Skill 3
Central Venous Catheter Placement

Indications
Central venous access is required for central venous and pulmonary artery wedge pressure monitoring and for the placement of a transvenous cardiac pacing device. It might also be necessary for fluid infusion or blood transfusion if a peripheral IV cannot be established.¹,²

Equipment
- Sterile gloves
- Sterile gown and mask (optional)
- Sterile prep solution
- Local anesthetic
- Central venous catheter kit—different types of kits are available. All have the use of the Seldinger over-the-wire technique for placement. Likewise, the type of catheter inserted varies with its intended purpose. A multiple lumen catheter might be needed to infuse several different types of vasoactive medications, while a large-bore catheter is better for infusing a large volume of fluid or as a port for inserting a Swan-Ganz catheter.
- Syringes
- Sterile flush solution
- Suture material (might be included in the kit)
- Dressing material

Technique
The three central veins most commonly used for catheter insertion are the femoral vein, the internal jugular vein, and the subclavian vein. The insertion technique is as follows:

1. Determine the vein into which the catheter will be inserted and identify the external landmarks.
   a. Femoral vein: The femoral vein lies in the medial portion of the anterior thigh (groin). The portion of the vein distal to the inguinal ligament is most commonly used as a site for catheter insertion. This section of the vein is medial and slightly posterior to the femoral artery, and both the vein and the artery are somewhat superficial. To identify the correct site for insertion, identify the arterial pulse 1 to 2 cm distal to the inguinal ligament. A towel roll placed beneath the ipsilateral buttock can improve exposure. The correct site for insertion is 1 to 2 cm medial to the femoral arterial pulse. The needle is directed along the course of the vein and at a 45-degree angle to the skin.¹
   b. Internal jugular vein: The internal jugular (IJ) vein is located in the anterior neck. The more cephalad portions of the vein are located somewhat deep within the neck, but the caudal portions are more superficial. The location of the vein is best understood in relation to the sternocleidomastoid muscle. For much of its course, the vein runs directly beneath the muscle. However, its more cephalad section lies just medial to the sternal head of the muscle. Its medial portion courses through a triangle formed by the sternal and clavicular heads of the sternocleidomastoid muscle. As the vein progresses caudally, it is found medial to the clavicular head of the muscle. The IJ veins ultimately join the subclavian veins to become the innominate veins, which in turn empty into the superior vena cava (SVC). On the right side, the IJ forms a nearly straight pathway into the SVC; therefore, the right IJ is preferred when possible. The carotid artery lies medial and slightly posterior to the vein. Several approaches to cannulation of the IJ vein have been described. Of these, the most popular is the “median” approach. The key landmark is the apex of the triangle formed by the sternal and clavicular heads of the sternocleidomastoid muscle. When the
patient's head is turned away from the insertion site, this triangle becomes relatively easily identified. The needle is inserted at the apex at an approximately 30-degree angle with the skin and is directed toward the ipsilateral nipple.1

c. Subclavian vein: The subclavian veins lie just beneath the clavicles. They are less often chosen as an insertion site because attempted cannulation of the subclavian veins is associated with many potentially serious complications. The most commonly used approach to the subclavian is the so-called infraclavicular approach. The insertion site is the junction of the distal and middle thirds of the clavicle. This site should be approximately 1 cm lateral to the lateral border of the clavicular head of the sternocleidomastoid. The needle is inserted into the skin, and the tip is directed toward the sternal notch. The needle is then guided beneath the clavicle while still directed toward the notch.1

2. Prepare the area with sterile prep solution and apply sterile drapes.

3. Recheck landmarks and administer a small amount of local anesthetic medication into the skin and subcutaneous tissue without puncturing the vein.

4. Attach a 5- to 10-mL syringe to the needle. Insert the needle using the landmarks described and advance the needle while aspirating continuously.

5. The easy aspiration of dark-colored venous blood indicates that the needle is in the correct location. If the blood is bright red, the syringe should be removed from the needle. Pulsatile blood return suggests that the needle has entered the arterial lumen. If this occurs, the needle should be removed and pressure held on the site.

6. Once the clinician is reasonably certain that the needle is within the lumen of the vein, the syringe is removed and the guidewire inserted into the needle. The flexible, or “soft,” end of the guidewire should be inserted into the vein first. The guidewire should then be advanced well into the vein. If the needle and wire are in the proper location, there should be almost no resistance to wire advancement. Significant resistance indicates that the needle and wire are improperly located. In such cases, the wire should be removed and the needle repositioned or removed and reinserted.

7. When the wire is positioned, withdraw the needle. Keep one hand firmly holding the wire at all times.

8. Using a #11 scalpel blade (often supplied in the kit), make a small nick in the skin over the guidewire. Take care not to injure the underlying vessel.

9. Pass the dilating device down the wire and insert it fully into the vessel lumen. As previously described, one hand must be firmly holding the wire.

10. Remove the dilating device and insert the central venous catheter by passing it down the guidewire and into the vessel. A slight twisting motion can facilitate placement.

11. Remove the guidewire and confirm proper location by aspirating blood from the catheter.

12. Infuse fluids into the catheter to keep the lumen patent and secure the catheter in place with sutures. Apply a sterile dressing to the site.

Site-Specific Complications1,2

- Femoral vein: Few significant complications are associated with femoral vein cannulation. The most potentially serious complication is inadvertent penetration of the peritoneal cavity or rectum. This complication can be avoided by ensuring the site of insertion is below the inguinal ligament and the needle is not directed too posteriorly or inserted too deeply.

- Internal Jugular vein: Cannulation of the IJ vein is also relatively safe but less so than femoral vein cannulation. As
previously described, inadvertent puncture of the carotid artery can be problematic. Accidental injury to the brachial plexus has also been described. The most important potential complication is accidental pneumothorax.

- Subclavian vein: The location of the subclavian vein is such that it is possible for the needle to inadvertently penetrate the pleural space and create a pneumothorax. This complication occurs in up to 5% of attempted subclavian line placements. More skilled operators have a lower incidence of this complication, so subclavian cannulation is recommended only for those who have experience with this technique.

References
