

# **Madigan Army Medical Center Clinical Practice Guidelines**

## **Central Line Placement**

Madigan Army Medical Center  
Maintained by Quality Services Division  
Clinical Practice and Referral Guidelines Administrator

Last Review for this Guideline: **July 2010**  
Clinical Guidelines require review every three years

## Core Document

**TITLE:** Clinical Guideline for Central Line Placement and Post-Line Management.

**INDICATIONS FOR THE CLINICAL GUIDELINE:** This consensus paper will provide a uniform approach central line placement at Madigan Army Medical Center and serve as a guide for training new providers in this medical procedure.

**METRICS: THE KEY ELEMENTS OF THE CLINICAL GUIDELINE THAT WILL BE USED TO MONITOR PROVIDER ADHERENCE TO THE CLINICAL GUIDELINE:**

1. Patient Risk is assessed and documented.
2. Ultrasound is used and Doppler study is performed on all patients with previous IJ's.
3. Real time ultrasonic guidance should be used for placement of internal jugular and femoral central lines. Real time ultrasonic guidance should be considered for placement of subclavian central lines
4. The MAMC CLABSI Prevention Bundle is used and documented.

**DATE:** Published: January 2002 Revised: September 2010

### **AUTHORS:**

Please contact the administrator at 253-968-3013 for information regarding the authors of this clinical guideline.

**AREAS OF DISAGREEMENT:** There are no areas of disagreement among the affected services.

**CONCURRENCE WITH OTHER MAMC CLINICAL PRACTICE RECOMMENDATIONS:** There are currently no Pharmacy & Therapeutic Guidelines, Laboratory Management Guidelines and/or Referral Guidelines for the disease covered by the clinical guideline.

**PUBLISHED GUIDELINES OF CARE AND OTHER REFERENCES UPON WHICH THE CLINICAL GUIDELINE IS BASED:**

### References

**CLINICAL PRACTICE RECOMMENDATIONS:** The central line placement clinical guideline consists of an algorithm and text annotations that are linked to the algorithm.

### Clinical Practice Guidelines

#### **KEY POINTS:**

1. Use Annotations for Internal Jugular Line Placement, Obtaining Subclavian Venous Access, Obtaining Femoral Venous Access, and Post Line Management for specific key points.
2. Patient Risk should always be assessed and documented (audited standard). Consider sending high-risk patients to Interventional Radiology. Patients are considered high risk for central line placement if they have 3 or more of the following risk factors:
  - Obesity
  - Coagulopathy
  - Malnutrition
  - Absolute neutrophil count < 500/mm<sup>3</sup>
  - Platelets <50,000/mm<sup>3</sup>
  - BUN > 60mg/dl or serum creatinine >2.5mg/dl
  - Prothrombin time > 1.5 times control
  - Active sepsis with hypotension
  - HIV +
  - Previous catheterization in or near same central vein location
3. Ultrasonography is used and Doppler study is performed on all patients with previous internal jugular line placement (audited standard).

4. If patient is on hemodialysis, the recommended approach is to use Internal Jugular or Femoral venous line placement in order to avoid Subclavian vein stenosis and subsequent loss of hemodialysis graft.
5. Use of antibiotic impregnated catheters is required for:
  - patients with previous line infections
  - patients with difficult or limited central venous access
  - patients who will be given TPNUse of antibiotic impregnated catheters is optional for all other patients.
6. Real time ultrasonic guidance should be used for placement of all Internal Jugular central lines and should be considered for placement of Femoral and Subclavian lines
7. The MAMC Central Line Associated Bloodstream Infection (CLABSI) Prevention Bundle must be followed and documented with every central line insertion to decrease the risk of development of CLABSI (audited standard).

**IMPACT STATEMENT TO INSTITUTION:** This clinical guideline will impact the following departments/services: Department of Medicine, Vascular Surgery, General Surgery, Trauma Services, Emergency Department and Critical Care Services.

**LINKS WITHIN THE MAMC INTRANET:** No additional links at this time.

**METHODS OF PROVIDER EDUCATION:** Central line placement is essentially a practice guideline that works best under the “see-do-teach” methodology. Providers with much experience will work closely with those who are learning to place central lines. Additionally, providers will be afforded the opportunity to train through the Anderson Simulation Center on central line placement techniques. This clinical guideline will serve as the framework for teaching appropriate line placement techniques.

**METHODS OF PATIENT EDUCATION:** No patient education is needed for this clinical guideline.

**REVISION FREQUENCY:** Reviewed bi-yearly and revised every 3-5 years.

#### **High Risk Patient Annotations (A)**

Patients are considered high risk for central line placement if they have 3 or more of the following risk factors:

- Obesity
- Coagulopathy
- Malnutrition
- Absolute neutrophil count < 500/mm<sup>3</sup>
- Platelets <50,000/mm<sup>3</sup>
- BUN > 60mg/dl or serum creatinine >2.5mg/dl
- Prothrombin time > 1.5 times control
- Active sepsis with hypotension
- HIV +
- Previous catheterization in or near same central vein location

#### **Ultrasound Annotations (B)**

##### **Ultrasound for vascular cannulation: general principles**

The ultrasound probe on the SonoSite portable Ultrasound machine offers sufficient resolution and depth to identify vascular structures and to guide needle placement. The use of ultrasound by

clinical practitioners has been demonstrated safe and has been shown to reduce the number of complications in jugular venous cannulation<sup>1</sup> and thoracentesis<sup>2</sup>. It has been shown less useful for subclavian vein cannulation.<sup>3</sup>

### **Use of ultrasound to cannulate the internal jugular vein**

Use of the ultrasound device to insolate the internal jugular vein prior to starting the procedure allows the practitioner to determine that:

- The vein is patent and compressible (not thrombosed or severely stenotic)
- The vein is located in the expected region-or is not (approx 5-8% of the time, the internal jugular vein will be medial to the carotid artery)
- The direct path to the vein does not pass through the carotid artery. In addition to use of the ultrasound as a "scout" device, the ultrasound can be placed inside a sterile sheath and used to guide placement of the catheter in real time. This allows direct visualization of the entry of the needle into the vein.

### **Practical points to the use of the ultrasound**

The ultrasound machines are kept in the utility rooms in each ICU. When the procedure is complete, the probe should be wiped down and the unit returned to the utility room. The ultrasound should be plugged in to re-charge after cleaning.

Sterile ultrasound sheaths with sterile gel are located in the Central Line Cart in each ICU.

Scouting the area before sterile prepping allows for confirmation of an appropriate site and prevents wasting time and supplies prepping an unusable site. Indications to change site include a non-compressible vein or a vein that is too small in diameter to successfully cannulate. Use anatomic landmarks and physical exam to locate suitable sites. Ensure the transducer is in optimal position. The raised notch extending from the side of the transducer should point toward the person doing the procedure. If the notch is oriented in another direction, the image will be reversed, making needle insertion more difficult.

Venous anatomy: Compressibility is the hallmark of a patent vein. Arteries can be compressed as well, but will generally require a great deal more pressure and will remain circular in cross section long after veins have been flattened. Be sure to identify both the artery and vein. It is usually possible to see the needle compressing the soft tissue over the vein, and to see the release of that pressure as the needle "pops" into the vein. In this fashion you can guide the needle by making a "bouncing" motion while advancing toward the vein. The risk of a through and through puncture is reduced by this technique.

## **Central Line Associated Blood Stream Infection (CLABSI) Prevention Bundle (C)**

MAMC Infection Prevention and Control has developed a protocol or "Bundle" to help prevent the development of central line associated blood stream infections (CLABSI), a major cause of morbidity in hospitalized patients. Adherence to this Bundle is documented in the "MAMC Procedure Note" and should be completed each time a central venous line is placed (or attempted, whether or not there was successful placement). Additionally, the "MAMC Central Line Procedural Checklist Observation" form can be used by nursing staff to document practices related to insertion technique and patient safety. Use of this form does not preclude the requirement to document the procedure in the "MAMC Procedure Note"

The evidence-based Bundle includes the following components:

- 1) Providers should attempt to avoid placement of a Femoral venous line if possible as this site is more susceptible to infection than either the Internal Jugular or Subclavian venous sites
- 2) Providers must perform hand hygiene before donning sterile gown and gloves and after line insertion has been completed
- 3) Chlorhexidine is to be used for skin asepsis in all adults and children over the age of 2 months old
- 4) Maximum barriers must be employed including: full body sterile sheet for the patient and mask, hat, sterile gown and gloves for the operator and assistant.
- 5) The Bundle must be documented– the MAMC Procedure Note – which is comprised of "drop down" boxes and "check mark" boxes to ensure a standardized format for documentation
- 6) The necessity of the line must be reviewed daily and documented in the patient's Daily Progress Note
- 7) The patient or their decision maker will be educated about the necessity of the line and the procedure for insertion

Before MAMC staff can participate in central line insertion, they will be educated on the CLABSI Bundle and documentation of this training will be maintained in the CAF

### **Internal Jugular Line Placement Annotations (D)**

- **Risks:** Common-pneumothorax, cannulation of the artery, line infection, vein misdirection. Rare--mediastinal hematoma
- **Benefits:** Patient comfort, ready access to cardiac monitoring, large veins allow for installation of hypertonic fluids (chemotherapy, TPN) and minimize risk of thrombosis.
- **Operator:** sterile gown, glove and mask. Eye protection is strongly recommended.
- **Patient:** in Trendelenburg or flat with head turned toward opposite side to achieve maximum exposure of sternocleidomastoid triangle.
- **Prep:** Prep with Chlorhexidine on entire side of chest attempted, from mandible and neck down to lower costal margin, from anterior axillary line (laterally) to 5cm beyond contralateral to opposite sternal border. A sterile, full body drape must be used, with additional smaller sterile drapes (OR towels) as needed.
- **Equipment:** Portable Ultrasound machine, sterile ultrasound cover, sterile ultrasound gel
- **Technique:** Use the Ultrasound as described in Annotation B to scout and confirm location of the Internal Jugular Vein. Administer local anesthesia. Attach the needle to an empty syringe and insert into the skin above the scouted site. Advance the needle slowly while retracting on the syringe plunger (with or without real time Ultrasound guidance as described previously). Once a flash of blood is returned into the syringe, confirm venous placement:
  1. No more than three passes of the needle should be performed by any one provider in search of the vein; at this point, a more experienced provider should assume access responsibility. The Ultrasound should be employed, or the attempt abandoned until a later time or for a different site.
  2. To confirm placement in the venous system, attach a long length of IV tubing to the catheter and hold upright. Blood rising and pulsing out of the top of the catheter is more consistent with arterial placement. Certain cardiac conditions (CHF, severe tricuspid regurgitation) cause jugular venous congestion and higher venous system pressures, resulting in blood rising to the top of the tubing. However, these conditions should not cause blood to pulse out of the tubing. Sending a sample of blood for immediate arterial blood gas analysis with determination of PaO<sub>2</sub> can also be helpful in determining whether the needle is in an artery or vein.
  3. If an arterial stick is suspected, remove the catheter/needle and apply direct pressure to the site for at least 15 minutes and until hemostasis is achieved.
  4. If venous placement is confirmed, proceed with central line placement. Disconnect any IV tubing that was used. Thread the guidewire through the catheter/needle and remove the catheter/needle while maintaining control of the guidewire. If the vein is entered but the guidewire is unable to pass, remove the entire needle/guidewire ensemble as one unit to avoid mediastinal injury or shearing off the guidewire in the chest. Repeat attempt as indicated. Make a small skin incision where the guidewire enters, being careful not to cut the guidewire. Thread the dilator over the guidewire and, in a twisting motion, insert the dilator through the skin incision, dilating the soft tissue. The dilator should not be inserted more than 1 to 2cm to avoid dilating the vein. Remove the dilator and thread the central venous catheter over the guidewire, leaving 1 to 2cm of the catheter outside of the skin. Remove the guidewire. Flush all catheter ports. Suture the line in place, using two contact points to the skin. Obtain a stat portable Chest X-ray to confirm appropriate placement and ensure absence of pneumothorax.
- **Documentation:**
  - All central venous line placements should be documented in the MAMC Procedure Note, including unsuccessful attempts. This note is a continuous note that is additive for the patient's entire inpatient stay. Once opened, it can be found at the top of the patient's "Notes Menu" screen. To add additional procedures including central lines, open the note, edit the note and select the "More Fields" button.

### **Obtaining Subclavian Venous Access Annotations (E)**

- **Risks:** Common-pneumothorax, cannulation of the artery, line infection, vein misdirection. Rare--mediastinal hematoma, thoracic duct injury (Left Subclavian)

- **Benefits:** Patient comfort, ready access to cardiac monitoring, large veins allow for installation of hypertonic fluids (chemotherapy, TPN) and minimize risk of thrombosis.
  - **Operator:** sterile gown, glove and mask. Eye protection is strongly recommended.
  - **Patient:** in Trendelenburg or flat with head turned toward opposite side to achieve maximum exposure of sternocleidomastoid triangle. A towel roll placed between the patient's shoulder blades can also assist with optimum positioning.
  - **Prep:** Prep with Chlorhexidine on entire side of chest attempted, from mandible and neck down to lower costal margin, from anterior axillary line (laterally) to 5cm beyond contralateral to opposite sternal border. A sterile, full body drape must be used, with additional smaller sterile drapes (OR towels) as needed.
  - **Technique:** Administer local anesthesia. With guiding hand place index finger at prepped sternal notch and thumb at transition point (one-third the distance of the clavicle from the sternal notch) along clavicle between medial and middle thirds ([see diagram](#)). Insertion hand will advance syringe and needle beneath clavicle at the point identified by guiding thumb. Insert the needle and angle beneath the clavicle toward the sternal notch, or, alternately, up to 20 degrees cephalad. Once beneath the clavicle, the angle of the syringe and needle should be kept maximally shallow: parallel (1-10deg) with respect to the clavicle and chest wall to prevent inadvertent puncture of the deeper structures (subclavian artery and lung). Note: By using the index finger and thumb of the non-dominant hand to guide the needle, in point of fact the needle insertion will be slightly lateral and inferior to the actual bend of the clavicle at the medial and middle thirds, allowing successful transit of the needle beneath the periosteum at this point.
1. No more than three passes of the needle should be performed by any one provider in search of the subclavian vein; at this point, a more experienced provider should assume access responsibility. The Ultrasound should be employed, or the attempt abandoned until a later time or for a different site. Of note, the more often that unsuccessful attempts are made at one subclavian site, the more likely there is a resulting hematoma beneath the clavicle that can displace the normal anatomic structures and make successful subclavian cannulation less likely.
  2. Before additional attempts at subclavian access are made on the contralateral side of the chest, a chest radiograph should be obtained to rule out pneumothorax, hemothorax, or mediastinal hematoma.
  3. To confirm placement in the venous system, attach a long length of IV tubing to the catheter and hold upright. Blood rising and pulsing out of the top of the catheter is more consistent with arterial placement. Certain cardiac conditions (CHF, severe tricuspid regurgitation) cause jugular venous congestion and higher venous system pressures, resulting in blood rising to the top of the tubing. However, these conditions should not cause blood to pulse out of the tubing. Sending a sample of blood for immediate arterial blood gas analysis with determination of PaO<sub>2</sub> can also be helpful in determining whether the needle is in an artery or vein.
  4. If you are in the artery, remove the catheter/needle and apply direct pressure to the site for at least 15 minutes and until hemostasis is achieved.
  5. If venous placement is confirmed, proceed with central line placement. Disconnect any IV tubing that was used. Thread the guidewire through the catheter/needle and remove the catheter/needle while maintaining control of the guidewire. If the vein is entered but the guidewire is unable to pass, remove the entire needle/guidewire ensemble as one unit to avoid mediastinal injury or shearing off the guidewire in the chest. Repeat attempt as indicated. Make a small skin incision where the guidewire enters, being careful not to cut the guidewire. Thread the dilator over the guidewire and, in a twisting motion, insert the dilator through the skin incision, dilating the soft tissue. The dilator should not be inserted more than 1 to 2cm to avoid dilating the vein. Remove the dilator and thread the central venous catheter over the guidewire, leaving 1 to 2cm of the catheter outside of the skin. Remove the guidewire. Flush all catheter ports. Suture the line in place, using two contact points to the skin. Obtain a stat portable Chest X-ray to confirm appropriate placement and ensure absence of pneumothorax.
  6. Documentation:

All central venous line placements should be documented in the MAMC Procedure Note, including unsuccessful attempts. This note is a continuous note that is additive for the patient's entire inpatient stay. Once opened, it can be found at the top of the patient's "Notes Menu" screen. To add additional procedures including central lines, open the note, edit the note and select the "More Fields" button.

### **Obtaining Subclavian Venous Access Annotations (E) Figure**



### **Landmarks and Angle of Insertion**

With guiding hand, place index finger at prepped sternal notch and thumb at transition point along clavicle between medial and middle thirds. Insertion hand will advance syringe and needle, after local anesthesia administered, beneath clavicle at the point identified by guiding thumb. Insertion through the skin should be performed approximately 1-2 cm lateral and inferior to this point, and angled beneath the clavicle toward the sternal notch, or, alternately, up to 20 degrees cephalad. Once beneath the clavicle, the angle of the syringe and needle should be kept maximally shallow: parallel (1-10deg) with respect to the clavicle and chest wall to prevent inadvertent puncture of the deeper structures (subclavian artery and lung).

### **Obtaining Femoral Venous Access Annotations (F)**

- **Risks:** Common--cannulation of femoral artery, line infection.

Rare--injury to femoral nerve, entry into peritoneal space, retroperitoneal hematoma.

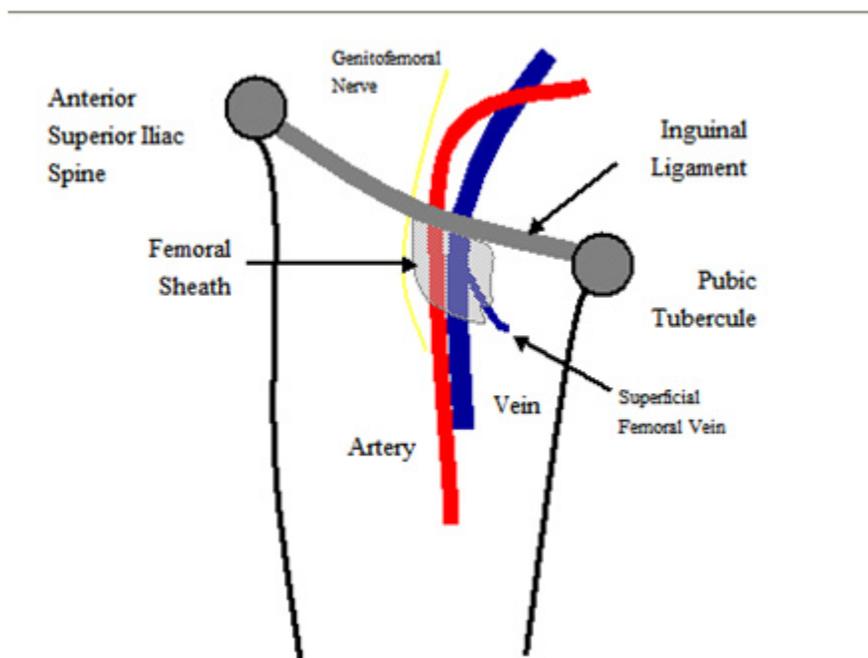
- **Benefits:** Can be placed without interrupting chest compressions in cardiac arrest, hemorrhage can be controlled with compression, cannulation of artery does not require immediate removal of catheter.
- **Other issues:** avoid in patients with known lower extremity deep venous thromboses.
- **Operator:** sterile gown, glove and mask. Eye protection is strongly recommended
- **Patient:** Patient should not be in Trendelenburg; ideally, should be flat and supine, position patient's leg in slight "frog-leg" position to open up inguinal fossa.
- **Prep:** Prep with Chlorhexidine superiorly to 10 cm above inguinal ligament, medially to scrotum or labia majora, inferiorly to 15 cm below inguinal ligament, laterally to anterior superior iliac spine. A sterile, full body drape must be used, with additional smaller sterile drapes (OR towels) as needed.
- **Technique:**
  1. Trace the inguinal ligament from the pubic tubercle to the anterior superior iliac spine. The femoral artery lies at the junction of the medial and middle thirds of this line. The femoral pulse can be palpated just inferior to the ligament. The femoral vein lies 1 to 2 cm medial to this. The needle should be inserted 2 to 3 cm below the inguinal ligament to minimize the risk of entering the peritoneal space. ([See Figure 1](#))

2. The needle should be inserted at a 45 to 60 degree angle (not a shallow angle) directed in the sagittal plane. A common error is to direct the needle in a line perpendicular to the inguinal ligament. This will cause the needle to pass medial to the vein. The vein is usually at a depth of greater than 2 cm; in obese patients the needle may need to be hubbed in order to obtain access. (See Figure 2) The fingers of the opposite hand can be positioned to help guide your needle and avoid puncturing the artery. Place the second and third fingers over the medial aspect of the femoral artery. The needle should always point in front of these fingers which are positioned over the artery in order to avoid or reduce the risk of sticking the artery.
  3. Please see “Ultrasound Annotations (B)” for guidance on using Ultrasound for placement of a femoral venous line
- **Common Problems/Fixes**
    3. Unable to palpate femoral pulse in a code situation. Accept cannulation of either artery or vein. If artery is cannulated, infuse fluids and or pressors as needed until another access is gained or circulation is restored. Remove sheath, holding pressure, when patient more stable.
    4. Unable to locate vein. Try repositioning leg; try ultrasound; move closer to inguinal ligament.
    5. Strong resistance to passage of needle. Likely within the inguinal ligament. Remove needle and repeat attempt more caudally.
    6. Vein entered but unable to pass wire. May be in superficial femoral vein or leg may be positioned poorly. Reattempt from a slightly different angle; reposition leg.
    7. First attempt yields flash but poor blood flow. Subsequent attempts yield small amounts of blood but no flow upon aspiration. Likely a hematoma has been formed and is now being entered with subsequent sticks. Try another site or use ultrasound.

**Documentation:**

0. All central venous line placements should be documented in the MAMC Procedure Note, including unsuccessful attempts. This note is a continuous note that is additive for the patient’s entire inpatient stay. Once opened, it can be found at the top of the patient’s “Notes Menu” screen. To add additional procedures including central lines, open the note, edit the note and select the “More Fields” button.

**Obtaining Femoral Venous Access Annotations (F) Figure 2**



**Post Line Management Annotations (G)**

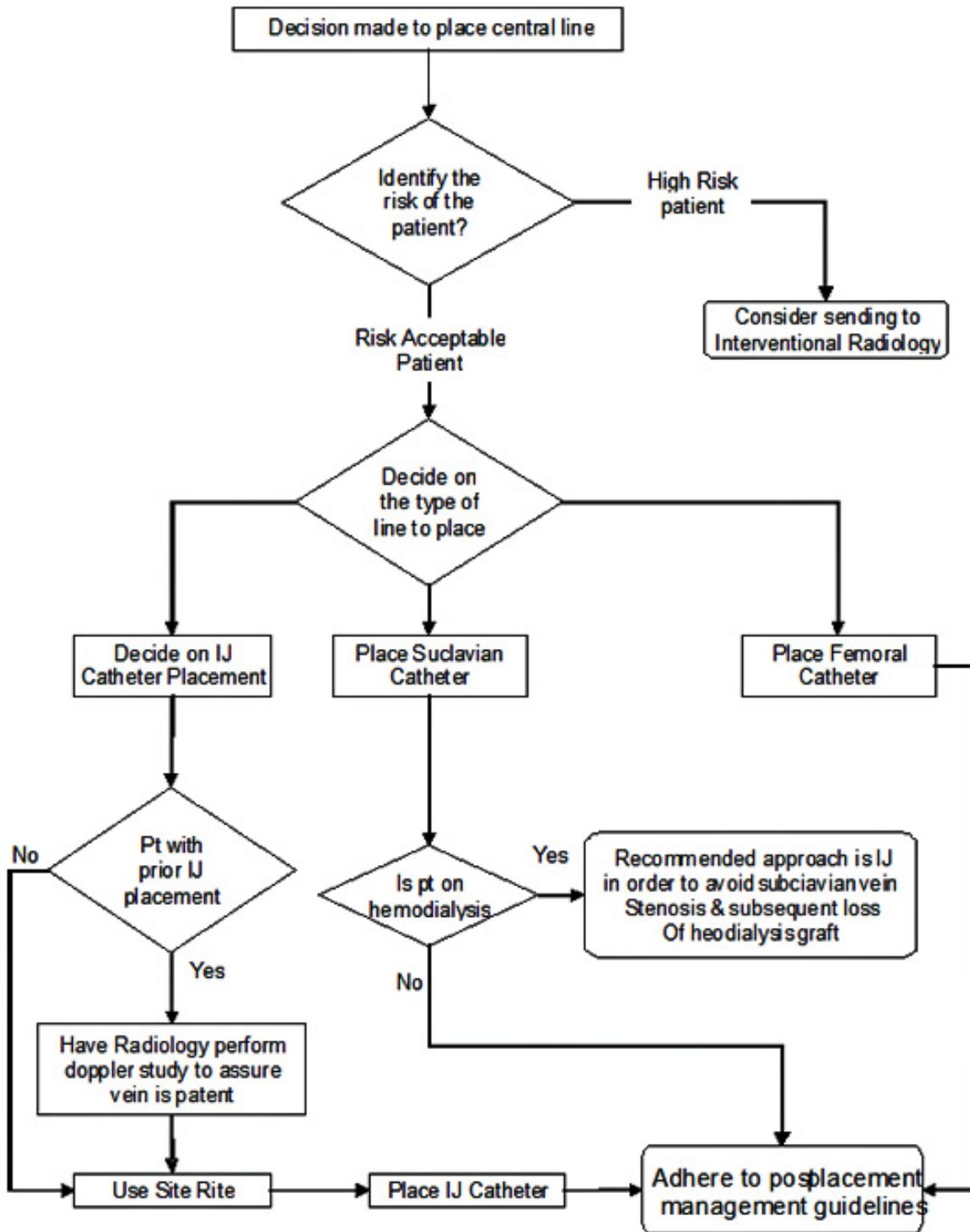
1. Continued need for central venous access should be assessed on every patient, for every central line, on every day and documented in the patient's Daily Progress Note.
  - a. In the "Physician's Note", click the box next to "Continued need for Central Line/PICC assessed" and enter the correct information via the drop box. This information should be updated every day
2. Post placement CXR
  - a. if < 10% pneumothorax and asymptomatic may watch closely with monitoring and repeat film in 4-6 hours. For any symptoms or > 10% pneumothorax, place chest tube.
3. Catheter malfunction:
  - a. flushes well but doesn't draw back. Obtain bedside contrast study and continue to use if line in place.
  - b. Doesn't draw or flush - CXR to check position followed by 2 cc of TPA administration, clamp line for 20 min, withdraw TPA and recheck function. May repeat as needed.
4. Line infection:
  - a. Fever – in the absence of cellulitis or other obvious line site skin infection, draw blood cultures through the line and begin empiric coverage for Gram positive organisms. Once culture data has returned, antibiotics can either be discontinued or tailored to specific organisms and sensitivities.
  - b. Fever in the presence of a line site superficial skin infection – draw blood cultures through the line and begin empiric coverage for Gram positive organisms. Once culture data has returned, antibiotics can either be discontinued or tailored for specific organisms and sensitivities. If superficial skin infection worsens, - remove the central venous line and send the portion of the catheter that resided in the skin/soft tissue for culture.
  - c. Tunnel infection - remove the central venous line and send the portion of the catheter that resided in the skin/soft tissue for culture.
  - d. Septic thrombus - If infection recurs after improvement or if the line does not draw back (even if it flushes) there is a fibrin plug at the tip which is now assumed to be infected. Must treat with TPA (as indicated in #2 above) in order to clear infection.
5. Dressings:
  - a. Wound must be checked for cellulitis daily - do not need to change dressing daily unless visualization of wound is impossible (OPSITE with Chlorhexidine impregnated biopatch or gel dressing preferred for initial dressing)
  - b. Dressing changes must be done with sterile technique and should occur at an interval of every 7 days or sooner if needed.
6. Line usage:
  - a. Line must be flushed after blood is drawn, use either heparin or saline depending upon clinical situation.

If line capped off - must flush q 4 hours with heparin or q 1 hour with saline to avoid thrombus at tip.

Clinical Guideline

**Madigan Central Line Placement Algorithm**

(For placement of internal jugular, subclavian and femoral line placement)



### **Metrics**

1. Patient Risk is assessed and documented.
2. Ultrasonography is used and Doppler study is performed on all patients with previous Internal Jugular lines.
3. CLABSI Prevention Bundle is used and documented.

### **Key Points**

1. Use Annotations for Internal Jugular Line Placement, Obtaining Subclavian Venous Access, Obtaining Femoral Venous Access, and Post Line Management for specific key points.
2. Patient Risk should always be assessed and documented (audited standard). Consider sending high-risk patients to Interventional Radiology. Patients are considered high risk for central line placement if they have 3 or more of the following risk factors:
  - Obesity
  - Coagulopathy
  - Malnutrition
  - Absolute neutrophil count < 500/mm<sup>3</sup>
  - Platelets <50,000/mm<sup>3</sup>
  - BUN > 60mg/dl or serum creatinine >2.5mg/dl
  - Prothrombin time > 1.5 times control
  - Active sepsis with hypotension
  - HIV +
  - Previous catheterization in or near same central vein location
3. Ultrasonography is used and Doppler study is performed on all patients with previous internal jugular line placement (audited standard).
4. If patient is on hemodialysis, the recommended approach is to use Internal Jugular or Femoral venous line placement in order to avoid Subclavian vein stenosis and subsequent loss of hemodialysis graft.
5. Use of antibiotic impregnated catheters is required for:
  - patients with previous line infections
  - patients with difficult or limited central venous access
  - patients who will be given TPNUse of antibiotic impregnated catheters is optional for all other patients.
6. Real time ultrasonic guidance should be used for placement of all Internal Jugular central lines and should be considered for placement of Femoral and Subclavian lines
7. The MAMC Central Line Associated Bloodstream Infection (CLABSI) Prevention Bundle must be followed and documented with every central line insertion to decrease the risk of development of CLABSI (audited standard).

### **Provider Tools**

The Clinical Practice Guidelines for Central Line Placement include one algorithm and its accompanying annotations.

Central Line Placement Algorithm

High Risk Patient (Annotation A)

Site Rite (Annotation B)

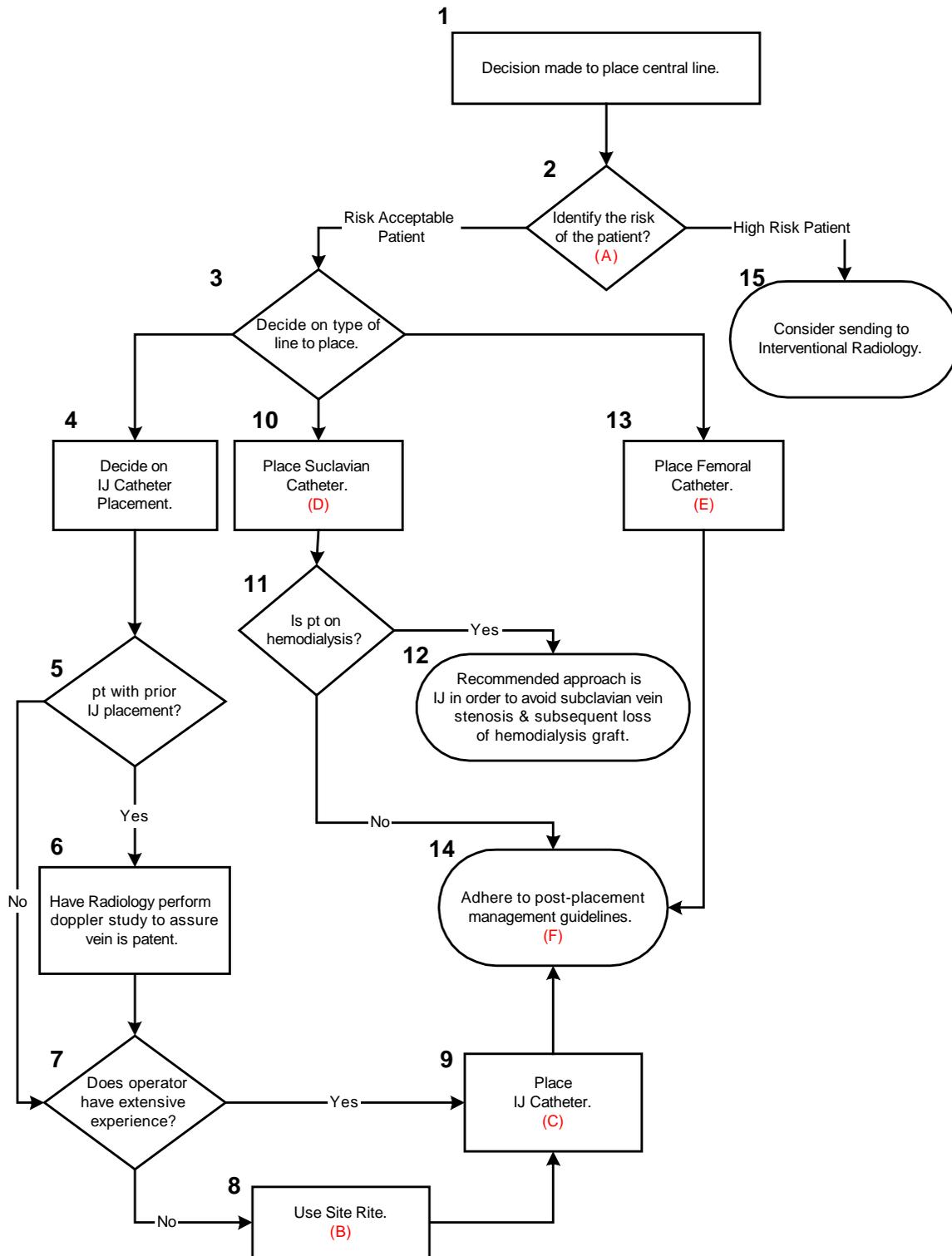
Internal Jugular Line Placement (Annotation C)

Obtaining Subclavian Venous Access (Annotation D)

Obtaining Femoral Venous Access (Annotation E)

Post Line Management (Annotation F)

**MADIGAN CENTRAL LINE PLACEMENT ALGORITHM**  
 (For placement of internal jugular, subclavian and femoral line placement)



**High Risk Patient Annotations (A)**

Patients are considered high risk for central line placement if they have 3 or more of the following risk factors:

- Obesity
- Coagulopathy
- Malnutrition
- Absolute neutrophil count < 500/mm<sup>3</sup>
- Platelets <50,000/mm<sup>3</sup>
- BUN > 60mg/dl or serum creatinine >2.5mg/dl
- Prothrombin time > 1.5 times control
- Active sepsis with hypotension
- HIV +
- Previous catheterization in or near same central vein location

## **Site Rite Annotations (B)**

### **Ultrasound for vascular cannulation: general principles**

The ultrasound probe used for vascular access is inferior to the probes used by the radiology department, which can usually provide better resolution, a longer usable depth, and the ability to detect flow in blood vessels, tumors, and fluid collections. It does, however, offer sufficient resolution and depth to identify vascular structures and to guide needle placement. The use of ultrasound by clinical practitioners has been demonstrated safe and has been shown to reduce the number of complications in jugular venous cannulation<sup>1</sup> and thoracentesis<sup>2</sup>. It has been shown less useful for subclavian vein cannulation.<sup>3</sup>

### **Use of ultrasound to cannulate the internal jugular vein**

Use of the ultrasound device to insonate the internal jugular vein prior to starting the procedure allows the practitioner to determine that:

- The vein is patent and compressible (not thrombosed or severely stenotic)
- The vein is located in the expected region-or is not! (approx 5-8% of the time, the internal jugular vein will be medial to the carotid artery)
- The direct path to the vein does not pass through the carotid artery.
- In addition to use of the ultrasound as a "scout" device, the ultrasound can be placed inside a sterile sheath and used to guide placement of the catheter in real time. This is more cumbersome and usually requires a second operator, but allows direct visualization of the entry of the needle into the vein.

### **Practical points to the use of the ultrasound**

The ultrasound machines are kept in the utility rooms in each ICU. When the procedure is complete, the probe should be wiped down and the unit returned to the utility room.

Check the battery! The battery is in the back of the unit and is rechargeable. However, it is better for overall battery life to run the battery down and swap it out when discharged than to swap preventatively. A green indicator light on the front of the unit blinks when the battery is low. Ensure that a sterile sheath and jelly are available-you might decide that you want them even if at first you just want to use the machine to scout the terrain. Batteries and sheaths are in the supply area of ICU-W. A sterile glove can be substituted for a sheath if caution is used (the cable connecting the ultrasound probe to the machine can slide into the prepped area if not closely observed).

Scout the area before sterile prepping if time permits. This prevents you from wasting time and supplies sterilely prepping an unusable site. If there is no fluid to tap, or if the vein is thrombosed or very small, you will want to move to a more suitable site.

Use anatomic landmarks and physical exam to hone in on suitable sites.

Spend some time getting the transducer in optimal position. The rib extending from the side of the transducer should point toward the person doing the procedure. If it points away from you, the image will be reversed-hard to guide in a needle that way.

Venous anatomy: Compressibility is the hallmark of a patent vein. You cannot determine whether flow is present because Doppler is not part of the system. Arteries can be compressed as well, but will generally require a great deal more pressure and will remain circular in cross section long after veins have been flattened. Be sure to identify both the artery and vein! It is often not possible to see the tip of the needle entering a vein. It is, however, usually possible to see the needle compressing the soft tissue over the vein, and to see the release of that pressure as the needle "pops" into the vein. In this fashion you can guide the needle by making a "bouncing" motion while advancing toward the vein. The risk of a through and through puncture is reduced by this-which is nice when dealing with coagulopathic patients.

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<sup>1</sup> Ultrasound guidance for placement of central venous catheters, a meta-analysis of the literature. *Critical Care Medicine* Dec 1996, 24(12) p2053-8.

<sup>2</sup> Complications associated with thoracentesis...*Arch Int Med* 1990 Apr, 150(4), 873-7.

<sup>3</sup> Complications and Failures of Subclavian Vein Catheterization. *N Engl J Med*, Dec 29 1994, 331(26) p1735-8.

### **Internal Jugular Line Placement Annotations (C)**

- **Operator:** gown, glove and mask.
- **Patient:** in Trendelenburg or flat with head turned toward opposite side to achieve maximum exposure of sternocleidomastoid triangle.
- **Prep:** Prep a large area in case you need to go from IJ to subclavian or vice versa. Prep from submandibular area to shoulder to ipsilateral nipple and including sternum.
- **Technique:** Prior to threading the larger catheter, thread an 18 gauge catheter unless that patient is too large and/or the vein too deep. You can use this to determine if you are in an artery prior to threading the larger catheter.
- **Tips that you are in the artery:**
  1. Bright red blood that moves the syringe under its own pressure.
  2. Attach a stopcock to catheter and then attach 52k tubing to the stopcock and hold the tubing upright. If the tubing pulsates out of the catheter you can assume you are in the artery. In patients with severe CHF and/or severe tricuspid regurgitation, you may get blood going to the end of the catheter but it usually does not pulsate out.
- If you are in the artery, pull the catheter and hold pressure until bleeding and swelling of the area stops.
- If you are in the vein: remove stopcock and 52k tubing; thread wire through catheter; pull 18 gauge catheter and thread large catheter; pull wire, flush catheter, and obtain stat CXR to assure line acceptable line placement and that there is no pneumothorax.

### **Obtaining Subclavian Venous Access Annotations (D)**

- Operator: gown, glove and mask.
- Risks
  1. Common-pneumothorax, cannulation of subclavian artery, line infection, jugular vein misdirection
  2. Rare--mediastinal hematoma, thoracic duct injury
- Benefits: constancy of anatomy, patient comfort, ready access to cardiac monitoring, large veins allow for installation of hypertonic fluids (chemotherapy, TPN) and minimize risk of thrombosis.
- Positioning/Prepping
  1. Patient should be in Trendelenburg with towel roll between shoulder blades to splay anterior chest up and out. Arms should be at patient's side; head should be neutral or turned away from side of cannulation.
  2. Left subclavian cannulation is preferred to right subclavian due to favorable curvature of subclavian vein as it joins jugular to form innominate/SVC. Right side has very acute angle that makes jugular cannulation more likely. There is risk of thoracic duct injury with left subclavian venipuncture attempts but this is a rare complication.
  3. Prep with iodine or Hibiclens on entire side of chest attempted, from mandible and neck down to lower costal margin, from anterior axillary line (laterally) to 5cm beyond contralateral to opposite sternal border. Surgical cap and mask plus sterile gown and gloves must be worn throughout insertion. The prepped site must also be surrounded with sufficient sterile drapes to allow a broad operative field.
- Landmarks and Angle of Insertion: with guiding hand place index finger at prepped sternal notch and thumb at transition point along clavicle between medial and middle thirds (see [diagram](#)). Insertion hand will advance syringe and needle, after local anesthesia administered, beneath clavicle at the point identified by guiding thumb. Insert the needle at one-third the distance of the clavicle from the sternal notch (this is the transition point between the medial and middle thirds of the clavicle), and angled beneath the clavicle toward the sternal notch, or, alternately, up to 20 degrees cephalad. Once beneath the clavicle, the angle of the syringe and needle should be kept maximally shallow: parallel (1-10deg) with respect to the clavicle and chest wall to prevent inadvertent puncture of the deeper structures (subclavian artery and lung). Note: By using the index finger and thumb of the non-dominant hand to guide the needle, in point of fact the needle insertion will be slightly lateral and inferior to the actual bend of the clavicle at the medial and middle thirds, allowing successful transit of the needle beneath the periosteum at this point.
- Common Problems/Fixes

1. No more than three passes of the needle should be performed by any one provider in search of the subclavian vein; at this point, a more experienced provider should assume access responsibility. The Site Rite should be employed, or the attempt abandoned until a later time or for a different site. Of note, the more often that unsuccessful attempts are made at one subclavian site, the more likely there is a resulting hematoma beneath the clavicle that can displace the normal anatomic structures and make successful subclavian cannulation less likely.
2. After any attempt at subclavian cannulation, and certainly before additional attempts at same on the contralateral side of the chest, a chest radiograph should be obtained to rule out pneumothorax, hemothorax, or mediastinal hematoma.
3. Attach extension tubing with three-way stopcock (also known as "K-52 tubing") to catheter and hold the tubing upright. If the tubing pulsates out of the catheter you can assume you are in the artery. In patients with severe CHF and/or severe tricuspid regurgitation, you may get blood going to the end of the raised catheter but it usually does not pulsate out.
4. Vein entered but unable to pass guidewire. Remove entire needle/guidewire ensemble as one unit to avoid mediastinal injury or shearing off the guidewire in the chest. Repeat attempt as indicated.
5. If you are in the artery, pull the catheter and hold pressure until bleeding and swelling of the area stops.

### **Obtaining Femoral Venous Access Annotations (E)**

- Operator: gown, glove and mask.
- Risks
  1. Common--cannulation of femoral artery, line infection.
  2. Rare--injury to femoral nerve, entry into peritoneal space, retroperitoneal hematoma.
  3. Other issues: difficult to pass SG catheter without fluoroscopic guidance from this position; avoid in patients with known deep venous thromboses.
- Benefits
  1. Can be placed without interrupting chest compressions in cardiac arrest
  2. Hemorrhage can be controlled with compression.
  3. Cannulation of artery does not require immediate removal of catheter.
- Positioning/Prepping
  1. Patient should not be in Trendelenburg; ideally, should be flat and supine.
  2. Position patient's leg in slight "frog-leg" position to open up inguinal fossa.
  3. Prep with iodine superiorly to 10 cm above inguinal ligament, medially to scrotum or labia majora, inferiorly to 15 cm below inguinal ligament, laterally to anterior superior iliac spine.
- Landmarks and Angle of Insertion Trace the inguinal ligament from the pubic tubercle to the anterior superior iliac spine. The femoral artery lies at the junction of the medial and middle thirds of this line. The femoral pulse can be palpated just inferior to the ligament. The femoral vein lies 1 to 2 cm medial to this. The needle should be inserted 2 to 3 cm below the inguinal ligament to minimize the risk of entering the peritoneal space. ([See Figure 1](#))
- Depth/Angle of Insertion The needle should be inserted at a 45 to 60 degree angle (not a shallow angle) directed in the sagittal plane. A common error is to direct the needle in a line perpendicular to the inguinal ligament. This will cause the needle to pass medial to the vein. The vein is usually at a depth of greater than 2 cm; in obese patients the needle may need to be hubbed in order to obtain access. ([See Figure 2](#)) The fingers of the opposite hand can be positioned to help guide your needle and avoid puncturing the artery. Place the second and third fingers over the medial aspect of the femoral artery. The needle should always point in front of these fingers which are positioned over the artery in order to avoid or reduce the risk of sticking the artery.
- Common Problems/Fixes
  1. Unable to palpate femoral pulse in a code situation. Accept cannulation of either artery or vein. If artery is cannulated, infuse fluids and or pressors as needed until another access is gained or circulation is restored. Remove sheath, holding pressure, when patient more stable.
  2. Unable to locate vein. Try repositioning leg; try ultrasound; move closer to inguinal ligament.

3. Strong resistance to passage of needle. Likely within the inguinal ligament. Remove needle and repeat attempt more caudally.
4. Vein entered but unable to pass wire. May be in superficial femoral vein or leg may be positioned poorly. Reattempt from a slightly different angle; reposition leg.
5. First attempt yields flash but poor blood flow. Subsequent attempts yield small amounts of blood but no flow upon aspiration. Likely a hematoma has been formed and is now being entered with subsequent sticks. Try another site or use ultrasound.

**Post Line Management Annotations (F)**

1. Post placement CXR - if < 10% pneumothorax and asymptomatic may watch closely with monitoring and repeat film in 4-6 hours. For any sx or > 10% pneumothorax, place chest tube.
2. Catheter malfunction:
  - a. Flushes well but doesn't draw back. Obtain bedside contrast study and continue to use if line in place.
  - b. Doesn't draw or flush - CXR to check position followed by 2 cc of TPA administration, clamp line for 20 min, withdraw TPA and recheck function. May repeat as needed.
3. Line infection:
  - a. Fever - no cellulitis, culture through the line, cover for gram pos until culture back and either stop or tailor antibiotics.
  - b. Fever and exit wound cellulitis - culture through line and cover for gram pos until culture back, then tailor treatment. If no resolution or cellulitis worsens - pull line
  - c. Tunnel infection - pull line.
  - d. Septic thrombus - for any of the above - If infection recurs after improvement daily unless visualization of wound is impossible (OPSITE preferred for initial dressing)
  - e. When dressing changed - must be done with sterile technique.
4. Line usage:
  - a. Line must be flushed after blood is drawn, use either heparin or saline depending upon clinical situation.
  - b. If line capped off - must flush q 4 hours with heparin or q 1 hour with saline to avoid thrombus at tip.