

# Central Venous Line and Femoral Intra-Arterial Line Insertion

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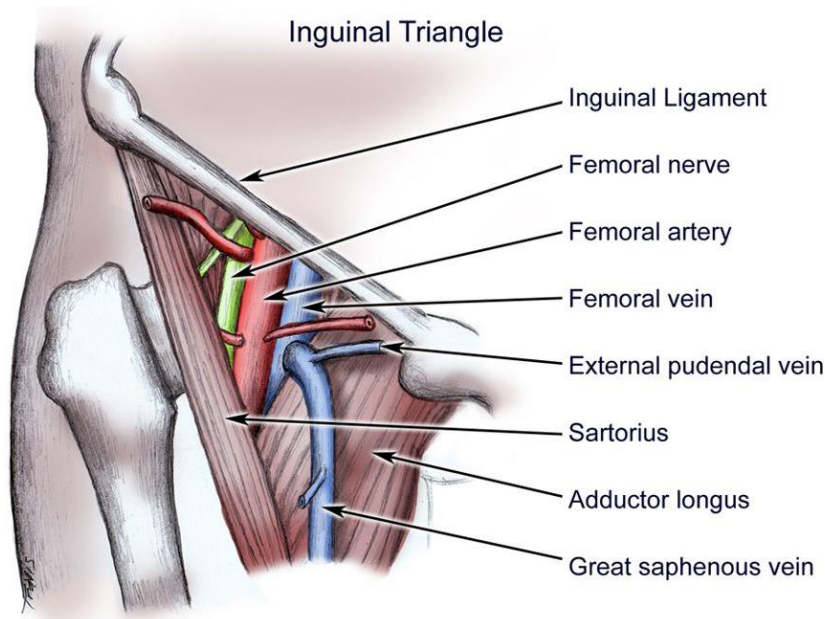
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## CENTRAL VENOUS LINE INSERTION

### Anatomy

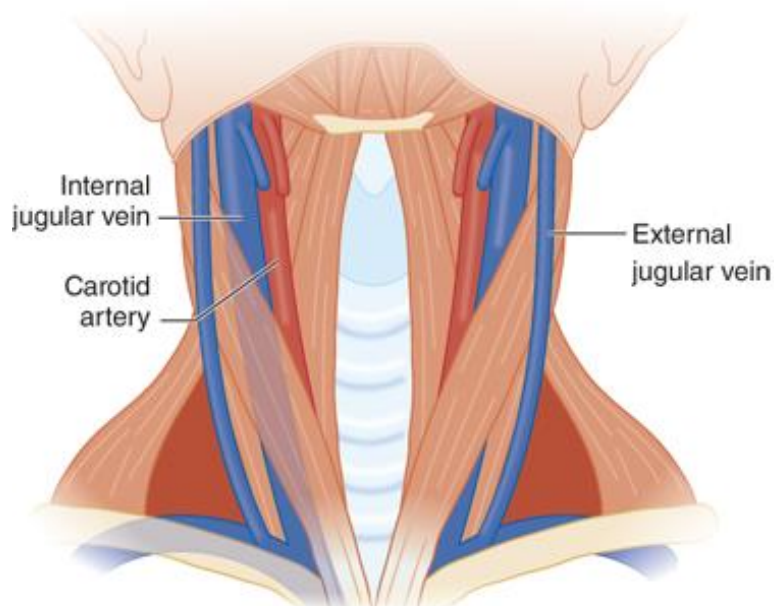
#### Femoral Vein relations

Lateral → Medial	OR	Medial → Lateral
Nerve → Artery → Vein → Empty space → Lymphatics (Acronym: <b>NAVEL</b> )		Vein → Artery → Nerve (Acronym: <b>VAN</b> )



**Internal Jugular Vein (IJV) relations**

Lateral → Medial
Internal Jugular Vein → Carotid Artery

**Indications for Central Venous Line Insertion**

- a) Vascular access to administer inotropes / high osmolality or caustic medications
- b) To perform haemodialysis / plasmapheresis
- c) Monitoring central venous pressure

**Contra-indications**

- a) Infection of placement site
- b) Distortion of anatomy
- c) Coagulopathy
- d) Thrombosed veins
- e) Prior injury to the vein
- f) Uncooperative patient

For femoral venous catheters, an additional contra-indication includes suspected disruption of the inferior vena cava secondary to abdominal trauma.

**Site Selection**

The femoral vein would be the primary choice for central venous cannulation within our unit for senior residents/residents. Attempts at IJV cannulation should only be performed under supervision by the CICU consultant, given the risk of pneumothorax or injury to the carotid artery and thoracic duct.

Before an attempt, review the patient's history and consider/discuss if the patient is a candidate for extracorporeal membrane oxygenation or continuous renal replacement therapy as that may impact on site selection. We strongly encourage the use of ultrasonography to guide cannulation.

**Selecting the Appropriate Catheter Size**

Selecting the appropriate size and length of central venous catheter to use depends on the age and weight of the patient, as well as the site of the procedure:

**Guidance for Central venous catheter size**

Weight	Age	Size (French)	Brand	Length (cm)	Lumens	Recommended Site	Recommended length of insertion
< 10kg	0-6 months	4	Arrow	8	3	Neck	4.5-5cm (3-4 kg)* 5.5 cm (4-5 kg)*
		4	Arrow	13	3	Femoral	
10-20kg	6 months – 4 years	4.5	VYGON	6	3	Neck	
		4.5	VYGON	12.5	3	Femoral	
20-40 kg	4 – 12 years	5.5	Arrow	8	3	Neck	6-8 cm (16-40 kg)#
		5.5	Arrow	13	3	Femoral	
> 40 kg	> 12 years	7	Arrow	16	3		
		8	Arrow	16	3		

**Use the smallest size required.**

\*The optimal depth for CVL for infants < 5kg. Kim et al. Anesth Analg. 2005

#Paediatric vascular access. BJA education 2015;15:199-206

Vascular Catheters are larger double (or triple) lumen catheters placed in the femoral, IJV or subclavian veins to carry out renal replacement therapy or plasmapheresis. The size of the catheter used is also based on the size of the patient.

**Guidance for Vascular catheter size**

Weight of patient (kg)	Brand	Catheter size (French)	Lumens	Length (cm)
3-6	Gambro	6.5	2	10
6-15	Gambro	8	2	10 / 12.5
	Covidien	8	2	12
15-30	Medcomp	9	2	12
	Covidien	10	2	12
>30	Gambro	11.5	2	15
	Gambro	12	3	15
	Gambro	13	3	15 / 20

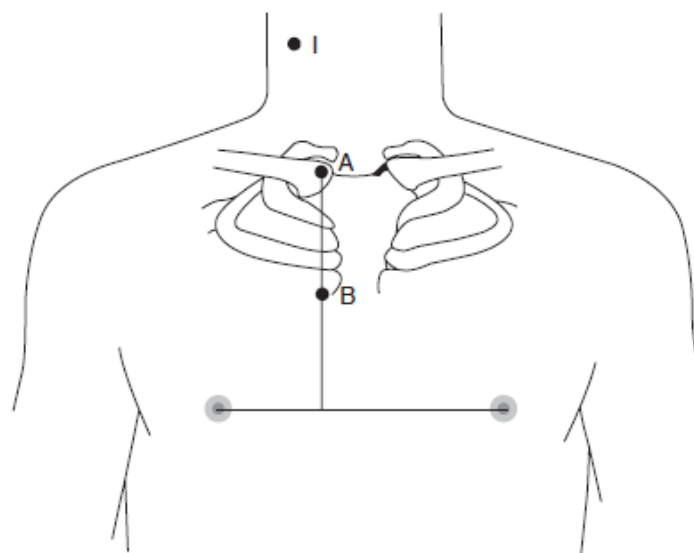
Appropriate positioning and securing of the vascular catheter are especially important to prevent kinking of the catheter and abutting of the catheter tip on the vessel wall, so as to minimize resistance to blood flow within the catheter lumen. These measures will help to reduce the risk of clot formation and preserve renal replacement circuit lifespan.

If regional anticoagulation with citrate is used during renal replacement therapy, a triple lumen vascular catheter or separate CVL/PICC would be required for calcium administration to the patient.

**Catheter Tip Position:**

For femoral venous catheterization, the catheter tip should be sited below the liver and diaphragm.

For IJV catheterization, the catheter tip should be sited at the junction of the superior vena cava and right atrium. If placed within the right atrium, the catheter tip may traumatize the myocardium, resulting in arrhythmias or myocardial injury and perforation. The diagram below denotes a surface marking method to estimate the insertion depth of an IJV catheter.



Point A is the sternal head of the right clavicle. Point B is the midpoint of a perpendicular line from Point A to the line connecting both nipples. Point I is the insertion point of the needle. The estimated depth of the IJV CVL is calculated as follows:

**Estimated depth = (Distance from Point I to A) + (Distance from Point A to B) – 0.5 cm**

Source: Na HS, Kim JT, Kim HS, Bahk JH, Kim CS, Kim SD. Practical anatomic landmarks for determining the insertion depth of central venous catheter in paediatric patients. Br J Anaesth. 2009; 102(6): 820-823.

**Procedural Steps**

Video – Ultrasound-Guided Placement of Femoral Venous Catheter

<https://www.nejm.org/doi/full/10.1056/NEJMvcm0801006>

Video – Ultrasound-Guided Placement of Internal Jugular Vein Catheter

<https://www.nejm.org/doi/full/10.1056/NEJMvcm0810156>

**Preparation prior to CVL insertion:**

1. Clarify indication for CVL / Ensure there are no contra-indications / Discuss site selection and catheter size and length
2. Obtain consent
3. Preparation of equipment / cap / mask / gown / gloves
4. Examine cannulation site - Perform surface marking or screen with ultrasound prior to gowning up
5. Positioning of patient:
  - Femoral: Supine position, with hip abducted, slightly externally rotated. Hip roll if necessary.
  - Neck: Trendelenburg position, head turned to opposite side, shoulder roll if necessary.

*\*If the proceduralist has not placed a CVL in the last 6 months, please discuss and revise the procedural steps with your supervising consultant. If manpower permits, we encourage having a dedicated nurse/doctor observer during the procedure to ensure that procedural steps are adhered to.*

**Equipment/Drugs for Procedure**

1. Central venous catheter set
2. Sterile procedure set
3. Cleansing solution – Chlorhexidine
4. 2 additional disposable sterile drapes
5. Blade (if not provided in set)
6. Silk 3/0 with curved needle
7. Gallipot for heparin saline
8. Additional 3ml / 5ml syringes
9. Additional sterile gauze
10. Tegaderm
11. Sterile ultrasound sheath with sterile conducting gel
12. Heparin saline
13. Lignocaine 1% solution

Optional: 22G (Blue) / 20G (Pink) venous cannula → If a cannula that is not from the set is used, please ensure that the guidewire from the set is an appropriate size and can pass through the cannula that is selected.

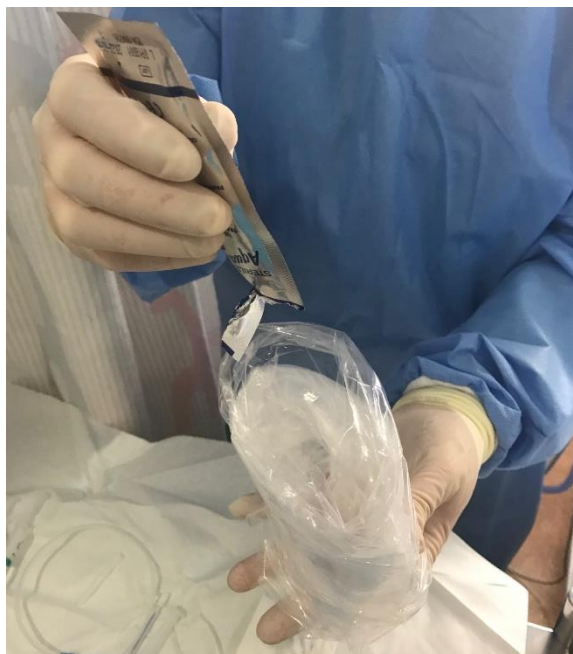
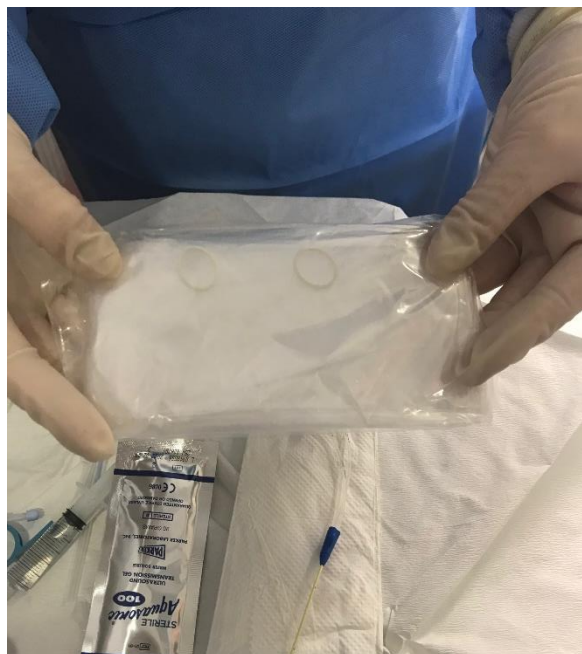


Lay out the equipment neatly in order of use. From left to right: Swab holding forceps, syringe and needle to administer local anaesthesia, syringe with needle/cannulae, guidewire, blade, dilator, central venous catheter, needle holder with suture.



**Preparation for Ultrasound-guided technique**

1. Position the ultrasound machine where the designated insertion site and ultrasound screen can be seen easily by the proceduralist. (e.g. on the opposite side of the bed) An assistant will need to assist with operating the ultrasound machine.
2. After cleaning and draping the patient, prepare to place the sterile sheath over the probe.



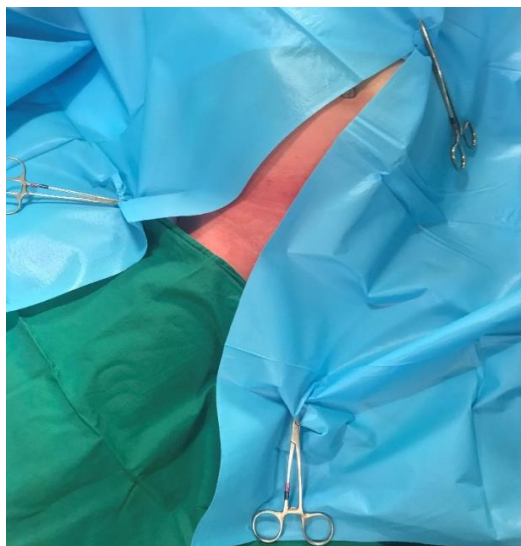
3. Prepare the sterile sheath by applying gel on the inner surface. Hold up the sterile sheath and ask an assistant to place the vascular “hockey stick” probe into the sheath.
4. Grasp the probe through the sheath and the assistant must now pull and unfold the sheath over the probe and its adjoining cable.
5. Ensure that there are minimal air bubbles between the probe and surface of the sheath and place a rubber band around the sheath.



6. The now “sterile” probe can be placed on the drape as you prepare for cannulation.

**Technique / Steps for Femoral venous catheterization**

1. Gown up / Open and prepare equipment / Flush all lumens of the catheter with heparin saline and lock the lumens / Prepare a syringe with 2-3ml of heparin saline.
2. Time out.
3. Clean and Drape, while maintaining visualization of the umbilicus.



An example of appropriate draping, where the designated insertion site and umbilicus can be seen. Use artery forceps to secure the drapes. Take care not to apply the forceps on the patients' skin

4. Reassess insertion site via surface marking or ultrasonography.
5. Ensure adequate sedation and analgesia / Administer local anaesthetic.
6. Puncture the skin using either a needle / cannula, connected to the syringe with heparin saline. The angle of approach should be 30-45 degrees relative to the skin, while aiming the needle / cannula towards the umbilicus. A smaller angle of approach may be used for smaller patients. Gently aspirate the syringe while advancing the needle.
7. Once the vein is punctured, blood should be easily aspirated into the syringe.
  - a. If a needle was used, fix the depth and angle of the needle, while gently rotating the syringe to disconnect it from the needle.
  - b. if a cannula was used, fix the needle in place and advance the cannula.
8. Confirm that a vein has been cannulated by assessing the flow and colour of blood. If necessary, a blood gas can be performed to assess PaO<sub>2</sub>. Alternatively, if a cannula was used, a primed intravenous tubing may be connected to visualize pulsatile flow of blood, which would indicate arterial cannulation.
9. Remove the syringe and advance the guidewire into the needle / cannula. This process should be smooth, with little to no resistance encountered. Avoid forcing the guidewire in if resistance is encountered. Avoid using the "rear" end of the guidewire, as it may be sharper than the "front" end and can potentially damage the vessel.
10. Carefully remove the needle / cannula while holding the guidewire in place.

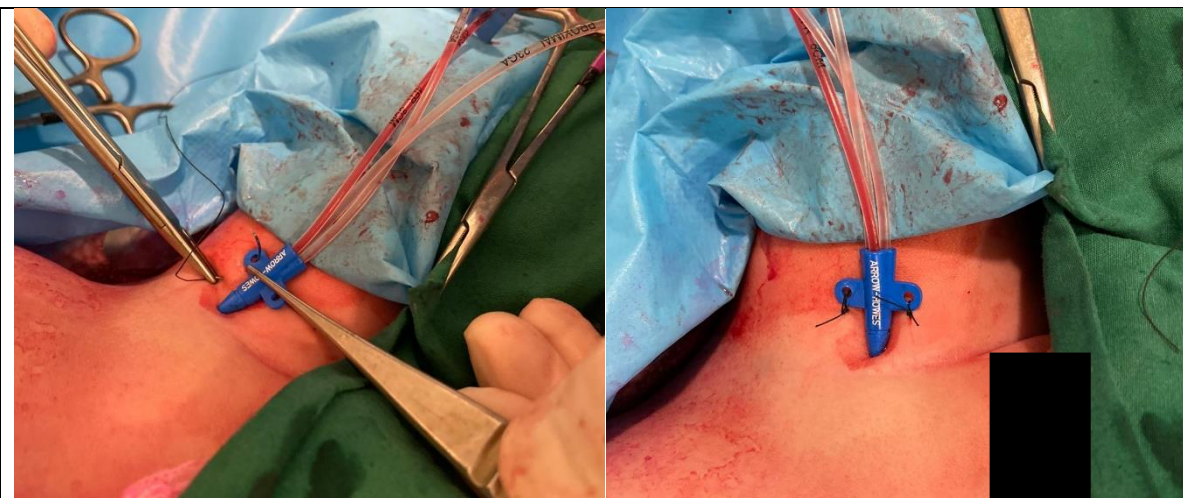


11. Use a blade, with the sharp edge facing away from the guidewire, to make a small incision in the skin at the puncture site, to facilitate passage of the dilator.
12. Pass the dilator over the guidewire and advance it into the vein by holding the dilator at its midpoint and making a rotating movement, up to a similar depth at which backflow was first obtained with needle / cannula.
13. Carefully remove the dilator while securing the guidewire and be prepared to use a gauze to apply pressure proximal (relative to the vessel) to the puncture site to minimize bleeding.



14. Unlock the distal lumen of the catheter and pass it over the guidewire.
15. When the catheter tip is ~2-3cm from the skin, carefully withdraw the guidewire until its “rear” tip has emerged from the distal lumen of the catheter (yellow arrow in image).
16. While holding the guidewire, advance the catheter into the vein.
17. Remove the guidewire and ensure it is intact.
18. Check each lumen for backflow and flush each lumen with heparin saline.
19. Secure the catheter by applying sutures.





For the 2 sutures at the sides, place sutures in a “proximal – distal” fashion, to secure the catheter.



The 3<sup>rd</sup> suture should be placed in a “side-way” fashion, with the suture lying in the groove of the catheter

20. Clean and dry the site before applying a clear adhesive dressing (e.g. Tegaderm).
21. Count all sharps with a nurse before disposing of them. Complete the sharps disposal form (**Annex A**).
22. Maintain sterility of the procedure trolley, as the nurses will use the set to connect infusions to the catheter.
23. If indicated, ask the nurses to setup a transducer to measure central venous pressure.
24. Order the appropriate radiograph to confirm placement of the central venous catheter.

#### Additional considerations:

- Ensuring adequate analgesia and sedation will enhance patient comfort and success of the procedure.
- Consider paralysis in intubated patients if the patient does not remain still in spite of optimal sedation. Discuss this with your consultant if necessary.
- Do NOT dilate the vessel if you suspect that you have cannulated an artery. Check to ensure that a vein has been cannulated.
- **Avoid using clamps/forceps on the guidewire**, as this may lead to kinks in the guidewire, which may prevent smooth sliding of the catheter over the guidewire.
- If resistance is encountered while attempting to withdraw the guidewire from the needle, do not use excessive force. Attempt to withdraw the needle and guidewire together. Call for help if necessary.

**Confirming placement of the CVL before use:**

Blood should be easily aspirated from all lumens and should not be pulsatile (which can be seen in the clear tubing of the catheter). We routinely use radiography to ensure (1) appropriate placement, (2) guidewire removal and (3) that the catheter is not kinked before using the CVL. The only exception where the CVL may be used before radiography is performed is in the setting of severe hypotension when inotropic support must be urgently started.

Other methods of confirming appropriate placement of the CVL include transducing the pressure in the catheter, obtaining a blood gas to assess PaO<sub>2</sub> and using ultrasonography to assess which vessel the guidewire (before dilatation) or the catheter is in.

**Complications**

a) Infection	g) Air embolism
b) Bleeding / Haematoma	h) Catheter migration/embolization
c) Thrombosis (Femoral venous catheters may carry a higher risk of thrombosis)	i) Retained guidewire
d) Arterial puncture	j) Pneumothorax / Haemothorax
e) Fistula	k) Cardiac irritation by guidewire
f) Pseudoaneurysm	l) Inadvertent arterial cannulation
	m) Nerve injury

**Post-CVL Insertion Care**

- a) Monitor for bleeding / swelling / leaking of infusions / extravasation / signs of infection
- b) Maintain sterility when accessing / breaking the line
- c) Review the need for the CVL daily – avoid keeping the CVL in situ for more than 7-10 days

**FEMORAL INTRA-ARTERIAL LINE INSERTION****Indications for IA Line Insertion**

- a) Beat-to-beat blood pressure monitoring
- b) Patients requiring significant respiratory support and arterial blood gas sampling
- c) Frequent blood sampling required
- d) Use of vasoactive agents that requires close BP monitoring and titration

\*Common sites for IA line insertion include the radial, dorsalis pedis and posterior tibialis arteries. An attempt at femoral artery cannulation should only be made when peripheral IA line insertion is difficult.

**Contra-indications**

- a) Infection at the insertion site
- b) Traumatic injury proximal to the insertion site
- c) Distal limb ischaemia / thrombosis
- d) Arterio-venous fistula
- e) Arterial aneurysm

**Selecting the Appropriate Catheter Size**

A Leadercath catheter is used for femoral arterial cannulation

Weight of patient (kg)	Brand	Catheter size (French)	Length (cm)
< 10 kg	Vygon	3 (~20G)	8
> 10 kg	Vygon	4 (~18G)	10

\*The 3 Fr Leadercath catheter can typically be used for most patients.

If a smaller sized catheter is required, 22G (4cm) Leadercath catheters can be obtained from the Operating Theatre.

**Procedural Steps**

1. Gown up / Open and prepare equipment / Flush the lumen of the catheter with heparin saline / Prepare a syringe with 2-3ml of heparin saline.
2. Ask our nurses to prepare a transducer.
3. Time out.
4. Clean and Drape as with femoral venous catheterization.
5. Reassess insertion site via surface marking or ultrasonography.
6. Puncture the skin using either a needle / cannula, connected to the syringe with heparin saline. The angle of approach should be 30-45 degrees relative to the skin, while aiming the needle / cannula towards the umbilicus. A smaller angle of approach may be used for smaller patients. Gently aspirate the syringe while advancing the needle.
7. Once the femoral artery is punctured, pulsatile blood should be easily aspirated into the syringe.
  - a. If a needle was used, fix the depth and angle of the needle, while gently rotating the syringe to disconnect it from the needle.
  - b. If a cannula was used, fix the needle in place and advance the cannula.
8. After removing the syringe, advance the guidewire into the needle / cannula. This process should be smooth, with little to no resistance encountered. Avoid forcing the guidewire in if resistance is encountered. Avoid using the "rear" end of the guidewire, as it may be sharper than the "front" end and can potentially damage the vessel.
9. Carefully remove the needle / cannula while holding the guidewire in place.
10. There is **no need to cut the skin or dilate the vessel**.
11. Advance the Leadercath catheter over the guidewire.
12. Remove the guidewire.
13. There should be free flowing, pulsatile blood from the catheter. Cover the catheter to limit bleeding.
14. Connect the transducer line to the arterial catheter.
15. Secure the catheter by applying sutures.
16. Clean and dry the site before applying a clear adhesive dressing.
17. Count all sharps with a nurse before disposing of them. Complete the sharps disposal form.
18. Order an AXR to confirm placement of the femoral arterial catheter.

**Complications**

- |                                  |                           |
|----------------------------------|---------------------------|
| a) Distal ischaemia / thrombosis | e) Arterial air embolism  |
| b) Infection                     | f) Arterio-venous fistula |
| c) Haemorrhage / haematoma       | g) Arterial aneurysm      |
| d) Trauma to the artery          |                           |

**Post-Femoral IA Line Insertion Care**

- a) Monitor for bleeding / swelling / signs of infection
- b) Monitor distal perfusion of the lower limb
- c) Maintain sterility when accessing the line

## Annex A – Sharps Disposal Form

## Needle / Sharp Counts for Procedure

Patient Sticky label

Date &amp; Time : \_\_\_\_\_

Name of procedure : \_\_\_\_\_

Time Out ☐

Items In CVP/ Vascath/ Leader Cath Set:	Items from package	Initial Count (During time out)	Add-on		Guidewire count/check (before flushing port)	Final Count (upon discard)
Guidewire	1					
Needle						
Blade						
Suture Needle		1				
Witnessed by (Nurse/Dr)						

Sign Out ☐

Performing Doctor: \_\_\_\_\_

*Name and Signature*

Assistant (Nurse/Dr): \_\_\_\_\_

*Name and Signature*

Use new form whenever there is a change of procedural set and/or invasive catheter set.