Central Venous Access

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Introduction

A great deal of this course is geared toward making you more comfortable with central venous access. In this section we are going to examine the indications, contraindications, equipment and the general skill of placing multilumen catheters and introducer sheaths. Following this, we will use these techniques at the various sites where they can be performed; namely the femoral vein, the internal jugular vein and the subclavian vein.

Indications

There are a number of reasons why we may wish to gain central venous access in our patients. They include:

1. Vascular Access

Obtaining peripheral vascular access can be challenging in patients with burns, previous vein injuries (such as IV drug use) or in the context of cardiopulmonary arrest. In these situations, a central venous line may be the preferred technique of gaining vascular access.

2. Volume Loading

Central venous lines do provide a method for infusing fluids or blood products in critically ill patients. It is important to remember that the flow in central lines is determined not only by the diameter of the catheter but also by the length of the line (Poiseuille's law for you physics buffs). Thus a 16g peripheral IV will have far greater flow rates than a double or triple lumen central venous catheter. A 5-6 cm long 6Fr introducer sheath, though, will provide flow rates greater than that of the accompanying IV tubing.

3. Provision of Caustic Medications or Solutions

Many medications we provide for critically ill patients can be quite caustic to smaller peripheral veins. Central lines are useful tools to prevent peripheral venous injury and extravasation of such fluids. As such, consider central venous access when using vasoactive medications (vasopressors or inotropes), caustic fluids (such as chemotherapies or high concentration solutions), or hyperalimentation.

4. Central Venous Pressure Monitoring

Once a central venous line is placed, it can be used to measure the patient's central venous pressure. This can be exceptionally helpful if we are trying to decide if the patient needs more volume resuscitation (as in sepsis for example) or if we are getting too high pressures (such as in right heart failure).

5. Repeated Blood Sampling
Although not an indication we usually consider, the ability to draw blood samples from a central line will negate multiple needle pokes for the patient who needs frequent blood sampling.

6. Introduction of Pacemakers or Pulmonary Artery Catheters
Central venous access with an introducer sheath provides us a route for placing tools into the central circulation. This is particularly helpful when a patient requires either a pacemaker or pulmonary artery catheter. There will be more on this later!

Contraindications
As we are usually placing central lines in critically ill patients, these contraindications are all relative. Thus the physician must balance the risks and contraindications of the line with its need. Common general contraindications include:

1. Distorted Anatomy
Trying to place a central line in an area of trauma or deformity decreases the success rate of central venous cannulation and increases the risk of complications. Generally speaking areas of distorted anatomy should be avoided.

2. Infection at the Site of Access
It seems obvious, but placing a central venous catheter through infected tissue is just asking for infection related complications. Avoid such areas if at all possible.

2. Proximal Vascular Injury
Placing a central line distal to an injury or thrombus will negate the utility of the line. It seems obvious, but sometimes we forget this. A classic example might be the placement of an internal jugular line in a patient with superior vena cava obstruction. Consider using another site in such examples (such as a femoral line in SVC obstruction).

3. Bleeding Disorders or Anticoagulation
As you might suspect, patients with bleeding disorders or on anticoagulant therapy have a higher incidence of complications than those who have normal coagulation systems. A review by Mumatz et al looking at central lines in those with bleeding potential (i.e. platelets $< 50 \times 10^9$/L or on anticoagulation) reported only a 3% complication rate only as long as there was no arterial puncture. So as long as you are sure you are going to cannulate the vein, there is no need to give blood product therapy prior to central line insertion. Having said that, arterial puncture is one of the common complications of central line insertion. So in these patients you may still wish to reverse their coagulopathy prior to attempting a central line or consider placing the line under ultrasound guidance.

4. Combative Patients
There are times when the critically ill patient requires a central line, but is combative due to issues such as hypoxia, CNS injury or delirium. These patients are likely to benefit

from sedation prior to the insertion of their central line, as the complication rate and risk of harming yourself is high in the agitated patient.

Let us review a few of the contraindications related to each central line site. We will review these when we go over each central line site, but are worth considering here. Remember that these contraindications are all still relative, but the presence of contraindications should make you consider another site for your central line.

1. Subclavian Vein Site
As you will see, accessing the subclavian vein requires placement of your needle under the clavicle and near the dome of the lung. As such, the biggest risk of the procedure is pneumothorax. As such, chest wall deformities, pneumothorax or COPD are relative contraindications for subclavian access.

2. Internal Jugular Site
As neck rotation is helpful in accessing the internal jugular vein, patients in cervical spine immobilization are poor candidates for central lines at this site. Unfortunately the jugular system is also a site for intravenous drug use. So patients with a history of jugular IV drug injection have a relative contraindication to line placement at this site.

3. Femoral Vein Site
The femoral vein is associated with the fewest vascular and pulmonary complications due to its location. Unfortunately the femoral site is associated with higher infection rates than the internal jugular or subclavian sites. Furthermore, a femoral central line will limit the patient's ability to sit upright and walk. So for patients who are expected to be ambulatory, the femoral line is relatively contraindicated.

So we know when to place a line (and when not to). Let us explore the tools and techniques a bit more!

Sterile Technique
Before we venture into the actual theory and steps of placement of central lines, it should be emphasized that these procedures should be done under sterile technique. Outside of cardiac arrest, there is little to be gained by placing lines under 'dirty' conditions, and the complications of an infected central line can be immense. If a central line is placed under such 'dirty' conditions, it should be replaced once the patient is stabilized. If this patient is being transported to another facility, it is very helpful to inform the receiving physician that the central line requires replacement at the earliest opportunity.

We will not review sterile technique in depth here, but feel free to ask us if you would like a refresher in this. For the physician, sterile technique means wearing a surgical cap, procedure mask, sterile gown and sterile gloves.

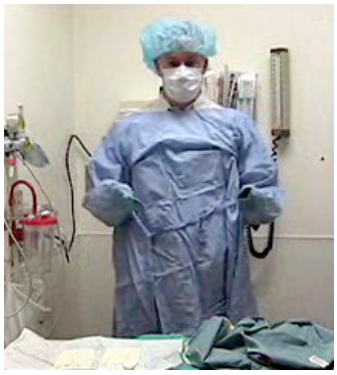

Figure 1. Cap, mask gown and…gloves? Getting ready to put in my central line.

Sterile setup for the patient should begin with adequate skin preparation with a sterilizing solution (proviodine, hibitane, etc.) in a large area surrounding your procedure site. Place a large sterile sheet on your patient following this and then isolate the procedural field with four to six sterile towels. This will minimize infective complications of your procedure.

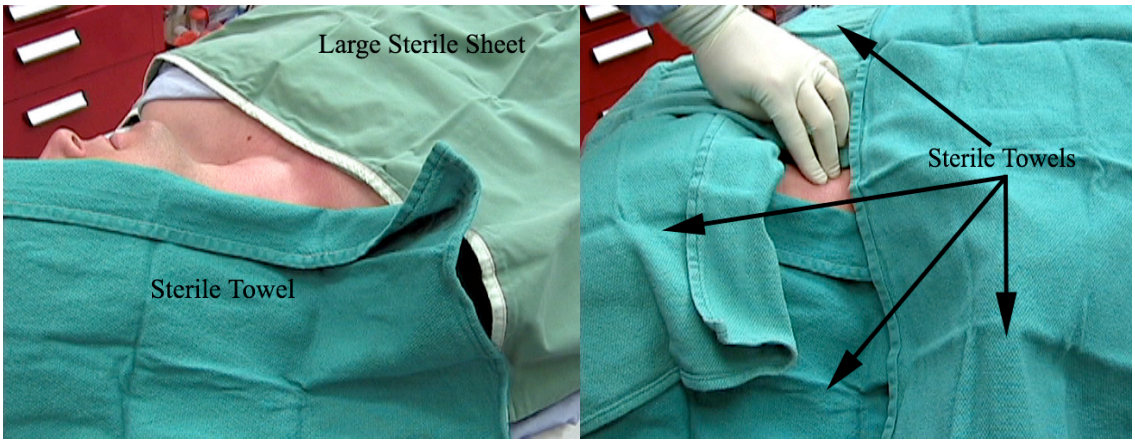

Figure 2. After prepping the patient place a large sterile sheet on your patient. Continue by surrounding your procedure field with sterile towels.

Central Venous Access and the Seldinger Technique

Placing a central line begins by choosing a catheter type for insertion. In general, these come in two flavors: multilumen catheters and introducer sheaths. We are going to look at each of these separately and explore the techniques used to place each type of central line. What you will notice is that the technique of placing multilumen catheters and introducer sheaths is almost identical. Furthermore, the steps you use to place these catheters in the various sites are the same. Only the anatomy changes. So if you know how to place a femoral multilumen catheter, you know all the steps needed to place an internal jugular multilumen catheter. You just need some different landmarks!

Multilumen Catheters

As their name implies, a multilumen catheter is a central line that has a number of 'lines' within it. As you might guess, a triple lumen catheter has three 'lines' in it. A double

lumen catheter has two. Multilumen catheters are especially useful for situations where you may wish to run multiple fluids and medications, or run medications that are normally incompatible with each other. The limitation of multilumen catheters is that you cannot feed invasive tools such as pacemakers or pulmonary artery catheters through them.

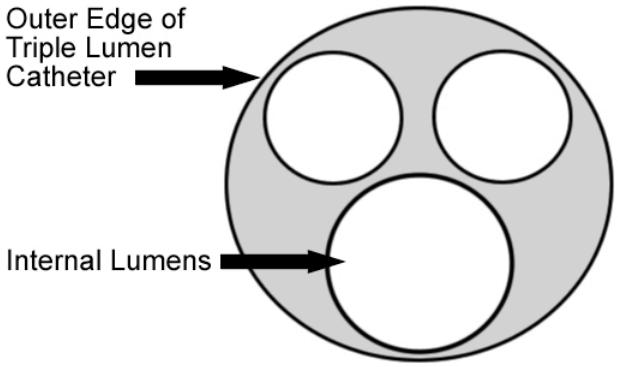

Figure 3. Cross section of a triple lumen catheter

Demonstrated below is a triple lumen catheter set. There are a number of important pieces of equipment here, and their uses will become clear as we walk you through the steps of placing a multilumen catheter. For the next bit, though, we are going to review the generalities of placing a central line. We'll get more in depth when we review placing these in the individual sites.

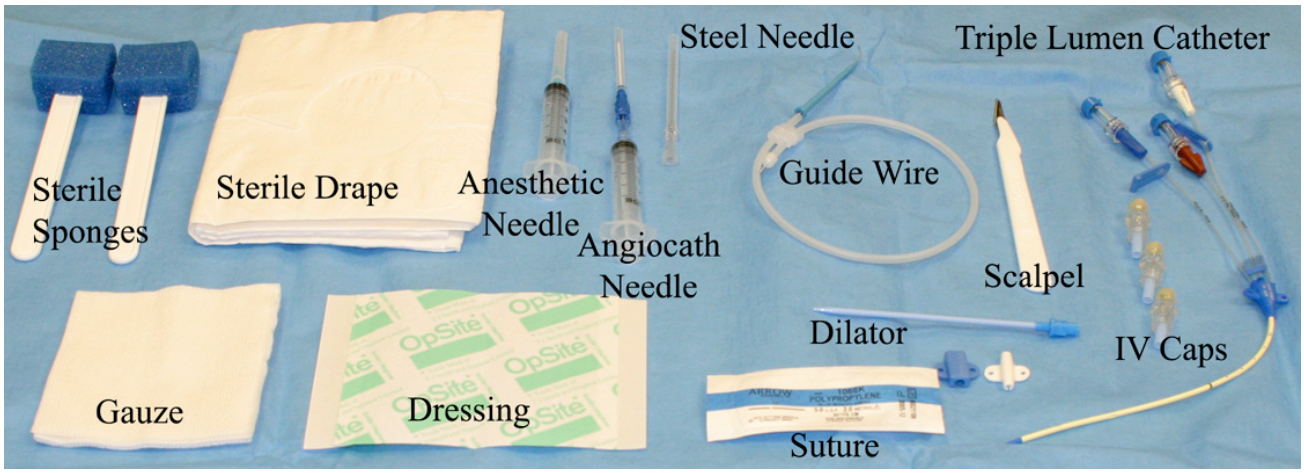

Figure 4. Contents of the triple lumen central line kit.

The technique of placing a central venous catheter is called the Seldinger technique and involves placing a wire in the central vein and then guiding our catheter over it. One can summarize the steps as the following:

1. Setup of Equipment and Sterile Preparation
2. Landmarking the Access Site

3. Anesthesia
4. Location of the Vein with a Seeker Needle [Optional]
5. Placing the Introducer Needle in the Vein
6. Assessment for Venous or Arterial Placement
7. Insertion of the Guide Wire
8. Removal of the Introducer Needle
9. Skin Incision
10. Insertion of the Dilator
11. Placement of the Catheter
12. Removal of the Guide Wire
13. Flushing and Capping of the Lumens
14. Secure the Catheter

1. Setup of Equipment and Sterile Preparation
Begin by assembling your equipment. Once you are sterilely gowned and gloved, open the inner package of the central line kit. Have an assistant pour your skin sterilizing solution into the provided container. Proceed to apply three coats of the sterilizing solution to a large area surrounding your vascular access site using sponges. Start from the centre of the area where you plan to place your catheter and work outwards in a circular manner. Don't worry about the specifics of the site for now, as we will discuss them further when we review the individual sites.

Continue by placing your large sterile sheet on your patient and then sterile towels creating a sterile field. At this point you're ready to proceed.

2. Landmarking the Access Site
We will deal with this section individually with each particular site. Obviously this is different if you are performing an internal jugular, subclavian or femoral line.

3. Anesthesia
Using a sterile 25-27g needle, infiltrate the skin around your vascular access site with a few milliliters of local anesthetic. If your patient is under general anesthesia, this is not necessary. For awake and restless patients, consider sedation for the procedure as a moving patient can make central venous access both challenging and dangerous.

4. Location of the Vein with a Seeker Needle [Optional]
As mentioned this is an optional step. It is used when you are concerned about puncturing an arterial vessel. The theory is that you first begin by seeking the central vein with a small diameter needle attached to a syringe. Once you have located the vein, you then remove the seeker needle and then proceed to place the larger introducer needle using the same path as the seeker needle. The benefit of this step is that if you inadvertently puncture an artery, the hole you make in this vessel is much smaller than the one made with an introducer needle.

To do this step, assemble a sterile 25 or 27g 1 ½ inch needle on a 3 or 5 cc syringe. Insert the needle into the skin and begin aspirating on the syringe. Follow the path you

would normally use to place the particular central line you are inserting (more on this with each individual line). When you hit the vein you should get good flow of blood into the syringe. If the blood looks venous then proceed to the next step (below) using the introducer needle. If the blood looks bright and arterial then remove the seeker needle and apply five minutes of pressure to the arterial site.

As mentioned, this is an optional step, and many physicians do not do this.

5. Placing the Introducer Needle into the Vein
The goal of this step is to cannulate the vein with an introducer needle. This will then allow you to pass the guide wire into the vein. The kits we use contain two introducer needles, a 18g steel introducer needle or a 18g angiocatheter. Which to use is simply a matter of preference. The steel introducer needle works best in the models used in this course, but we will review both here.

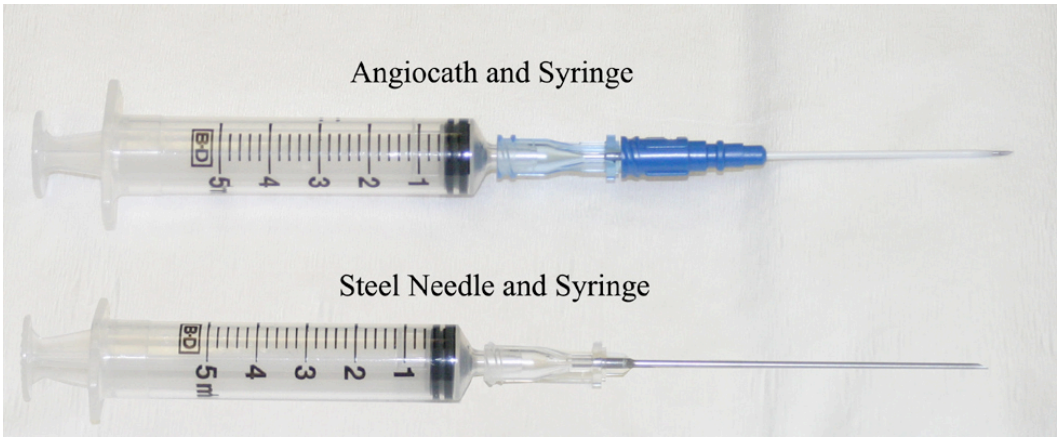

Figure 5. Angiocath and Steel Introducer Needles

If you are using the steel needle, load it on syringe from your kit. Insert it into the skin and direct it towards the vein while aspirating on the syringe. Once you have entered the vein, you should get venous blood flowing rapidly back into the syringe. Advance the needle ½ cm further into the vein to ensure the entire lumen of the needle is in the vein. Reaspirate and ensure you still have good blood flow into your syringe. Now remove the syringe, taking care to leave the needle in place. You are now ready to proceed to the next step.

Using the angiocath is similar. Load the angiocath onto a syringe and advance it through the skin while aspirating on the syringe until you get good venous blood flow from the central vein you are looking to cannuate. Advance the needle ½ cm further and reaspirate, ensuring you have the lumen of the angiocath in the vein. While holding the syringe and needle still, advance the catheter until its hub abuts the skin. Remove the needle portion of the angiocath, leaving only the catheter in your patient. You are now ready to proceed to the next step.

6. Assessment for Venous or Arterial Placement

This is a very important step. If your introducer needle is placed correctly in the vein, you should notice a low pressure venous type flow of dark blood from the needle. If the blood is bright or very pulsatile, you may have an arterial puncture. While sticking a needle into the artery is usually well tolerated, dilating an artery and jamming a large vascular catheter in it is not. Ensuring venous placement of your catheter is important.

If you are unsure as to whether you have an arterial or venous puncture, there are a couple of ways to test this. Probably the fastest way to do this is to attach sterile manometer tubing to your introducer needle/catheter. Lower the tubing so that it fills with blood (confirming that you are still in the vein), then hold the tubing up. If you are in the vein, you should see the blood column equilibrate about 3-10 cm above the level of the right atrium (as long as your patient has normal right sided pressures). The column of blood in the tube might change somewhat with respiration, but should not be markedly pulsatile. Arterial placement will result in a steady rise in the blood column, and would eventually flow out the end of the tubing (if your patient has a reasonable blood pressure).

If you have an arterial puncture, you will note a very pulsatile nature of the blood column in the tubing (correlating to the carotid pulse). This column of blood also tends to rise far above the right atrium in normotensive patients. This is not always true in those with profound hypotension, though.

If this technique is not available to you, consider sending a blood gas from your introducer needle and an arterial gas from another site. Compare the two, and if they are the same, you are in the artery. If your sample has a lower pO2 and higher pCO2, you are likely fine and in the vein.

7. Insertion of the Guide Wire

When you are sure you are in the vein, it is time to place your guide wire. Note that the guide wire comes wrapped in a circular tube and has a cone like piece that serves to feed the guide wire into your introducer needle. This cone is quite useful as you will notice that the guide wire itself has a folded tip (called a J-wire for that reason). This tip protects the vein from being lacerated by the guide wire, but it means that placing the wire into your introducer needle is challenging without the cone like piece.

Proceed by placing your guide wire assembly on the introducer needle. Then advance the guide wire down the needle and into the vein. Continue this until the wire is 10-15 cm in the vein.

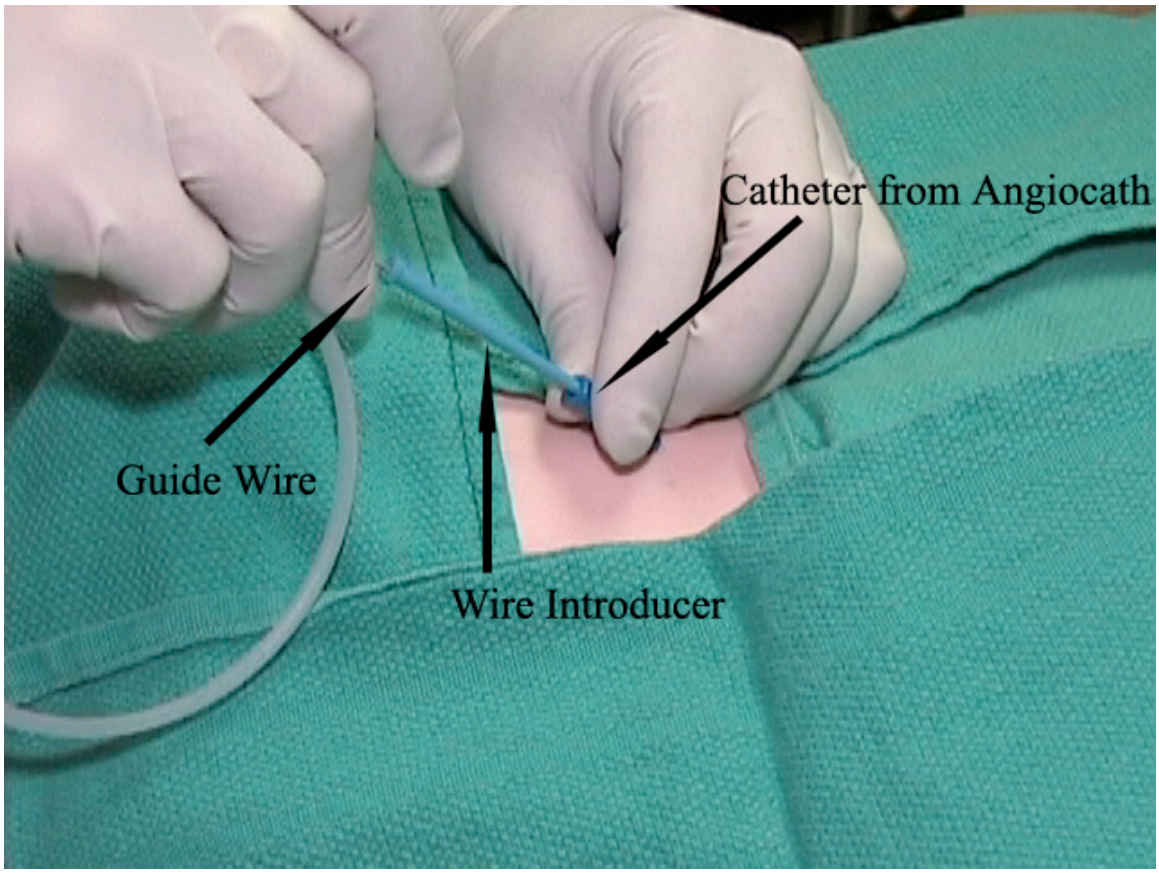

Figure 6. Introducing the guide wire down the angiocath. The wire introducer is the cone like piece that guides your wire into the needle.

There are a couple of important safety points here. First, the guide wire should advance smoothly with little resistance. **You should never force a wire.** If you require force, the wire is in the wrong spot and continued attempts at advancement will just make the process harder, and can result in laceration of the vessel. If you cannot advance the guide wire, consider rechecking your introducer needle for flow (to ensure you are in the vein) and consider pulling back on the introducer needle (as you may be abutting the far wall of the vessel). If all of this fails, remove your equipment, apply pressure to the site and consider placing your central line elsewhere or trying again.

The safety mantra of central lines is "Never let go of the wire!" If the guide wire is in use, your fingers should control it at all times. This applies when you are placing it through the introducer, and all subsequent steps. A guide wire can float all the way into the central vein rapidly and disappear. This is a bit of a disaster, so just remember, "Never let go of the wire!"

8. Remove the Introducer Needle

Now that your guide wire is placed in the vein, remove your introducer needle leaving the guide wire in place. Remember our mantra from before, "Never let go of the wire".

Control the guide wire from above or below the introducer needle when removing the introducer needle.

9. Skin Incision
We need to make a small incision in the skin in order to facilitate the passage of our dilator and line. To do so, take your scalpel and lay it flat along the guide wire. Advance the scalpel along the wire incising the full thickness of the dermis. You are still holding that guide wire aren't you?

10. Insertion of the Dilator
The job of the dilator is to dilate the path around the guide wire, enabling easy passage of the multilumen catheter into the vein. Feed the guide wire into the dilator. While controlling the guide wire, advance the dilator until its hub is flush with the skin. Now remove the dilator. Remember to still be holding some part of the guide wire at all times.

11. Placement of the Catheter
Once you have removed the dilator, place the multilumen catheter on the guide wire and advance it. During this step you may have to pull the guide wire out of the patient a bit in order to always be controlling it. Not to worry, you have got lots of wire.

The wire should exit one of the ports of the multilumen catheter (the brown one in our set as this is the distal port). Once you can grasp this part of the guide wire, proceed to advance the multilumen catheter down the guide wire and into the vein. Hey we are almost done!

12. Remove the Guide Wire
Now that our multilumen catheter is in place we can take out the guide wire. Hold the catheter in place and remove the wire. Aren't you glad to be done with that darn wire?

13. Flushing and Capping the Line.
The last step! Here we get the lumens of the lines free of air and ready for use. At this point it is helpful to have those three IV caps and three 10cc NS syringes ready that you read about in Step 1.

You will probably notice that there is blood coming up the lumen of the catheter from which you removed the wire from. Great! Let the blood come all the way back up the tube, as this clears the air from the line. While this is occurring, attach an IV cap to the 10 cc NS syringe and flush some fluid through the cap.

When the central line's tubing is completely filled with blood, attach the IV cap to it and then flush it with the rest of the 10cc's of NS. Now do the same for the remaining IV lines on the catheter. Bleed them back, attach the IV cap and then flush!

14. Secure the Catheter

After so much work, you wouldn't want the central line to fall out now would you? Begin by suturing the line to your patient. Although we will not do this to the model, here is how to do it.

Place your suture through the skin ½-1 cm away from the catheter. Leave yourself lots of suture on either side and tie a couple of knots into the skin. After this, pass your needle through the little hole on the catheter apparatus and then tie a couple of more surgical knots. Doing it this way allows for some movement of the catheter without breaking the suture.

Once sutured in place, add a large sterile dressing to the area. Voila, you are complete! Well done.

Introducer Sheath

As opposed to a multilumen catheter, the introducer sheath is essentially a very large intravenous with a port on it that allows you to introduce a tool such as a pacemaker or Swann-Ganz catheter into the central vein. The introducer sheath is limited by the fact it only has one lumen, and thus you cannot simultaneously run incompatible medications and fluids through it like you can do with a multilumen catheter.

Figure 7. The introducer sheath. Note it has only one lumen and port.

Luckily, the steps for placing an introducer sheath are almost identical to that of placing a multilumen catheter. The only real difference is that the placement of the sheath and the dilator occur in a single step. You will find the steps almost identical to what you have just read:

1. Setup of Equipment and Sterile Preparation
2. Landmarking the Access Site
3. Anesthesia
4. Location of the Vein with a Seeker Needle [Optional]
5. Placing the Introducer Needle in the Vein
6. Assessment for Venous or Arterial Placement
7. Insertion of the Guide Wire

8. Removal of the Introducer Needle
9. Skin Incision
10. Insertion of the Dilator and Catheter

Here in lies the difference between placing a multilumen catheter and an introducer sheath. Begin by assembling the dilator and the catheter together. Place the dilator through the introducer sheath as shown below:

Figure 8. When you are getting ready to place an introducer sheath, preload the dilator as shown. The sheath and dilator are placed in a single step.

Feed the guide wire into the dilator and sheath. While controlling the guide wire, advance the dilator/sheath unit until the hub of the sheath is flush with the skin and thus placed in the vein.

11. Removal of Guide Wire and Dilator

Now while stabilizing the sheath, remove the dilator and guide wire together, leaving only the introducer sheath in the patient.

12. Flushing and Capping of the Lumens
13. Secure the Catheter

Specific Sites

All right! You have mastered the concepts of placing a multilumen catheter and an introducer sheath. Let's explore how you place these in the various sites. In this course we are going to review gaining central venous access through the internal jugular vein, the subclavian vein and the femoral vein.

The Internal Jugular Vein

The internal jugular vein is an attractive site for a central line for a number of reasons: The vein has a fairly predictable course running lateral to the carotid artery, it can be punctured well above the dome of the lung (thus creates fewer pneumothoracies than the

subclavian approach) and the right IJ has a fairly direct route to the superior vena cava and right atrium (useful for placing pacemakers and pulmonary artery catheters).

The drawbacks to the IJ approach is that it does have a slightly higher failure rate than the subclavian approach and it cannot be used for patients in cervical spine collars.

Firs let's review the anatomy. If you are standing at the head of the stretcher, your view of the vascular anatomy would look something like this:

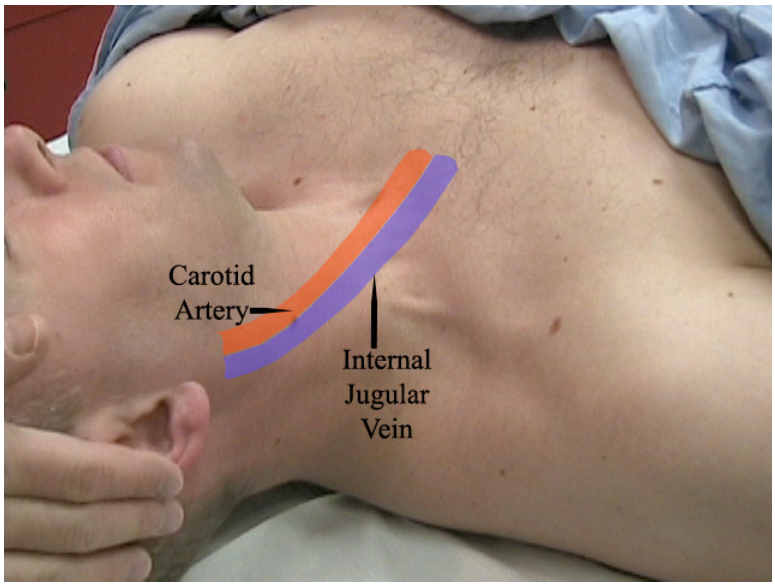

Figure 9. Anatomy of the internal jugular and carotid artery.

Note that the vein runs lateral to the carotid artery. Furthermore, the vein has a fairly consistent relationship to the sternocleidomastoid muscle. In fact, it often sits under the triangle formed by the clavicle and the two heads of the sternocleidomastoid muscle as shown here:

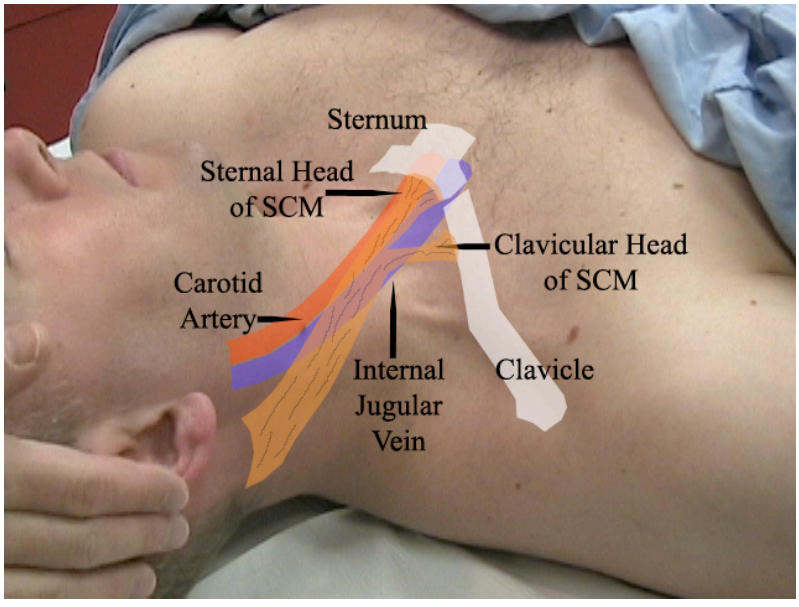

Figure 10. More anatomy of the internal jugular and carotid

Technique

Let's see how our technique is used for the internal jugular approach, as steps 1-5 are different for each site.

1. Setup of Equipment and Sterile Preparation
Begin this step by setting up all your equipment as discussed previously. Have your patient laying supine on a stretcher and place him/her in Trendelenberg position. This position will help fill the internal jugular vein, making it a much larger and easier to hit. Furthermore, this position will help limit the chance of air embolism during the procedure.

2. Landmarking the Access Site – Internal Jugular
For our course, we will show you the medial approach to the right internal jugular. Position your patient with his/her head rotated approximately 15^{o} to the left. Note that you don't need extreme rotation of the head. In fact too much rotation makes it harder to locate the IJ.

Now place one of your fingers in the patient's suprasternal notch. Moving laterally along the clavicle, the first muscle you encounter is the sternal head of the sternocleidomastoid. Continuing laterally, the next muscle you encounter is the clavicular head of the sternocleidomastoid. If you are having trouble locating these muscles, have the patient lift his head slightly off the stretcher and they will be much easier to palpate. If you follow these two muscles you will note that they converge together about 5cm above the clavicle. This is where we will place our introducer needle (and seeker needle if you choose to use it).

4. Location of the Vein with a Seeker Needle [Optional]
If you choose to use a seeker needle, assemble it on a 3 or 5cc syringe. Place your left 2^{nd} and 3^{rd} fingers along the sternal head of the sternocleidomastoid muscle and ensure that the carotid pulse is medially to where you are about to place your seeker needle. Now insert the seeker needle into the apex of the sternocleidomastoid-clavicular triangle at a $30\text{-}40^{o}$ angle to the skin. Aim the needle caudally towards the patient's ipsilateral nipple.

Advance the seeker needle while aspirating on the syringe. The vein is usually only 2-3cm deep to the surface. When you puncture the vein you will get rapid return of venous blood into your syringe. You may now either remove the seeker needle (remembering its orientation) or leave it in and go to Step 5 following the seeker needle's orientation when placing the introducer needle.

5. Placement of the Introducer Needle
The placement of the introducer needle is identical to that of the seeker needle (just using our bigger needle). Place your left 2^{nd} and 3^{rd} fingers along the sternal head of the

sternocleidomastoid muscle and ensure that the carotid pulse is medially to where you are about to place your seeker needle. Now insert the introducer needle into the apex of the sternocleidomastoid-clavicular triangle at a 30-40^{o} angle to the skin. Aim the needle caudally towards the patient's ipsilateral nipple.

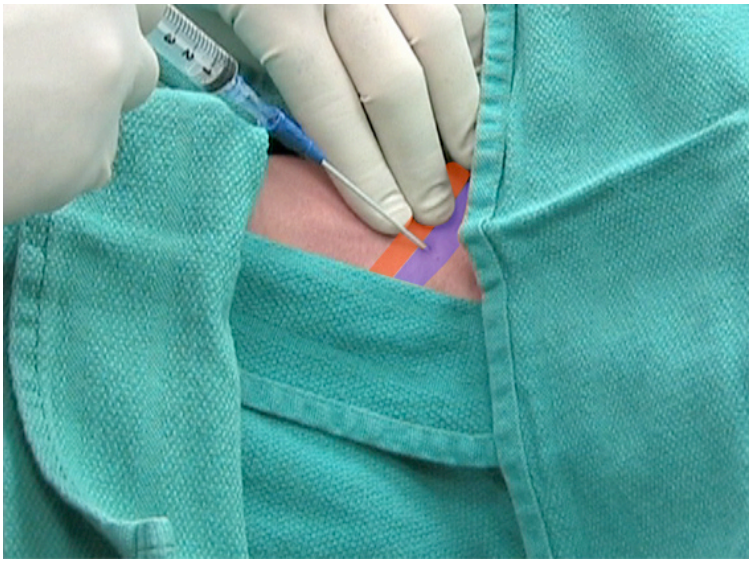

Figure 11. Placing an angiocath into the internal jugular.

Advance the introducer needle while aspirating on the syringe. The vein is usually only 2-3cm deep to the surface. When you puncture the vein you will get rapid return of venous blood into your syringe. Remember to advance the needle about ½ cm and reaspirate for venous blood. This is to ensure your entire needle tip is in the vein. The remaining steps are the same for each site.

Subclavian Vein

Catheterizing the subclavian vein has some advantages. It is a site that is available to patients in cervical spine precautions (such as in trauma) and the subclavian vein changes diameter less in hypovolemia due to its semirigid attachments to the costoclavicular ligament and surrounding structures. Having said this, the rate of pneumothorax in this procedure is slightly higher than that seen with the internal jugular approach. Furthermore, this site in not compressible due to its location under the clavicle. So consider another site in patients with coagulopathies or bleeding disorders.

Let's look at the anatomy of the subclavian vein. It begins distally as the axillary vein and then becomes the subclavian vein at the outer aspect of the first rib. After passing the first rib it runs directly behind the clavicle and the costroclavicular ligament holds it in a firm position here. This constant anatomy makes it quite ideal for placement of a central line. The vein then continues on to become the innominate vein as it joins the internal jugular vein and then becomes the superior vena cava. Let's look at the anatomy on our patient.

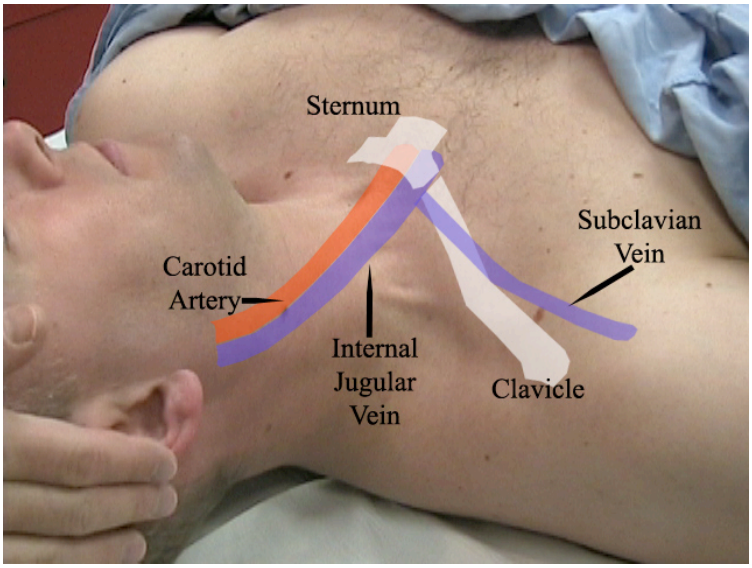

Figure 12. Subclavian vein anatomy.

What you need to realize is that the close association of the subclavian vein and the clavicle only occur proximal to the middle third of the clavicle. Thus attempts to cannulate the vein laterally have a high risk of failure and pneumothorax.

Technique

Lets examine which steps are different:

1. Setup of Equipment and Sterile Preparation
Begin by placing your patient supine on a stretcher in 10^{o} or so of Trendelenberg to help prevent air embolism. Also consider placing a small towel roll or 1 L IV bag between the patient's shoulder blades to get them to extend their chest. This will allow for better access to the subclavian vein. Don your sterile gown, gloves and mask. Apply your sterile skin solution as discussed previously to a wide area from the distal third of the clavicle passed the sternum. Drape patient with a large sterile drape and sterile towels as previously discussed.

2. Landmark the Access Site
In the case of subclavian vein access, the site of access lies at the junction of the medial and middle thirds of the clavicle. The site of needle insertion lies about 1 cm caudal to the clavicle allowing for the needle to pass under the clavicle.

4. Location of the Vein with a Seeker Needle [Optional]
Again, this is an optional step, but the needle orientation and technique is exactly the same as you would do with the introducer needle.

Place your needle at the previously identified access site (1cm caudal to the junction of the medial and middle thirds of the clavicle). Direct the needle to a point just above and posterior to the sternal notch. Advance the needle while withdrawing on the syringe. Rapid flow of venous blood will signify when you enter the vessel and usually occurs in

3 to 4 cm. You may now either remove the seeker needle (remembering its orientation) or leave it in and go to Step 5 following the seeker needle's orientation when placing the introducer needle.

5. Placing the Introducer Needle in the Vein
This is the exact same technique as the seeker needle, just that we use our larger introducer needle. This can be either the angiocath or the steel introducer needle. Most of us have found, though, that the depth of penetration needed makes the steel needle an easier option.

Place your needle at the previously identified access site (1 cm caudal to the junction of the medial and middle thirds of the clavicle). Direct the needle to a point just above and posterior to the sternal notch. Advance the needle while withdrawing on the syringe. Rapid flow of venous blood will signify when you enter the vessel and usually occurs in 3 to 4 cm. Advance the needle ½ cm into the vein and reaspirate to ensure the entire distal portion of the needle is in the vein.

The Femoral Vein

It is easy to see why physicians like the femoral vein. No lungs to collapse, no carotid arteries to puncture… why go anywhere else? Although we agree the femoral vein makes a site for central vascular access, there are a couple reasons why you might not use it.

First, a patient with a femoral line cannot get up out of bed and walk. So if you have imminent plans to have your patient to do this, consider another site. Second, the femoral vein site has a higher risk of infective complications than the other sites. It is just tougher to keep the groin clean.

It is also harder to float pacemakers or pulmonary artery catheters from a femoral source. Consider one of the more proximal sites if this is in your patient's near future.

Having said all this, when the proverbial feces hits the fan and there is lots of activity around the airway and the chest, you will still see many of using the femoral vein as our central venous access site.

A quick review of the anatomy of the femoral vein. It is located medial to the femoral artery and is accessed best just distal to the inguinal ligament. To remember the anatomy I had always read of the 'NAVL' pneumonic – Nerve, Artery, Vein, Lymphatics. This is great, but then I can't remember whether this is medial to lateral or lateral to medial. So I modified the pneumonic to 'NAVLS' – Nerve, Artery, Vein, Lymphatics, Scrotum. OK, now you should know where medial is!

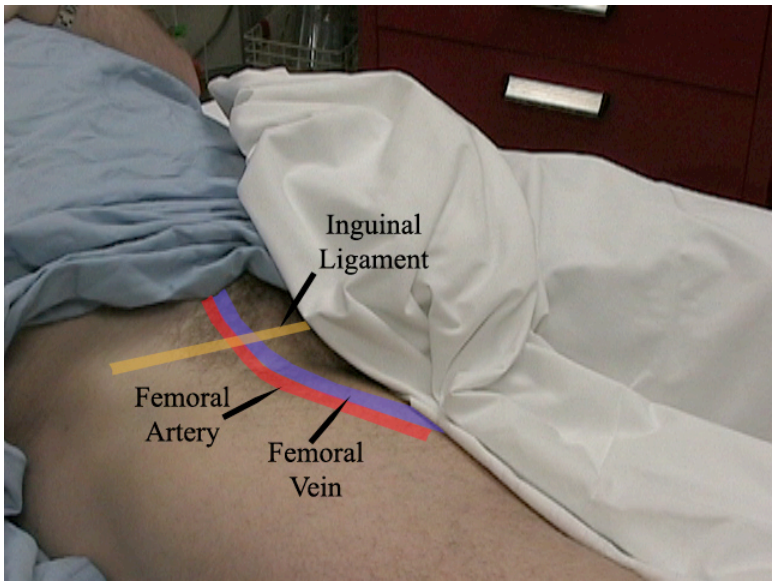

Figure 13. Femoral vein anatomy. Remember the NAVLS pneumonic!

Lets examine how the steps are different:

1. Setup Equipment and Sterile Preparation

Place your patient supine on a stretcher. Abduct the patient's leg at the hip and slightly externally rotate the hip. Don your sterile gown, gloves and mask. Prep a large area around the patient's inguinal ligament. Drape the patient with a large sterile sheet and then with sterile towels surrounding the access site.

2. Landmarking the Access Site

Locate the site for access by palpating the femoral artery's pulse just distal to the inguinal ligament. The femoral vein lies just medial to this. If access is being attempted during CPR, start medial to the palpable pulsation, but be aware the pulse you feel may be a venous pulse generated by CPR. This may necessitate you moving somewhat lateral to place your catheter.

4. Location of the Vein with a Seeker Needle [Optional]

If choosing to use a seeker needle, load it onto a 3-5 cc syringe as described previously. Begin again by palpating the femoral artery's pulse just below the inguinal ligament. Place the seeker needle 1-2 cm medial to this. Advance is a cephalad direction with a 45^{o} angle to the skin while aspirating. As with the other techniques, rapid filling of your syringe with venous blood signifies the needle's entrance into the vein.

5. Placing the Introducer Needle in the Vein

This is the same technique as using the seeker needle. Begin again by palpating the femoral artery's pulse just below the inguinal ligament. Place the seeker needle just medial to this. Advance is the needle in a cephalad direction with a 45^{o} angle to the skin while aspirating. As with the other techniques, rapid filling of your syringe with venous blood signifies the needle's entrance into the vein. Advance the needle ½ cm into the vein and reaspirate to ensure the entire distal portion of the needle is in the vein.

Complications

No discussion of procedures would be complete without referring to some of the problems we can cause doing it. Central lines are an invasive procedure, and if you have never had a complication, you have not put in many lines.

General Complications if central lines include:

1. Air Embolism
2. Intravenous Thrombus Formation
3. Catheter Embolism
4. Local Hematoma
5. Arterial Puncture
6. Local Cellulitis
7. Catheter Infection
8. Intravascular Loss of Guide Wire

There are many techniques to prevent air embolism. The most useful ones include placing your patient in Trendelenberg when doing the IJ or SC line, and placing a finger over your introducer needle's lumen prior to placing the guide wire. Thankfully air embolism is a rare complication.

Unfortunately arterial puncture is not so rare. If recognized early (i.e. when placing the seeker or introducer needle) 5 minutes of solid pressure on the site will resolve most bleeding issues without consequence. This is different, though, if you have dilated the artery and placed a catheter or introducer sheath in it. If this occurs, leave the line in place and consult your local vascular surgeon.

And speaking of vascular surgeons, they would also be the ones to call if you lose your guide wire in the patient's vein. This is a preventable complication, though! If you always control the guide wire with your fingers, you will never lose it and thus never have to suffer through sheepishly consulting your surgeons for this complication.

Complications from the internal jugular and subclavian sites include:

1. Pneumothorax
2. Hemothorax
3. Chylothorax
4. Phrenic nerve injury
5. Brachial plexus injury
6. Cerebral infarct from carotid artery cannulation

Pneumothorax is by far the most common complication of the IJ/SC site. There is not a consensus as to whether all of these patients require chest tubes if a pneumothorax occurs. Stable patients with small pneumothoracies may be closely observed. Patients

with large pneumothoracies or those who are undergoing positive pressure ventilation require chest tubes to manage this complication.

Finally the femoral vein site! It has fewer complications, but includes:

1. Bladder Perforation
2. Bowel Perforation
3. Increased Risk of Local and Line Infection

Thankfully most of these complications are rare, and the common ones are usually easily managed by the physician doing the central line.