

# Central Venous Catheterization

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# Definition



- A Central Venous Catheter (CVC) is an indwelling intravenous device that is inserted into a vein of the central vasculature.





## 1. Difficult Peripheral Vascular Access

Ex - patients with burns, previous vein injuries (such as IV drug use)

## 2. Volume Loading

- Time-consuming to insert and are associated with high complication rates.
- Flow rate is determined by the calibre and length of the catheter (Poiseuille's law)
- Shorter and greater calibre catheters delivering greater volumes over equivalent amounts of time



### 3. Provision of Caustic Medications or Solutions

- Vasoactive medications (vasopressors or inotropes)
- Irritant substances (chemotherapeutic agents, cytotoxic drugs or high concentration solutions)
- Total parenteral nutrition

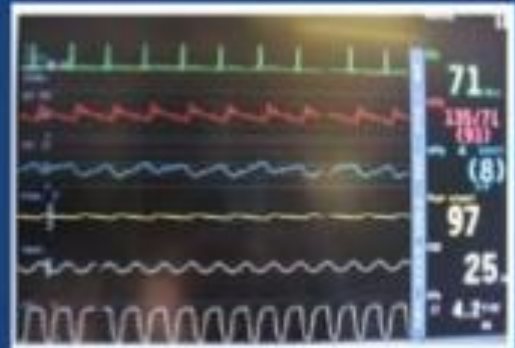
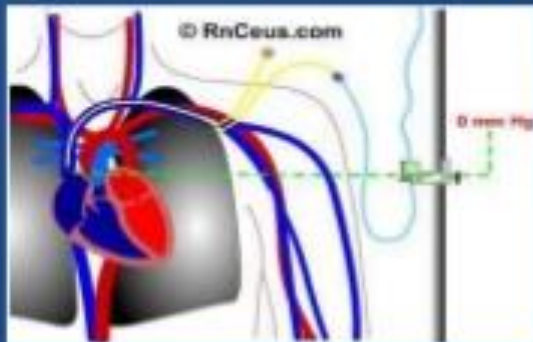






## 4. Central Venous Pressure Monitoring

- The central venous pressure (CVP) is the pressure measured in the central veins close to Right atrium.
- It indicates mean right atrial pressure and is frequently used as an estimate of right ventricular preload.
- Being used as a guide for fluid management, though some researches suggest otherwise  
(<http://www.ncbi.nlm.nih.gov/pubmed/18628220>)





## 5. Repeated Blood Sampling

## 6. Introduction of Pacemakers or Pulmonary Artery Catheters

## 7. For haemodialysis/haemofiltration - For acute and chronic haemodialysis access

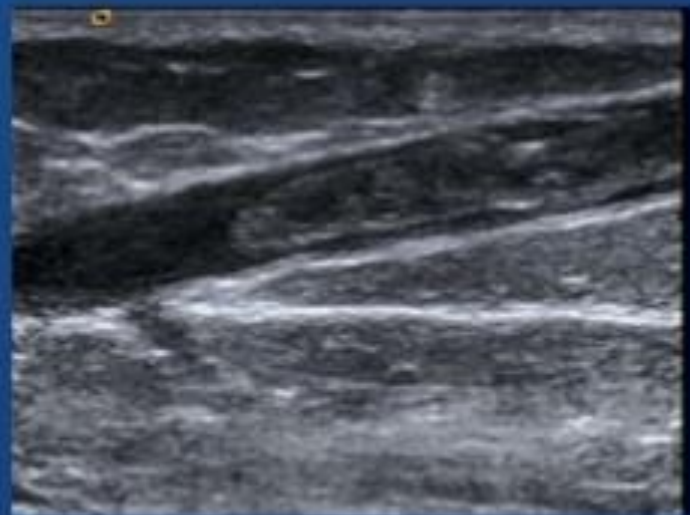


# Contraindications



## Absolute

- Overlying skin or soft tissue infection
- Thrombophlebitis





# Contraindications .cont



## Relative

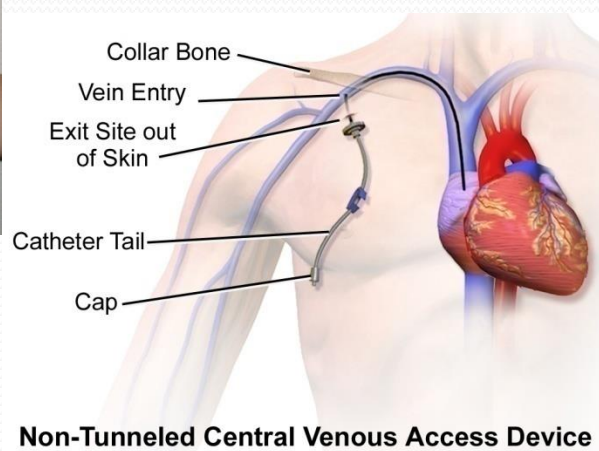
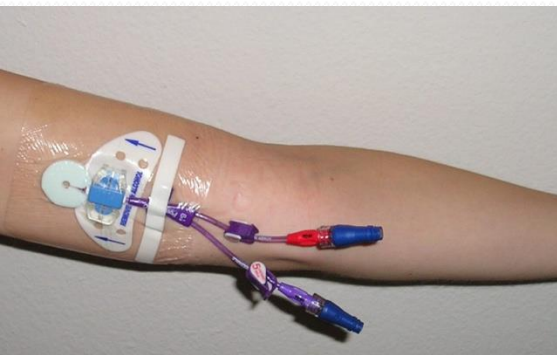
1. Distorted Anatomy – Trauma, deformity, burns.
2. Infection at the Site of Access – cellulitis
3. Uncooperative patients
4. Proximal Vascular Injury
5. Bleeding disorders & anticoagulation or thrombolytic therapy.
  - 3% complication rate as long as there are no arterial punctures (Mumatz et al)
  - Absolute contraindication for subclavian access
  - Ultrasound guidance is recommended





# Central venous access devices in COVID patients

- PICC (peripherally inserted central catheters)
- CICC (centrally inserted central catheters)
- FICC (femorally inserted central catheters)



# Principles

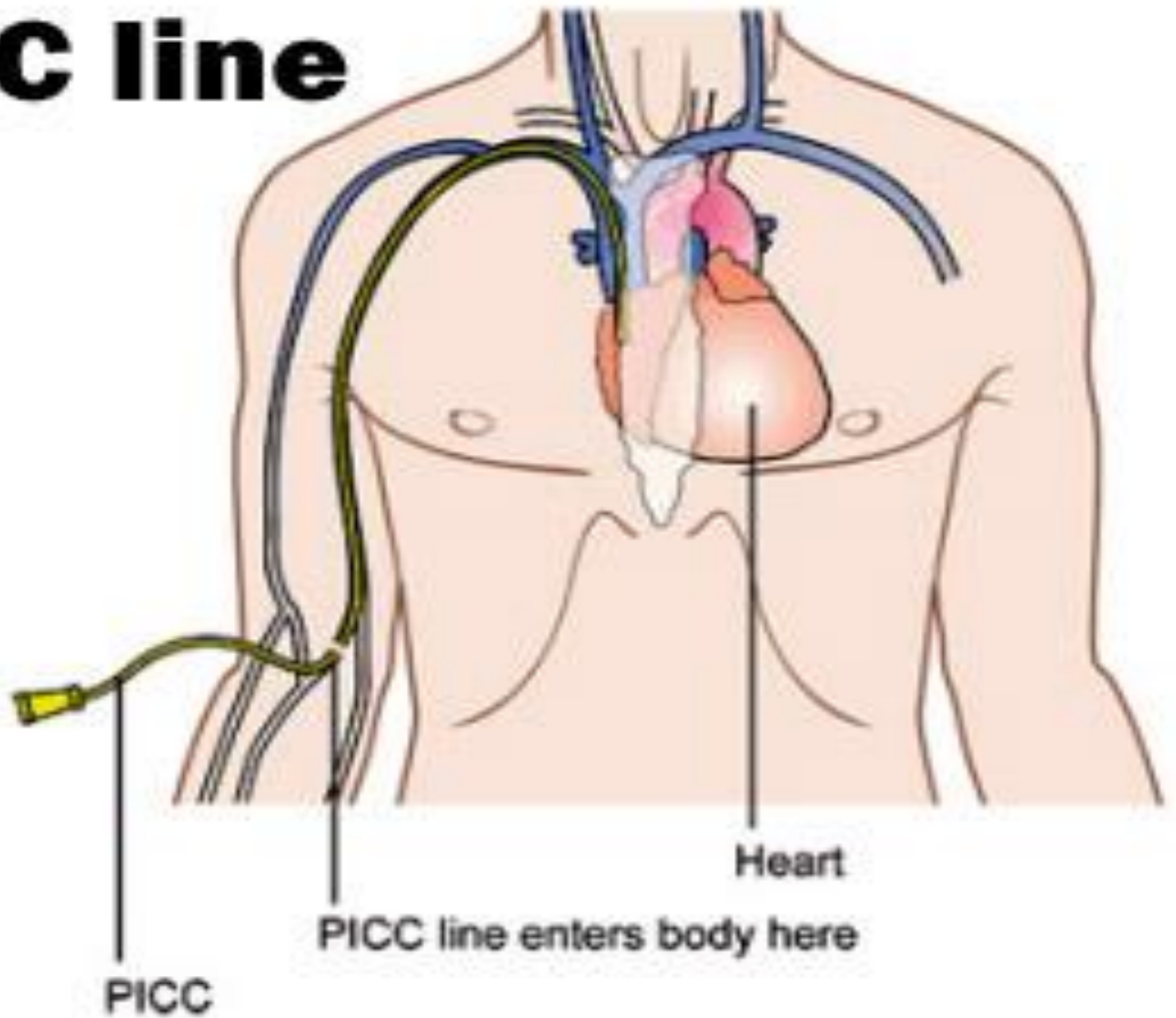
- Preferably u/s guided with wireless ultrasound probes
- Avoid radiology after central venous cannulation
- Catheter tip location-intracavitary electrocardiography (IC-ECG) and transthoracic echocardiography (TTE).
- Consider the use of subcutaneously anchored securement, which will make the dislocation less likely especially in the agitated patient or in the patient undergoing periodic pronation.

# PICC (peripherally inserted central catheters)

- No risk of pleuropulmonary complications (pneumothorax, hemothorax)
- PICC can be given in any position.(supine /sitting /pronated)
- PICC is theoretically safer for the operator than the insertion of a CICC, where the operator dangerously close to the patient's face and to his oral, nasal and tracheal secretions
- **Risk-thrombosis**



# PICC line



# Can be useful

- In patients on non-invasive ventilation (with mask or helmet), keeping the neck free
- In the pronated COVID-19 patient, the dressing is comfortable, easy to monitor the exit site the connection/disconnection of the infusion lines and not flooded by the patient's oral and tracheal secretions
- In tracheostomized patients
- In heavily anticoagulated patient
- PICCs offer longer life expectancy

# Central insertion catheters (CICCs)

- In case of specific contraindications and as an alternative to PICCs
- In the absence of specifically trained personnel
- Indication - preferential use of CICCs is the need for a central route with more than three lumens.
- Supraclavicular/ an infra-clavicular approach
- In the presence of helmets, face masks, tracheostomies, etc., (**ultrasound-guided puncture and cannulation of the axillary vein**) provide greater protection and stability of the catheter at the exit site.
- Use **U/S** to verify the absence of pneumothorax



# FICC (femorally inserted central catheters)

- Minimizes the risk of operator contamination by the patient's oral, nasal and tracheal secretions
- The exit site can be
  - (a) by puncturing the common femoral vein and then tunneling to mid-thigh, or
  - (b) by directly puncturing the superficial femoral vein at mid-thigh;
- For CVP- tip must be in atrium
- For others - in the middle tract of the inferior vena cava (above the bifurcation of the iliac veins and below the renal veins).

- COVID-19 patient - due to his hyper-coagulability status - may have a high risk of catheter-related thrombosis (either after PICC, CICC or FICC insertion).
- In the absence of contraindications, then, for all central venous catheters in COVID-19 patients, subcutaneous administration of low molecular weight heparin at prophylactic (100 units/kg/24h) or even therapeutic (100 units/kg/12h or 150 units/kg/24h) dose should be considered.

# Types Of Central Venous Catheters

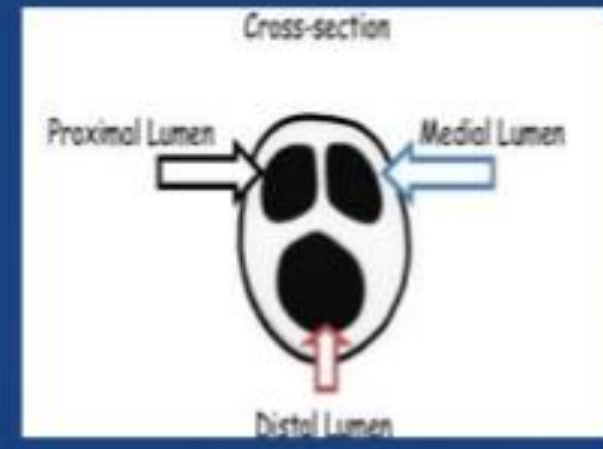
1. Non-tunneled central catheters
2. Tunneled central catheters
3. Peripherally inserted central catheters (PICC)
4. Implantable ports





# Types Of Central Venous Catheters .cont

- Single & multi-lumen catheters are available in all catheter types
- Each lumen must be treated as a separate catheter



# Types Of Central Venous Catheters .cont

## Open-ended

- The catheter is open at the distal tip
- The catheter requires clamping before entry into the system
- Clamps are usually built into the catheter
- Requires periodic flushing



# Types Of Central Venous Catheters .cont

## Closed-ended

- A valve is present at the tip of the catheter (eg. Groshong<sup>®</sup>) or at the hub of the catheter(eg. PAS-V<sup>®</sup>)
- Clamping is not required as the valve is closed except during infusion or aspiration





# Types Of Central Venous Catheters .cont

## Composition

- Silicone
- Polyurethane

## Coatings

- ◆ Antimicrobial or antiseptic coating
- ◆ Heparin coating
- ◆ Radiopaque to confirm tip placement



## The type of CVC inserted depends on the

- Type of therapy to be administered
- Length of therapy (Short term or Long term)
- Previous devices and complications
- Patient preference



# Non Tunnelled Catheters



- Polyurethane
- Single or multiple lumens
- Flow varies depending on size and ID
- Inserted percutaneously
  - Internal jugular vein
  - Subclavian vein
  - Femoral vein







## ● Advantages

- Easier placement, removal and replacement
- Economical

## ● Disadvantages

- Highest risk of infections
- Unused ports must be routinely flushed with heparin solution and clamped
- Dislodged more easily
- Temporary - requires frequent exchanges

# Femoral Vein Central Venous Access

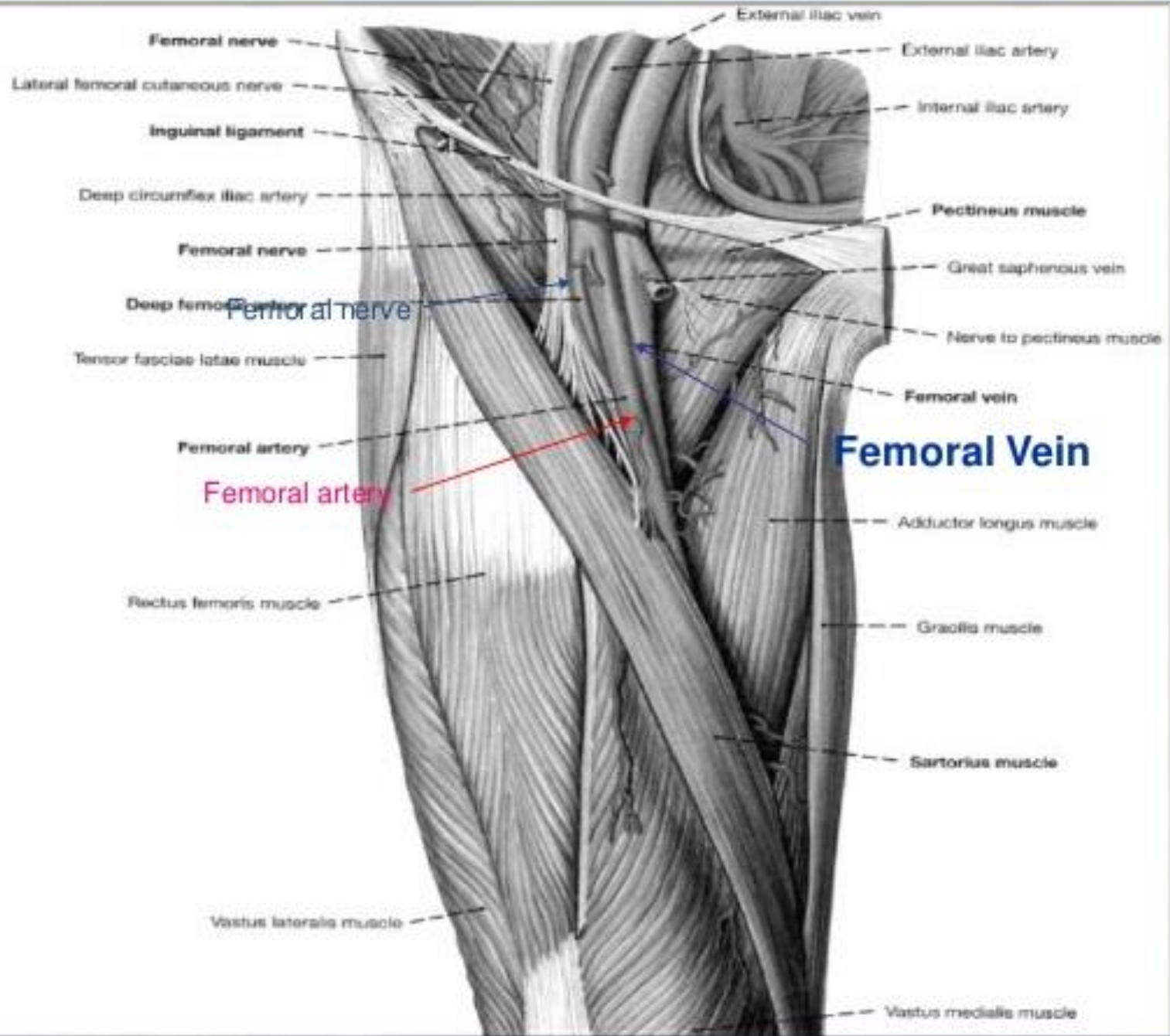
- The insertion of a central venous line is potentially life-saving as, in emergent situations, it allows rapid administration of high-volume isotonic fluids and medications that would otherwise be caustic to peripheral veins

# Anatomy

- In the leg, popliteal vein drains to the ***superficial femoral vein***. The superficial femoral vein is joined by the **deep femoral vein** in the upper thigh becoming the ***common femoral vein***
- The **great saphenous vein** then joins the common femoral vein near the inguinal ligament.
- Superior to the inguinal ligament, the **common femoral vein** becomes the **external iliac vein**.
- The internal iliac vein drains into the external iliac vein becoming the common iliac vein, and the common iliac veins join to become the inferior vena cava

- The **common femoral vein** is the ideal vein to puncture when performing central venous access at the femoral site.
- The common femoral vein lies within the “femoral triangle” in the inguinal-femoral region which is bordered by the inguinal ligament superiorly, the adductor longus medially, and the sartorius muscle laterally.
- Mnemonic “**NAVEL**.” Moving laterally to medially, (N) femoral nerve, (A) femoral artery, (V) femoral vein, (E) empty space, (L) lymphatics.





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- In most instances, central venous access with ultrasound-guidance is considered the standard of care.

# Indications

- Peripheral access is unobtainable
- Medication to be infused is known to induce peripheral phlebitis
- High volume fluid and/or parenteral nutrition administration is required
- Emergency resuscitation is warranted
- Monitoring of central venous oxygen saturation and central venous pressure is indicated
- Frequent blood sampling needs to be performed
- Access is required to perform hemodialysis, hemofiltration, or apheresis.

# Contraindications

Potential contraindications to central venous access via the femoral vein are the following:

- Thrombosis
- Skin infection at the site of needle puncture
- Trauma
- Distorted anatomy
- Coagulopathy



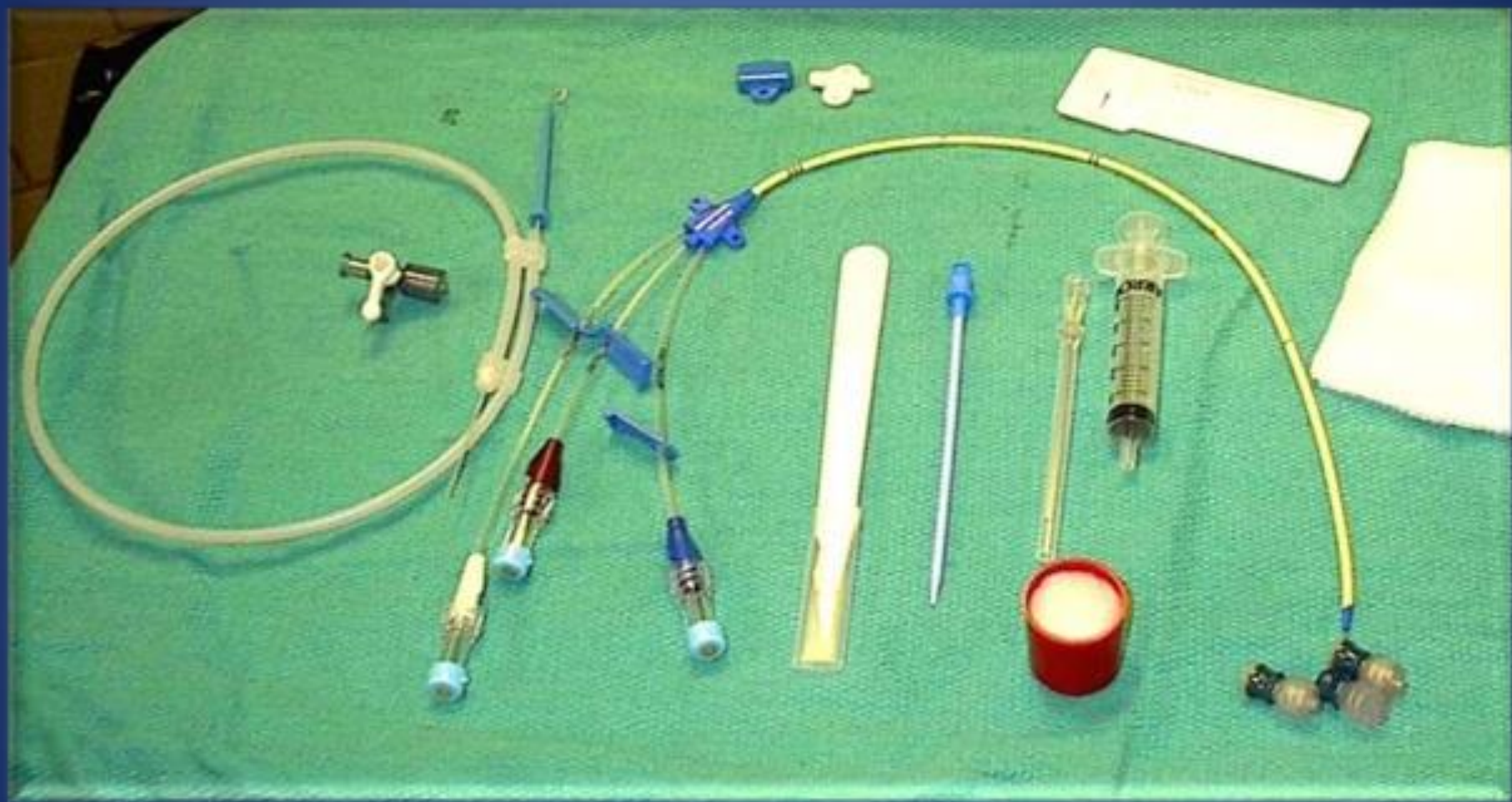
# Equipment

- Central venous catheter
- Introducer needle and a slip-tip syringe
- Guidewire
- Dilator
- Scalpel
- Gauze (4x4)
- Hubs for access ports on catheter
- Normal saline for flushing catheter
- Facemask and hair cap  
Chlorhexidine gluconate (e.g., chloraprep) or povidone-iodine solution for topical cleaning
- Topical anesthesia (e.g., 1% lidocaine)

- 25-gauge needle and a syringe for administration of topical anesthesia
- Sterile gown and gloves
- Sterile drape that is long enough to cover patient from head to toe
- Needle holder and silk sutures
- If using ultrasound-guidance: ultrasound, sterile ultrasound probe cover, sterile and non-sterile ultrasound gel
- For line dressing: Transparent dressing to allow for visualization of the insertion site (e.g., Tegaderm).

# Equipments needed

Central line kit containing:	Additional items:
<ul style="list-style-type: none"><li>• needle or a cannula over needle</li><li>• central venous catheter</li><li>• guidewire</li><li>• dilator</li><li>• anchoring clips.</li></ul>	<ul style="list-style-type: none"><li>• suture</li><li>• scalpel</li><li>• appropriate dressing</li><li>• syringes</li><li>• blue and green needles</li><li>• three-way taps, one for each lumen</li><li>• drapes</li><li>• cleaning fluid (2% chlorhexidine gluconate in 70% isopropyl alcohol is recommended)</li><li>• swabs</li><li>• Gallipot or similar</li><li>• sterile ultrasound probe sheath</li><li>• 0.9% normal saline</li></ul>






# Preparation

- Informed consent of the patient by explaining the risks and benefits of the procedure
- Choose an appropriately sized central venous catheter for the patient. This decision may be influenced by the clinical indication, patient size and/or vessel caliber.
- Consider the following:
  - Catheter size in French (F) (e.g., 4F, 7F)
  - Catheter length (in centimeters)
  - Number of lumens required

# Positioning

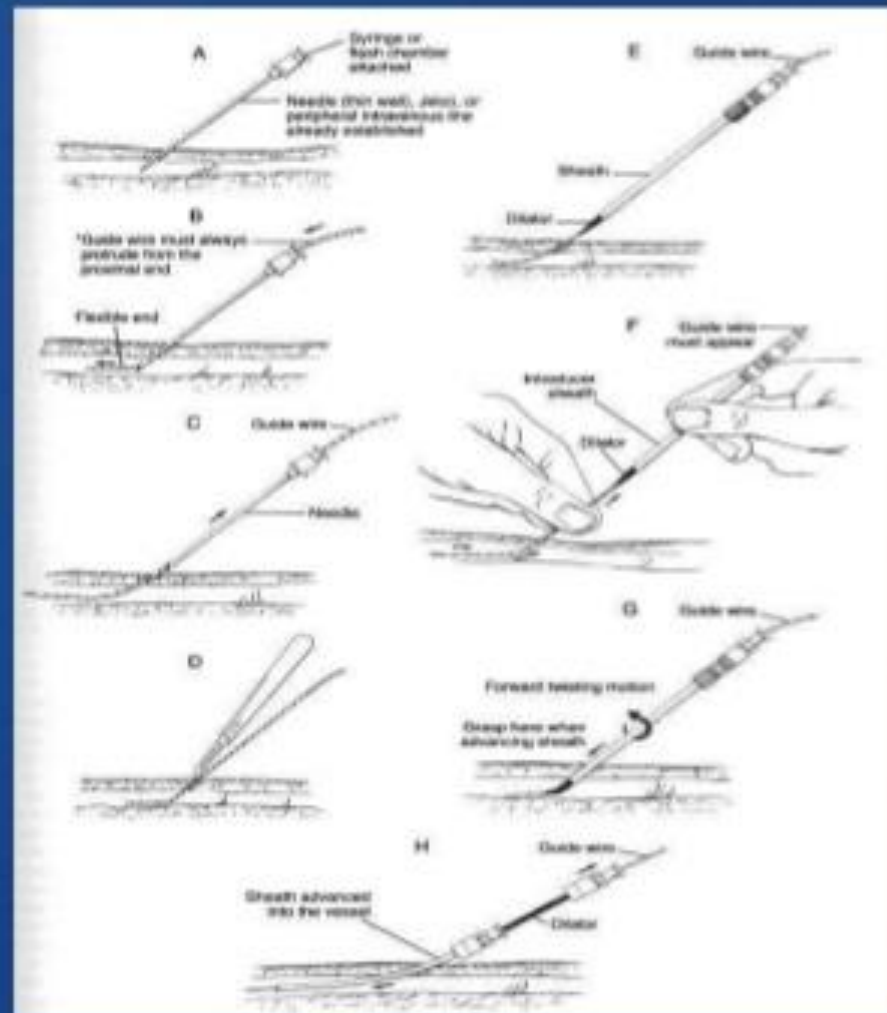
- The patient can be placed in a reverse Trendelenburg position to engorge the femoral vein which could potentially increase the vessel's caliber
- The patient's leg can be positioned in one of three ways: frog-leg position, external rotation at the hip with full leg extension, abduction of a fully extended leg with external rotation at the hip.
- Operator washes hands with soap and water
- Operator dons sterile personal protective equipment (PPE) (i.e., cap, facemask, sterile gown and gloves)
- European Centre of Disease Prevention and Control (ECDC) strongly recommend the use of a double mask (N95mask + surgical mask) for the insertion of vascular access devices, considering the high risk of aerosol in the environment,

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- Sterile prepping of the skin at the site of insertion with chlorhexidine gluconate or povidone-iodine solution
  - Place a sterile drape over the patient ensuring coverage from head to toe
  - Administer local anesthetic as an effort to minimize the use of systemic analgesia/sedation
  - Flush all lumens of the central venous catheter with normal saline.

# Seldinger technique



- Use introducing needle to locate vein
- Wire is threaded through the needle
- Needle is removed
- Skin and vessel are dilated
- Catheter is placed over the wire
- Wire is removed
- Catheter is secured in place





# landmark technique

- Use your index finger to locate the arterial pulsation along the inguinal ligament at the midpoint between the anterior superior iliac spine and the pubic symphysis.
- Then move 1 cm to 2 cm inferior to this position as the needle puncture must be performed below the inguinal ligament. Next, move 1 cm to 2 cm medially as the vein lies medial to the artery.
- Puncture just medial to your index finger in a direction just medial to your middle finger

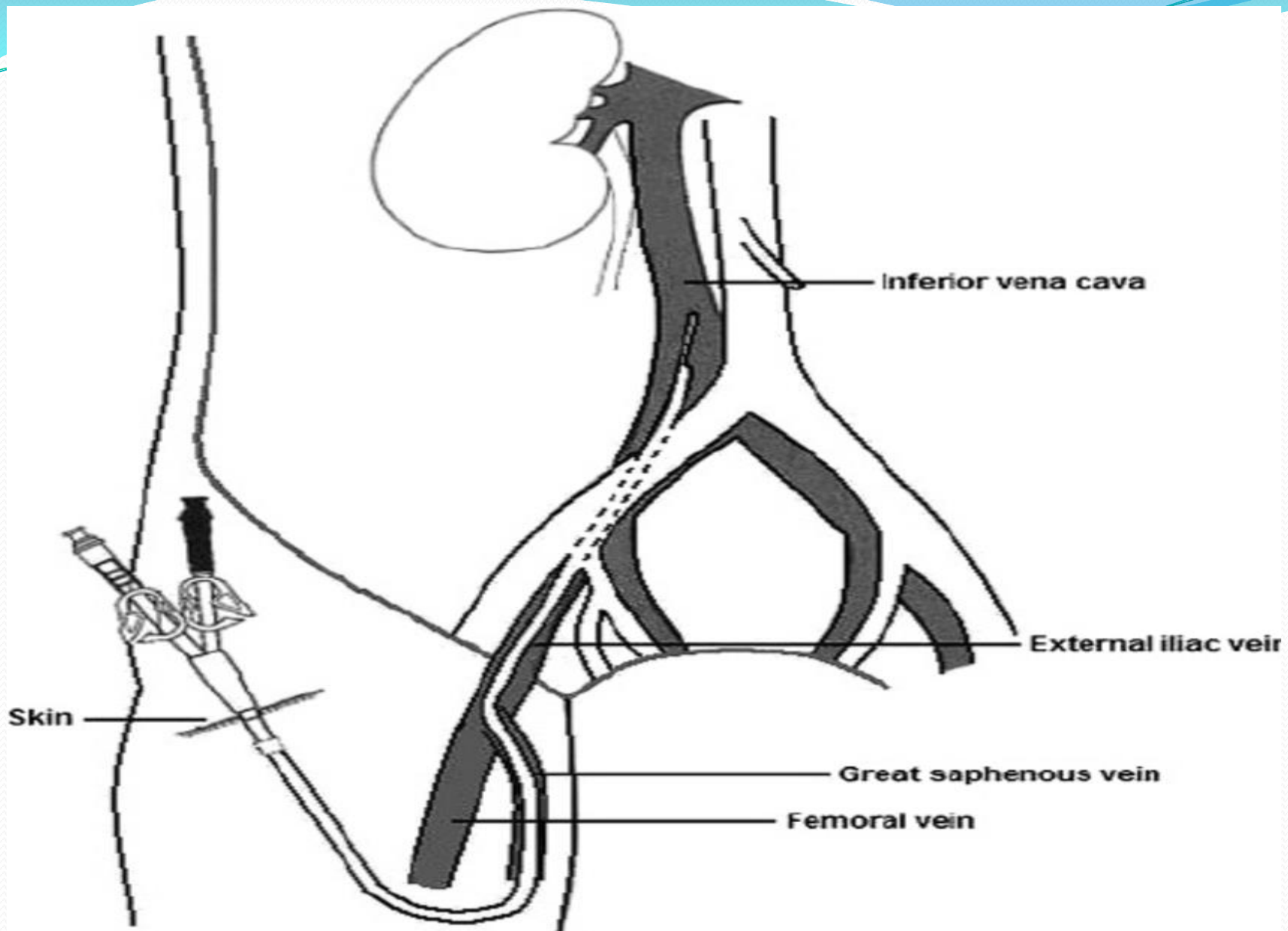
# Complications

- **Early**
- Arterial puncture which could result in formation of a hematoma
- Hematoma formation could also result from routine placement
- Bladder puncture. At our institution, we catheterize or insert a foley catheter prior to placement of a femoral central line
- Hemorrhage
- Catheter fragment resulting in a guidewire embolism
- Cardiac dysrhythmias, particularly from high-lying central lines

# LATE

- Central Line Associated Bloodstream Infection (CLABSI)
- Phlebitis
- Thrombosis
- Erosion/perforation
- The following are not complications, per se, but can lead to complications:
  - Uncooperative patient
  - Lack of experience/supervision

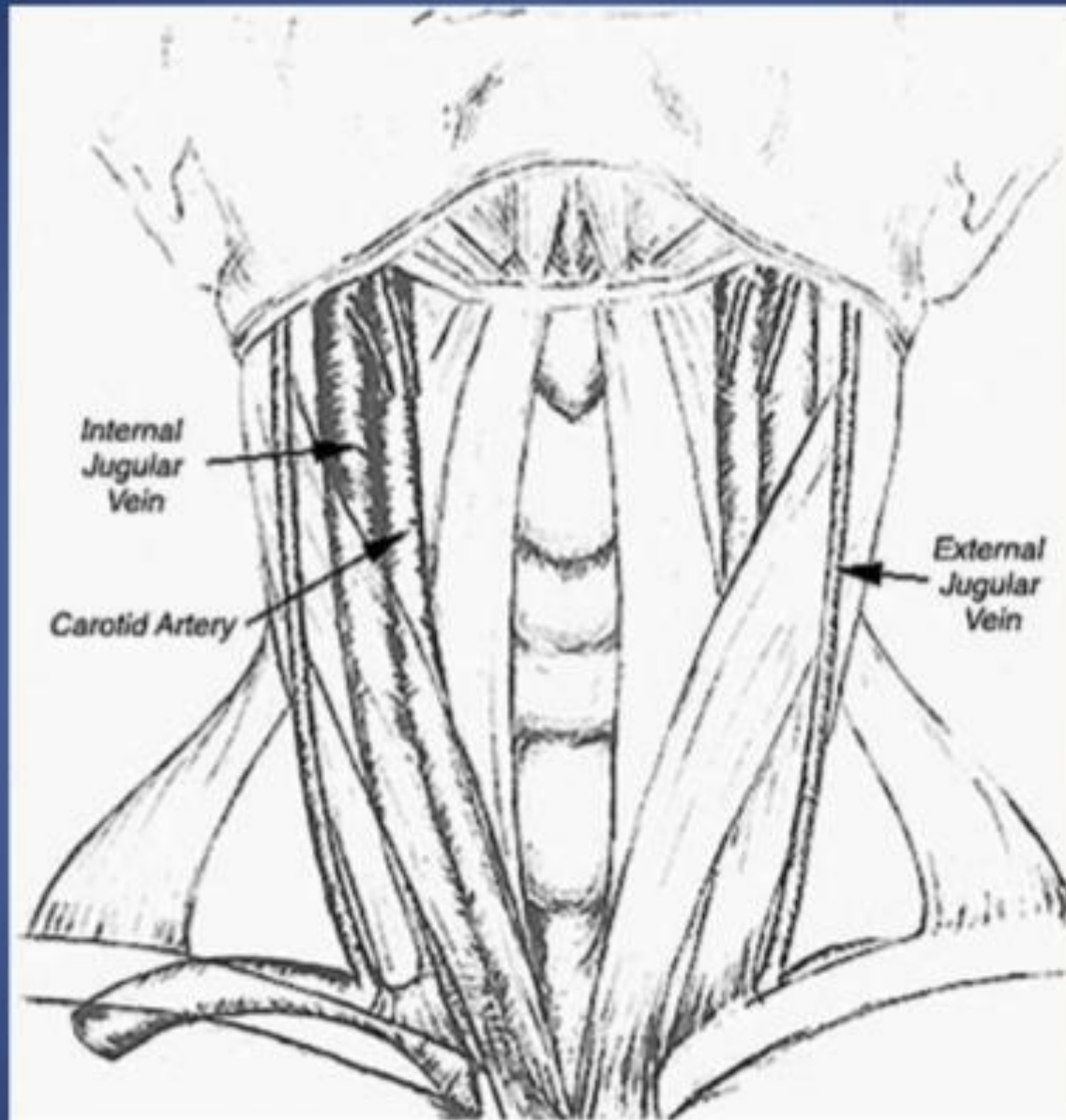
Site	Advantage	Disadvantage
Femoral	<ul style="list-style-type: none"><li>• Safest vein to place large lines, for example for veno-veno haemofiltration because there are fewer important structures nearby.</li><li>• Puncture of femoral artery can usually be treated with pressure</li></ul>	<ul style="list-style-type: none"><li>• Femoral artery puncture leading to retroperitoneal bleed</li><li>• Femoral nerve damage</li><li>• Difficult to nurse and keep clean</li><li>• Highest likelihood of infection</li></ul>





# Internal Jugular Approach

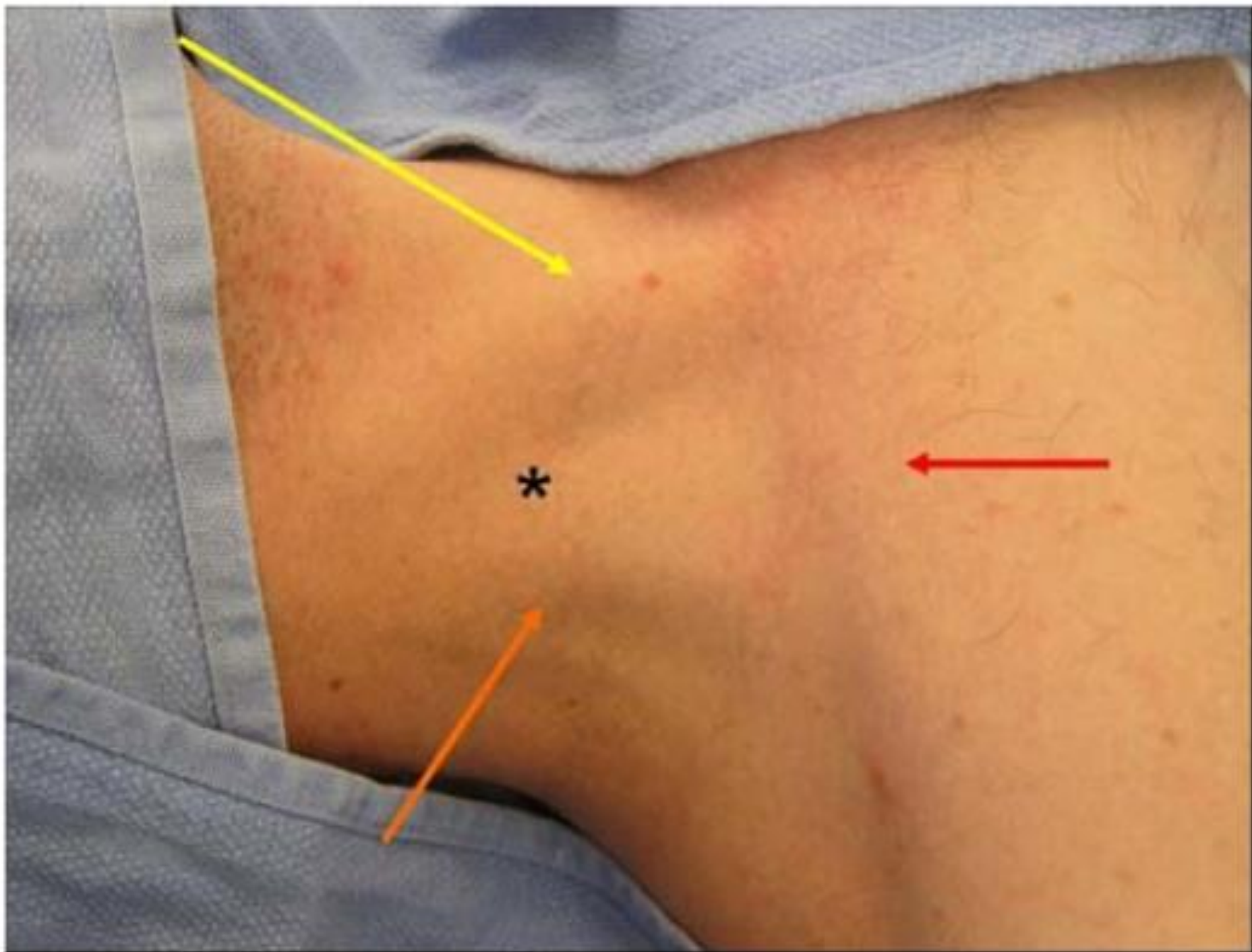
- Positioning
  - Right side preferred
  - Trendelenburg position
  - Head turned slightly away from side of venipuncture
- Needle placement: Central approach
  - the triangle formed by the clavicle and the sternal and clavicular heads of the SCM muscle is located
  - three fingers of left hand are gently palced on carotid artery
  - Needle should be placed at 30 to 40 degrees to the skin, lateral to the carotid artery
  - Aim toward the ipsilateral nipple under the medial border of the lateral head of the SCM muscle
  - Vein should be 1-1.5 cm deep, deep probing in the neck should be avoided.



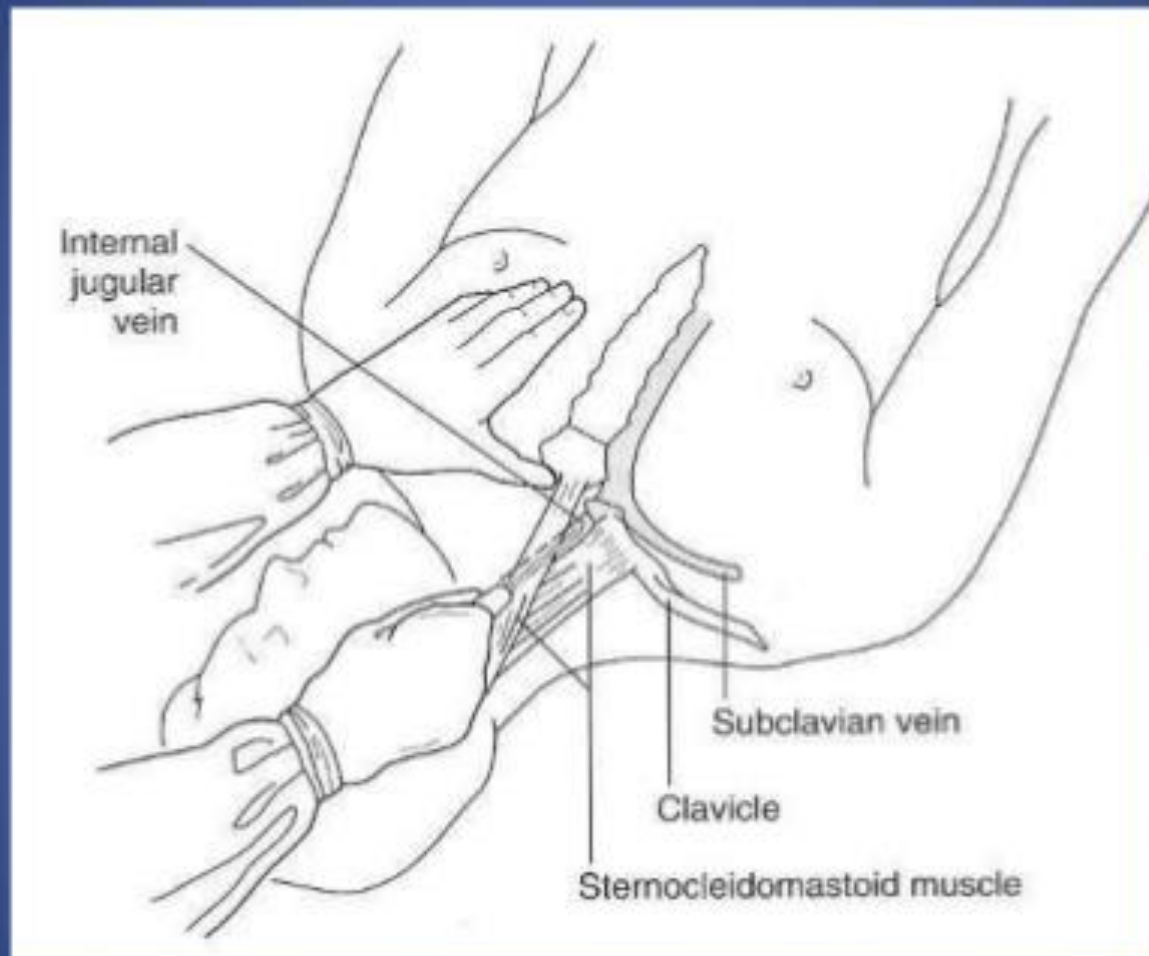
*Internal  
Jugular  
Vein*

*Carotid Artery*

*External  
Jugular  
Vein*



# Internal Jugular Central Approach



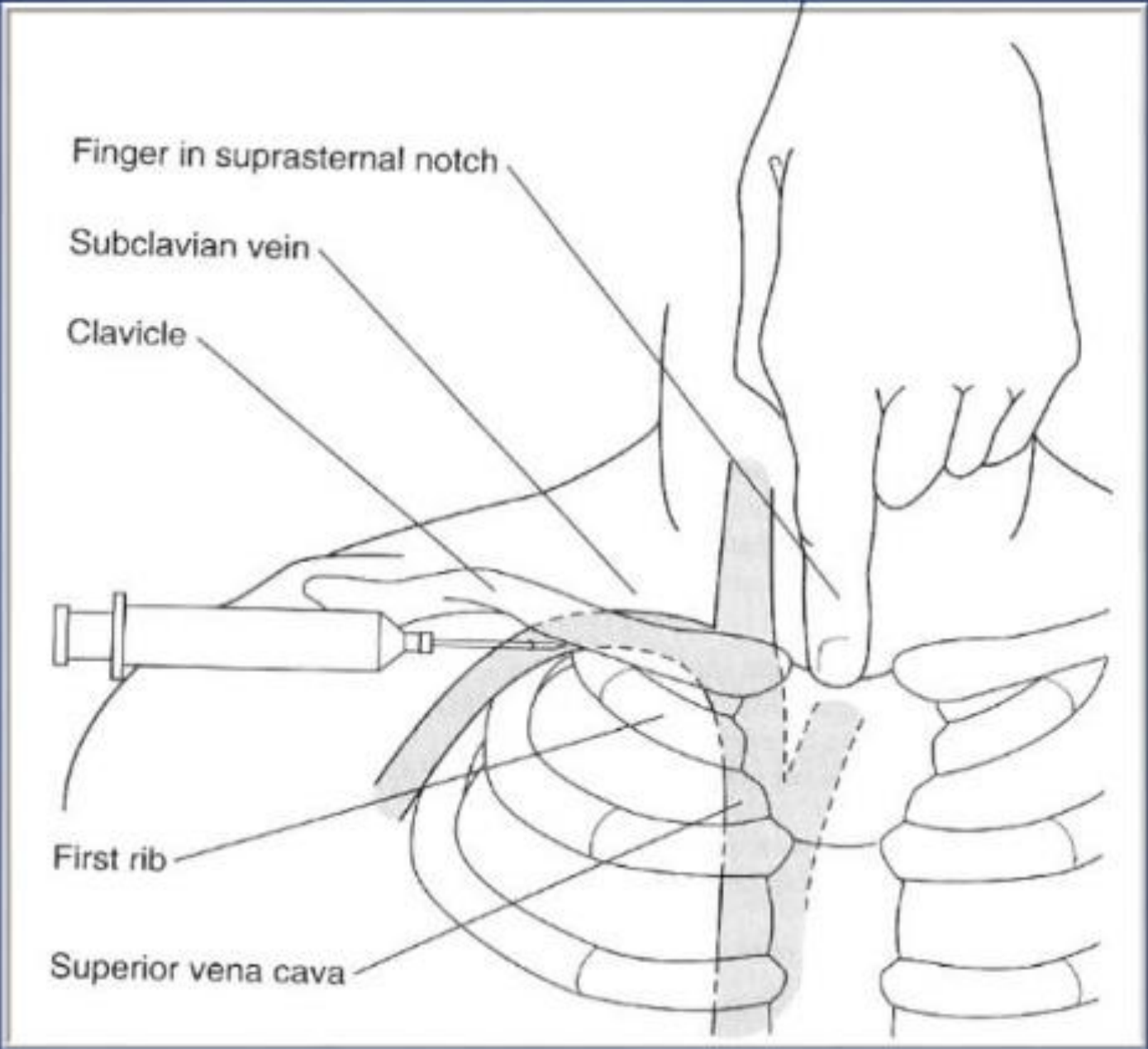


Site	Advantage	Disadvantage
<b>Internal jugular</b>	<ul style="list-style-type: none"><li>•Anatomy readily visible with ultrasound</li><li>•Can be adapted to accommodate patient size and position</li><li>•Easily accessed surface of patient</li></ul>	<ul style="list-style-type: none"><li>•Puncture of internal carotid or misplaced line in the internal carotid</li><li>•Pneumothorax is a recognised complication</li><li>•Difficult to nurse long term.</li></ul>

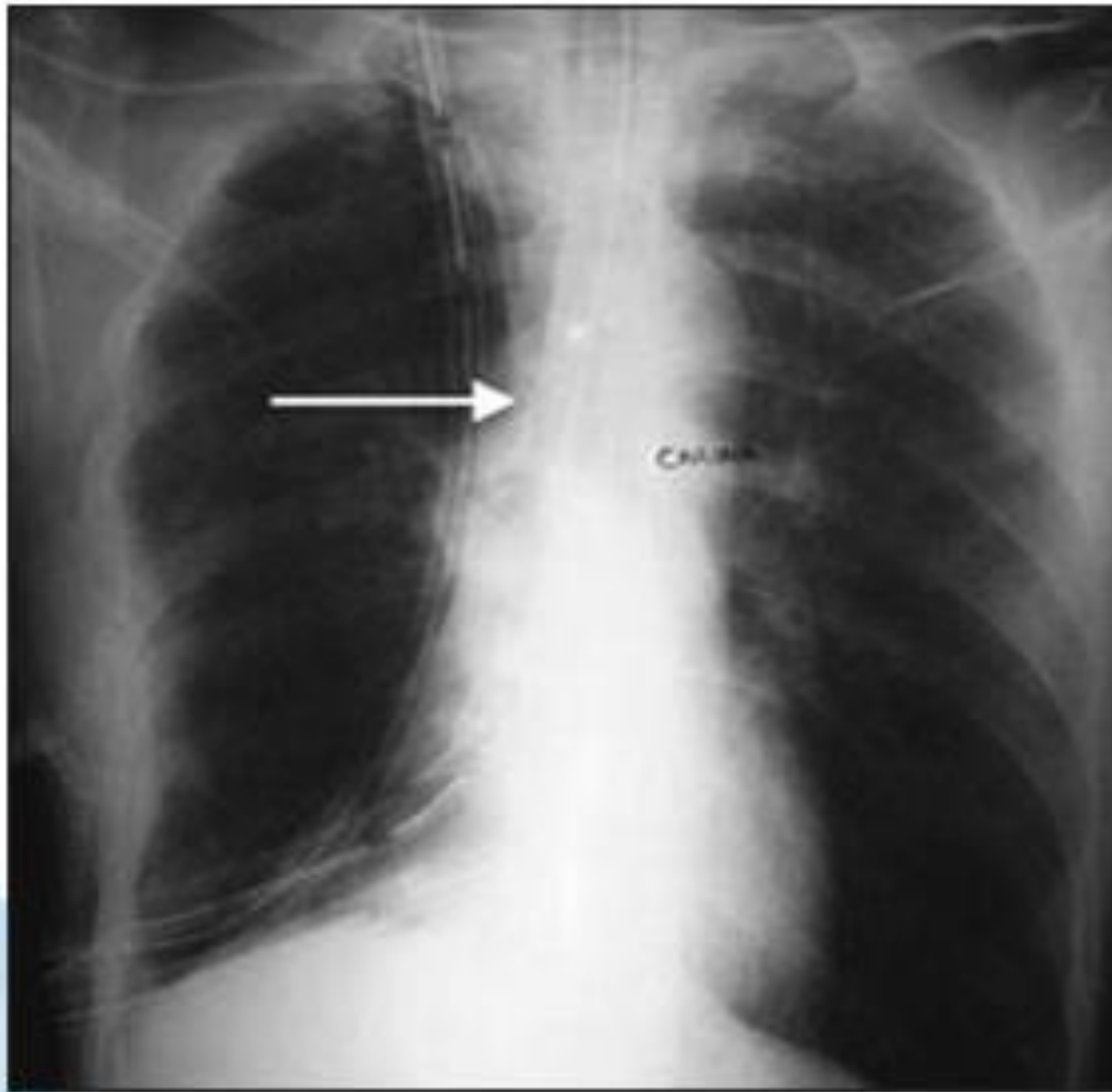


# Subclavian Approach

- Positioning
  - Right side preferred
  - Supine position, head neutral, arm abducted
  - Trendelenburg (10-15 degrees)
  - Shoulders neutral with mild retraction
  - Right side preferred
- Needle placement
  - Junction of middle and medial thirds of clavicle
  - At the small tubercle in the medial deltopectoral groove
  - Needle should be parallel to skin
  - Aim towards the supraclavicular notch and just under the clavicle



Site	Advantage	Disadvantage
<b>Subclavian</b>	<ul style="list-style-type: none"><li>• Lower risk of infection</li><li>• Does not require movement of patient's head and can be accessed during c-spine immobilisation</li><li>• Useful in emergencies</li><li>• Vein does not collapse fully in hypovolaemic states</li></ul>	<ul style="list-style-type: none"><li>• Highest chance of pneumothorax</li><li>• Puncture of tracheostomy or ET tube cuff</li><li>• Cannot apply pressure to stop bleeding</li><li>• Can be painful even with good skin anaesthesia</li><li>• Less easy to visualise with USG</li></ul>



**Figure 3:** Postinsertion chest X-ray displaying normal position of CVC tip (arrow) in relation to carina



# Maintenance of CV line

- Hepsol flush 8 hourly
- Central Short channel is used for measuring CVP
- Rest two channels are used for medication and TPN
- The dressing should be changed at regular interval
- Catheter should not be kept for more than 3 weeks



# Complications



- Acute
- Chronic

Complication rate depends on

- Site
- Patient factors (illnesses, variations in anatomy)
- Operator skill and experience.

# Acute complications



- Cardiac Dysrhythmias
  - Due to cardiac irritation by the wire or catheter tip.
  - Withdraw the line into the superior vena cava.
  - Always use a cardiac monitor.
- Haematoma formation – Arterial/Venous puncture
- Mechanical injury to nearby structures
  - Pneumothorax/Haemothorax
  - Atrial wall puncture - pericardial tamponade.
  - Bowel penetration, Bladder puncture, Femoral nerve injury
- Air embolus
- Malposition
- Lost Guide-wire

# Chronic complications



- Infections
- Catheter fragmentation
- Non-function/Blockage - fibrin builds on and around the catheter and vessel, drug precipitates, lipid deposits
- Thrombosis/Thromboembolism





# Air embolism



- Deadly complication associated with CVC's
- Signs and Symptoms
  - Respiratory changes: sudden shortness of breath, cyanosis
  - CVS changes: sudden onset of chest pain, ↑HR, ↓BP
  - CNS changes: altered neurological signs, dizziness, confusion, loss of Consciousness



## Management

- Left lateral decubitus with head low Position (Durant maneuver and Trendelenburg position)
- Clamp the Central Venous Catheter
- 100% O<sub>2</sub>
- Direct removal of air from the venous circulation by aspiration from a central venous catheter in the right atrium may be attempted







- To minimize the chance of air entering the system:
  - Ensure the lumen is clamped prior to opening the system
  - Position the patient so that the insertion site is at or below the level of the heart during insertion and removal of catheter

# Infections



- Most frequent and serious complications.
- Types
  - Local infection – Cellulitis
  - Central Line-Associated Bloodstream Infections (CLABSI)





## ● Causative Organisms

- Staph epidermidis 25-50%
- Staph aureus 25%
- Candida 5-10%

## ● Risk Factors

- Cutaneous colonization of the insertion site
- Moisture under the dressing
- Prolonged catheter time
- Technique of care and placement of the central line

# Evidence-Based Strategies Selected to Reduce CLA-BSIs

1. Hand hygiene
2. Maximal sterile barriers
3. Chlorhexidine for skin asepsis
4. Avoid femoral lines
5. Avoid/remove unnecessary lines



# Care of central line

## Maintenance bundle

- Daily assessment of whether catheter is needed

## Catheter site care

- No iodine ointment

- Chlorhexidine scrub to site with dressing changes (30-s scrub and 30-s air dry)

- Change gauze dressings every 2 d unless soiled, dampened, or loosened (CDC recommended)

- Change clear dressing every 7 d unless soiled, dampened, or loosened (CDC recommended)

- Prepackaged dressing change kit (each unit to define package contents)

## Catheter hub/cap/tubing care




- Dressing changes per protocol
  - Use sterile technique
  - Change when damp, soiled or loosened
  - Change every 7 days if transparent
  - Change every other day if gauze is used
  - Clean skin around insertion site with alcohol in a circular motion. Also clean cath with alcohol

## ■ Flushing of lines

- Each lumen is treated as a separate cath
- Injection caps are vigorously cleaned with alcohol
- Use 10cc or larger syringe for administration of meds or flush
- Turbulent flush technique is recommended

- The infusion lines are changed every 24 hours
  - Disinfect the infusion lines with sterile gauze and 70% alcohol daily.
  - When blood samples are collected flush the lines with heparinised saline to keep patent and prevent it from blocking or patient is on 24 hours Heparin infusion (0.9% normal saline)
  - Clean the cap with 70% alcohol before connecting the 3 ways valve.
-

- The CVC must be handled with sterile gloves
- The Hickman's catheter comes either in one, two or three lumens in three different colours.
- The red cap is for blood and blood components and Chemotherapy drugs.
- Blue cap for drugs that are not compatible with intravenous fluids.
- White cap for total parenteral nutrition (TPN), if patient is not on TPN, it is plugged.
- All these are done under Aseptic techniques.

Category	Type of bag/container	Type of waste	Treatment disposal options
<b>Yellow</b>	Non chlorinated colour coded bags in coloured bins  Separate collection system leading to ETP	<ul style="list-style-type: none"> <li>• Human anatomical waste</li> <li>• Animal anatomical waste</li> <li>• Soiled waste</li> <li>• Expired or discarded medicines</li> <li>• Chemical waste</li> <li>• Micro, biotech &amp; clinical lab waste</li> <li>• Chemical liquid waste</li> </ul>	Incineration/deep burial
<b>Red</b>	Non chlorinated plastic bags in coloured bins,  containers	Contaminated waste (recyclable) tubing, bottles, urine bags, syringes (without needles) and gloves	Auto/micro/hydro and then sent to recycling
<b>White</b>	Translucent, puncture, leak & tamper proof	Waste sharps including metals	Auto/dry heat sterilization followed by shredding /mutilation/encapsulation
<b>Blue</b>	Water proof card board boxes/containers	Glassware waste	Disinfection or auto/micro /hydro then sent to recycling

\*Disposal by deep burial is permitted only in rural or remote areas where there is no access to common bio-medical waste treatment facility. This will be carried out with prior approval from the prescribed authority





**Thank You  
So Much!**