated for control of surface bleeding from percutaneous catheters and vascular access sites.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Instruction & Observation: This instruction and observation on the use of the GuardIVa® Antimicrobial Hemostatic Dressing is intended to impart the knowledge and skills required to apply and remove the dressing in accordance with the Instructions for Use. This checklist is provided for informational purposes only, and is NOT intended to replace, the Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, indications, contraindications, warnings and precautions, etc.

Training Component	*Date:*	*Requirements Met*
Clinician has completed a GuardIVa® Dressing class, either live or online.		

Performance Criteria	*Date:*

Application:
- Prepare the skin surrounding the percutaneous device according to hospital protocol.
- Remove the GuardIVa® Dressing from the sterile package using aseptic technique.
- Place the GuardIVa® Dressing around the catheter/pin site, with the printed side facing up and the catheter resting on the slit portion of the GuardIVa® Dressing. The slit edges should come in contact with one another to assure best efficacy.
- Secure the catheter and the GuardIVa® Dressing to the skin with a transparent dressing. Assure complete contact between the skin and the GuardIVa® Dressing.

Care Maintence:
- Change the dressing as necessary, according to facility protocol; dressing can be left in place for up to 7 days. More frequent changes may be needed with highly exuding wounds.

Removal:
- To remove the GuardIVa® Dressing, hold the catheter and pick-up the corner of the transparent dressing. In a slow and low motion, pull the dressing away from the catheter. The GuardIVa® Dressing will lift off with the transparent dressing.

References:

GuardIVa® Antimicrobial Hemostatic Dressing, Instructions for Use.

Comments:

Clinician Signature _____

Observer(s) Signature _____

MC-MM-960-03

CLINICIAN OBSERVATION *checklist*

ACCESS·U™ | BARD ACCESS SYSTEMS

StatLock® IV Stabilization Device

Clinician Name _____ *Facility Name* _____

Observer Name and Title _____ *Observation Date(s)* _____

Indications: The StatLock® stabilization device is a stabilization device for compatible medical tubes and catheters. Multiple pad and retainer designs are available.

Contraindication: Known tape or adhesive allergies.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Instruction & Observation: This instruction and observation on the use of the StatLock® stabilization device is intended to impart the knowledge and skills required to apply, remove, observe, and train clinical users on the utilization and benefits of the StatLock® stabilization device, in accordance with the Bard Access Systems Instructions for Use. This checklist is intended as a supplement to, and is NOT intended to replace, the Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, indications, contraindications, warnings and precautions, etc.

Performance Criteria	*Date:*

Application:
Demonstrates process of proper application of StatLock® stabilization device:

- **Remember the 4 P's of StatLock® Stabilization Device Application -** Prep, Press, Peel and Place:

Prep:
- Cleanse and degrease insertion and stabilization site with chlorhexidine, alcohol or per hospital policy. Allow the targeted area to dry completely.
- Insert catheter and connect extension set per manufacturers' directions for use. Tighten Luer lock firmly.
- Apply skin protectant to stabilization site. Allow to dry completely, in accordance with facility protocol. Skin should feel smooth to the touch.

Press:
- Align anchor pads so directional arrow points towards insertion site.
- For IVs, press StatLock® stabilization device retainer (see below) while supporting underneath the extension set.
  - > IV Ultra: over catheter hub to capture push tab
  - > IV Premium: over extension set Luer lock
  - > IV Select: over the extension set directly behind the Luer lock (not sides)
  - > IV Universal: over the top of the Luer nut (not on sides)

Peel and Place:
- Position the StatLock® stabilization device over the targeted skin area.
- Hold the StatLock® stabilization device retainer securely as you peel away paper backing from the anchor pad, one side at a time, and place on skin.

- Instruct to use sterile foam strips, if desired.
- Apply antimicrobial disc per manufacturer's instructions for use, if indicated and per hospital policy.
- Apply transparent dressing per hospital policy and procedure. Date and time the site per hospital protocol
- Demonstrates understanding of alternate method of placing transparent dressing first, where applicable.

Performance Criteria
Application: (cont.)

Date:

Removal:
Demonstrates process of removal of StatLock® stabilization device:

- **Remember the 4 D's of StatLock® Stabilization Device Removal -** Dissolve, Disengage, Document and Dispose:

Dissolve:
- Remove transparent dressing and foam strips using "stretch technique."
- First lift corner edge of anchor pad using 3-4 stacked alcohol pads. Then continue to stroke the undersurface of the pad with alcohol to dissolve anchor pad away from skin. Fold the anchor pad under itself and repeat on opposite side. Do not pull or use force to remove pad. The more alcohol used, the easier the removal.

Disengage:
- Discontinue the IV and remove the IV and anchor pad together.

Document:
- Document the StatLock® stabilization device dressing change in the patient chart.

Dispose:
- Dispose of all equipment in appropriate containers.

Care & Maintenance:
The StatLock® stabilization device should be replaced when clinically indicated, per hospital policy.
The StatLock® stabilization devices should be replaced at least every 7 days.

References:

StatLock® Stabilization Device Instructions for Use, Bard Access Systems.

Bard Access Systems' device-related collateral, including articles, posters, brochures, etc.

Articles as outlined in the Training Component section of the checklist.

Infusion Nurses Society: Policies and Procedures for Infusion Nursing 4th ed. 2011.

CDC guidelines for infection prevention, 2010.

Comments:

Clinician Signature _____

Observer(s) Signature _____

MC-MM-1026-01

CLINICIAN OBSERVATION *checklist*

ACCESS·U™ | BARD ACCESS SYSTEMS

StatLock® PICC/CVC
Stabilization Device

Clinician Name _____ *Facility Name* _____

Observer Name and Title _____ *Observation Date(s)* _____

Indications: The StatLock® stabilization device is a stabilization device for compatible medical tubes and catheters. Multiple pad and retainer designs are available.

Contraindication: Known tape or adhesive allergies.

Please consult product labels and inserts for any indications, contraindications, hazards, warnings, precautions, and directions for use.

Instruction & Observation: This instruction and observation on the use of the StatLock® stabilization device is intended to impart the knowledge and skills required to apply, remove, observe, and train clinical users on the utilization and benefits of the StatLock® stabilization device, in accordance with the Bard Access Systems Instructions for Use. This checklist is intended as a supplement to, and is NOT intended to replace, the Instructions for Use. Please refer to the complete Instructions for Use for risks, safety information, indications, contraindications, warnings and precautions, etc.

Performance Criteria	*Date:*
Application Steps	
1. Opens package maintaining sterility of contents. States contents are latex free.	
2. Cleanses and degreases the insertion and stabilization sites using alcohol pads or chlorhexidine solution. Extends on both sides to an area larger than where the anchor pad will be placed. Allows to dry completely.	
3. Applies the provided skin protectant over the stabilization site. Extends application to both sides of the insertion site, to an area larger than where the anchor pad will be placed. Allows skin protectant to dry completely.	
4. Orients the StatLock® stabilization device anchor pad so directional arrows point toward the insertion site.	
5. Places catheter wing holes over StatLock® stabilization device posts one side at a time.	
6. Supports under-surface of anchor pad and catheter while closing retainer doors, one side at a time.	
7. Peels away paper backing from anchor pad, one side at a time. Places StatLock® PICC Plus stabilization device on skin.	
8. If indicated, applies chlorhexidine disc per manufacturer's instructions for use.	
9. Applies transparent dressing per hospital protocol.	
10. Dates and times the site per hospital protocol.	
11. Monitors daily and changes StatLock® stabilization device anchor pad as clinically indicated, at least every 7 days or per hospital's policy and procedure.	

Performance Criteria	*Date:*
Removal Steps	
1. Opens StatLock® PICC/CVC dressing change kit and prepares aseptic field per hospital policy and procedure.	
2. Removes transparent dressing using “stretch technique”, leaving portion of dressing remaining over insertion site.	
3. Stabilize catheter while holding the StatLock® stabilization device. Use thumb of opposite hand to gently lift lower tab of retainer door. Reposition hands and repeat process to open second retainer door.	
4. Carefully removes PICC from retainer.	
5. Uses 3-4 alcohol pads to lift the edge of anchor pad. Continues to stroke the under surface of the pad with alcohol to dissolve the anchor pad away from the skin.	
6. Folds adhesive anchor pad onto itself and repeats on opposite side. Understands the more alcohol used, the easier the StatLock® stabilization device is to remove. Does not pull or use force to remove the pad.	
7. Removes remaining transparent dressing toward catheter insertion site.	
8. Completes dressing change per policy or discontinues line.	

Performance Criteria	*Date:*
Commitment	
1. Verbalizes commitment to use the StatLock® stabilization device product at least 3 times to get comfortable with application/removal	

Comments:

Clinician Signature _____

Observer(s) Signature _____

MC-MM-1030-02

Glossary

The following glossary is reprinted with permission from the Infusion Nurses Society Standards of Practice.
It is provided for solely the information of the reader and is not intended to replace clinical training or expertise.
Bard Access Systems does not endorse or provide comment on the information contained therein.

A

Add-on Device. An additional component such as an inline filter, stopcock, y-site, or needleless connector that is added to the administration set or vascular access device.

Administration Set. A device used to administer fluids from a container to a vascular access device.

Admixing. The preparation or compounding of medications.

Advanced Practice Nurse (APN). A nurse practitioner, clinical nurse specialist, nurse anesthetist, or nursemidwife.

Adverse Event. Any unintended or untoward event that occurs with a patient receiving medical treatment; can be related to medications, products, equipment, and procedures.

Air Embolism. The presence of air in the vascular system.

Airborne Precautions. Methods used to prevent transmission of infectious agents that remain infectious over long distances when suspended in the air; examples include measles (rubeola), varicella zoster virus infections, Legionella infection, disseminated zoster, and tuberculosis.

Allen Test. A test performed on a radial artery prior to arterial puncture to ascertain adequate arterial perfusion.

Ambulatory Infusion Device. An electronic infusion device specifically designed to be worn on the body to promote patient mobility and independence.

Amino Acids. Organic components of protein.

Ampoule. A hermetically sealed glass medication container that must be broken at the neck to access the medication.

Analgesic Infusion Pump. An electronic microprocessing machine that can be programmed to deliver a prescribed amount of medication via continuous infusion, at specified intervals, or on demand by activation of a button; also referred to as a PCA pump.

Anastomosis. The surgical formation of a passage between 2 normally distant structures (eg, 2 blood vessels).

Anti–Free-Flow Administration Set. An administration set that stops the flow of intravenous fluid when removed from the infusion device, yet allows gravity flow when the user manipulates the regulatory mechanism.

Anti–Free-Flow Protection. Technology that prevents intravenous fluid from flowing into the patient when the administration set is removed from the flow-control device.

Anti-Infective Central Vascular Access Device (CVAD). A central vascular access device that is coated or impregnated with antiseptic or antimicrobial agents.

Antineoplastic Agent. Medication that prevents the development, growth, or proliferation of malignant cells.

Antineoplastic Therapy. In oncology practice, the term is used synonymously with cytotoxic (cell-killing) drug therapy.

Antiseptic. An agent that inhibits the growth of, or kills, microorganisms on the external surfaces of the body.

Antiseptic Ointment. A semisolid preparation that prevents the pathogenic action of microbes.

Apheresis. A process of separating whole blood into 4 components—plasma, platelets, red blood cells, and white blood cells—by removing one of the components and then reinfusing the remaining components. Types of apheresis include peripheral blood progenitor cell collection, leukapheresis, granulocyte collection, plateletpheresis, plasmapheresis, and erythrocytopheresis.

Arterial Pressure Monitoring. Monitoring of arterial pressure through an indwelling arterial catheter connected to an electronic monitor.

Arteriovenous (AV) Fistula. A surgical anastomosis between an artery and a vein, creating an access for hemodialysis.

Arteriovenous (AV) Graft. A surgical structure connecting an artery and a vein with synthetic material to create an access for hemodialysis.

Aseptic Technique. A set of specific practices and procedures performed under carefully controlled conditions in order to minimize contamination by pathogens.

Assent. Agreement by an individual not competent to give legally valid informed consent (eg, a child or cognitively impaired person).

Authorized Agent Controlled Analgesia (AACA). A method of pain control in which a consistently available and competent individual is authorized by a licensed independent practitioner and properly educated to activate the dosing button of an analgesic infusion pump when a patient is unable, in response to that patient's pain.

B

Bacteria. A microorganism that may be nonpathogenic (normal flora) or pathogenic (disease-causing).
Beneficence. An ethical principle referring to actions that promote the well-being of others.

Beneficence. An ethical principle referring to actions that promote the well-being of others.

Beyond-Use Date. The date added to a product label during the admixing process after which a product may not be used based on the fact that the manufacturer's original container has been opened and exposed to ambient atmospheric conditions and may not have the integrity of the original packaging.

Biohazardous Waste. Blood, body fluids, body parts, or materials that have come in contact with blood, body fluids, or body parts and have the potential to carry bloodborne pathogens.

Biologic Agent. A medicinal preparation made from living organisms and their products, including serums, vaccines, antigens, and antitoxins.

Biological Safety Cabinet. A ventilated cabinet using high-efficiency particulate air filtration, laminar air flow, and containment to provide protection against particulates or aerosols from biohazardous agents.

Biotherapy. A treatment using biological agents made by the process of genetic engineering.

Blood Warmer. An electronic device that raises refrigerated blood to a desired temperature during administration.

Body Surface Area. The surface area of the body expressed in square meters; used in calculating pediatric dosages, managing burn patients, and determining radiation and chemotherapy doses.

Bolus. A concentrated medication and/or solution given over a short period of time.

C

Caregiver Controlled Analgesia (CCA). A nonprofessional individual (eg, parent, significant other) who has been authorized to administer medications to the patient via a PCA pump.

Catheter. A tube for injection or evacuating fluids; hollow tube made of plastic, silastic, rubber, or metal that is used for accessing the body.

Catheter-Associated Venous Thrombosis. A secondary vein thrombosis related to the presence of a central vascular access device; includes extraluminal fibrin sheath, mural thrombosis overlying the fibrin sheath, and veno-occlusive thrombosis.

Catheter Clearance. The process to reestablish catheter lumen patency using medications or chemicals instilled into the lumen.

Catheter Dislodgment. A catheter movement into and out of the insertion site indicating tip movement to a suboptimal position.

Catheter Dysfunction. The inability to withdraw blood or infuse solutions via the catheter; may result from mechanical obstruction or catheter damage.

Catheter Exchange. The replacement of an existing central vascular access device with a new central vascular access device using the same catheter tract.

Catheter Malposition. The catheter tip is in a suboptimal position.

Catheter-Related Bloodstream Infection (CR-BSI). A bacteremia or fungemia in a patient with a vascular access device and no apparent source for the bloodstream infection other than the vascular access device. There must be at least 1 positive blood culture (obtained from a peripheral vein) in addition to clinical manifestations of infection (ie, fever, chills, and/or hypotension).

Catheter Stabilization Device. A device/system specifically designed and engineered to control movement at the catheter hub, thereby decreasing catheter movement within the vessel and risk of catheter malposition.

Central Line-Associated Bloodstream Infection (CLABSI). A primary bloodstream infection that occurs in a patient with a central vascular access device inserted within 48 hours prior to the development of the bloodstream infection.

Central Vascular Access Device (CVAD). A device that permits access to the central vascular system. A catheter is inserted with the tip residing in the lower one-third of the superior vena cava, or above the level of the diaphragm in the inferior vena cava.

Chemical Incompatibility. A change in the molecular structure or pharmacologic properties of a substance that may or may not be visually observed.

Clinical Decision Support System (CDSS). An electronic system that provides guidance on medications, dosage, formulary support, drug allergy, and other dosing parameters based on patient factors and/or nursing protocols.

Closed System. An administration system with no mechanism for external entry after initial setup and assembly.

Closed System Transfer. The movement of sterile products from one container to another in which the container's closure system and transfer devices remain intact through the entire transfer process, compromised only by the penetration of a sterile, pyrogenfree needle or cannula through a designated closure or port to effect transfer, withdrawal, or delivery.

Color Coding. A system developed by manufacturers that identifies products and medications by the use of a color system. Color code systems are not standardized (since each manufacturer uses different color code systems).

Compatibility. Capable of being mixed and administered without undergoing undesirable chemical and/or physical changes or loss of therapeutic action.

Competence. The capability of the nurse to apply knowledge, critical thinking, interpersonal decision making, and psychomotor skills to the performance of infusion therapy; maintenance of the required knowledge, skills, and attitudes to provide safe, competent care from the time of initial licensure.

Competency. An integration of behaviors in the varied circumstances of the work environment demonstrating the individual's ability to perform the desired jobrelated activities and tasks.

Competency Assessment. The process of reviewing and documenting the individual's demonstrated ability to perform a job, role, specific tasks, or other patient-care activities.

Complex Needleless Connector. A device that contains an internal mechanism that allows both the injection and aspiration of fluids; commonly referred to as a mechanical valve.

Compound. To form or make by combining different elements, ingredients, or parts; as to compound a medicine.

Computerized Prescriber Order Entry (CPOE). A computer- based system with varying levels of sophistication for automating and standardizing medication orders.

Conscious Sedation. A minimally depressed level of consciousness in which the patient retains the ability to maintain a patent airway independently and continuously and to respond appropriately to physical stimulation and verbal commands. The drugs, doses, and techniques used are not intended to produce loss of consciousness.

Contact Precautions. Methods used to prevent the transmission of infectious agents by direct contact (person to person) or indirect contact (medium to susceptible person).

Contamination. The introduction or transference of pathogens or infectious material from one source to another.

Continuing Competence. Maintenance of the required knowledge and skills to provide safe, competent care since the time of initial licensure.

Corrective Action. A defined plan to eliminate deficiencies.

Criteria. Relevant, measurable indicators.

Cross Contamination. The movement of pathogens from one source to another.

D

Delivery System. Product(s) that allows for the administration of medication. The system can be integral or can have component parts, and it includes all products used in the administration, from the solution container to the catheter.

Disclosure. The process of revealing to the patient and family all the facts necessary to ensure an understanding of what occurred when a patient experiences a significant complication from a medical error or mistake; information that is necessary for the patient's wellbeing or relevant to future treatment.

Disinfectant. An agent that eliminates all microorganisms except spores.

Distal. Farthest from the center, or midline of the body or trunk, or from the point of attachment; the opposite of proximal.

Distention. An increase in size because of pressure from within; a stretching out or inflation.

Document. A written, printed, or electronic record containing original, official, or legal information.

Documentation. The act of recording information on a written, printed, or electronic form.

Dome. A plastic component used in hemodynamic monitoring.

Dose Error Reduction System. Electronic flow-control devices manufactured with drug libraries containing drug name and soft and hard infusion limits, designed to prevent errors in solution and medication delivery; often called "smart pumps."

Droplet Precautions. Methods used to prevent the transmission of infectious agents from the respiratory tract.

Durable Medical Equipment. Equipment that may be considered property or capital equipment; it is reusable and cleaned between patient use; examples include intravenous poles, flow-control devices, and ultrasound machines.

Dwell Time. The suggested length of time a vascular access device may remain in place.

E

Electronic Infusion Device (EID). A programmable device powered by electricity or battery used to regulate infusion rate and volume.

Emancipated Minor. A child who has been granted the status of adulthood by a court order or other formal arrangement, such as marriage.

Embolus. A mass of clotted blood or other material, such as catheter fragments or air, brought by the blood from one vessel and forced into a smaller one, obstructing the circulation.

Epidemiology. A study of the distribution and determinants of health-related states and events in populations; defines and explains the interrelationships among the host, agent, and environment.

Epidural Space. The area surrounding the spinal cord and its coverings that may be used for the infusion of anesthesic agents or opioids.

Epithelialized. The healing of a wound or catheter site by the process of epithelial growth.

Erythema. A redness of skin along a vein track that results from vascular irritation or capillary congestion in response to irritation; may be a precursor to phlebitis.

Exit Site Infection. An erythema or induration within 2 cm of the catheter exit site without evidence of a bloodstream infection or purulent drainage.

Expiration Date. The date beyond which a manufacturer has designated a product not to be used.

Extravasation. The inadvertent infiltration of vesicant solution or medication into surrounding tissue.

Extrinsic Contamination. Contamination that occurs after the manufacturing process of a product.

F

Failure Mode and Effects Analysis (FMEA). A methodology for analyzing potential reliability problems.

Fidelity. Faithfulness to obligations, duties, or observances.

Filter. A porous device integrated or added to an administration set to prevent the passage of air or other undesired substances into the vascular system.

Flow-Control Device. A manual, mechanical, or electronic infusion device used to regulate flow rate.

Fluid Warmer. An electronic device that raises parenteral fluids to a desired temperature during administration.

Flushing. The act of moving fluids, medications, blood, blood products, and nutrients out of a vascular access device into the bloodstream, ensuring delivery of those components and verifying device patency.

Free Flow. The unintentional, nonregulated administration of fluid.

G

Grade. A degree of standing or value.

H

Health Care-Associated Infection (HAI). An infection that is not present when a patient is admitted into the health care system.

Health Literacy. The degree to which individuals have the capacity to obtain, process, and understand basic health care information and services needed to make appropriate decisions.

Hemodynamic Pressure Monitoring. The use of a pulmonary artery catheter to directly measure intracardiac pressure changes, cardiac output, blood pressure, and heart rate.

Hemolysis. The destruction of the membrane of the red blood cells.

Hemostasis. An arrest of bleeding from a blood vessel.

Heparin-Induced Thrombocytopenia (HIT). A potentially life- and limb-threatening immunologic reaction caused by platelet activation resulting in a hypercoagulable state with a strong association to vascular and arterial thrombosis as a result of heparin exposure.

High-Risk Tasks. Invasive procedures that may be harmful or life-threatening to a patient.

Hypertonic. Having a concentration greater than the normal tonicity of plasma; solution of higher osmotic concentration than that of an isotonic solution.

Hypodermoclysis. The subcutaneous administration of isotonic fluids for the treatment or prevention of dehydration.

Hypotonic. Having a concentration less than the normal tonicity of plasma; solution of lower osmotic concentration than that of an isotonic solution.

I

Immediate-Use Medication. Medication that is administered within 1 hour of preparation.

Immunocompromised. Having an immune system with reduced capability to react to pathogens or tissue damage.

Immunohematology. The study of blood and blood reactions with respect to the immune system.

Immunologic Transfusion Reaction. Untoward effects of a blood transfusion that are not unexpected and in many cases are benign.

Implanted Port. A catheter that is surgically placed into a vessel, body cavity, or organ and is attached to a reservoir located under the skin.

Implanted Pump. A catheter that is surgically placed into a vessel, body cavity, or organ and is attached to a reservoir located under the skin that contains a pumping mechanism for medication administration.

Incompatible. Incapable of being mixed or used simultaneously without undergoing chemical or physical changes or producing undesirable effects.

Infection. The presence and growth of a pathogenic microorganism.

Infiltration. The inadvertent administration of a nonvesicant solution or medication into surrounding tissue.

Informed Consent. A person's voluntary agreement, based on adequate knowledge and understanding of relevant information, to participate in research or to undergo a diagnostic, therapeutic, or preventive procedure. In giving informed consent, subjects may not waive or appear to waive any of their legal rights, or release or appear to release the investigator, the sponsor, the institution, or agents thereof from liability for negligence.

Infusate. A parenteral solution administered into the vascular or nonvascular systems.

Infusate-Related Bloodstream Infection. An infection caused by intrinsic or extrinsic contamination of the administration delivery system, infusing fluids, and/or medications.

Infusion-Related Hypersensitivity Reactions. Any sign or symptom experienced by the patient during the infusion of a pharmacologic or biologic agent that results in an immediate hypersensitivity reaction and anaphylactic or anaphylactoid response.

INR (International Normalization Ratio). A system established by the World Health Organization for reporting the results of blood coagulation tests.

Intermittent Infusion. The administration of intravenous medications or solutions at prescribed intervals.

Intradermal. Within or between the layers of skin.

Intraosseous (IO). The space located in the marrow of the bone that may be accessed for the administration of solutions and medications.

Intrathecal. Inside the spinal cord; within the spinal canal.

Intravenous Fat Emulsion (IVFE). A preparation of lipids administered intravenously to maintain or support nutrition.

Intrinsic Contamination. Contamination that occurs during the manufacturing process of a product.

Introducer. A needle used to control, direct, and place a catheter into a blood vessel.

Investigational Drug. An intravenous drug that has not been approved for general use by the US Food and Drug Administration but is under investigation in clinical trials to evaluate its safety and efficacy.

Iontophoresis. A noninvasive transdermal method of administering medication via an electrical charge.

Iron Overload. Abnormally high levels of iron that may cause life-threatening organ damage; a side effect of frequent blood transfusions.

Irritant. An agent capable of producing discomfort or pain along the internal lumen of the vein.

Isotonic. Having the same osmotic concentration as plasma.

J

Joint Stabilization. A device used to stabilize or restrict movement of the joint.

Just Culture. An environment that recognizes human potential for error and clearly defines acceptable behavior in a consistent manner.

L

Laminar Flow Hood. A contained workstation with filtered airflow; assists in preventing bacterial contamination and collection of hazardous chemical fumes in the work area.

Latex Precautions. Measures taken to prevent and eradicate latex allergy.

Latex-Safe Environment. A health care setting in which all products containing natural rubber latex intended for contact with mucosa or nonintact skin are removed or covered.

Legally Authorized Representative. An individual person, judicial body, or other body of individuals authorized under state and federal laws to consent on behalf of a legally designated person.

Licensed Independent Practitioner. An individual permitted by law to provide care and services without direction or supervision within the scope of the individual's granted clinical privileges, license, and organizational policies.

Locking. The instillation of a solution into a vascular access device to maintain device patency.

Low-Frequency Tasks. Tasks that are performed infrequently (less than weekly).

Lumen. The interior space of a tubular structure, such as a blood vessel or catheter.

M

Manual Flow-Control Device. A manually operated device to control the flow rate of the infusion.

Mature Minor. Someone who has not reached adulthood (as defined by state law) but who may be treated as an adult for certain purposes, such as consenting to medical care. A mature minor is not necessarily an emancipated minor.

Maximal Sterile Barrier Protection. Equipment and clothing used to avoid exposure to pathogens, including mask, gown, protective eyewear, cap, sterile gloves, sterile drapes, and towels.

Mechanical Infusion Device. A device that uses a nonelectronic method to regulate infusion flow rates; examples include the elastomeric balloon device and the spring coil piston syringe device.

Mechanical Valve Device. A needleless connector with an internal mechanical device that provides a fluid pathway capable of infusion and aspiration.

Medication Reconciliation. The process of collecting and documenting complete and accurate medication information for each patient, including prescribed, over-thecounter, and herbal medications that the patient is currently taking.

Microabrasion. A superficial break in skin integrity that may predispose the patient to infection.

Microaggregate. A microscopic collection of particles, such as platelets, leukocytes, and fibrin that occurs in stored blood.

Microaggregate Blood Filter. A filter that removes microaggregates and reduces the occurrence of nonhemolytic febrile reactions.

Microintroducer. A dilator/introducer assembly used in the Modified Seldinger Technique for insertion of a peripherally inserted central catheter.

Micron. A unit of length equal to one millionth of a meter or one thousandth of a millimeter.

Microorganism. An extremely small living body not perceptible to the naked eye.

Mid-Arm Circumference. Measurement of the upper arm at a predetermined distance above the insertion of a peripherally inserted central catheter or midline catheter.

Midline (ML) Catheter. A vascular access device measuring 8 inches or less with the distal tip dwelling in the basilic, cephalic, or brachial vein, at or below the level of the axilla and distal to the shoulder.

Milliosmoles (mOsm). One thousandth of an osmole; osmotic pressure equal to one thousandth of the molecular weight of a substance divided by the number of ions that the substance forms in 1 L of solution.

Modified Seldinger Technique. A method of percutaneous insertion of a catheter into a blood vessel. A needle is inserted into the vein and a guidewire is threaded through the needle. The needle is removed, and a small nick is made in the skin. A dilator/introducer unit is threaded over the guidewire. The guidewire and dilator are removed, and the catheter is advanced through the introducer, followed by removal of the introducer. This technique reduces trauma to the vein as well as the risk of artery or nerve injury.

N

Needleless Connector. A device designed to accommodate needleless devices for the administration of solutions into the vascular system.

Needleless System. An umbrella term used to encompass all types of needleless devices or products.

Negative Displacement. Blood reflux into the catheter lumen upon disconnection with movement of valve mechanism, or when a fluid container empties and remains connected to the administration set.

Neonate. Pertaining to the first 4 weeks of life.

Neutral Connector. A needleless connector with an internal mechanism designed to prevent blood reflux upon connection or disconnection.

No-Touch Technique. A method to ensure the aseptic preparation of a peripheral insertion site. Once the site has been prepared, it is not to be touched unless sterile gloves are used.

Noncritical Equipment. Items that touch only intact skin, not mucous membranes, or that do not directly touch the patient.

Nonimmunologic Transfusion Reaction. An infusion reaction that is not related to the immune system including, but not limited to, circulatory overload, hypothermia, electrolyte imbalance, or iron overload.

Nonmaleficence. An ethical principle based on the Hippocratic maxim, primum non nocere, or "first, do no harm."

Nonpermeable. Impervious to the passage of substances.

Nontunneled Central Vascular Access Device. A vascular access device inserted by puncture directly through the skin and to the intended location without passing through subcutaneous tissue.

Nurse-Controlled Analgesia (NCA). A nurse who has been authorized to administer medications to the patient via a PCA pump.

Nurse Practice Act. Legislation that defines the practice of registered nurses and licensed practical or vocational nurses within each state.

Nursing Diagnosis. A clinical judgment of a patient's experiences and responses to actual or potential health issues.

Nursing Interventions. Concepts that link specific nursing activities and actions to expected outcomes.

Nursing Process. An orderly, logical approach to administering nursing care so that the patient's needs for such care are met comprehensively and effectively; includes the steps of assessment, problem identification, planning, intervention, and evaluation.

O

Occlusion. The state of being occluded; the inability to infuse or inject fluid into a catheter; the inability to aspirate blood from a catheter or both.

Off-Label Use. The use of an approved drug in the treatment of a condition or for a purpose for which it has not been approved or cleared for use by the US Food and Drug Administration.

Older Adult. Greater than 65 years of age as defined by the American Society of Geriatrics.

Osmolality. The number of milliosmoles per kilogram of solvent.

Osmolarity. The number of milliosmoles per liter of solution.

Outcome. The interpretation of documented results.

P

Paired Blood Samples. Blood samples are drawn from a catheter and from a peripheral venipuncture site; both samples should be of the same volume and obtained within a 10-minute period.

Palpable Cord. A vein that is rigid and hard to the touch.

Palpation. An assessment technique used to evaluate the condition of a vessel.

Parenteral. Admixtures containing macronutrients and micronutrients that are vital for the maintenance of metabolism and growth.

Parenteral Nutrition. The intravenous provision of total nutritional needs for a patient who is unable to take appropriate amounts of food enterally; typical components include carbohydrates, proteins, and/or fats, as well as additives such as electrolytes, vitamins, and trace elements.

Particulate Matter. Matter relating to or composed of fine particles.

Pathogen. A microorganism or substance capable of producing disease.

Patient-Controlled Analgesia (PCA). A method of pain control designed to allow the patient the ability to administer bolus doses of an analgesic as needed.

PCA by Proxy. Activation of the analgesic infusion pump by anyone other than the patient.

Pediatric. Newborn to 21 years of age.

Percutaneous. Technique performed through the skin.

Peripheral. Pertaining to a vessel located outside the central circulation.

Peripherally Inserted Central Catheter (PICC). A central vascular access device inserted into an extremity and advanced until the tip is positioned in the vena cava.

Personal Protective Equipment (PPE). Specialized equipment worn by an individual for protection against health and safety hazards; examples include, but are not limited to, face masks, caps, goggles, gloves, or fluid-resistant gowns.

pH. The degree of acidity or alkalinity of a substance.

Phlebitis. Inflammation of a vein; may be accompanied by pain, erythema, edema, streak formation, and/or a palpable cord.

Phlebotomy. Withdrawal of blood from a vein.

Physical Incompatibility. An undesirable, visible reaction within a solution such as a change in color, clarity, presence of precipitate, or gas formation.

Physical Restraint. Physical, mechanical, or manual device that immobilizes or decreases the ability of the patient to move arms, legs, body, or head freely.

Pocket Infection. A purulent fluid found in the subcutaneous pocket of an implanted port or pump without evidence of a bloodstream infection. It may or may not be associated with spontaneous rupture and drainage or necrosis of the overlying skin.

Point-of-Care Testing. Diagnostic testing that is performed at or near the site of patient care.

Policy. Written statement(s) of a course of action intended to guide decision making.

Positive Displacement. The result of a small amount of fluid being pushed out of the end of the catheter lumen, clearing any blood reflux resulting from the disconnection of an administration set or syringe.

Pounds per Square Inch (psi). A measurement of pressure; 1 psi equals 50 mm mercury (Hg) or 68 cm water (H2O).

Power-Injectable Central Vascular Access Device. A device capable of withstanding high-pressure injections up to 300 psi.

Practice Guidelines. Direct clinical care decisions based on the current state of knowledge about a specific disease state or therapy.

Precipitation. The act or process of a substance or drug in solution to settle in solid particles.

Preservative-Free. Containing no added substance capable of inhibiting bacterial growth.

Primary Catheter Malposition. A tip location of any central vascular access device found to be in a suboptimal position as determined by the initial chest radiograph.

Primary Continuous Administration Set. The main administration set used to deliver solutions and medications to the patient.

Primary Intermittent Administration Set. An administration set that is connected and disconnected with each use.

Problem-Prone Tasks. Tasks that are documented to produce issues for the patient, staff, or organization.

Procedure. A written statement of a series of steps required to complete an action.

Product Integrity. The condition of an intact, uncompromised product suitable for intended use.

Proximal. Closest to the center or midline of the body or trunk, nearer to the point of attachment; the opposite of distal.

Psychomotor. Characterizing behaviors that place primary emphasis on the various degrees of physical skills and dexterity as they relate to the thought process.

Purulent. Containing or producing pus.

Push. Manual administration of medication under pressure.

Q

Quality Improvement. An ongoing, systematic process for monitoring, evaluating, and problem solving.

Quantitative Culture Technique. A laboratory protocol used for isolating and identifying microorganisms in which a catheter segment is flushed or soaked in broth followed by serial dilutions and surface plating on agar.

R

Radiopaque. Impenetrable to X-rays or other forms of radiation; detectable by radiographic examination.

Risk Evaluation Mitigation Strategies (REMS). A strategy to manage a known or potential serious risk associated with a drug or biological product. REMS can include a medication guide, patient package insert, a communication plan, elements to ensure safe use, and an implementation system; must include a timetable for assessment of the REMS.

Risk Management. The process that centers on identification, analysis, treatment, and evaluation of real and potential hazards.

Root Cause Analysis (RCA). The process for identifying factors that contribute to variations in performance.

S

Safety Device System. An engineered physical attribute of a device that effectively reduces the risk of bloodborne pathogen exposure.

Scale. A tool to measure gradations.

Sclerosis. Thickening and hardening of the layers in the wall of the vessel.

Secondary Catheter Malposition or Tip Migration. Tip location of any central vascular access device found to be in a different, suboptimal position following initial correct positioning.

Secondary Continuous Administration Set. An administration set attached to the primary administration set for a specific purpose, usually to administer medications; also known as a piggyback set.

Seldinger Technique. A method of percutaneous insertion of a vascular access catheter into a blood vessel. The vessel is accessed with a needle, and a guidewire is placed through the needle. The needle is removed. A catheter is placed into the vessel over the guidewire and advanced to the desired location. The guidewire is removed, leaving the catheter in place.

Semiquantitative Culture Technique. A laboratory protocol used for isolating and identifying microorganisms in which a catheter segment is rolled across the surface of an agar plate, and colony-forming units are counted after overnight incubation.

Sentinel Event. An unexpected occurrence involving death, serious physical or psychological injury; serious injury specifically includes loss of limb or function.

Sepsis. The presence of infectious microorganisms or their toxins in the bloodstream.

Sharps. Any device or item having corners, edges, or projections capable of cutting or piercing the skin.

Simple Needleless Connector. A device with a straight fluid pathway that contains no internal mechanisms or moving pieces.

Single-Use Product. A device, such as a vial or syringe, that is intended for 1 entry or use.

Single-Use Vial. A bottle that is hermetically sealed with a rubber stopper and is intended for one-time use.

Site Protection. A method or product used to protect the catheter insertion site.

Six Sigma. A data-driven, fact-based philosophy of quality improvement that values prevention over detection.

Skill Validator. An individual with documented competency in a specific skill who is qualified by training and education to objectively assess the performance of others.

Split-Septum Device. A simple needleless connector with a prepierced septum that can be of blunt cannula or luer-lock design.

Standard. An authoritative statement enunciated and promulgated by the profession by which the quality of practice, service, or education can be judged.

Standard Precautions. Guidelines designed to protect workers with occupational exposure to bloodborne pathogens; all blood and body fluids are treated as potentially infectious.

Statistics. The systematic science of collection, organizing, analysis, and interpretation of numerical data.

Sterile. Free from living organisms.

Stylet. A rigid metal object within a catheter designed to facilitate insertion.

Subcutaneous Infusion. Administration of medications or solutions into the tissues beneath the skin.

Surfactant. A surface-active agent that lowers the surface tension of fluid.

Surveillance. Active, systematic, ongoing observation of the occurrence and distribution of disease within a population and of the events or conditions that increase or decrease the risk of such disease occurrence.

T

Tamper-Proof. Unable to be altered.

Therapeutic Phlebotomy. Removal of a specific volume of blood from a patient for the treatment of a specific condition or disease.

Thrombolytic Agent. A pharmacologic agent capable of dissolving blood clots.

Thrombophlebitis. Inflammation of the vein in conjunction with formation of a blood clot (thrombus).

Thrombosis. The formation, development, or existence of a blood clot within the vascular system.

Thrombus. A clot composed of fibrin and blood cells that is attached to a vessel. The thrombus may grow to surround a vascular access device, eventually obstructing the device as well as the vessel. Factors that promote the formation of a thrombus are vascular endothelial damage, venous stasis, and hypercoaguable states (Virchow's Triad).

Transducer. An electronic device that converts one form of energy to another.

Transfusion Reaction. A complication of a blood transfusion in which there is an immune response against the transfused blood cells or other components of the transfusion.

Transfusion-Related Acute Lung Injury (TRALI). A potentially fatal acute lung injury characterized by noncardiogenic pulmonary edema following transfusion of blood products.

Transmission-Based Precautions. Methods used to protect health care workers when patients are suspected or known to be infected or colonized with infectious agents that cannot be controlled with standard precautions alone.

Transparent Semipermeable Membrane (TSM) Dressing. A sterile dressing that allows moisture to pass through the dressing away from the skin while preventing external moisture from contacting the insertion site of the vascular access device.

Tubing Misconnection. An inadvertent connection of a tubing to the wrong catheter, port, or lumen that may result in serious injury or death; examples include enteral or oxygen tubing connected to an intravenous administration set, or an intravenous administration set connected to a feeding tube.

Tunnel Infection. Tenderness, erythema, and/or induration 2 cm from the catheter exit site, along the subcutaneous tract of a tunneled catheter with or without a confirmed bloodstream infection.

Tunneled Catheter. A vascular access device whose proximal end is tunneled subcutaneously from the insertion site and brought out through the skin at an exit site.

U

Ultrafiltration. A method used to remove excessive amounts of sodium and water from patients with fluid overload, such as patients with congestive heart failure.

Unusual Occurrence. An event determined to have an impact on patient care, and/or any practice felt to be outside the norm of acceptable patient care according to the organization.

Unusual Occurrence Report. Documentation of an event that requires action because of potential or implied consequences.

V

Vascular Access Device (VAD). Catheters, tubes, or devices inserted into the vascular system, including veins, arteries, and bone marrow.

Veracity. A legal principle that states that a health care professional should be honest, give full disclosure to the patient, abstain from deceit or misrepresentation, and report known lapses of the standards of care to the proper agencies.

Vesicant. An agent capable of causing blistering, tissue sloughing, or necrosis when it escapes from the intended vascular pathway into surrounding tissue.

Virchow's Triad. The pathophysiological explanation for the development of vascular thrombosis. The triad consists of the following components: vessel wall damage or injury, alterations in blood flow, and hypercoagulability of the blood.

Visual Infusion Phlebitis (VIP) Scale. A tool developed by the Royal College of Nursing in the United Kingdom to determine the degree of phlebitis.

Visualization Technology. A device that employs the use of sound waves or light to allow for the location and identification of blood vessels.