



## **What's Your Line: An Overview of Central Venous Access Devices & Infusates**

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## **Acknowledgments**

***RN.com acknowledges the valuable contributions of...***

***...Juli Heitman, RN, MSN.*** Juli has thirteen years of nursing experience. For five years she worked at the bedside in medical-surgical and cardiovascular intensive care units. The last eight years have been in the nursing education role as a nursing adjunct instructor and a critical care hospital educator. She currently works as an Education Specialist for Mercy Regional Health Center, Manhattan, Kansas. She specializes in critical care, cardiovascular lab and radiology education and staff development. She received her Bachelor of Science in Nursing from the University of Nebraska Medical Center in 1999 and Masters of Science Degree in Nursing- Education at University of Central Missouri in 2010. She is a member of the American Nurses Association, National Nurse Staff Development Organization and American Association of Critical Care Nurses.

***...Carolyn "Carrie" Roeser RN and Rhonda Zenger MSN, RN, CRNI*** work in the Advanced Intravenous Services department at Mercy Regional Health Center in Manhattan, Kansas.

***...Bryce Heitman, DO.***

## **Purpose and Objectives**

The purpose of this course is to identify conditions which require fluid therapy and differentiate between infusates. This basic information will allow the reader to understand the significance of central venous access devices (CVADs) and the care and maintenance associated with these devices. At the end of the course the reader will have an opportunity to apply what has been learned through two case studies.

***After successful completion of this course, you will be able to:***

1. Identify indications for the need for intravenous fluid therapy.
2. Differentiate between the types of intravenous fluid replacement therapy.
3. Distinguish the differences between central venous access devices.
4. Describe the insertion procedure of peripheral and central lines.
5. Explain nursing management of a CVAD.
6. Explain nursing management of CVADs complications.
7. Examine PICC and central line removal procedure and post removal care.
8. Use case studies to apply what has been learned.

## **Introduction**

Years ago steel reusable needles pierced the skin and entered the vein to give life sustaining blood and intravenous fluids. Now one-time use flexible plastic catheters are used in the vein to deliver a wide variety of blood products, fluids and medications.

Peripheral intravenous (IV) catheters which are used for medication administration and obtaining blood samples are short catheters placed in the peripheral veins. They are most commonly used when the IV therapy is only going to be a week or less in duration. If the IV therapy is longer than a week, then central vascular access devices (CVADs) should be considered. Peripheral IV catheters will not be discussed in this course, but they do serve an important purpose to deliver short-term intravenous medications or fluids and for blood draws for laboratory evaluation.

There have been many advances in vascular access devices (VADs) over the years. VADs are inserted into many parts of the vascular system and are used to infuse or evacuate blood and its components from the body for further evaluation.

## **Anatomy & Physiology of a Cell**

There are many factors to consider when assessing the type of vascular access needed for various infusates. Let us take a closer look at the anatomy and physiology of a cell to assist in determining what type of infusate is needed.

The body is made of up 60% water. However, depending on age, sex, and percentage of body fat that number may fluctuate. The more body fat a person has, the lower the water composition. Conversely the higher muscle mass, the higher the water composition.

The majority of the water is within the cells (intracellular compartment). The rest of the water is located in the extracellular compartment which is broken down into three parts: intravascular, interstitial and transcellular.

- Intravascular is the fluid within the blood vessels.
- Interstitial is the fluid between the blood vessels and the cells.
- Transcellular fluid is found in cerebrospinal, pericardial and synovial fluid. This type of fluid will not be discussed in this course.

It is the function of the body to keep the intracellular and extracellular compartments regulated and in balance. When disease process or a medical condition of the patient disrupts the body's ability to regulate this fluid balance, then intravenous fluids may be administered to correct the imbalance.

## **Why Use A Central Vein?**

As medical science advanced, physicians and surgeons started inserting catheters into central veins. They found the turbulence of blood flow is higher in central veins; therefore infusates are able to mix better with the blood, causing less irritation to the vein wall.

In addition, a larger central vein is able to tolerate an increased amount of fluid infusing into it than a smaller peripheral vein. An average flow rate of blood in the superior vena cava is 1800 mL/minute (Genentech, 2011).

## Indications for Fluid Therapy

There are numerous conditions and diagnoses which require a patient to undergo IV infusion therapy.

Here are three generalized indications:

- IV **maintenance therapy** for daily fluid requirements (e.g. nothing by mouth, pre-post procedure/surgery)
- IV **replacement therapy** for fluid already lost (e.g. dehydration, trauma)
- IV **therapy to replace ongoing fluid or blood loss**, repair imbalances (e.g. draining fistulas, nasogastric suctioning)

(Alexander, Corrigan, Gorski, Hankins & Perucca, 2010)

## Maintenance Therapy

Maintenance therapy provides basic nutrients and fluid for the body. It is important to remember the patient will still lose 500-1000 mL every 24 hours through insensible loss. Insensible loss is an estimation of water lost from the body through the skin (evaporation) and lungs (respiration) (Crawford & Harris, 2011).

When a patient's fluid balance is being evaluated in the hospital it is important that both the nurse and practitioner remember insensible loss. Since these fluids cannot be measured or documented, patients can become dehydrated or have a negative fluid balance regardless of a positive documented intake. This becomes even more critical information when the patient cannot drink or eat because of their condition or upcoming procedure.

## Replacement Therapy

Replacement therapies for existing fluid losses are indicated for patients who have deficits in fluid, electrolytes or blood products. Examples of these conditions are low blood counts secondary to hemorrhage or other trauma, vomiting, diarrhea and lack of intake of proper nutrition (Alexander et al., 2010).

## Replacement Therapy Example

For example, patient X has returned to the surgical unit after undergoing a 2-hour surgery, where he is now your patient. The report from the post-anesthesia care unit (PACU) nurse stated the patient's estimated blood loss was 700 mL during the two-hour surgery. During his post-operative recovery his blood pressure dropped to a systolic of 80 mmHg and heart rate increased to 140 beats per minute (bpm). A 500 mL bolus of isotonic fluids was administered in PACU per the surgeon's orders.

Fifteen minutes later the systolic pressure was 95 mmHg and the heart rate decreased. The cardiac monitor reveals sinus tachycardia rates in the 120s. When you receive the patient he is stable and orders have been written to check his hemoglobin and hematocrit in four hours. You receive the results from the blood draw and the patient's hemoglobin is 10 gm/dl and hematocrit is 23%, showing a decrease of two points. The practitioner was notified of the drop in blood levels and was given a current set of vital signs. The surgeon orders one unit of homologous blood to be administered over four hours and to recheck a complete blood count (CBC) four hours after the blood is transfused.

Using the organizations policy and procedure on blood administration, you transfused one unit of packed red blood cells (PRBCs) without incidence. The four hour post transfusion CBC revealed the patients' hemoglobin and hematocrit are the same as they were pre-op. The patient's systolic blood pressure is consistently in the 120s and cardiac monitor shows sinus rhythm with rates in the 80s.

## **Ongoing Fluid Loss**

Therapy for ongoing fluid loss is defined by an accurate 24-hour intake and output. These are patients with sepsis, burns, abscesses, draining wounds (wound vac and chest tubes included) and draining fistulas.

In all patients receiving IV fluids it is recommended to document an accurate intake and output because the providers use intake and output as one of their main determinants of initiating, titrating or discontinuing IV fluids. Without this information, there is a possibility errors will be made in their fluid status and cause harm to the patient.

## **Ongoing Fluid Loss Example**

Patient L was a restrained passenger in a two-vehicle accident. She sustained multiple injuries to her chest and abdomen. Exploratory surgery found a tear in her aorta which was repaired. She had a 1500 mL estimated blood loss. She is intubated and not receiving enteral feedings yet. She has fluids, vasopressors, antibiotics, three transfusions and sedation running in her IVs. She has a nasogastric tube to low-intermittent suction and a right chest tube to -20 cm of suction. She has a Foley catheter draining amber, clear urine to dependent drainage.

Due to the disruption of hemostasis secondary to trauma the patient will require continuous hemodynamic and lab monitoring to correct her fluid loss.

Her estimated blood loss (in surgery), nasogastric tube, chest tube and Foley catheter would be examples of ongoing fluid loss.

## **Pieces of the Fluid Puzzle**

The fluid ordered by the practitioner depends on the type of bodily fluids lost. The provider will assess the patient and review the patient's lab and test results to decide which IV fluid is best for the patient. Infusing the appropriate types of IV fluids can change frequently to improve the condition of the patient.

When determining your patient's IV fluid status, measuring intake and output are just part of the fluid status puzzle. Assess the whole patient as you do your head to toe assessment. Here is a quick review of what to assess fluid when monitoring volume status in patients.

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## **Lab Value Assessment**

While determining which fluids to infuse it is best-practice to evaluate renal function specifically blood urea nitrogen (BUN) and creatinine (Culleiton & Simko, 2011).

The renal function assists the provider to assess how the patient is able to filter blood and how much the kidneys will excrete.

Other labs that may be ordered while the patient is undergoing fluid therapy include: arterial blood gases, CBC, electrolytes, specific gravity and urine osmolarity.

## Physical Assessment

**Skin Assessment:** Assess skin for the temperature, turgor, diaphoresis and color.

**Mucus Membrane Assessment:** Are the mucus membranes dry or moist? This is a good indicator of fluid status.

**Mental Status Assessment:** What is the patient's mentation and are they oriented? Note that dehydration can cause changes in mental status.

**Cardiovascular Assessment:** When auscultating the heart and lungs, if there is a S3 or S4 auscultated or crackles in the lungs there is a high probability the patient is experiencing fluid overload. If their lung sounds are clear throughout but their heart rate is tachycardic, that would demand further investigation into the increase heart rate. Dehydration is a probable cause, but other possibilities are increased core temperature or pain.

**Abdominal Assessment:** Examine the abdomen for an ascites. Also palpate the extremities for peripheral edema.

## Types of IV Therapy Options

Depending on the patient needs, the practitioner will order either crystalloid or colloid fluids. The next section discusses the differences within the crystalloids.

There are three types of crystalloid fluids that can be administered to the patient:

- Isotonic
- Hypotonic
- Hypertonic crystalloid solutions

To better understand these fluids, it is important to understand the word tonicity. Tonicity refers to the concentration of the dissolved particles within crystalloid fluid (Crawford & Harris, 2011). Does the tonicity of the fluid be it isotonic, hypotonic or hypertonic solutions make the cell stay the same, swell or shrink?

Furthermore, it is important to understand the difference between osmolarity and osmolality as they are frequently used interchangeably. Osmolarity is used when describing fluids that are outside of the body, while osmolality is used when describing fluids inside the body (Alexander et al., 2010).

## Isotonic Fluids

Isotonic fluids essentially have the same molecular composition of plasma. They have an osmolarity of 250 to 375 mOsm/L whereas blood and body fluids have an osmolality of 280 to 295 mOsm/L (Alexander et al., 2010). When isotonic fluids are infusing, there is little to no difference in osmotic pressure, therefore, the intravascular cells do not shrink nor get bigger. As a result the isotonic fluids remain in the extracellular fluid and increase intravascular volume.

Examples of isotonic fluids are 0.9% sodium chloride, Lactated Ringer's solution (LR), 5% dextrose in water (D5W) (Crawford & Harris, 2011).

Since isotonic fluids do not shift water in or out of the patient's cells, patients receiving isotonic fluids are at risk for fluid overload.

Some signs and symptoms of fluid overload include:

- Increased heart rate
- Hypertension
- Audible crackles

- Extra heart sounds on auscultation
- Jugular venous distention
- Dyspnea

Isotonic fluids are used as first-line fluids in resuscitations as well as existing and ongoing fluid loss. Remember these fluids are much like the body's own plasma and it will aid in replenishing intravascular volume.

Note! D5W (5% dextrose in water) is packaged as an isotonic fluid when in the IV bag, but becomes hypotonic physiologically, when infused into the body because the glucose (solute) is rapidly metabolized in the cells.

Furthermore, it does contain calories, but it does not provide enough for prolonged use and should not be used as a nutritional option (Crawford & Harris, 2011).

### **Hypotonic Fluids**

Hypotonic solutions have an osmolarity less than 250 mOsm/L. They are used to shift fluid back into the cells. While this type of fluid serves an important purpose, it is important to closely monitor the patient for hypervolemia because as the interstitial cells expand they deplete the intravascular fluid. These fluids help treat conditions like diabetic ketoacidosis, in which the cells are dehydrated.

Examples of hypotonic solutions include: 0.45% sodium chloride, 0.33 % sodium chloride and 2.5 % dextrose in water. These hypotonic fluids should not be used for resuscitation, because they will cause more fluid to move out of the intravascular space and into the cells. Astute monitoring for hypotension and hypovolemia in the presence of this type of fluid is important and the practitioner should be notified and IV solution changed to an isotonic fluid if symptoms occur.

Hypertonic fluids are used to correct fluid, electrolyte and acid-base imbalances. They have an osmolarity of 375 mOsm/L. They have a higher solute concentration (i.e. 3% NaCl) causing an unequal pressure gradient which draws water out of cells and into the extracellular space, thereby increasing extracellular fluid volume. These fluids are known as volume expanders.

Examples of hypertonic fluids are 3% sodium chloride, 5% sodium chloride and dextrose 10% in water. The high sodium chloride concentration is used for patients with severe hyponatremia (Crawford & Harris, 2011). These patients need to be placed on a cardiac monitor and frequently assessed for volume overload especially if they have underlying cardiovascular disease.

### **Test Yourself:**

3% Normal Saline is considered what type of solution?

- Isotonic
- Hypotonic
- Hypertonic – Correct**

### **Colloid Solutions**

Crystalloid solutions are defined by their tonicity and osmolarity. Does the cell stay the same, shrink or swell to help restore fluid balance? Now we will discuss different types of colloid solutions.

Colloid Solutions have molecules that are too large to pass through the capillary walls and therefore remain in the intravascular compartment. These solutions also pull fluid from the interstitial space and bring it into the intravascular space.

Examples of colloids or volume expanders as they are also called are albumin (5% or 25%), dextrans (low-molecular weight and high-molecular weight), and hydroxyethylstarches (hetastarch and hespan).

## **Blood**

Blood is another infusate that can be administered intravenously. However, all blood products and the patient receiving the blood transfusion require ABO and RH typing before transfusing.

Blood products such as whole blood and packed red blood cells are volume expanders and have other benefits such as increasing hemoglobin and hematocrit.

## **What is a CVAD**

The Centers for Disease Control (CDC) defines a central venous access device (CVAD) as a “catheter which terminates in one of the great vessels in or near the heart and be used for one of the purposes: infusions, withdrawal of blood and hemodynamic monitoring” (2013). The great vessels are: superior vena cava (SVC) and inferior vena cava (IVC). Insertion sites include the basilic veins, brachiocephalic veins, internal jugular veins, external and common iliac veins and femoral veins, and subclavian veins. In neonates the umbilical artery and vein are considered great vessels. Infusing Nursing Society (INS) further defines this definition for CVADs distal tip dwelling is in the lower one third of the SVC to the junction of the SVC and right atrium (Alexander et al., 2010).

In the image to the left, the red dots signify the great vessels and the black lines point to insertion sites for CVADs.

## **Indications for CVAD**

Most of the IV fluids that have been discussed so far can be administered through a peripheral IV. However, due to some disease processes and the patient conditions, intensive IV therapy is warranted. Central venous access devices for intensive IV therapy will be discussed.

One indication for insertion of a central venous access device (CVAD) is due to the pH of the infusate ordered. The pH refers to the hydrogen ions in the concentration of fluid. The neutral range for pH is 7.35 to 7.45. IV infusions with a pH from a range of 6.0 to 8.0 minimize damage to the venous endothelium. CVAD insertion is appropriate for IV solutions with pH lower than 5.0 and higher than 9.0.

Another indication involves osmolality of the infusates ordered. When an infusate has an osmolality greater than 600 mOsm/L the IV solution is an irritant to the peripheral vein. Vancomycin is an example of an IV drug that is particularly irritating to peripheral veins. CVADs are considered if the infusion treatment plan requires long-term therapy.

Finally, if the patient’s condition warrants the need for hemodynamic monitoring or frequent blood draws a CVAD is indicated.

Based on these guidelines, infusions such as chemotherapy, total parenteral nutrition, frequent blood draws, vesicants and multiple infusions are indications for the insertion and maintenance of a CVAD.

(Genentech, 2011)

## **Do You Know: What devices are NOT CVAD?**

Extracorporeal membrane oxygenation (ECMO), intra-aortic balloon pump (IABP) and arterial catheters are not considered CVADs (CDC, 2013). Devices entering the arterial system are not CVADs.

### **Non-Tunneled Catheters**

Nontunneled, percutaneous inserted central catheters (also known as subclavian) may be used for days to weeks before discontinuing. They are inserted percutaneously into the subclavian, jugular and femoral veins (Alexander et al., 2010). By definition there are considered CVADs because their tips terminate in a vena cava.

Nontunneled CVADs are often placed at the bedside by a practitioner. These catheters have multiple lumens to facilitate various hemodynamic monitoring, such as central venous pressure (CVP) readings. Intravenous cardiac medications can be irritants to peripheral vessels and may be administered centrally. They also allow for a large amount of infusates and blood may be infused through these catheters rapidly. In addition, CVADs allow blood sampling for labs.

### **Tunneled Catheters**

Tunneled or cuffed catheters are surgically inserted in a sterile environment. They are designed for long term use in patients who need chemotherapy, long-term antibiotics or parenteral nutrition, with and without lipids.

Thirty years ago, tunneled catheters were designed to decrease catheter related blood stream infections. These devices separated or created a tunnel between the catheter's point of insertion into the vein and the exit site in the skin. At this time, these catheters are used for long-term IV Therapy, although they have not yet been proven to reduce catheter related bloodstream infections (Alexander et al., 2012).

### **PICC**

A PICC line is inserted using the upper extremity of the patient. The basilic vein is commonly used because of its larger diameter.

### **Advancement of PICC Popularity**

Peripherally inserted central catheters have increased their market share by advancing technologies such as power injectable PICCs which are manufactured to withstand the fast rate of the contrast infusion administered during computed tomography (CT) scans. The PICC catheter can dwell six months to a year, but its maximum dwell time has not been fully researched. Many PICC manufacturers guarantee the integrity of the catheter for 12 months. A catheter flushing without resistance, with good blood return and free from infection may be used past a year without the manufacturer's warranty.

Early placement of PICCs was a procedure performed by interventional radiologists. Now the majority of PICCs are inserted by specially trained RNs. In 2008, RNs placed 74% of all PICC lines (Genentech, 2011). They are now placed at the bedside or in an outpatient setting. PICCs are used for long-term IV therapeutics, blood draws for lab as well as the capability of monitoring CVPs.

### **Midline Catheters**

Midline catheters are inserted much like the PICCs, however they are not CVADs. Again the basilic vein is recommended for midline placement because of its size in diameter in comparison to other veins in the arm.

This type of catheter is used for IV therapy lasting more than one week. However, it is not designed to withstand IV solutions with pH <5.0 or >9.0 and the osmolarity cannot be greater than 600 mOsm/L because the tip is located in the periphery with limited blood flow. Midline use should be limited to neutral pH infusates (Alexander et al., 2010).

### **Implanted Ports**

Implanted ports consist of two parts, a catheter and a portal body with a reservoir. These long term catheters are surgically placed under the skin in a sterile environment. The port body is accessed through the skin using a non-coring Huber™ needle. Implanted ports are usually used for patients undergoing chemotherapy but may also be used for any other IV therapeutics and obtain blood for lab monitoring.

### **Other Notable Catheters: Arterial Catheters**

Arterial catheters are not considered CVADs.

Note! Never infuse IV medications or fluids into these catheters.

The only appropriate IV fluid connected to the arterial catheter is the flush solution to maintain patency.

**Follow your organizations policy and procedure for care of arterial catheters.**

### **Other Notable Catheters: Dialysis & Pheresis Catheters**

Dialysis and pheresis catheters are rarely used for IV infusions. They should be reserved for their intended function. In any emergency situation where IV access cannot be obtained these catheters may be considered as a means of vascular access. However specific training is needed to decide in which situations it can be accessed and how to correctly access the catheters. If a dialysis needs to be accessed in an emergent situation, the access should be done by a specialty nurse. Please check your organization policy and procedure before completing such actions.

### **Identification of the CVAD**

Identify specifically what vein the CVAD is inserted in. Even though this issue is under some debate, the optimal tip location is the caval atrial junction or the lower third of the superior vena cava.

### **Valved Versus Non-Valved Devices**

Is the catheter valved or non-valved?

A valved catheter does not have clamps and does not require heparin flush.

A non-valved catheter should be clamped when the lumen is not in use. A non-valved catheter is inserted when the patient requires invasive hemodynamic monitoring such as a CVP.

Note! Advances in technology have led to power-injectable catheters which can withstand the high pressure of contrast being injected into the port during CT scans.

CDC Guidelines for Venous & Arterial Access Catheters

**Table 1. Catheters used for venous and arterial access.**  
<http://www.cdc.gov/hicpac/BSI/bsi-table-1-2011.html#>

Catheter Type	Entry Site	Length	Comments
<b>Peripheral venous catheters</b>	Usually inserted in veins of forearm or hand	<3 inches	Phlebitis with prolonged use; rarely associated with bloodstream infection
<b>Peripheral arterial catheters</b>	Usually inserted in radial artery; can be placed in femoral, axillary, brachial, posterior tibial arteries	<3 inches	Low infection risk; rarely associated with bloodstream infection
<b>Midline catheters</b>	Inserted via the antecubital fossa into the proximal basilic or cephalic veins; does not enter central veins, peripheral catheters	3 to 8 inches	Anaphylactoid reactions have been reported with catheters made of elastomeric hydrogel; lower rates of phlebitis than short peripheral catheters
<b>Nontunneled central venous catheters</b>	Percutaneously inserted into central veins (subclavian, internal jugular, or femoral)	≥8 cm depending on patient size	Account for majority of CRBSI

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Catheter Type	Entry Site	Length	Comments
<b>Pulmonary artery catheters</b>	Inserted through a Teflon <sup>®</sup> introducer in a central vein (subclavian, internal jugular, or femoral)	≥30 cm depending on patient size	Usually heparin bonded; similar rates of bloodstream infection as CVCs; subclavian site preferred to reduce infection risk
<b>Peripherally inserted central venous catheters (PICC)</b>	Inserted into basilic, cephalic, or brachial veins and enter the superior vena cava	≥20 cm depending on patient size	Lower rate of infection than nontunneled CVCs

<b>Tunneled central venous catheters</b>	Implanted into subclavian, internal jugular, or femoral veins	≥8 cm depending on patient size	Cuff inhibits migration of organisms into catheter tract; lower rate of infection than nontunneled CVC
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**Table 1. Catheters used for venous and arterial access.**  
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<b>Catheter Type</b>	<b>Entry Site</b>	<b>Length</b>	<b>Comments</b>
<b>Totally implantable</b>	Tunneled beneath skin and have subcutaneous port accessed with a needle; implanted in subclavian or internal jugular vein	≥8 cm depending on patient size	Lowest risk for CRBSI; improved patient self-image; no need for local catheter-site care; surgery required for catheter removal
<b>Umbilical catheters</b>	Inserted into either umbilical vein or umbilical artery	≥6 cm depending on patient size	Risk for CRBSI similar with catheters placed in umbilical vein versus artery

**Test Yourself:**

Which vein is can be used if the patient has a mastectomy on the right side?

- A. Right basilic vein
- B. Left basilic vein - Correct**
- C. Right brachial vein

**PICC Line Insertion**

The types of CVADs have been discussed. The following slides will discuss the procedure(s) for insertion of PICC and CVADs.

PICC line insertions have increased from 11% in 1999 to 29% in 2007 (Alexander et al., 2010). The increase in the number of insertions has risen due to PICC programs that have been developed in hospitals.

Registered Nurses with at least two years of nursing experience and given specific training on advanced peripheral venous insertion skills are considered to be a PICC-nurse or a part of the advanced intravenous (vascular) services.

## **PICC Insertion: Ensuring Patient Safety**

When a PICC is ordered by a provider the following steps take place to ensure patient safety:

Informed consent must be obtained from the patient who is alert and oriented and not under the influence of narcotics at the time of the signature. If the patient is unable to sign for themselves, the patient's next-of-kin or medical durable power of attorney must sign the informed consent before the PICC line is inserted. The majority of organizations already have a consent form specifically for PICC line insertion which identifies risks and benefits specific to PICC line insertion.

Supplies will vary depending on the patient and what kind of PICC is appropriate for their plan of care and disease process. There are many PICC insertion kits which include what is needed for an insertion. In addition, other supplies such as 0.9% NS and lidocaine vial, drapes, gown, surgical cap and probe covers need to be made available and within reach of the clinician inserting the PICC line. This is a sterile procedure. The patient should be covered full body with a sterile drape and supplies should be opened using sterile technique.

### **Measurement of the PICC Line**

The measurement of the PICC line is essential. Anatomical landmarks are used to measure how many centimeters the PICC should be inserted. The PICC nurse identifies the insertion site and measures it to the right sternal notch and then follows it down to the 3rd intercostal space (ICS). This estimation allows the PICC nurse to either trim the PICC or know how much to leave outside of the insertion site (Alexander et al., 2010).

There are PICCs that can and cannot be trimmed. If they are not able to be trimmed, some of the catheter is left outside of the body. It is coiled and an occlusive sterile dressing is applied. It is imperative the catheter outside of the body remain sterile during dressing changes.

Finally, catheter tip is verified by a chest x-ray or special navigation devices. Depending on the state and scope of practice of the registered nurse, either RNs and/or radiologist can confirm placement of the catheter tip.

### **Non-tunneled CVAD Insertion**

Other non-tunneled IV catheters should be placed using the same principles of the PICC line. Those include: informed consent, using a pre-procedure check-off, scrupulous hand hygiene, maintaining sterility throughout procedure, use of securement device, applying appropriate dressing, obtaining radiograph to ensure proper placement and document procedure.

One difference in the insertion process is that patients must be placed in supine or Trendelenburg position for subclavian or jugular insertion to decrease the chances of an air embolism.

### **Assessment of the CVAD**

A successful, non-contaminated CVAD insertion can only be shortly celebrated, because now the surveillance clock of blood stream infections has started. The assessment of the CVAD is comprehensive and should not be rushed or eliminated. During the CVAD assessment the practitioner assesses and documents the following:

- Dressing should be intact and able to clearly visualize the insertion site. An IV stabilization device is recommended.
- Insertion site should be without the following: redness, tenderness, swelling, actively oozing blood/bleeding or drainage.
- IV solution - check the medication/solution and the IV administration set for any breaks in the system as well as expiration dates. The medication/solution bag and IV administration set should always be labeled and changed according to the organizational policy and procedures.

- Lab values - review patients lab values for any increase of white blood count which may indicate an infection.
- Vital signs - review the patients vital signs for indications of an infection such as a fever, tachycardia or in late stages of an aggressive infection, hypotension.
- Chest x-ray - if warranted, the chest x-ray should be evaluated for central line tip location.

## **Nursing Management of CVAD**

The RN assumes the care for the patient as well as any CVADs that are inserted into the patient. Applying your knowledge and looking through the patient chart will assist in keeping your patient safe from complications.

When taking care of patients with CVADs it is imperative to correctly identify what kind of vascular device has been inserted.

Some questions to ask are:

- Where is the catheter inserted (assess patient)?
- Where is the catheter tip located (look up results of chest radiograph)?
- Is the catheter valved or non-valved?
- Is the catheter power-injectable?

## **Securement Device**

Is the catheter secured with a catheter securement device? Or does it have sutures?

Catheter securement devices have proven to decrease the risk for infection and catheter dislodgement.

Furthermore, using a securement device has a lower incidence of infection than sutures (Petree, Wright, Sanders & Killion, 2012).

## **Dressings**

The dressing should be transparent and occlusive.

If there are any concerns about the dressing contamination then the dressing should be removed, the insertion site cleaned and new dressing applied immediately using sterile technique.

## **SASH Technique**

Using the **Saline-Administer medication-Saline Heparin (SASH)** technique will assist in decreasing catheter complications such as development of precipitate in the IV line and occlusions.

First the practitioner flushes the line with saline and checks for blood return. Next administer the IV medication as prescribed. Flush carefully following medication administration because there is a small amount of medication in the port and catheter. Finally, end the IV medication administration with a heparin flush. (Check with your organizational policy and procedure to verify heparin is indicated as a flush.)

While flushing the ports, is it best-practice to use the push-pause method. This will prevent fibrin from building up and around the catheter lumens.

(Alexander et al., 2010)

## **Education**

When caring for the CVADs, it is important for clinicians to complete a comprehensive educational session during orientation and annually, to keep updated on best-practices. We will discuss the evidence which suggests best-practice in preventing central line complications.

## **Hand Washing**

Handwashing is an imperative infection control technique to be used before and after CVAD. Handwashing is one of the means of reducing CVAD infection.

The standard practice for hand hygiene is that it should be performed before and after all clinical procedures as well as before and after donning gloves. It is appropriate to use alcohol-based hand rub product if hands are not visibly soiled. If visibly soiled, then rinsing them with soap and water is the only acceptable way of cleaning hands. It is also an INS standard, that any bedside practitioner who performs infusion therapy procedures shall NOT wear artificial nails or nail products (Alexander et al., 2010).

What does the mnemonic SASH stands for?

- A. Saline-Alternate with Saline-Heparin
- B. Saline-Administer medication - Saline-Heparin - Correct**
- C. Saline-Administer medication - Saline-Hespan

## **CVAD Complications**

CVAD complications are a threat to the patient's mortality and morbidity, increases length of stay and causes a financial burden.

Common CVAD complications are:

- Catheter migration
- Infection
- Occlusion
- Air embolism
- Pneumothorax
- Thrombosis
- Bleeding

## **Catheter Migration**

Catheter migration is when the tip of the catheter is no longer in the appropriate, documented position. Migration can be caused by improper care, disease process, changes in intrathoracic pressure or forceful flushing. Patient signs and symptoms of catheter migration are headache or discomfort in the shoulder, arm or neck. However, the patient may remain without symptoms and the nurse may have difficulty flushing or aspirating from the catheter. Also an "ear gurgling" sound may be heard when the catheter is flushed.

If catheter migration is suspected, the practitioner should be notified immediately.

(Alexander et al., 2010)

## **Infection**

A common complication of a CVAD is an infection. Many national organizations such as the Infusion Nursing Society (INS), The Joint Commission (TJC), Centers for Disease Control and Prevention (CDC) and The Joint Commission National Patient Safety Goal (NPSG) have published performance standards as well as research supporting implementation of evidence-based practices.

In recent years, healthcare associated infections have been a significant source of financial drain and sadly, increased the number of patients who die every year from CVAD related infections.

Catheter-Related Bloodstream Infections (CRBSI) and Central Line Associated Blood Stream Infections (CLABSI) are two different terms which should not be used interchangeably.

CRBSI is a clinical definition used for diagnosing and treatment of CVAD infection. It requires specific lab testing (i.e. catheter tip cultures) to determine if the infection is related to the CVAD.

In contrast, CLABSI is a surveillance of infection based on data collection, tracking and trending. Due to its generalized definition, CLABSI may lead to an overestimation of actual CRBSI.

In 2013, the CDC estimated there are 250,000 CRBSIs per year causing an estimated 14,000 to 28,000 deaths per year in the United States (Petree et al., 2012). The extra cost to each CLABSI was estimated at \$16,550 (Association of State and Territorial Health Officials, 2010).

In recent years the Center for Medicare and Medicaid Services (CMS) have not paid for infections that are deemed preventable in the healthcare setting and central line infections are in this category.

What are the factors which increase CLABSIs? There are three high risk points of entry for organization contamination when a CVAD is inserted, they are: the insertion site, the catheter hub and the IV solution connected to the hub (To & Napolitano, 2012). Coagulase-negative Staphylococci is the most common pathogen found that causes CLBSI.

### **Prevention of Infection**

How do we prevent CLABSIs?

To & Napolitan (2012) discussed The Guidelines for Prevention of Intravascular Catheter-Related Infections which were updated in 2011. Prevention started with continual education and training for practitioners who inserted and cared for the CVAD.

Secondly, always using sterile barrier precautions and full-body sterile drape over the patient will decrease and/or eliminate contamination.

Next, the guidelines state to use a solution greater than 0.5% chlorhexidine with alcohol for skin preparation.

Finally, CVADs should only be inserted when absolutely necessary, and after careful consideration.

### **Dressing Changes**

Dressing changes and site care should be given appropriate time to complete in a sterile manner. A semi-permeable transparent dressing should be used to accurately assess the insertion site. Once the CVAD is inserted a dressing is placed and should be changed 24-48 hours after the insertion. Then the CVAD dressings should be changed every seven days. However, if the patient develops post-insertion bleeding, then sterile gauze may be placed on top of the insertion site and underneath the dressing to provide absorption and a small amount of pressure to the insertion site. The gauze dressing should be changed every 48 hours (Alexander et al., 2010) or according to your organizational policy and procedure.

When changing the dressing it is very important to use scrupulous hand hygiene and when appropriate don personal protective equipment (PPE) and sterile gloves. After the antiseptic has been applied it is imperative to allow the solution to completely dry on its own. DO NOT wave your hand over it, blow on it or blot it dry to increase drying time. This will decrease the effectiveness of the antiseptic and contaminate the insertion site and the area beneath the dressing.

### **Extra Dressing Precautions**

Additionally, chlorhexidine-impregnated foam dressing may be placed around the catheter at the insertion site. Research completed in 2005 showed there was no difference in the number of catheter-associated bloodstream infections when using the foam dressing.

The Infectious Diseases Society of America (IDSA) and the Society for Healthcare Epidemiology of America (SHEA) recommended chlorhexidine-impregnated dressings be used if:

- The organization has a high CLASBI rate despite using Central Line Bundle
- The patient has limited venous access and a history of CLASBI
- A patient has a higher risk of a CLASBI due to their medical or surgical history

(Alexander et al., 2010)

### **BioFilm**

Another culprit which may lead to a CLASBI is biofilm. Biofilm is a matrix of microorganisms which collect on the catheters external or internal surface. Biofilm creates its own reservoir to protect the microorganisms and can potentially cause an infection. It may develop within 24 hours after insertion of the CVAD. Presently antimicrobial impregnated catheters are available and showing promise to reduce biofilm (Alexander et al., 2010).

### **Injection Cap Disinfection**

Injection cap disinfection and changes- the caps are exposed to the patient-hospital environment which has a high probability to include their own skin, soiled hospital gown or linen, non-sterile gloved hand or non-gloved hand during care and transportation of the patient. The caps can be exposed to endless microorganisms in a matter of minutes. Therefore, it is very important to ALWAYS disinfect the caps before they are accessed for any reason.

Disinfect the cap with 70% alcohol and using friction, much like juicing an orange, for at least 15 seconds. Attach the sterile syringe or IV connection as prescribed.

### **Test Yourself:**

What is the most frequently found culprit of a central line infection?

- A. Vancomycin resistance bacteria
- B. Clostridium Difficile
- C. **Coagulase-negative Staphylococci - Correct**

## Occlusion

Many times nurses have needed to obtain a blood sample or start a vasoactive IV infusion only to be delayed by a port(s) that do not flush or flush sluggishly. Many things can contribute to the occlusion and a nurse should never continue to push on the plunger of the syringe until he or she gets his desired result and here is why.

Signs of an occlusion include not being able to aspirate blood return, resistance or sluggishness felt with flushing, not able to flush or aspirate entirely, or the IV infusion device keeps alarming occlusion.

Alexander et al. (2010) identified four categories of thrombotic catheter occlusions: fibrin tail, fibrin sheath, intraluminal occlusion and mural thrombus.

- **Fibrin Tail:** A layer of fibrin attaches onto the tip of the catheter, causing a “tail”. This results in an inability to withdraw blood, but fluids can still be infused.
- **Fibrin Sheath:** Fibrin adheres to the external surface of the catheter, and may cover all or part of the catheter, causing a partial or complete occlusion of the catheter tip.
- **Intraluminal Occlusion:** An accumulation of fibrin partially or completely blocks the catheter. This occurs when blood refluxes inside the catheter lumen.
- **Mural Thrombus:** Forms where the catheter rubs against the wall of the vein.

## Other Occlusion Causes

Other non-thrombotic causes are: catheter malposition, catheter migration, catheter tip rests on or close to the vein wall, internal catheter fracture, and precipitate and lipid aggregation.

As mentioned earlier, preventative measures such as following the proper flushing techniques and protocols will decrease the likelihood of these complications from happening. The treatment for occlusions includes anti-thrombolytics. Check with your organizations policy and procedure.

## Air Embolism

Another rare complication of CVADs is an air embolism. An air embolism is caused when a bolus of air is forced into the vascular system. With an overall mortality of 30%, this potentially deadly complication can happen during the following situations: deep inspiration during the insertion or removal of the CVAD; accidental infusion of air from an IV administration set; catheter is fractured; disconnect of the catheter caps without the lumen being clamped (Cook, 2013).

An increased likelihood of air emboli can occur with pressure bags and/or incorrectly primed IV bags, pressure tubing or syringes (Cook, 2013).

## Sequence of Events of an Air Embolism

When a significant amount of air rushes into the vascular system, it passes through the right atrium and into the right ventricle. The air then produces an air lock at the pulmonary artery in which blood cannot pass into the pulmonary system. The heart continues to pump blood against the air lock causing an increase in central venous pressure. Since blood cannot travel to the pulmonary circulation there isn't any blood return to the left atrium or ventricle thus causing a rapid decrease in blood pressure and if not treated immediately vascular collapse may occur.

The nurse must closely monitor for signs and symptoms of an air embolism since passive entry of air can occur at the insertion of the catheter to several days after the catheter has been removed. It has been further proved that a 14 gauge (5 French) catheter 5 cm in length if permitted will allow 100mL of air/second into the vasculature if not occluded or clamped appropriately (Cook, 2013).

## **Air Embolism Signs, Symptoms & Treatment**

Signs and symptoms of an air embolus include dyspnea, tachypnea, tachycardia, hypoxia, confusion, chest pain, hypotension, impending doom and changes in mentation. Death can occur within minutes.

If an air embolism is suspected, the immediate action should be to position the patient in the left lateral Trendelenburg position. The vital signs should be taken and 100% oxygen should be administered as the practitioner is being notified. The left lateral Trendelenburg position keeps the air bubbles away from the pulmonic valve. The administration of oxygen assists in dissolving the nitrogen trapped in the air embolus (Alexander et al., 2010).

## **Air Embolism, Treatment & Prevention**

Earlier it was discussed what causes air emboli. Now, let us focus on prevention of air emboli. Ensure proper and complete priming of all IV lines; when changing caps ensure the port is clamped; use proper patient position when removing the CVAD.

Even though PICCs have a lower risk of an air embolism when removed have the patient use the Valsalva maneuver. The Valsalva maneuver decreases the risk of an air embolism by making the thoracic pressure higher than the atmospheric pressure.

***Note! Use the Valsalva maneuver with extreme caution if the patient has a history of a recent myocardial infarction or with severe coronary artery disease.***

## **Pneumothorax**

A pneumothorax is most frequently seen immediately after insertion of the CVAD. This is one of the reasons why a radiograph is taken. A pneumothorax is caused when the parietal and visceral pleural spaces are compromised during insertion. Depending on the size of the pneumothorax, it will usually resolve on its own. If it is larger or does not resolve, then a needle-compression may be performed or a chest tube may be placed to resolve the pneumothorax.

Signs and symptoms of a pneumothorax are dyspnea and chest pain. If the pneumothorax is small, the patient may be asymptomatic. However, if it is left unmonitored it could develop into a life-threatening tension pneumothorax.

## **Thrombosis**

There is small percentage of patients who develop a thrombosis secondary to their CVAD.

Thrombosis etiology was first recognized in the late 1800s by a German physician named Rudolf Virchow. His research is summarized into Virchow's Triad.

Virchow's Triad consists of three factors that increase the patients susceptibility to forming a thrombosis:

- Venous stasis
- Hypercoagulopathy
- Vessel wall injury

## Test Yourself:

Virchow's Triad consists of:

- A. **Venous stasis, hypercoagulopathy and vessel wall injury - Correct**
- B. Arterial flow, abnormal white blood count and vessel wall injury
- C. Venous stasis, elevated PT & INR and percutaneous bruising

## UEDVT in PICCs

Another complication which may occur with a PICC is an upper extremity deep vein thrombosis (UEDVT) (Brewer, 2012).

Knowing the Virchow's Triad will assist in identifying which patients are at risk for thrombosis as well as the signs and symptoms associated with UEDVT.

Signs and symptoms of an upper extremity thrombosis related to the PICC include:

- Edema in the cannulated extremity
- Pain, tenderness, warmth and redness at insertion site

It is also plausible the patient will be asymptomatic (Raby & Rossie, 2011).

Virchow's Triad shows what factors increase a patient's risk for thrombosis. Other factors to consider the type of catheter inserted, catheter size, insertion site and terminal tip position.

Brewer (2012) noted in her review of literature when choosing a catheter, the patient's disease process, anatomy and the indication for the PICC should be taken into consideration.

Secondly it is recommended the smallest size of catheter should be used. If at all possible the PICC should be inserted using guidance from an ultrasound and on the right arm because the anatomical distance between the superior vena cava is shorter.

In general the tip should terminate in the lower third of the SVC (Alexander et al., 2010).

## UEDVT Treatment

Once the UEDVT has been diagnosed, anticoagulation therapy is recommended. Kucher (2011) recommends using low-molecular-weight-heparin once a day. Then oral anti-coagulant therapy is recommended for three to six months.

Prevention starts with proper management of the PICC. Even with proper care patient populations with underlying causes such as malignancy, pregnancy and coagulopathies can increase the patient's risk of a UEDVT.

## DVT & PE

CVADs that are not PICCs carry a higher risk of lower extremity deep vein thrombosis (DVT) and pulmonary emboli (PE). Signs and symptoms of a DVT include swelling of the affected extremity, pain, tenderness and warmth. Signs and symptoms of a PE include dyspnea, chest pain, paleness, impending doom and hypoxia.

Both are caused when clots dislodge from the CVAD and enter the circulation.

The treatment for DVT and PEs include anticoagulant therapy for a certain period of time. Depending on the patient's condition, the CVAD may need to be removed.

At this time proper CVAD care is the best prevention. Also, informing patients on the signs and symptoms of a DVT and PE are advantageous.

### **Bleeding**

Bleeding is a risk that is associated with the insertion of CVADs. However, more likely it is the patient's coagulation state or lack thereof that increases the risk of bleeding. For example, malignancy and sepsis are just a few conditions that cause decreased platelet function and therefore increase the risk of bleeding.

### **Central Line Bundle**

The IHI has compiled evidence-based practice and recommends a central line bundle as part of everyday practice for a patient who has a CVAD. The central line bundle components are to ensure hand hygiene, maximum barriers used during insertion, use of chlorhexidine skin preparation, optimal catheter site placement while avoiding the femoral site in adults and daily review of central line necessity (IHI, 2012).

Chlorhexidine should only be used in patients who are two months or older. It is acceptable in patients who are two months of age or younger to use povidone-iodine or 70% alcohol for skin preparation (Alexander et al., 2010).

### **Daily Assessment of necessity of CVADs**

CVADs are removed when IV therapy has been terminated or if a complication of the CVAD occurs that deems it necessary to remove the device.

The CDC recommend practitioners perform a daily assessment on their patients to determine if CVADs necessity (CDC, 2011).

The catheter should be removed if the IV has been discontinued, if there are signs and symptoms of a CVAD infection or if there is a complication with the catheter which cannot be resolved (Alexander et al., 2010).

***Note! PICC removal is within the scope of practice for a registered nurse; however, consult your state of licensure.***

### **Preparation Before Pulling**

Before you remove the catheter, gather the supplies needed and ensure you have discussed with the patient how and why you are going to remove the catheter.

Wash hands and don the necessary personal protection equipment.

Be sure to use aseptic technique and standard precautions throughout the procedure.

### **Discontinuing the PICC**

Since the PICC is pulled through a vein during removal, the vein's intima may become irritated and cause venous spasm resulting in resistance of catheter removal.

Alexander et al. (2010), recommends the following if resistance is encountered. Never pull against resistance because the catheter may break or the intima of the vein may be damaged. If resistance occurs, stop and place a sterile dressing

over the insertion site and place a warm compress proximal to the insertion site for vein dilatation. It is important to place a sterile dressing over the insertion site to prevent contamination of the insertion site.

### **Tips to an Easier Removal of PICC**

The patient may become anxious before or during the removal of the PICC therefore encouraging relaxation techniques may prevent the veins from constricting. After a short period of time using the warm compress and relaxation techniques, try to remove the catheter again. If resistance continues, stop pulling, cover the site with a sterile dressing and call the practitioner. In this situation, be prepared to transfer the patient to the radiology department where an interventional radiologist will remove the catheter.

### **Discontinuing the PICC**

In most cases the removal of a PICC goes without incident. Remove the dressing and inspect and disinfect the insertion site. Then place two fingers gently above the insertion site using gauze between the fingers. Ask the patient to use the Valsalva maneuver and using gentle pressure, slowly retract the catheter.

Once the catheter is out, inspect it to ensure the catheter itself and the tip of the catheter is intact and measure the catheter to make sure it compares to the measurement of how much was inserted. If there are any discrepancies, immediately notify the practitioner.

Finally, document all assessment findings and the removal procedure according to your institutions policy and procedure (Alexander et al., 2010).

### **Removal of Non-Tunneled CVADs**

It is important to remember for all CVAD removals to watch for complications such as air embolism, bleeding, pulmonary embolism and vasospasm.

Fundamentally, all other CVADs should be removed in the same manner as the PICC, however there are a few differences that should be noted.

When removing the CVAD that is not a PICC, the patient must be placed in the supine position and have the patient use the Valsalva maneuver to decrease the risk of getting an air embolus.

After all CVAD removal, place a dressing which should be changed daily until the insertion site is epithelialized (Alexander et al., 2010).

### **Test Yourself:**

You have an order to discontinue a PICC line. After discussing the procedure with the patient, the nurse performs hand hygiene and dons the appropriate PPE. While discontinuing the catheter the nurse feels resistance. What is the next appropriate step?

- A. Slowly keep pulling on catheter
- B. Stop and apply a warm compress - Correct**
- C. Give the patient pain medication

### **Summary**

In summary, indications for IV therapy have been discussed as well as the different types of IV solutions that may be used to assist in correcting fluid balance.

The differences between CVADs have been discussed and how to appropriately give nursing care and what complications to watch for and how to treat them have been discussed.

Now, let's take a look at two case studies which will help you apply the information you have learned in this course.

### **Case Study #1**

#### **Assessment**

Patient X is a 25-year-old male whose roommates called 911 after finding him on the couch unresponsive.

According to the one of the roommates they had been on boat at a lake fishing three days ago when the patient accidentally dropped some fishing equipment on the top of his foot causing it to break the skin. The roommate stated the patient put his foot into the lake to wash it off and wrapped an old sock around it for the rest of the time they were out on the boat.

The assessment in the emergency department showed patient X to be moaning and only moving to painful stimuli.

His blood pressure was 64/40 with a heart rate of 140, sinus tachycardia.

His tympanic temperature was 103.5.

His lung sounds were clear bilaterally.

The patient's right foot abrasion was approximately two inches long and was draining green purulent drainage. The top of his foot was red, swollen and warm to touch. Some dark red streaking was noted distal and proximal from the wound.

Labs were drawn and cultures were taken from the wound on the foot.

#### **Primary Diagnosis**

His primary diagnosis was sepsis. The sepsis order sheet was signed by the ED physician and transfer orders to the ICU were noted.

Due to the results of his arterial blood gas and current condition it was decided to intubate the patient and place him on the ventilator. The ED nurses started a 20 gauge peripheral IV in the right antecubital fossa.

**It was infusing an isotonic fluid, what fluid would be the best choice from the information given?**

***Answer: 0.9% NS is correct because isotonic fluids are the best choice for someone with hypotension, septic shock.***

#### **Transfer to ICU**

A broad spectrum antibiotic was initiated in the ED and the patient was transferred to the ICU.

The ICU assessed the patient's need for more vascular access due to his septic shock. He will require frequent blood draws to monitor labs, vasoactive medications, IV antibiotics and blood product administration.

Because of his profound hypotension and in septic shock, the physician is considering monitoring the patient's central venous pressure.

Taking all of these factors into consideration, the ICU nurse consulted with the primary physician about her assessment of her patient's IV needs. The physician agreed with her assessment and ordered a central and arterial line to be placed.

The ICU physician was consulted to the case for their expertise as well as central and arterial line insertion.

### **Insertion of Central Line**

Since the patient needs fluid resuscitation, lab draws, and hemodynamic monitoring the physician chose to insert a central line into the right subclavian vein and an arterial line into the right femoral artery.

**What should pose a 'red flag' for you for his anatomical choice of central or arterial lines?**

*Answer: The femoral arterial line.*

*Since there is not contraindication for the patient to have an arterial line placed in the radial artery, a critical conversation needs to take place between the nurse and the physician on arterial line placement. You discuss with the physician you are concerned placing an arterial line in the right femoral artery will only increase the patients risk of a secondary infection. The physician reconsidered and will attempt to place it in the right radial artery instead.*

### **Insertion of Central Line**

**Now he is ready to insert the central line, what should be done prior to insertion?**

*Answer: Time out, central line checklist, proper sterile set-up, PPE.*

*The physician successfully inserts the central line and there is blood return and is able to flush the four ports of the central line without resistance.*

**During the insertion, this patient is at risk for what complications?**

*Answer: Pneumothorax, bleeding, air embolism*

### **Insertion of Central Line**

You receive confirmation of placement and the order to use the central line. You continue to infuse fluid resuscitate the patient with isotonic fluids, the CVP reads 2 mmHg and currently you are drawing blood for specific labs every 2-4 hours.

**Each time you access the central line you should scrub the hub/cap for at least?**

*Answer: 15 seconds*

The hub/cap should be disinfected with?

*Answer: 70% alcohol wipe*

### **IV Medications**

The patient is now requiring two vasoactive IV medications to increase blood pressure and perfusion. He also requires a small amount of sedation, intermittent antibiotics every six hours and isotonic IV fluids. You properly label and date all of your IV lines and check for compatibility of the medications before connecting them together.

**What are the signs the medications are not compatible and are running through the same line?**

*Answer: Precipitate, cloudiness*

## **Infection Control**

At this time you are talking to the family and giving them updates. You notice the practitioner who is inserting the arterial line is not wearing a mask. You excuse yourself from the family, but it is too late, the arterial line is already placed. You have a critical conversation with the provider and that he was not wearing a mask, but he did not care and left the room.

You discuss this with the charge nurse and bring it to the attention of the primary physician. This is outside of the policy and procedure and the primary physician talks directly to the provider.

Four hours later, the arterial line was removed and cultured. Another arterial line was inserted in the left arterial artery using proper insertion technique.

## **Conversion to a PICC Line**

Forty-eight hours have passed and the patient's vital signs have remained stable through the night. He is alert and oriented and scheduled to be extubated after they take him to surgery to have his foot irrigated and debrided.

He will continue IV antibiotics, fluids and nutrition until he is able to take food and drink by mouth. As the patient is able to tolerate food and drink, the central will be discontinued.

According to the cultures taken upon admission, the surgeon has ordered for the patient to have a PICC line placed because he will need IV antibiotics for up to three months. The culture of the arterial line grew out methicillin-resistant staphylococcus aureus (MRSA).

## **Is the femoral arterial line considered a central catheter?**

*Answer: No, it is an intravascular catheter because it does not terminate in a great vessel or near the heart.*

## **What likely caused the arterial line culture to be positive for MRSA?**

*Answer: Provider was not wearing mask.*

## **Case Study #2**

### **Case Study on Upper extremity deep vein thrombosis.**

Patient P is a 34 year-old woman who has one son and is 17-weeks pregnant with her second child. Her medical history includes two pregnancies and one live birth. In her first pregnancy she complained of severe nausea from the 8th to the 18th week of gestation. She was prescribed Zofran 4mg every six hours as needed. She did not require IV fluids and nausea lessened as the weeks of pregnancy continued. In this pregnancy she started becoming nauseated at week 10 and she has been admitted to the hospital today after being seen in the OB/GYN office.

This patient has not been able to eat for four days or keep down fluids for 48 hours. She is pale and her mucus membranes are dry. Her blood pressure is 90/40 mmHg and heart rate of 125 bpm. Her lung sounds are clear. Her urine is dark and cloudy. The fetal heart tones are heard per doppler and are within normal limits. The patient has undergone all conservative therapies for hyperemesis gravidarum (HG) and will be admitted to the hospital for dehydration

secondary to NG and a PICC line has been ordered to provide supportive nutritional therapy until her symptoms are improved or other reversible etiologies are found to be causing her symptoms.

## **Admission**

The patient was admitted to room 330. She was tearful but as her nurse you were able to give her your undivided attention and talk to her about what a PICC line was and how it will help her.

**What are the benefits of having a PICC line?**

*Answer: Infuse needed IV fluids, medications, nutrition.*

**What are some of the complications of a PICC line?**

*Answer: Infection if not properly cared for.*

## **Consent**

**Before the patient consents for the PICC line what must the RN assure?**

*Answer: That the patient is alert and oriented, and not under the influence of narcotics.*

The PICC line is inserted without difficulty and a chest radiograph is ordered and extra lead protection is given to the mother and her unborn child.

**Where should the catheter terminate?**

*Answer: Lower part of the SVC*

## **Fluid and Medication Administration**

The catheter is in the right position. The PICC has been ordered to use and isotonic fluids, anti-nausea IV medications have been ordered.

**What should the nurse check before administered any IV fluid or IV medication into the PICC?**

*Answer: Blood-Return*

**What should the nurse check before administered any IV fluid or IV medications together?**

*Answer: Compatibility*

## **Complications**

### **Dressing Changes and Complications**

It has been 48 hours since the insertion of the PICC line and the dressing with the 4x4 gauze needs to be changed to a transparent non-occlusive dressing using sterile technique.

As you change the dressing you notice slight swelling of the extremity the PICC is inserted in, but the patient does not complain of pain. The PICC has good blood return and the total parenteral nutrition (TPN) is infusing without difficulty.

It has been 72 hours since the patient was admitted and her intake and output has balanced and normalized. She has been walking around and requests assistance in setting her up for a shower. The nurse is helping her and the patient states "this IV fluid really makes my arm sore." The nurse takes a closer look at her cannulated extremity and notes it is red, swollen and patient is complaining of pain. The nurse measures her arm circumference and notes there is a 3 cm difference prior to the PICC insertion.

**What may be going on in this situation?**

**Answer:** UEDVT

### **Management of Complications**

The nurse notifies the advanced IV services as well as the physician. The physician orders labs to rule out an infection as well as an ultrasound of the right upper extremity to rule out a deep vein thrombosis. The advanced IV team assesses the PICC line and notes it still flushes without resistance and there is appropriate blood return.

The white blood count is within normal limits and the patient has always remained afebrile. The ultrasound of the right upper arm confirmed the diagnosis of an UEDVT.

**What are the risk factors this patient had which made her more at risk for an UEDVT?**

**Answer:** Pregnancy

**What are the treatment principles?**

**Answer:** Patient was placed on anti-coagulant regimen as per the guidelines of the organization. The decision was made to attempt to continue with the current PICC line due to her continued nutritional needs with the caveat that PO transition with oral therapies should be aggressively pursued.

Patient was continued on subcutaneous low-molecular-weight heparin for the duration of her pregnancy due to her UEDVT.

### **Conclusion**

There are many different types of CVADs available to our patients to assist them as their disease process or medical condition warrants.

The invasive nature of these catheters potentiates the risk of life-threatening complications.

Despite inherent risks proper care following updated guidelines set out by agencies such as CDC and INS will assist to keep your patient safe and free from complications.

### **References**

Alexander, M., Corrigan, A., Gorski, L., Hankins, J. & Perecucca, R. (2010). Infusion nursing: An evidence-based approach. T.M. Myers (Ed.). St. Louis, MO: Saunders/Elsevier.

Association of State and Territorial Health Officials. (2011). Retrieved from [http://www.cdc.gov/hai/pdfs/toolkits/toolkit-hai-policy-final\\_01-2012.pdf](http://www.cdc.gov/hai/pdfs/toolkits/toolkit-hai-policy-final_01-2012.pdf)

Brewer, C. (2012). Reducing upper extremity deep vein thrombosis when inserting PICCs. *British Journal of Nursing*, 21, S12-S17.

Centers of Disease Control and Prevention [CDC], (2013). Device –Associated Module. Retrieved from [http://www.cdc.gov/nhsn/pdfs/pscmanual/4psc\\_clabscurrent.pdf](http://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf)

Cook, L. S. (2013). Infusion-related air embolism. *Journal of Infusion Nursing*, 36, 26-35.

Culleiton, A. L. & Simko, L. C. (2011). Keeping electrolytes in balance. *Nursing2011 Critical Care*, 6, 30-35.

Crawford, A. & Harris, H. (2011). I.V. fluids what nurses need to know. *Nursing2011*, 5, 30-38.

Genentech (2011). CathEd™ Online Catheter Management Education. <http://cathetermanagement.com>

Institute for Healthcare Improvement [IHI], (2011). Implement the IHI Central Line Bundle. <http://www.ihl.org/knowledge/Pages/Changes/ImplementtheCentralLineBundle.aspx>

Kucher, N. (2011). Deep-vein thrombosis of the upper extremities. *The New England Journal of Medicine*, 264, 861-869.

Petree, C., Wright, D. L., Sanders, V. & Killion, J. B. (2012). Reducing blood stream infections during catheter insertion. *Radiologic Technology*, 83, 532-540.

Raby, L. & Rossie, J. (2011). Peripherally inserted central catheter thrombosis: Literature review and trauma center experience. *Journal of Trauma Nursing*, 18, 43-46. DOI: 10.1097/JTN.0b013e31820e3ef4

To, K. B. & Napolitano, L. M. (2012). Common complications in the critically ill patient. *Surgical Clinics of North America*, 92, 1519-1557. <http://doi.org/10.1016/j.suc.2012.08.18>.

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