
12th January, 2008

Hall C

15.30 to 18.00 hrs.

Co-ordinator

Dr. S. S. Mehta, MD
Associate Professor of Internal Medicine, Division of Emergency Medicine, Seth G.S.Medical College & K.E.M.Hospital, Mumbai
Workshop on
Emergency Procedures:
Airway Management and
Vascular Access

Co-ordinator

Dr. S. S. Mehta
MD
Associate Professor of Internal Medicine, Division of Emergency Medicine
Seth G.S.Medical College & K.E.M.Hospital, Mumbai

Faculty

Dr. V. M. Kothari
MD, MRCP, EDIC, DNB
Associate Professor of Internal Medicine, Division of Critical Care
Seth G.S.Medical College & K.E.M.Hospital, Mumbai.

Dr. S. Galwankar
MD, MPH
Assistant Professor of Global Health, University of South Florida
Global Emergency Medical Sciences, Tampa, FL, USA

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Aims and Objectives

Airway Management:
This workshop is designed to provide basic information, in the form of text, presentations and hands-on training on mannequins to understand, learn and practice the techniques of airway management:
1. Understand the airway anatomy
2. Understand the respiratory physiology
3. Learn airway management- Learn insertion of endotracheal tubes with minimal risk to the patient, including the important anatomy and equipment used in the process of intubation.
4. Understand the complications that can arise in the setting of intubation.

Central Venous Access:
This workshop is designed to provide basic information, in the form of text, presentations and hands-on training on mannequins to understand, learn and practice the techniques of vascular access:
1. Understand central venous catheters and their uses
2. Understand the physiology behind central venous pressure monitoring
3. Learn insertion of central venous catheters with minimal risk and pain to the patient, including the important anatomy and equipment used in the process of catheterization.
4. Understand the complications that can arise in the setting of invasive catheter placement and use.
5. Interpret the information given by catheter pressure measurements and waveforms
Airway Management

Overview

- Indications
- Positioning
- Bag mask ventilation
- Preintubation assessment
- Orotracheal intubation
- Approach to the failed airway
- Nasotracheal intubation

Indications

Definitive control of the airway. Airway support: Obtunded patient, Inability to clear secretions, Airway edema,

- Pulmonary disease: ARDS , Type II failure, excessive work of breathing
- Circulatory disorders: Cardiac arrest, Shock, Sepsis
- Other: Increased ICP, transport of critically ill patients, severe metabolic acidosis, in burns with inhalational smoke injury

Positioning: Does the patient have cervical spine injury?- Then do Jaw thrust along with in-line stabilization of the neck

In-line stabilization of the cervical spine

- Sniffing Position: Flexion of the neck-20-30* and extension of the head of 80-85*
- Aligns the 3 axes oral, pharyngeal and laryngeal
- Moves the tongue forward
- Moves the epiglottis away from the glottis
**Sniffing Position**

![Sniffing Position Image]

**Bag mask ventilation**
- Important aid to ventilating the patient
- Buys time before definitive airway management
- Buys time during the failed airway

![Bag mask ventilation Image]

- Correct technique important: Slide appropriate mask over nose and mouth, thumb over nasal end and index finger over chin-end, middle and ring fingers on mandibular ridge, little finger under angle of the jaw, maintain sniffing position and do not push down or exert pressure on eyeballs and nose, insert Guedels airway and keep dentures or 4X4 inch gauze inside cheeks of edentulous patients, slow even breaths, 2 seconds of inspiration
- Bearded Obesity No teeth Elderly Snorer predicts difficulty: **BONES**

**Pre-intubation assessment**: LEMON law:
- L-ook for anatomical features
- E-xamination-3 3 2 rule
- M-allampati grading
- O-bstruction of the airway: Supra or infraglottic?, fixed or mobile, progression
- M-obility-Touch chin on chest and look at the ceiling

![Pre-intubation assessment Images]
Systems check

- Neurologic: Elevated ICP, intracranial aneurysms, intracranial bleed
- Cardiovascular: Ischemia, hypovolemia, MI, CHF, dysrhythmias
- Drug allergies
- Pulmonary: Hypoxemia, obstruction
- Aspiration risk: Gastroparesis, pregnancy, obesity
- Coagulation: Thrombocytopenia, coagulopathy, anticoagulant or antithrombotic therapy
- Contraindications to Scoline: Burns, crush injury, spinal cord injuries, malignant hyperthermia

Other assessment

- History of difficult airway, RA, AS, TMJ
- Obese with short neck and receding chin
- Teeth: Inter incisor gap < 3 cm, buck teeth, upper incisors>1.5 cm
- Tongue-Mallampati class>II
- Palate-High arched palate
- Mandible-Thyromental distance<5 cm
- Larynx-Thyroid cart-floor of mouth< 3 cm
- Sterno-mental distance<12.5 cm

Preparation

- Preparation-SOAPME Drugs
- S-uction
- O-xygen
- A-irway: ETT, Oral/Nasal airway, LMA, 2 laryngoscopes, stylet, self inflating bag, Fibre-optic bronchoscope
- P-osition: Sniffing, bed at the navel level
- M-onitors: ECG, oximetry
- E-sophageal detection- Capnography, self inflating bulb, syringe aspiration
- Drugs: Atropine, IV lidocaine, adrenaline, glycopyrrolate, succinylcholine, rocuronium/ atracurium
- Topical anesthesia- Lidocaine spray
- Sedation-Decreases sympathetic discharge, decreases reflex rise in ICP, decreases vasovagal responses
- Muscle paralysis: Prevents gagging and increase in ICP, improves tissue compliance, decreases trauma

Rapid sequence intubation in raised ICP and anatomically favourable airway

- Pancuronium 1 mg
- Preoxygenation/hyperventilation 3 minute
• Cricoid pressure
• Midazolam 0.03 mg/kg
• Fentanyl 1-2 mic/kg or 30 mg fortwin
• Lidocaine 100 mg
• Thiopental 3-5 mg/kg or propofol 2mg/kg
• Scoline 1.5 mg/kg or rocuronium 1.0 mg/kg
• Hyperventilate 45 sec with BM for scoline and 90 sec with roc
• Laryngoscopy/intubation
• Confirm tube placement with auscultation/capnography
• Elevate head of bed and hyperventilate

**Technique of orotracheal intubation**

• Open mouth with left hand
• Insert laryngoscope right angle of mouth
• Aim for right tonsillar pillar
• Sweep tongue towards left
• Position tip in vallecula in the midline
• Lift in direction of the handle
• Terminal radial flexion at the wrist
• Insert tube from the right side of mouth
• Hold tube proximally
• Pass through vocal cords during inspiration
• Pass upto horizontal black line or 20-21 cm at teeth in female, 22-23 cm in males
• Do 5 point auscultation
• Confirm tube placement with moisture condensation and capnography
• Get CXR to show tip of tube at level of aortic knuckle

**Insertion of Laryngoscope**
Aligning the three axes

Correct placement of Laryngoscope blade with glottis visualization

Difficult glottic visualization
- BURP maneuver, stylet, bending ETT proximally between left ring and middle finger
- Add another pillow
- Further sedation/paralysis
- No 4 laryngoscopic blade
- Miller blade
- McCoy Blade

Failed Airway algorithm
- Do not attempt intubation for more than 45 sec
- If unable to intubate than consider inserting bougie and railroading ETT over
- If bougie unsuccessful then insert LMA
- If LMA unsuccessful cricothyroid puncture with 14 G catheter over needle or cricothyroidotomy
• Call for senior anesthetic help early rather than late

**Immediate complications of endotracheal intubation**
• Esophageal intubation
• Right mainstem intubation
• Dental injury and tooth aspiration
• Gastric aspiration
• Tracheal or esophageal tear
• Hypertension, tachycardia, myocardial ischemia, hypotension, arrhythmias
• Bronchospasm, vocal cord trauma, arytenoid cartilage dislocation
• Elevated ICP

**Insertion of LMA**
• Tightly deflate cuff: facilitates insertion and avoids contact with the epiglottis
• Lubricate posterior surface with water soluble lubricant
• Hold like a pen and press backwards towards the ear
• Advance until resistance is felt
• Inflate cuff
• If tip flattens or curls over: withdraw and reinsert or withdraw and insert the deflated LMA similar to Guedels airway insertion or insert with cuff partially inflated
• Perform jaw thrust, extend head, pull tongue forwards or use laryngoscope

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![Image](image)

**Signs of correct LMA placement**
• Slight outward movement of tube on inflation of balloon
• Smooth oval swelling in neck around thyroid and cricoid cartilage
• No cuff visible in the oral cavity
• Before taping in place insert bite block 3 cm thick
Nasotracheal Intubation

- In awake and breathing patients
- Select the more patent nostril
- Preoxygenate
- Small ETT, 6-6.5 females and 7-7.5 males
- Lubricate with xylocaine and insert backwards and not upwards with bevel facing towards septum
- If resistance encountered withdraw slightly and insert after extending head further
- Use breath sounds as guidance with opposite nostril and mouth closed

Contraindications and Complications of nasotracheal intubation

- Contraindications: # BOS, nasal # or DNS, nasal polyps, coagulopathy
- Disadvantages: Small tube so increased WOB, decreased clearance of secretions,
- Complications: Sinusitis, epistaxis, shearing of nasal turbinate, intracranial placement of ETT

Combitube

The combitube is combined oesophageal tracheal lumen airway. It is a double lumen tube with two lumens that end at approximately the same level. The oesophageal lumen is blind at the distal end. It has eight perforations that are intended to be located at the level of the lower pharynx. The other lumen (tracheal) is open at the distal end and unperforated throughout. There are two balloons, one smaller distal and a larger proximal balloon. The larger balloon fixes the combitube in the hypopharynx. The distal balloon forms a seal either in the oesophagus or the trachea. Between the balloons are the perforations of the oesophageal lumen The combitube can be inserted blindly or with the aid of a laryngoscope. The hypopharyngeal tube requires 100 ml air whilst the smaller tube takes 10-15 ml of air to either seal the tracheal or prevent aspiration of gastric contents. In about 95% of the cases the combitube ends up inserted into the oesophagus. Ventilation takes place via the perforations in the wall of the oesophageal tube. The distal cuff occlude the upper airway, so that the inflating gas pressurises the laryngopharynx and inflates the lungs via the open glottis. It is indicated only in the ‘cannot intubation-cannot ventilate’ situation. Its major disadvantage is that no tracheal suctioning is possible if the distal lumen is placed in the oesophagus.
References


The Physiology of Central Venous Pressure Catheters

Blood from systemic veins flows into the right atrium; the pressure in the right atrium is the central venous pressure (CVP). CVP is determined by the function of the right heart and the pressure of venous blood in the vena cava. Under normal circumstances an increased venous return results in an augmented cardiac output, without significant changes in venous pressure. However with poor right ventricular function, or an obstructed pulmonary circulation, the right atrial pressure rises. Loss of blood volume or widespread vasodilation will result in reduced venous return and a fall in right atrial pressure and CVP.

The CVP is often used to make estimates of circulatory function, in particular cardiac function and blood volume. Unfortunately the CVP does not measure either of these directly, but taken in the context of the other physical signs useful information can be gained. The supply of blood to the systemic circulation is controlled by the left ventricle. In a normal patient the CVP closely resembles the left atrial pressure and is usually used to predict it. However in patients with cardiac disease the right and left ventricles may function differently; this can only be detected clinically by measuring the pulmonary capillary wedge pressure.

CVP is a good approximation of right atrial pressure, which in turn is a major determinant of right ventricular end diastolic volume (or the preload of the right ventricle.) The preload is a reflection of the resting myocardial fiber length, which is also the ventricular end diastolic volume.

CVP ~ right atrial pressure ~ right ventricular end diastolic volume (preload)

Thus, the right atrial pressure (and thus central venous pressure) is a reflection of:
1. Cardiac function
2. Venous return to the heart

Knowing the status of these two variables is very important when taking care of critically ill patients. However, these two variables are interrelated and influence one another, so this can make it very difficult to interpret how one (or both) may be influencing the central venous pressure. There are 4 major determinants of cardiac function: preload, afterload, heart rate and contractility.
According to the Frank-Starling curve, if the right atrial pressure (preload) stays constant, cardiac output can still be influenced by changes in the other three factors. So while CVP alone cannot tell the whole story, it can give a good approximation of the hemodynamic status and right-sided cardiac function of the patient. Furthermore, if the patient is healthy and has good heart and lung function, the central venous pressure can provide a good estimate of the cardiac function of the left side of the heart as well.

**Normal CVP Waveforms**

The central venous waveform seen on the monitor reflects the events of cardiac contraction; the central venous catheter “senses” these slight variations in pressure that occur during the cardiac cycle and transmits them as a characteristic waveform. There are three positive waves (a, c, and v) and two negative waves (x and y), and these correlate with different phases of the cardiac cycle and EKG.

- **‘a’ wave**: This wave is due to the increased atrial pressure during right atrial contraction. It correlates with the P wave on an ECG.

- **‘c’ wave**: This wave is caused by a slight elevation of the tricuspid valve into the right atrium during early ventricular contraction. It correlates with the end of the QRS segment on an ECG.

- **‘x’ descent**: This wave is probably caused by the downward movement of the ventricle during systolic contraction. It occurs before the T wave on an ECG.

- **‘v’ wave**: This wave arises from the pressure produced when the blood filling the right atrium comes up against a closed tricuspid valve. It occurs as the T wave is ending on an ECG.

- **‘y’ descent**: This wave is produced by the tricuspid valve opening in diastole with blood flowing into the right ventricle. It occurs before the P wave on an ECG.

**Pathologic CVP Waveforms**

Variations on the normal central venous waveform can provide information about cardiac pathology. For example:

- In atrial fibrillation, ‘a’ waves will be absent, and in atrioventricular disassociation, ‘a’ waves will be dramatically increased (“cannon waves”) as the atrium contracts against a closed tricuspid valve.

- In tricuspid regurgitation, the ‘c’ wave and ‘x’ descent will be replaced by a large positive wave of regurgitation as the blood flows back into the right atrium during ventricular
contraction. This can elevate the mean central venous pressure, but it is not an accurate measurement. A better way of estimating CVP in this case would be to look at the pressured between the regurgitation waves for a more accurate mean.

• In cardiac tamponade, all pressure will be elevated, and the ‘y’ descent will be nearly absent.

Central Venous Catheter Placement

There are a few places on the body where central venous access can be (more or less) easily attained. In order to measure central venous pressure, the catheter tip should end up just above, or at the junction of, the superior vena cava and the right atrium. Possible cannulation sites for central venous access include:

• Basilic (arm) vein
• Femoral vein
• Subclavian vein
• Internal jugular vein
• External jugular vein

Choosing the central vein site

There are a number of central veins and for each of these there are a variety of techniques. It should be remembered that, with the exception of the external jugular, central veins are often deep and have to be located blindly. This is associated with risk to nearby structures, especially in the hands of the inexperienced operator. Veins commonly lie close to arteries and nerves, both of which can potentially be damaged by a misplaced needle. The subclavian vein also lies close to the dome of the pleura, damage to which can cause a pneumothorax. The choice of route will therefore depend on a number of factors:

Factors which determine the choice of central vein

| Patient:                          | How long will the catheter be required? ie. long term / intermediate / short term.  
|                                  | Suitability of the vein for technique chosen e.g. for CVP measurement the tip of the catheter must be within the thorax. A femoral route therefore needs a long catheter |
| Operator:                        | Knowledge and practical experience of the technique |
| Technique characteristics:       | Success rate for vein cannulation  
|                                  | Success rate of central placement  
|                                  | Complication rate  
|                                  | Applicability to patients of different ages  
|                                  | Ease of learning  
|                                  | Puncture of a visible and/or palpable vein or 'blind' venepuncture based on knowledge of anatomy |
| Equipment available:             | Availability of suitable apparatus  
|                                  | Cost  
|                                  | Suitability of material for long term cannulation |

Types of central venous catheters

Catheters are available which differ in length, internal diameter, number of channels (access ports), method of insertion (see below), material and means of fixation. Two useful lengths are 20cm catheters for subclavian and internal jugular lines, and 60cm catheters for femoral and basilic lines.

Different methods of insertion

There are several basic methods of inserting the catheter after the vein has been found:
• **Catheter over the needle.** This is a longer version of a conventional intravenous cannula and may be quickly inserted with a minimum of additional equipment. The catheter is larger than the needle, which reduces the leakage of blood from the insertion site, but using a larger needle to find the vein makes the consequences of accidental arterial puncture more serious. In addition it is easy to over-insert the needle.

• **Catheter over guidewire (Seldinger technique).** This is the preferred method of insertion. A small diameter needle (18 or 20 gauge) is used to find the vein. A guidewire is passed down the needle into the vein and the needle removed. The guidewire commonly has a flexible J-shaped tip to reduce the risk of vessel perforation and to help negotiate valves in the vein e.g the external jugular vein (EJV). Once the wire is placed in the vein, the catheter is passed over it until positioned in the vein. The wire should not be over-inserted as it may kink, perforate the vessel wall or cause cardiac arrhythmias. This technique allows larger catheters to be placed in the vein after the passage of appropriate dilators along the wire and a small incision in the skin at the point of entry.

• **Catheter through the needle or catheter through cannula.** The catheter is passed through a cannula or needle placed in the vein. The technique is becoming less popular as the hole made in the vein by the needle is larger than the catheter that is passed leading to some degree of blood leakage around the site. If a problem is encountered during threading the catheter, withdrawal of it through the needle risks shearing part of the catheter off with catheter embolisation into the circulation. This technique is mainly reserved for the antecubital route.

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**Internal Jugular Vein Cannulation:**

Each site has its limitations and advantages; however, the right internal jugular (IJ) vein is a very commonly used site for central venous cannulation due to a number of factors:

• Ease of accessibility to the anesthesiologist during surgery
• High success rate
• Low rate of complications
• Best for use of pulmonary artery catheters
• Suitable for long-term use

Disadvantages include the experience required to place a central venous catheter into the right IJ, and the possible complications during the procedure. The technique for CVC insertion is the same for single, double, and triple lumen catheters as well as dialysis lines.
**Anatomy**

The internal jugular vein begins just medial to the mastoid process at the base of the skull. (Remember from anatomy that the carotid artery, internal jugular vein, and the vagus nerve are all contained in the same carotid sheath in the neck.) The internal jugular vein runs directly inferior from the mastoid process, passing under the sternal end of the clavicle. Here it joins the subclavian vein, and then runs into the superior vena cava and then into the right atrium.

**Technique of cannulating the right IJV**

Looking at the surface anatomy, the internal jugular vein courses like a straight line down from the mastoid process to the medial side of the insertion point of the clavicular head of the sternocleidomastoid muscle (SCM). Recall that the SCM has two heads, the clavicular (lateral) head which inserts laterally on the clavicle, and the sternal (medial) head, which inserts medially on the sternum giving the whole muscle the shape of an upside-down ‘V’.

For purposes of internal jugular vein access, an important anatomic triangle is formed by the two heads of the SCM and the medial 1/3 of the clavicle. It is within this triangle that the right IJ is most safely and readily cannulated. Within this triangle, the carotid artery lies medial and slightly posterior to the internal jugular vein; therefore here there is less chance of accidentally puncturing the carotid artery during catheter insertion.

**The material**

Most of the instruments and materials needed for placing a central venous catheter come in a prepackaged, sterile “kit.” The list of material required is:
Vascular Access: Central Venous Pressure Catheterization

- Universal precautions material
- Tape and dressings
- IV tubing
- IV fluid
- Drapes.
- A 25 or 26 G needle with a small syringe attached and a vial of 1% lidocaine.
- A 22 gauge “finder needle” with 5ml syringe. This needle is used to find the internal jugular vein initially- its small size makes it safer to use when in the process of locating the vein. If the carotid artery is inadvertently punctured with this needle, there is a decreased risk of a large hematoma forming, and other complications arising.
- An 18 gauge IV needle with a catheter hub attached to a 10 ml syringe. This is used to create an opening in the vein large enough to pass the guide-wire through. The soft plastic IV catheter around the needle is left in the vein while the needle is withdrawn.
- A long clear tubing to test the venous access. The tubing is filled with sterile saline, attached to the IV catheter lying within the vein and is lifted straight up. If the column of water drops, the hub is successfully within the vein.
- Guide wire: This is a long, soft, flexible wire that is mounted in a plastic loop in order to ease the insertion into the hub of the IV catheter; the wire helps to direct the central venous catheter the vein. It has a “J” shaped bend on one end to protect the vein once it is inserted. The central venous catheter will be fed into the vein using this wire as a lead.
- A #11 scalpel: This is used to enlarge the entry into the vein while the guide wire lies within the vein.
- Suture: This is used to attach the body of the catheter to the skin after insertion. It acts as an added safety measure to prevent the catheter from being inadvertently pulled out.
- CVP Catheter: This is the catheter that will be inserted into the vein. This catheter could be single, double or triple lumen.
- Vessel dilator: This is the blue length of firm plastic that is part of the body of the catheter while the catheter is being inserted. It dilates the vein and helps the catheter pass smoothly into the vein. It is removed after insertion.

**Pre-procedure patient education:**
- Obtain informed consent
- Inform the patient of the possibility of major complications and their treatment. Explain the major steps of the procedure
- Explain the necessity of a prolonged Trendelenberg position

**The Procedure**
1. The first step will be to place the supine patient in Trendelenburg position. This head down position will make the internal jugular vein more prominent, and therefore, easier to cannulate. It also will help prevent against dangerous air emboli which could occur during the procedure.
2. First acquaint yourself with the anatomical landmarks you will be using during the procedure before the patient is sterile and draped. Ask the patient to turn their head to
the left; this will open up the right side of the neck which you will be working on. A
typical technique for ascertaining where the vein lies begins by first locating the two
heads of the SCM. You can ask the patient to try to lift their head up off the table, and
then look for the clavicular and sternal heads while the muscle is tense. Once you have
located both heads of the SCM, you will trace them back to where they form the superior
 apex of the “triangle” discussed earlier. This superior corner formed by the two heads
of the SCM will be where you will attempt cannulation of the internal jugular vein. You
will insert the needle here at a 45 angle and point it towards the ipsilateral nipple of the
patient.
3. Put on sterile gloves, prepare a wide area of the neck with an aseptic solution, and then
drape the area completely.
4. With everything draped and sterile, you must re-acquaint yourself with the anatomical
landmarks and again locate the “V” where the two heads of the SCM meet. Palpate
the carotid artery to reassure yourself it is medial to where you plan on cannulating the
patient. Draw up the 1% lidocaine with the 25 gauge needle to anesthetize the area.
Start by creating a wheal right under the skin, and then continue to inject the lidocaine
deeper, pulling back on the syringe before injecting at each depth, to make sure you have
not hit a vessel. Make the initial wheal large enough to anesthetize the area you will be
suturing later as well!
5. Begin by using the 22 gauge “finder needle” attached to a 5 ml syringe. Insert the needle
at a 45 degree angle in the corner formed by the two SCM heads, pointing towards the
ipsilateral nipple of the patient. Gently pull back on the syringe as you advance the
needle deeper. A stream of dark red blood into the syringe indicates that you’ve hit the
internal jugular vein. If the needle does not hit the vessel, withdraw the needle a bit and
then advance it again in a slightly more lateral course.
6. Sometimes, due to certain factors (a very long or very thick neck) it may be difficult to
find the internal jugular vein by landmarks alone. When finding the IJ proves difficult,
often it is helpful to use ultrasound guidance to place the finder needle.
7. Once the finder needle has been placed within the vein, take the larger 18 gauge IV
catheter and attached syringe, and insert it in the same location and course that the finder
needle was in when it punctured the vein. Advance the needle slowly while gently pulling
back on the syringe. Once the needle is within the lumen of the vein (as evidenced by
a stream of dark red blood into the syringe), the catheter can be advanced into the vein,
and the needle is withdrawn. Care should be taken to cover the end of the IV catheter
hub with a finger to prevent venous air embolism.
8. At this point the long plastic tubing, filled with sterile saline or aspirated blood, can be
connected to the hub within the vein, and raised straight up. The column of water should
fall slowly, indicating that the needle hub is successfully within the lumen of the vein.
Remove the tubing, and keep your finger covering the hub.
9. Take the guide wire in the hand that is not capping the catheter hub, and using your
thumb, slowly advance the wire into the needle hub, and into the vein. The wire should
advance easily, without resistance. When the wire is about 15cm into the vein, it is safe
to remove the needle hub over the wire.
10. With the #11 scalpel, make a small incision right along the guidewire into the skin to
increase the size of the opening through which the much larger catheter will have to pass.
The blade should be pointed away from the carotid artery, either laterally or
inferiorly, while making the incision.
11. With the dilator in place in the body of the introducer, thread the catheter over the guidewire into the neck. The catheter should slide into the vein, and at this point the dilator and the guidewire can be removed. To check for proper placement of the catheter, be sure the ports of the catheter flush and draw easily.

12. Using the suture provided, loosely secure the catheter to the skin and finish with a square knot.

13. At this time, a sterile dressing can be applied to cover the catheter and secure it to the neck.

Central Venous Catheter Complications

Certain problems can occur with any of the routes for central venous access. The incidence of each complication varies for each route described:

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<td>Bleeding</td>
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<td>Injury to surrounding nerves</td>
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<td>Air embolism</td>
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The main complications that can arise from central venous cannulation are as follows.

Problems during CV cannulation

- **Arterial puncture**: Usually obvious but may be missed in a patient who is hypoxic or hypotensive. If unsure, connect a length of manometer tubing to the needle / catheter and look for blood flow which goes higher than 30cm vertically or is strongly pulsatile. Withdraw the needle and apply firm direct pressure to the site for at least 10 minutes or longer if there is continuing bleeding. If there is minimal swelling then retry or change to a different route.

- **Suspected pneumothorax**: If air is easily aspirated into the syringe (note that this may also occur if the needle is not firmly attached to the syringe) or the patient starts to become breathless. Abandon the procedure at that site. Obtain a chest radiograph and insert an intercostal drain if confirmed. If central access is absolutely necessary then try another route on the same side or either femoral vein. Do not attempt either the subclavian or jugular on the other side in case bilateral pneumothoraces are produced.

- **Arrhythmias during the procedure**: Usually from the catheter or wire being inserted too far into the right ventricle. The average length of catheter needed for an adult internal jugular or subclavian approach is 15cm. Withdraw the wire or catheter if further than this.

- **Air embolus**: This can occur, especially in the hypovolaemic patient, if the needle or cannula is left in the vein whilst open to the air. It is easily prevented by ensuring that the patient is positioned head down (for jugular and subclavian routes) and that the guidewire or catheter is passed down the needle promptly.

- **The wire will not thread down the needle**: Check that the needle is still in the vein. Flush it with saline. Try angling the needle so the end of it lies more along the plane of the vessel. Carefully rotate the needle in case the end lies against the vessel wall. Reattach the syringe and aspirate to check that you are still in the vein. If the wire has gone through the needle but will not pass down the vein it should be very gently pulled back. If any resistance is felt then the needle should be pulled out with the wire still inside, and the procedure repeated. This reduces the risk of the end of the wire being cut off by the needle tip.

- **Persistent bleeding at the of entry**: Apply firm direct pressure with a sterile dressing. Bleeding should usually stop unless there is a coagulation abnormality. Persistent severe bleeding may require surgical exploration if there is an arterial or venous tear.
Subclavian Venipuncture - Infraclavicular Approach

Large veins such as the subclavian have relatively constant relationships to easily identifiable anatomic landmarks. This makes the subclavian a good site for central line placement.

**Indications**

- Placement of venous access line when other peripheral sites are unavailable
- Placement of a large-bore venous catheter in an emergent situation to deliver a high flow of fluid or blood products
- Central venous pressure measurement
- Administration of sclerosing agents such as chemotherapeutic agents, hyperalimentation fluids, etc.
- As an alternative to repetitive venous cannulations
- For placement of pulmonary wedge catheters
- For placement of trans venous pacemakers
- For performance of hemodialysis or plasmapheresis

**Contraindications**

- Infection over the insertion site
- Distortion of landmarks from any reason
- Suspected injury to the superior vena cava (e.g., SVC syndrome)
- Coagulopathies including anticoagulation therapy
- Pneumothorax or hemothorax on the contralateral side
- Inability to tolerate pneumothorax on the ipsilateral side
- Uncooperative patients
- Patients unable to tolerate a Trendelenberg position
- Prior injury to that vein (choose the one on the other side)
- Morbid obesity
- Recently discontinued subclavian catheter at the same location
- Planned mastectomy on the side of subclavian insertion
- Patients receiving ventilatory support with high end expiratory pressures (temporarily reduce the pressures)
- Patients with vigorous, ongoing cardiopulmonary resuscitation
- Children less than 2 years (higher complication rates)
- Fracture or suspected fracture of ipsilateral upper ribs or clavicle

**Materials**

- Universal precautions material
- Tape and dressings
- IV tubing
- IV fluid
- Central line kit
- Bath towel or rolled up sheet
Vascular Access: Central Venous Pressure Catheterization

- Availability of STAT chest radiography

**Pre-procedure patient education**

- Obtain informed consent
- Inform the patient of the possibility of major complications and their treatment. Explain the major steps of the procedure
- Explain the necessity of a prolonged Trendelenberg position

**Procedure (Infraclavicular Approach)**

- Use Universal Precautions and sterile technique
- Attach the IV tubing to the IV fluids and place at the bedside on an IV pole
- Place the patient in a Trendelenberg position (15 to 30 degrees head down) to reduce the chance of an air embolism
- Turn the patient's head to the side contralateral to the site chosen
- Place a rolled towel or sheet between the shoulder blades to make the clavicles more prominent but do not over-accentuate this position since it might move the clavicle closer to the first rib, making cannulation of the subclavian vein more difficult
- Place the arms to the sides of the patient (restrain if necessary)
- Locate landmarks

1. The subclavian vein is a continuation of the axillary vein
2. Subclavian vein is located just deep to the middle third of the clavicle, and runs parallel to it (this is the only area where there is a close anatomic relationship between the subclavian vein and the clavicle)
3. The subclavian vein is valveless and has a diameter of 1 to 2 cm.
4. The subclavian artery is superior and posterior to the vein and is separated from the vein behind the anterior scalene muscle.
5. The costoclavicular ligament connects the first rib to the clavicle
6. The costoclavicular ligament lies at the junction of the medial third and middle third of the clavicle at the point where the clavicle bends slightly posteriorly
7. The subclavian vein traverses an imaginary line connecting two points established by placing ones thumb over the costoclavicular ligament and index finger in the suprasternal notch
8. Contiguous structures include the phrenic nerve, the thoracic duct on the left side and the lymphatic duct on the right side.
9. The left subclavian approach has a sweeping curve to the apex of the right ventricle and is the preferred approach for temporary transvenous pacing
10. The right subclavian vein approach is generally preferred because the dome of the pleura of the right lung is usually lower than the left, and the left-sided large thoracic duct is less likely to be lacerated
11. By pre measuring the catheter length against the patient’s chest size, one can determine a catheter length that will place the catheter tip about 2 to 3 cm below the manubrial-sternal junction (in the superior vena cava, just above the right atrium)
Before gloving, mark a spot 1 cm caudad to the clavicle at the junction of the middle and medial thirds of the clavicle

Prepare and dress the area

Using a 25 gauge needle and 1 cc of lidocaine, anesthetize the spot that you have marked

Using a 22 gauge needle and more lidocaine, anesthetize the structures deeper to the spot marked

Use the 22 gauge needle (seeker needle) on a 3 cc syringe to locate the vein, aspirating as the needle is advanced until a flush of blood returns

Note the angle and depth of the seeker needle and remove it

Use an 18 gauge needle on a 5 cc syringe to follow the path of the seeker needle, aspirating as the needle is advanced. Entry into the vein is marked by a flush of blood.

Stabilizing the needle with the thumb and forefinger, remove the syringe and immediately occlude the hub of the needle (maintaining a “closed system”)

Thread the J wire into the 18 gauge needle leaving about half of the wire extruding from the needle

Secure the J wire with a finger tip and remove the 18 gauge needle over the exposed, remaining portion of the J wire

Make a small cut in the skin adjacent to the entry site of the J wire using a scalpel

Thread the silastic dilator over the wire

Advance the dilator fully into the chest

Remove the dilator while still leaving the J wire in place

Remove the hub from the long central catheter

Thread the long central catheter over the wire into the vein

Leave 5 to 10 cm of the catheter outside the skin

Carefully remove the J wire

Attach IV tubing to the catheter
Vascular Access: Central Venous Pressure Catheterization

- Lower the IV bag below the level of the patient to observe for blood return
- Discontinue the Trendelenberg position
- Secure the catheter in place using sutures and ties
- Place an occlusive dressing over the catheter
- Obtain a STAT post-procedure chest x-ray looking for a pneumothorax or hemothorax, and looking for the catheter position. The STAT chest x-ray should be obtained whether the procedure is successful or not.

Complications, Prevention and Management: similar to the IJV cannulation, described above.

Documentation in the Medical Record
- Written consent
- Indication(s) for the procedure
- The lack of contraindications
- The procedure including prep, anesthesia, technique
- Any complications or “none”
- Who was notified about any complication (family, attending physician, etc.)

The Femoral Vein CVC insertion:
This may be the safest and most accessible central vein in children requiring resuscitation where peripheral access has failed. It is also a preferred route for inexperienced operators, due to the minimal risk of serious complications. The femoral vein (FV) should not be used for more than a few days due to the risk of contamination and infection from the groin area. With pelvic or intra-abdominal injury an alternative central vein is preferred. Remember that the femoral route is not a good choice for CVP monitoring since the value will be altered by the intra-abdominal pressure unless a long catheter is used to pass above the level of the diaphragm.

Anatomy. The FV starts at the saphenous opening in the thigh and accompanies the femoral artery ending at the inguinal ligament, where it becomes the external iliac vein. In the femoral triangle the FV lies medial to the artery. Here it occupies the middle compartment of the femoral sheath, lying between the artery and the femoral canal. The femoral nerve lies lateral to the artery. The vein is separated from the skin by superficial and deep fasciae.

Preparation and positioning. Abduct and externally rotate the thigh slightly.

Performance of the technique. Identify the pulsation of the femoral artery 1-2 cm below the inguinal ligament. Insert the needle about 1cm medial to the pulsation and aim it towards the head and medially at an angle of 20-30° to the skin. In adults, the vein is normally found 2-4cm from the skin. In small children reduce the elevation on the needle to 10-15° since the vein is more superficial.

Complications. Arterial puncture is possible if the needle is directed too lateral. Femoral nerve damage may follow incorrect lateral insertion of the needle. Infection is the commonest problem with femoral catheters and they are not recommended for long-term use.

The Antecubital Veins CVC Insertion:
A palpable vein in the antecubital fossa provides the safest route for central venous access. A long 60cm catheter is required. There are a number of veins in the antecubital fossa - use one on the medial side.
Anatomy. Venous blood from the arm drains through two intercommunicating main veins, the basilic and the cephalic as illustrated in figure 3.

**Basilic vein.** Ascends from the hand along the medial surface of the forearm draining blood from that area and medial side of the hand. Near the elbow the vein changes to a position in front of the medial epicondyle where it is joined by the median cubital vein. It then runs along the medial margin of the bicep muscle to the middle of the upper arm where it pierces the deep fascia to run alongside the brachial artery becoming the axillary vein.

**Cephalic vein.** Ascends on the front of the lateral side of the forearm to the front of the elbow, where it communicates with the basilic vein through the median cubital vein. It then ascends along the lateral surface of the biceps muscle to the lower border of pectoralis major muscle, where it turns sharply to pierce the clavipectoral fascia and pass beneath the clavicle. It then usually terminates in the axillary vein although it can join the EJV. There are valves at the termination of the cephalic vein. The sharp angle and the valves frequently obstruct the passage of a catheter along the cephalic system.

**Median cubital vein.** The median cubital vein is a large vein that arises from the cephalic vein just below the bend in the elbow and runs obliquely upwards to join the basilic vein just above the bend in the elbow. It receives veins from the front of the forearm which themselves may be suitable for catheterisation. It is separated from the brachial artery by a thickened portion of the deep fascia (bicipital aponeurosis).

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**Preparation and positioning.** Apply a tourniquet to the upper arm to distend the veins and select the best one. The order of preference for veins are:

- A vein on the medial side of the antecubital fossa - the basilic or median cubital vein. Even when not visible, these veins are often easily palpable when engorged
- A vein on the postero-medial aspect of the forearm - a tributary of the basilic vein. Rotation of the arm may be required.
- The cephalic vein

Lie the patient supine with the arm supported at 45° to the body and the head turned towards you (helps prevent the catheter passing into the IJV on that side).

**Technique.** Stand on the same side of the patient. Estimate the length of catheter needed
Vascular Access: Central Venous Pressure Catheterization

to reach the SVC. Puncture the chosen vein with the needle and cannula and remove the needle. Insert the catheter through the cannula and advance it a short distance (2-4cm in adults, 1-2cm in children) then release the tourniquet. Steadily advance the catheter along the vein until it is estimated to be in the correct position.

**Complications.** Local bleeding since the catheter is smaller diameter than the needle used to puncture the vein. Apply direct pressure with a sterile swab.

**External Jugular Venous Catheter**
The external jugular vein is a peripheral vein that generally is neither collapsed (with a patient in a Trendelenberg position) nor thrombosed. This site is often difficult for the patient because the catheter entrance and the dressing are on the patient’s neck. The external jugular vein may be the site of last resort when a patient needs peripheral access but other veins are not usable. The external jugular vein may be used for non-sclerosing fluid administration. Note that, as with other IV sites, shorter catheters of a given caliber can deliver more fluid than a longer catheter, and shorter catheters may be preferred in the situation where large amounts of fluid are being given emergently.

**Indications**
- Placement of a venous access line when other peripheral sites are unavailable. Placement of a large-bore venous catheter in an emergent situation to deliver a high flow of fluid or blood products
- Rarely, for central venous pressure measurement or other CVP catheter uses (transvenous pacemaker, pulmonary wedge catheter, etc.)

**Contraindications**
- Infection over the insertion site
- Lack of anatomic landmarks due to neck size, shape or deformities
- Suspected or proven fracture of the cervical spine
- With coagulopathies, other more easily compressible sites should be considered.
- Patients unable to tolerate a Trendelenberg position
- Unsuccessful contralateral attempt at insertion with resultant hematoma

**Materials**
- Universal precaution material
- Tape and dressings
- Lidocaine (1 % lidocaine mixed 50:50 with sodium bicarbonate will lessen the sting of the lidocaine)
- Syringe (5 cc) and 25 gauge needle
- IV tubing
- IV fluid
- Prep wipes for the neck
- Large bore IV catheter over needle (for adults, 14 to 18 gauge)

**Preprocedure patient education**
- Obtain informed consent
- Inform the patient of the possibility of major complications and their treatment. Explain
the major steps of the procedure

- Explain the necessity of a prolonged Trendelenberg position

**Procedure**

- Use Universal Precautions and sterile technique
- Attach the IV tubing to the IV fluids and place at the bedside on an IV pole
- Place the patient in a Trendelenberg position (15 to 30 degrees head down) to reduce the chance of an air embolism
- Turn the patient’s head away from the side chosen for insertion
- Prep and drape the entire side of the neck chosen
- Identify the vein
  - Patient Valsalva may help engorge the vein
  - The vein runs from the angle of the mandible infero-laterally to the clavicle, crossing the sternomcleidomastoid muscle 5 cm above the clavicle
- Choose a site at about the midpoint of the vein
- Make a skin wheal with the lidocaine and a 25 gauge needle at the chosen site
- Stretch the skin over the external jugular vein cephalad with your free hand
- Using the other hand, insert the catheter over needle aiming along the axis of the vein toward the clavicle (the vein is generally shallower than one might think)
- When a flash of blood returns, advance the catheter over the needle and remove the needle
- Attach the IV tubing to the catheter and secure the catheter to the neck with tape. Turn on the IV fluids to ascertain that there is good flow.
- For an additional check to ascertain good flow into the vein, remove the IV solution from the pole and lower the bag below the level of the patient to establish that there is blood return from the vein.
- Return the solution bag to the IV pole and regulate the flow of the fluid as necessary.

**Complications, Prevention and Management:** Similar to IJV cannulation, described above.

**Documentation in the medical record**

- Consent if obtained
- The indications and any contraindications for the procedure on this patient. The procedure used including prep, anesthetic, type of needle
- Any complications or “none”
- Who was notified about any complication (family, attending physician, etc.)

**Helpful hints**

- Before removing the needle, slightly bend the IV catheter upwards in its sterile sheath. This “prebending” of the needle allows you to enter the vein in a more shallow fashion, reducing the chances of going too deeply (the external jugular vein, in average sized people is surprisingly shallow)
**Ultrasound guided Technique**

The use of ultrasound has obviated the absolute need for anatomical landmarks in the traditional method of CVC insertion. Ultrasound can readily identify the locations of veins relative to arteries and therefore can take into account for individual anatomic differences. The use of ultrasound in experienced hands decreases the number of attempts and arterial punctures compared with landmark method. It is also the preferred method in difficult cannulations such as those patients with obscure surface landmarks or hypotensive patients. Several meta-analyses have been performed and national recommendations have been made by both the National Quality Forum in the United States and the National Institute of Clinical Excellence in the United Kingdom.

**General Tips on CVC insertion**

1. Be aware that more than 3 failed attempts to cannulate the vein can result in a 6 fold increase in mechanical complication.

2. Aids to distinguish arterial vs. venous cannulation
   a. A pressure transducer can be attached to the needle cannulating the vessel to confirm the presence of venous waveforms and pressure
   b. Blood gases from the needle in the vessel can be measured and compared with a known arterial sample

3. When cannulating the vein be aware of the bevel position in order to direct the guidewire into the desired position. eg. bevel should be facing towards heart with subclavian insertions.

4. With subclavian and IJ insertions be aware that the guidewire need not be inserted to its full depth and may irritate the myocardium causing arrhythmias.

5. Keep track of the guidewire at all times to prevent its embolisation.

6. Advance the dilator only enough to dilate the skin in order to minimize shearing of the vessel.

7. Note the estimated terminal catheter positions for subclavian and IJ lines. This is dependent on the size of the patient. The right manubrium sternal border can be used as an external landmark for safe terminal position of the catheter.

8. In order to decrease the potential for air embolism open catheters should be covered at all times and getting patients to hum will create a positive intrathoracic pressure minimizing the potential of this complication.

**Catheter malposition**

Subclavian and internal jugular catheters should be above the junction of the superior vena cava and the right atrium. This landmark is identified as being above the third right costal cartilage. If not identified then the tip of the catheter should be at or above the tracheal carina. Catheters should not abut the wall of the superior vena cava. There is a risk of perforation of the vena cava and catheters need to be re-positioned as soon as possible. The estimated terminal catheter positions are:

<table>
<thead>
<tr>
<th>Insertion Site</th>
<th>Distance (cm)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
<td></td>
</tr>
<tr>
<td>Internal jugular</td>
<td>14-16</td>
<td>16-18</td>
<td></td>
</tr>
<tr>
<td>Subclavian</td>
<td>14-16</td>
<td>16-18</td>
<td></td>
</tr>
</tbody>
</table>
Comparison of CVC insertion sites

Each CVC insertion site has its associated risks and benefits. Choice of site will depend upon patient factors as well as these risks. The risk of central venous stenosis is much less with the right internal jugular vein than with any other upper body site. This may impact the patient requiring long-term dialysis as central venous stenosis may prevent the creation of fistula in the affected arm.

Comparison of CVC insertions sites

<table>
<thead>
<tr>
<th></th>
<th>Internal Jugular</th>
<th>Subclavian</th>
<th>Femoral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential for Pneumothorax</td>
<td>+</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Infection</td>
<td>++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Catheter tip malposition</td>
<td>+</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Compressibility of vessels in bleeding</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Ease of access during active resuscitation</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Ease of use with US guided techniques</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Patient comfort and maintenance of dressing</td>
<td>++</td>
<td>+++</td>
<td>+</td>
</tr>
</tbody>
</table>

Frequency of Mechanical Complications

CVC placements are associated with potentially lethal complications including arterial puncture, pneumothorax, an increase number of skin punctures causing bleeding complications, delay and failure to catheterize, thoracic duct injury with left subclavian or left internal jugular approach, air embolism, arrhythmias, and death. Delayed complications include infection and thrombosis.

Frequency of Mechanical Complications According to the Route of Catheterization:

<table>
<thead>
<tr>
<th>Complication</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal Jugular</td>
</tr>
<tr>
<td>Arterial puncture</td>
<td>6.3-9.4</td>
</tr>
<tr>
<td>Hematoma</td>
<td>&lt;0.1-2.2</td>
</tr>
<tr>
<td>Hemothorax</td>
<td>N/A</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>&lt;0.1-0.2</td>
</tr>
<tr>
<td>Total</td>
<td>6.3-11.8</td>
</tr>
</tbody>
</table>

Predictors of difficult cannulation

- Emergency Placement
- Obesity
- Coagulopathy
- Intubated
- Hypotensive/Hypovolemic
- Edematous patient
- Known previous difficult cannulation

Aftercare of the Central venous Catheter

- It is recommended that a chest x-ray be performed following placement of the subclavian and internal jugular CVC to confirm placement and to rule out pneumothorax.
Vascular Access: Central Venous Pressure Catheterization

- The longer a CVC remains in the patient the greater chance there is for infection and thrombosis. The utility of the CVC must be reviewed on a daily basis and be removed at the earliest opportunity.
- Aseptic technique should be maintained when connecting, disconnecting, injecting, and aspirating from the catheter.
- Keep the entry site covered with a dry sterile dressing
- Ensure the line is well secured to prevent movement (this can increase risks of infection and clot formation)
- Change the catheter if there are signs of infection at the site.
- Some people suggest changing a catheter every 7 days to reduce the risks of catheter related sepsis and thrombosis. However, providing that the catheter is kept clean (sterile injections and connections) and there are no signs of systemic sepsis, routine replacement may not be necessary. Repeated cannulation to change lines on a routine basis, rather than based on clinical need, can increase the risks to the patient.

How to measure the CVP

The CVP is measured using a manometer filled with intravenous fluid attached to the central venous catheter. It needs to be ‘zeroed’ at the level of the right atrium, approximately the mid-axillary line in the 4th interspace supine. Measurements should be taken in the same position each time using a spirit level and the zero point on the skin surface marked with a cross. Check that the catheter is not blocked or kinked and that intravenous fluid runs freely in, and blood freely out. Open the 3-way adopter so that the fluid bag fills the manometer tubing (check there is no obstruction to fluid flow and that the cotton wool in the top of the manometer is not blocked or wet). Turn the adapter to connect the patient to the manometer. The fluid level will drop to the level of the CVP which is usually recorded in centimeters of water (cmH2O). It will be slightly pulsatile and will continue to rise and fall slightly with breathing - record the average reading. An alternative to the manometer and 3-way tap is a butterfly needle inserted into the rubber injection port of ordinary intravenous tubing. In Intensive Care Units or theatres, electronic transducers may be connected which give a continuous readout of CVP along with a display of the waveform. Useful information can be gained by studying the electronic waveform. The CVP reading from an electronic monitor is sometimes given in mmHg. The values can easily be converted knowing that 10 cmH20 is equivalent to 7.5 mmHg (which is also 1kPa)

Interpretation of the CVP

As previously stated, the CVP does not measure blood volume directly and is influenced by right heart function, venous return, right heart compliance, intrathoracic pressure and patient
positioning. It should always be interpreted alongside other measures of cardiac function and fluid state (pulse, BP, urine output etc.). The absolute value is not as important as serial measurements and the change in response to therapy. A normal value in a spontaneous breathing patient is 5-10 cm water cmH2O, rising 3-5 cmH2O during mechanical ventilation. The CVP measurement may still be in the normal range even with hypovolaemia due to venoconstriction.

Guide to interpretation of the CVP in the hypotensive patient

<table>
<thead>
<tr>
<th>CVP reading</th>
<th>Other features that may be present</th>
<th>Diagnosis to consider</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Rapid pulse</td>
<td>Hypovolaemia</td>
<td>Give fluid challenges* until CVP rises and does not fall back again. If CVP rises and stays up but urine output or blood pressure does not improve consider inotropes</td>
</tr>
<tr>
<td>Low or normal or high</td>
<td>Rapid pulse</td>
<td>Sepsis</td>
<td>Ensure adequate circulating volume (as above) and consider inotropes or vasocostrictors</td>
</tr>
<tr>
<td>Normal</td>
<td>Rapid pulse</td>
<td>Hypovolaemia</td>
<td>Treat as above. Venoconstriction may cause CVP to be normal. Give fluid challenges and observe effect as above.</td>
</tr>
<tr>
<td>High</td>
<td>Unilateral breath sounds</td>
<td>Tension pneumothorax</td>
<td>Thoracocentesis then intercostal drain</td>
</tr>
<tr>
<td>High</td>
<td>Breathlessness</td>
<td>Heart failure</td>
<td>Oxygen, diuretics, sit up, consider inotropes</td>
</tr>
<tr>
<td>Very High</td>
<td>Rapid pulse</td>
<td>Pericardial tamponade</td>
<td>Pericardiocentesis and drainage</td>
</tr>
</tbody>
</table>

Catheter removal

Remove any dressing and suture material. Ask the patient to take a breath and fully exhale. Remove the catheter with a steady pull while the patient is breath holding and apply firm pressure to the puncture site for at least 5 minutes to stop the bleeding. Excessive force should not be needed to remove the catheter. If it does not come out, try rotating it whilst pulling gently.

References
