London School of Paediatrics

Part-Task Training Guide for Paediatricians

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BASIC AIRWAY MANAGEMENT

Basic airway management is the vital first step in managing the airway in the unwell child.

**Indication:**

1. Hypoxia
2. Hypercapnia
3. Respiratory failure
4. Neurological failure

**Equipment:**

- Intubating head – includes sim-baby
- Face masks – appropriately sized
- Oropharyngeal airways/Guedel airways – appropriately sized
- Nasopharyngeal airways – appropriately sized ETT
- Oxygen masks with reservoir
- Suction equipment – yankauer sucker
- Ambu-bag

Advanced airway equipment should be available.

**Procedure:**

1. **Airway opening manoeuvres**
   - The airway should be opened using the Head Tilt/Chin Lift – see below.
   - Infant – Neutral position.
   - Older child – Sniffing the morning air position.
   - The Jaw Thrust should be used where there is concern about the possibility of C-spine/basal skull fracture.

   ![Neutral position](image)

   ![Sniffing position](image)

   ![Jaw thrust – no head tilt](image)
2. **Bag-valve mask ventilation**
   - Place mask over airway covering nose and mouth with a good seal.
   - This is achieved ensuring that the airway remains patent, and using a jaw thrust grip. The thumb and fore-fingers hold the mask in place.
   - Using the Ambubag – squeeze the bag, and watch for inflation of the chest.

If there is no chest rise, then check that the airway is open and patent.

3. **Airway adjuncts**

   **Oropharyngeal airway/Guedel airway:**
   - Where the patient is unconscious, an oropharyngeal airway may assist with ventilation.
   - If placed in a patient with a gag reflex, this may lead to choking, bronchospasm or vomiting.
   - The oropharyngeal airway should be sized: this is from the centre of the mouth to the angle of the jaw.

   **Placement:**
   - Open the child’s airway using into the appropriate position.
   - In an infant place the oropharyngeal airway under direct vision using a tongue depressor or laryngoscope – and place the airway “the right way up”
   - In an older child, insert the airway concave upwards until the tip reaches the soft palate. Rotate it through 180° so that the concave side is down and slide it back over the tongue.
   - Re-check airway patency.
   - Provide oxygen.

![Diagram 1: Oro-pharyngeal airway in position](image-url)
Nasopharyngeal (NP) airway:

- This may be placed in a more awake patient. It is contraindicated where a basal skull fracture is suspected. Care should be taken if there is active bleeding or coagulopathy.
- The nasopharyngeal airway should be appropriately sized – there are no NP airways available for children, so ETT should be used and sized. The correct length is the tip of the nose to the tragus of the ear, and correct internal diameter is the size of the nostril of the patient or the size of the patient’s little finger.

Placement:

- The tip of the NP airway should be lubricated.
- Gently insert the airway into the nostril directing it posteriorly along the floor of the nose. There will be a “give” as the tube advances into the pharynx.
- If there is any difficulty, the NP airway should be withdrawn.
- The airway should be secured when fully inserted into the nostril.
- Re-check airway patency.
- Provide ventilation.

Diagram: Naso-pharyngeal airway in position

References:
APLS Manual 2005 / Images from www.google.co.uk

Mehrengise Cooper
ADVANCED AIRWAY INTUBATION

Part Task Teaching aims:

1. Indications for intubation
2. Clinical assessment of risk
3. Anaesthesia and muscle relaxation
4. Process of intubation

1. Indications for intubation
   - Respiratory failure (failure to oxygenate, failure to ventilate)
   - Airway patency or protection
   - Cardiovascular support (shock any cause)
   - Neuroprotection (suspected or known raised intracranial pressure)
   - GA for procedure
   - Interhospital transfer of a critically ill child lowers the threshold at which intubation should be considered
   - Cardio-respiratory arrest

2. Clinical assessment of risk
   - Do the benefits outweigh the risks?
   - The main risk is HYPOXIA due to:
     - Failure to ventilate (CAN'T BAG): difficult to maintain airway or lung disease
     - Failure to intubate: difficult laryngoscopy or ETT insertion (e.g. oesophageal intubation)
   - Other risks include:
     - Anaesthetic drug effects (see anaesthesia and muscle relaxation)
     - Complications include: airway trauma, endobronchial intubation, pneumothorax

3. Anaesthesia and muscle relaxation
   - Anaesthesia and muscle relaxation is used for 2 reasons
     i) Optimize the airway conditions for the operator: reduces failure
     ii) Renders the child unaware and reduces physiology stress of the procedure
   - All drugs used have predictable effects that are potentially detrimental

Trainees must know AT LEAST the following regarding the drugs they use in practice:

- Dose range and duration of action
- Side effects
- Contraindications and cautions
Anticipation of Difficult Ventilation / Airway:

If any of the following are identified senior anaesthetic assistance should be sought:

1. Difficulty with previous intubation (grade of larynx)
2. Known clinical syndromes: Down’s, Pierre Robin, Hurlers etc
3. Obvious anatomic problems: jaw protrusion, mouth opening, neck extension
4. Obstructive or deforming head and neck lesions or surgery, obesity
5. High risk pathology: upper airway obstruction e.g. croup, epiglottitis, foreign body, burns
6. Limited pulmonary reserve: pulmonary oedema, chronic lung disease
7. Full stomach

Rapid Sequence Induction (RSI) (Discussion only)

- Only when risk of SIGNIFICANT aspiration is high
- Priority is rapid securing of airway
- Bag and mask ventilation is avoided unless HYPOXIC
- Performed by a skilled operator and assistant
- A clinical example would be a child with bowel obstruction
- It is not a procedure that a paediatric trainee would be expected to perform without anaesthetic assistance
- If hypoxia occurs priority is OXYGENATION

4. Process of intubation

Successful intubation is:

- Clinical stability of the patient (NO HYPOXIA)
- Intubation within one minute with a maximum of 2 laryngoscopy attempts
- Oxygenation between attempts
- Correctly positioned and adequately secured ETT

Step 1. Confirmed low risk intubation scenario

- Notify nurse in charge and identify nurse assistant (inform consultant unless emergency)
- Check equipment available and working
- Confirm functioning iv access in situ
- Choose anaesthetic agent and muscle relaxation
- Emergency drugs available required: fluid bolus, atropine, adrenaline
- Inform parents

Equipment check list:

- Face mask & oropharyngeal airway
- Self inflating bag (+/- anaesthetic circuit)
- 2 appropriate working laryngoscopes (discuss straight v curved blades)
- Appropriate range of endotracheal tubes – cuffed and uncuffed ETT: traditionally ETT are chosen based on the following sizing guide: internal diameter of ETT – age/4+4, and length age/2 +12 (oral), age/2+15 (nasal)
- Magill forceps
- High pressure suction with yanker attached
- NG tube in situ and aspirated or ready to insert
- Mandatory monitoring: pulse oxymetry (set audible tone if possible), ECG, capnography and non invasive BP (1min intervals)
- Laryngeal masks available
- Gum elastic bougie (discuss when this might be used)

Step 2. Standard intubation algorithm NOT RSI

1. Preoxygenate for 3 minutes in 100% oxygen prior to induction
2. Administer anaesthetic agent, wait for effect, confirm ability to ventilate (gently)
3. If unable to ventilate or oxygenate urgently readjust position, use guedel airway, empty stomach via NGT, insert LMA, CALL FOR ASSISTANCE URGENTLY.
4. If able to ventilate administer muscle relaxant and wait for effect before laryngoscopy
5. Continue to oxygenate until muscle relaxation onset
6. Proceed to laryngoscopy

Step 3. Laryngoscopy: ensure oxygenation at all times

   Target = intubate trachea within ONE minute with maximum TWO laryngoscopy attempts

1. Patient supine, neutral/ sniffing position
2. Laryngoscope in left hand
3. Open jaw and advance blade down right tongue gutter over back of tongue
4. Pull handle forwards and to left (Movement at shoulder and elbow, wrist fixed)
5. DO NOT pivot on teeth or gums = trauma and inadequate view
6. Advance until larynx and cords come into view (see grades of laryngoscopy)
7. Straight blade may be used to compress epiglottis to expose cords
8. Curved blade lifts root of epiglottis (see picture below)
9. If advanced too far will note posterior wall of oesophagus
10. May need gentle pressure on cricoid to visualise airway fully
11. If inadequate view of glottis, remove blade and restart mask ventilation
12. Evaluate problem, reposition: usually solves problem
13. After two attempts at laryngoscopy, seek senior help
Grading what is seen at laryngoscopy: likely ease of intubation

Grade I-IV: Straightforward to Very challenging

Step 4. Insertion of Oral ETT

1. Insert oral ETT using right hand
2. Observe ETT advance through cords
3. Insert ETT to bold line on cords
4. DO NOT let go of ETT at any time until tape secured
5. Remove laryngoscope blade
6. Attach ventilation equipment
7. Ensure airway accessed with equal air entry bilaterally. Confirm with ET CO2
8. Secure ETT as unit policy: ACCIDENTAL EXTUBATION SHOULD NOT BE TOLERATED
9. Ensure ongoing adequate sedation +/- muscle relaxation depending on clinical state
10. Obtain chest XRAY: ideal position below clavicles no lower than base of T2
CHEST DRAIN INSERTION

Indications:
In children the main reasons for chest drain insertion are:

- Empyema or significant complicated parapneumonic effusion
- Pneumothorax
- Postoperative eg. thoracotomy, cardiac surgery

This is a relatively rare event in most district general hospitals and is seldom required urgently. Advice from BTS and BPRS in 2008 recommends that children who require chest drain insertion are transferred to a tertiary paediatric respiratory unit for the procedure, provided the child is well enough to transport. The only occasion when chest drain insertion may be necessary in a district general hospital is in the emergency setting when an unwell child is decompensating with a presumed diagnosis of tension pneumothorax or haemopneumothorax. On these occasions it would be appropriate to proceed without imaging as described below and a drain should be inserted by the most senior doctor available.

Contraindications:

- **Haemorrhage** - Where possible any coagulopathy or platelet defect should be corrected prior to chest drain insertion. However, routine measurement is not recommended unless known risk factors
- **Differential diagnosis** - Important to consider pneumothorax vs. bullous disease and differentiated between presence of collapse and a pleural effusion when CXR shows a unilateral 'white out'.
- **Post pneumonectomy** - Drainage should only be performed by a cardiothoracic surgeon

Pre procedure:

**Anaesthesia and personnel**

- General anaesthesia performed by a consultant paediatric anaesthetist is the preferred option for non cooperative children.
- Conscious sedation may be suitable for older, more cooperative children but safety is paramount and same level of monitoring as for GA is required.
- Adequately trained personnel, including a suitable assistant and trained nurse must be available.

Consent

Written informed consent should always be obtained. A patient information leaflet is highly recommended.

Image guidance

When chest drains are inserted for pleural fluid, ultrasound should be obtained to confirm the presence and size of the collection.
- The ultrasonographer must be experienced in pleural ultrasound.
- The doctor inserting the drain MUST be present when the ultrasound is performed, either to insert the drain at the time of ultrasound or to mark the site and depth (of fluid at that point) for safe insertion. In the latter, the operator must take careful note of the position of the child at the time of ultrasound and place them in the same position prior to insertion of the drain.

- Small bore (Mean size 10.2FG) drains are appropriate for most children. Studies in adults have shown that these small bore drains are as effective as large bore and are the choice of the majority of pediatricians. The children are more comfortable, tolerate the procedure better and mobilise more quickly, which aids recovery.
- Larger bore (Mean size 20.1FG) surgical drains, if required, should be inserted in the midaxillary line through the ‘safe triangle’. The only indications for large bore tubes are in emergency drainage of acute haemothorax, for the dual purpose of drainage of the thoracic cavity and assessment of ongoing blood loss, and in some post operative cases.

![Figure 1 The ‘Safe Triangle’](image)

**Equipment**
- Chest tube: 10-12FG (8-14FG should be available).
- Guidewire with dilators for Seldinger technique
- Sterile gloves and gown
- Skin antiseptic solution eg. povidone iodine (Betadine) or chlorhexidine in alcohol
- Sterile drapes
- Sterile gauze swabs
- A selection of syringes (2ml and 5ml) and needles (21-25 gauge)
- Local anaesthetic eg. 0.25% bupivacaine (Marcaine)
- Scalpel and blade
- Suture (eg.2/0 or 3/0 silk)
- Connecting tubing
- Closed drainage system (including sterile water if underwater seal being used)
- Steri strips and adhesive dressings
Procedure:

Technique for insertion of small bore drain using Seldinger technique:

- Position the patient and check radiologist’s mark is still on the skin
- Scrub and put on sterile gown and gloves.
- Check all equipment is present
- Clean the skin with suitable antiseptic
- Draw up and infiltrate local anaesthetic at insertion site. Remember the anatomy of the ribs and intercostals vessels which run along the lower side of the ribs. Local anaesthetic should be infiltrated into the muscle down to the parietal pleura. Unless you can aspirate pleural fluid (or air) at this stage you should not proceed further.

![Figure 1: Anatomy of the ribs and intercostal vessels](image_url)

- Attach a 5 ml syringe to the introducer needle and insert the needle slowly, aiming slightly posteriorly and inferiorly while pulling back gently on the plunger.
- When the needle tip is intrapleural, withdraw pleural fluid. Sometimes (particularly in a multiloculated effusion) very little fluid will be aspirated.
- Detach the syringe, ensuring that the needle stays in place.
- Pass the syringe to the assistant to place into sterile containers for microbiology and cytology as well as an anaerobic blood culture bottle.
- Take the Seldinger wire and pass it via the needle into the pleural space. Stop when you meet resistance. If you meet resistance very early, it may be that the needle was in the wrong position and the tip of the wire is in the muscle.
- When the wire is in place, withdraw the needle back over the wire ensuring the wire does not move.
- Take the scalpel and make a small incision (a few mm) in the skin at the entry point of the wire, in the line of the rib space.
- Pass the smallest dilator over the wire into the pleural space, then the next size up. The larger size drains have three dilators. If there is resistance to the dilator, initially extend the incision in the skin which is usually all that is necessary. Otherwise, try rolling the dilator gently whilst advancing or changing the angle of entry. If there is still resistance, it may be that the wire has become dislodged; if so, reinsert the needle and start again.
- Remove the largest dilator and then pass the drain over the wire into the pleural space. If the guide-wire has been advanced until “resistance is met” it is wise to withdraw the wire partially as the drain is advanced over it to take out the bend at the tip and facilitate easy removal.
- Remove the guidewire and pleural fluid should drain back.
Clamp the drain and suture into position or use a drain holding dressing. Ensure the drain is not kinked (See below).

Attach underwater drain and release clamp but ensure not too much fluid is drained initially; clamp when reaches 10 ml/kg. Release the clamp after an hour.

Apply tape and dressings

Chest radiograph to review position of drain and ensure no pneumothorax has developed. An effectively functioning drain should not be repositioned solely because of its Xray appearance, however.

Securing the drain

The incision may be closed using a non absorbable suture, although this may not be necessary for the smallest drains.

A ‘mattress’ suture or sutures across the incision are usually employed as this is appropriate for a linear incision.

![Figure 2](image)

The drain must be well secured to prevent it falling out. A stay suture can be placed through the skin and then criss crossed up the drain, ensuring this is not too tight as it is possible to occlude a soft drain. Alternatively, special dressings/fixation devices are available to hold small catheters and drains in place. A transparent adhesive dressing is often used to allow inspection of the drain site.

An omental tag of tape has also been described which allows the tube to lie a little away from the chest wall to prevent tube kinking and tension at the insertion site.

![Figure 3](image)

Post procedure:

Management of closed system drainage

- All chest drains should be connected to a unidirectional flow drainage system, such as an underwater seal bottle, which must be kept below the patient's chest at all times
- If air bubbles into the bottle it suggests air in the pleural space.
• The respiratory swing in the fluid in the chest tube is useful for assessing tube patency and confirms the position of the tube in the pleural cavity.

• Appropriately trained nursing staff must supervise the use of chest drain suction. If suction is used it is at a pressure of 5-10cm H2O.

• A bubbling chest drain should never be clamped.

• A clamped drain should be immediately unclamped and medical advice sought if a patient complains of breathlessness or chest pain.

• If draining an effusion, the drain should be clamped for 1 hour once 10ml/kg of fluid is initially removed.

• When there is sudden cessation of fluid draining, the drain must be checked for obstruction (blockage or kinking) by flushing.

Removal of the chest drain

• Analgesia should be used and sedation may be necessary in young children. Local anaesthetic cream applied to the adjacent skin 3 hours prior to removal has been shown to be as effective as iv morphine in pain control.

• The tube should be removed while the patient performs a Valsalva manoeuvre or during expiration, with a brisk firm movement. This should be performed by properly trained nursing or medical staff.

• A CXR should be taken shortly afterwards to ensure pneumothorax has not developed during removal.

Further information and references:

**BTS guidelines for insertion of a chest drain.**

**BTS guidelines for the management of pleural infection in children.**
Thorax 2005;60(Supplement 1 );i1-i21
I M Balfour-Lynn², E Abrahamson¹, G Cohen³, J Hartley⁴, S King⁵, D Parikh⁶, D Spencer⁷, A H Thomson⁸, D Urquhart⁹ on behalf of the Paediatric Pleural Diseases Subcommittee of the BTS Standards of Care Committee

**Guidance for the implementation of local Trust policies for the safe insertion of chest drains in children, following the NPSA Rapid Response Report – NPSA/2008/RRR003**
British Paediatric Respiratory Society/British Thoracic Society, Nov 2008
http://www.spiralblue.co.uk/index.php/View-Video/1/Chest-Drain-Station.html

*Louise Hutchinson*
CHEST DRAIN INSERTION – OPEN TECHNIQUE

Another method of insertion of chest drain is via the open technique. In general this is a technique which minimises lung damage, is more direct, and the largest drain that will pass between the ribs is the ideal.

**Indications, Contraindications:**
As in previous guideline.

**Pre-procedure:**
Appropriate anaesthesia and analgesia as in previous guideline.

**Equipment:**
- Chest drain part-task trainer or appropriate animal model (sheep or rabbit)
- Skin prep, surgical drapes, and appropriate sterile technique equipment
- Clamps and scissors
- Chest drain tube – appropriate size
- Equipment to connect drain including underwater seal
- Suture

**Procedure:**

**Position:**
Place the patient supine or at an elevated 45 degree angle; the arm on the affected side should be externally rotated and abducted.

**Placement:**
1. The usual insertion site is the fifth intercostal space, mid-axillary line.
2. Clean the chest wall and insertion site with surgical prep.
3. Infiltrate insertion site with local anaesthetic if indicated – and wait for this to take effect.
4. Make an incision along the line of the intercostal space just above the rib below – this may be up to 2 cm in length.
5. Perform blunt dissection using a Kelly clamp of the subcutaneous tissues just above the top of the rib and puncture the parietal pleura with the tip of the clamp – this may be deeper than expected.
6. Place a sterile gloved finger into the incision and gently open the tissues up into the pleura. It may be necessary to use the fifth finger in smaller children.

7. Advance the chest tube slowly – WITH NO TROCHAR - into the pleural space.
8. Ensure that the chest tube is in the correct place – checking for air movement etc.
9. Connect the end of the tube to appropriate container with an underwater seal.
10. Secure drain in place.

References:
APLS Manual 2005
eMedicine Tube Thoracostomy: Treatment and Medication April 2008
http://content.nejm.org/cgi/content/short/357/15/e15
Images from www.google.co.uk
CENTRAL VENOUS CATHETERS

The insertion of central lines should only be undertaken either by sufficiently trained staff, or by trainees under the direct supervision of a suitably-trained individual. Inform parents/child and obtain consent (as appropriate).

Strict asepsis should be maintained throughout.

Placement should be performed in the most appropriate clinical area with standard monitoring (including continuous ECG) attached. NICE guidelines recommend the use of 2D-imaging ultrasound guidance for the elective insertion of internal jugular central venous catheters in children and to consider its use in emergency situations. It is also recommended that 2D-imaging ultrasound is used where CVC insertion is considered. Appropriate training in the use of CVC placement using 2D-ultrasound is required for this.

Indications:
- Specific drug infusions (e.g. inotropes, hypertonic solutions, chemotherapy)
- Difficult access
- Parenteral nutrition
- Haemodynamic monitoring
- Replacement therapy (Renal/ECMO)

Contraindications:
- Coagulopathy: care must be taken in children with coagulopathy/thrombocytopenia when considering use of the subclavian route.
- Infection at insertion site.

Complications:
- Thrombosis
- Infected
  - Blood stream
  - Exit site
- Inadvertent arterial puncture
- Traumatic
  - Haematoma
  - Pneumothorax
  - Haemothorax
  - Chylothorax
  - Nerve damage
- Arrhythmias
- Blocked lines
Pre-procedure:

Anaesthesia and personnel

- Sedated and ventilated children on PICU, appropriate intensive care monitoring as standard.
- General anaesthesia performed by paediatric anaesthetist in the younger/non cooperative child.
- Conscious sedation, by appropriately trained staff, for the older child may be considered. Safety is paramount. Same level of monitoring as GA is required.
- Trained assistant.

Equipment

- Sterile field
  - Personal: Surgical scrub, Gown, Gloves, Hat, Mask
  - Ultrasound: Gel, Sheath
  - Patient: Skin disinfectant (eg chlorhexidine 2%, Chloroprep)
- Local anaesthetic (eg Lidocaine 1%)
- Central venous catheter (triple lumen) – appropriate sizes and lengths are listed below.
- Selection of syringes (2ml, 5ml, 10ml) and needles
- Sterile gauze swabs
- Scalpel
- 3-way taps/bungs
- 10ml sterile NaCl
- Suture (eg 2/0, 3/0)
- Transparent adhesive dressings (eg Tegaderm)

Recommended length of catheters at skin (cm)

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<thead>
<tr>
<th></th>
<th>0-5 kg</th>
<th>5-15kg</th>
<th>16-30kg</th>
<th>31-45kg</th>
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<tbody>
<tr>
<td>R Internal jugular</td>
<td>5</td>
<td>6.5/8</td>
<td>8/10</td>
<td>10/12</td>
</tr>
<tr>
<td>L Internal jugular</td>
<td>6.5</td>
<td>8/10</td>
<td>10/12</td>
<td>12/15</td>
</tr>
<tr>
<td>R Subclavian</td>
<td>6.5</td>
<td>8</td>
<td>10/12</td>
<td>10/12</td>
</tr>
<tr>
<td>L Subclavian</td>
<td>6.5</td>
<td>8/10</td>
<td>10/12</td>
<td>12/15</td>
</tr>
<tr>
<td>Femoral</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Size of CVC (Fr)</td>
<td>4.0-5.0</td>
<td>4.5-6.0</td>
<td>5.0-6.0</td>
<td>5.0-7.0</td>
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When placing Central Venous Lines it is important to choose the appropriate sized CVL. Typically when placing a Vascular Access Catheter for Renal Replacement Therapy, larger sized (both Fr and length) catheters are placed. In the majority of paediatric patients either a size 4.5Fr or 5Fr catheter is used (with 4.5 Fr catheters used in the smaller patient group). Check with a senior clinician when choosing a CVC.

Procedure

1. Ensure coagulation and platelet parameters are suitable.
2. Position the patient appropriately.
3. Put on mask and hat, scrub, and put on sterile gown and gloves.
4. Check all equipment is present and prepared (e.g. CVC flushed with saline).
5. Clean skin with antiseptic (and allow to dry).
6. Drape patient with sterile field. If using USS, dress probe with sterile sheath and identify vasculature.
7. Draw up local anaesthetic and infiltrate at insertion site for awake/lightly sedated patients (consider use in all patients).
8. Use the seldinger technique for insertion as outlined below.
9. Insert needle slowly, aspirating continually.
   - if Internal Jugular Vein - aiming for ipsilateral nipple.
   - if Subclavian Vein - aiming for sternal notch.
   - if Femoral Vein - aiming for umbilicus.
   - if using USS, then direct needle as indicated.

The Seldinger technique

1. An introducer needle is used to find the target vessel. This allows the insertion of a guidewire over which the catheter can be passed. The guidewire is then removed.
2. Attach 2ml or 5ml syringe containing saline to introducer needle or appropriate sized abbocath (20G abbocath is suitable for the wire from a 5Fr line; a 22G abbocath is suitable for the wires from the 4Fr and 4.5Fr lines).
3. Insert needle or abbocath slowly, aspirating continually
   - if Internal Jugular Vein - aiming for ipsilateral nipple
   - if Subclavian Vein - aiming for sternal notch
   - if Femoral Vein - aiming for umbilicus
   - if using USS, then direct needle as indicated
4. When blood is aspirated freely, hold needle securely and remove syringe
5. At this point it is important to confirm that the vein has been cannulated and not an artery (in particular for femoral CVC access) – this can be done by checking a blood gas and transducing the vessel.
6. Take guidewire and insert via needle.
   a. Ensure correct (J-shaped) end is inserted first.
   b. The guidewire should insert easily. If resistance is encountered early, consider misplacement and re-aspirate with syringe to confirm intravascular location of needle
7. Ask assistant to monitor looking for ECG changes (suggestive of intracardiac placement of wire). Withdraw until abolished, if this is encountered.
8. When guidewire is in place, withdraw needle. Ensure the guidewire is fixed at all times.
9. Pass dilator over guidewire and dilate passage through skin and subcutaneous tissues. It is not necessary to bury dilator up to the hilt. Consider using scalpel to make a small incision in the skin at the entry point of wire. Remove dilator
10. Pass central venous catheter over the guidewire. Insert to desired depth, according to size of child.
11. Remove guidewire.
12. Ensure all lines aspirate and flush easily.
13. Secure CVC (with sutures and adhesive dressing).

**Insertion site Internal jugular vein**
Right side preferred to left.

- **Advantages** (c.f. to Subclavian)
  - Easily compressible site if inadvertent arterial puncture
  - Lower risk of pneumothorax
  - Lower risk of Catheter Related Blood Stream Infections

- **Disadvantages** (c.f. to Subclavian)
  - More difficult to secure
  - Moves with neck
  - Approximately 8.5% normal variation in anatomy

*Figure 1. Insertion of CVC via the internal jugular approach.*

(Taken from N Engl J Med 2003;348:1125-33)
The apex of the triangle formed by the two heads of the sternocleidomastoid muscle and the clavicle serves as a landmark. The internal jugular vein runs deep to the sternocleidomastoid muscle and then through this triangle before it joins the subclavian vein to become the brachiocephalic vein. The patient is placed in Trendelenburg's position with the head rotated 45 degrees away from the site of cannulation. The physician places the index and middle finger of his or her nondominant hand on the carotid artery and inserts needle through the skin, immediately lateral to the carotid pulse and slightly superior to the apex of the triangle. The needle is advanced past the apex of the triangle, in the direction of the ipsilateral nipple, at an angle of 20 degrees above the plane of the skin. The vein is usually located near the surface of the skin. If the first pass is unsuccessful, the needle should be directed slightly more medially on the next insertion attempt.

**Insertion sight Subclavian vein**

Right side preferred to left

- **Advantages** (c.f to Internal jugular)
  - Anatomy more consistent
  - Catheter not affected by neck movement
  - Better patient tolerance

- **Disadvantages** (c.f to Internal jugular)
  - Increased risk of pneumothorax (beware in patients with significant respiratory disease)
  - Not able to compress haematoma (avoid in coagulopathy/thrombocytopenia)
  - More awkward in presence of chest wall/spinal deformity

![Figure 2. Insertion of CVC via subclavian approach](Taken from N Engl J Med 2003;348:1123-33)
The subclavian vein arises from the axillary vein at the point where it crosses the lateral border of the first rib. It is usually fixed in position directly beneath the clavicle. It is separated from the subclavian artery by the anterior scalene muscle. For catheterization, the patient is placed in Trendelenburg’s position, and a small rolled towel can be placed between the shoulder blades. The skin is punctured caudal to the midpoint of the clavicle. The needle is advanced in the direction of the sternal notch until the tip of the needle abuts the clavicle at the junction of its medial and middle thirds. The needle is then passed beneath the clavicle, with the needle hugging the inferior surface of the clavicle. If no blood returns with passage of the needle, the needle is withdrawn past the clavicle while gentle suction is applied. Blood return may be achieved during withdrawal of the needle. If the first pass is unsuccessful, the needle should be angled in a slightly more cephalad direction on the next insertion attempt.

**Insertion sight Femoral vein**

- **Advantages**
  - No risk of pneumothorax or arrhythmias
  - Easily compressible site
  - More accessible site for insertion

- **Disadvantages**
  - Higher risk of thrombosis (especially in younger patients)

![Image of femoral vein insertion](Taken from Putigna, F., Solenberger, R. Central Venous Access. Emedicine.)

**Figure 3. Insertion of CVC via the femoral approach.**

(Taken from Putigna, F., Solenberger, R. Central Venous Access. Emedicine.)
The femoral vein lies within the femoral triangle. The superior border of the triangle is formed by the inguinal ligament, the medial border by the adductor longus, and the lateral border by the sartorius muscle. The apex of the triangle is formed by the sartorius crossing the adductor longus muscle.

The neurovascular bundle consists of the femoral nerve, artery, and vein, and lies within the triangle in a lateral-to-medial position. The femoral sheath encloses the femoral artery and vein, and the nerve lies outside the sheath. The femoral canal is a space within the femoral sheath and medial to the femoral vein. The femoral artery lies at the mid-inguinal point, which lies midway between pubic symphysis and the anterior superior iliac spine.

The surface anatomy of the femoral vein is identified for venipuncture by palpating the point of maximal pulsation of the femoral artery immediately below the level of the inguinal ligament and marking a point approximately 0.5 cm medial to this pulsation. Distally, in the leg, the femoral vein lies almost posterior to the artery. This is important because arterial puncture is more likely in the sites distal to the inguinal ligament.

Post-procedure

- Document procedure in notes.
- Obtain chest radiograph (if internal jugular or subclavian approach) to ensure appropriate tip placement and absence of pneumothorax (CXR for unsuccessful attempts)
  - Tip position - in SVC just above right atrium. Withdraw tip under sterile conditions. Do not advance tip.
  - If pneumothorax, treat as appropriate
- Exclude arterial cannulation - identify CVP waveform or perform blood gas analysis
- Ensure CVC catheter care bundle in place for future care and access of line.

Additional information

For Video Clips of insertion technique: http://content.nejm.org/misc/videos.dtl
(requires subscription to NEJM)

References:
http://guidance.nice.org.uk/TA49

SMH PICU clinical guidelines


Rob Anker, Mehrengise Cooper
INTRAOSSEOUS ACCESS

Acknowledgements: Guidelines prepared by the Institute of Child Health
http://www.ich.ucl.ac.uk/clinical_information/clinical_guidelines/cpg_guideline_00049/

Indications

- Emergency venous access required
- APLS guidelines recommend its use for first line access
- To obtain urgent samples for blood glucose/crossmatch
- To deliver emergency medications and fluids
- Can be used in any age, including adults, but appropriate equipment must be chosen for age

The onset of medications via the intraosseous route is almost as fast as via a central venous line, and considerably faster than via a peripheral line in a collapsed patient.²

Contraindications

- Osteogenesis imperfecta
- Osteoporosis
- Fracture at that site
- Loss of skin integrity eg: burns
- Osteopetrosis
- Local infection eg: cellulitis, osteomyelitis

Clearly in an emergency, vascular access is a priority and the above contraindications should be considered and the most appropriate site selected.

Pre procedure

- Select appropriate site
  - Tibia – 2-3cm below the tibial tuberosity
  - Femur – 3cm above the lateral condyle
- Inform parents/child and obtain consent (as appropriate)
- Prepare appropriate equipment
  - Sterile swabs/alcohol based skin preparation fluid
  - Syringe and specimen bottles (for aspiration)
  - 3 way tap primed with 0.9% sodium chloride and tap left in the ‘off’ position
  - Gauze and tape for fixing
  - Appropriate sterile IO needle (differs between Trusts but 16G usually kept in resus trolleys)
- Prepare appropriate medications (adrenaline, fluids etc)
- Be aware of the actions of other members of the team (eg: defibrillation) and liaise with team leader to choose appropriate time for procedure

Each Trust will have its own equipment which often varies between hospitals. Make sure you know where IO needles are kept at your Trust, which brand they stock and how to use them.
Procedure

1. Clean selected site with appropriate alcohol based wipe
2. Immobilise chosen limb with non dominant hand, ensuring hand is not underneath limb, but held at either side
3. Hold the IO needle in the dominant hand at 90 degrees to the skin surface. Insert needle into site using a ‘twisting’ motion, avoiding a ‘rocking’ action as this can cause splintering of the bone.
4. When the needle is correctly located, you will feel a ‘give’ or loss of resistance
5. Remove the trocar (depending on model of IO needle) and secure to skin with gauze and tapes
6. Attempt aspiration (if required) for bone marrow sample
7. Attach 3 way tap and flush with 0.9% saline

Post procedure

- Ensure appropriate and safe disposal of sharps
- Administer appropriate medications and fluids according to guidelines
- Flush with 0.9% saline after each medication
- If you send samples to the laboratory, ensure they are labelled as from IO access.
- If the resuscitation attempt is successful, more permanent vascular access should be obtained as quickly as possible. IO cannulae are at high risk of infection, and should be removed as quickly as possible using an aseptic technique, and a gentle rotation to withdraw smoothly. This should be documented in the patient’s notes.
- If the resuscitation attempt is unsuccessful, all lines should remain in situ until the Coroner has consented for removal. All sites and attempted sites should be carefully documented.

Suggestions for further discussion

- What options are there if insertion has failed?
- What are the potential complications?
- Is it OK to insert an IO needle in the shocked but conscious child where IV access attempts have failed?
- Routes of delivery for emergency medication eg: tracheal, IV (central and peripheral), IO

References

APLS Guidelines

Buck et al; Intraosseous drug administration in children and adults during cardiopulmonary resuscitation; Ann Pharmacotherpy; 2007; Oct;41(10):1679-86

Further discussion

1. EZ-Io placement – using EZ-Io Power driver
2. Securing of O needle

Rebecca Hodgkinson & Alice Roueche
PERIPHERALLY INSERTED CENTRAL CATHETERS (PICC Lines)

A PICC line is a long flexible catheter, inserted into a peripheral vein with the tip lying in a larger central vein. PICC lines are used both in neonates and paediatrics.

Indications:

Where medium or long term venous access is required e.g.:

- Prolonged IV antibiotic or antiviral courses.
- Peripheral TPN (total parenteral nutrition).
- Regular blood product administration.
- Where standard peripheral cannulation becomes problematic.

Contraindications:

- Presence of device related bacteraemia or septicaemia is known or suspected
- Previous episodes of venous thrombosis at prospective insertion site
- Pre-existing skin infection at prospective insertion site
- Severe peripheral oedema
- Where high fluid volume infusions are required

Types of PICC lines

Multiple brands and types of PICC lines are in use in the NHS. All professionals responsible for the insertion of PICC lines have a duty to familiarise themselves with the varieties available in the unit they work at. Professionals should also read the instructions that are provided with each PICC line prior to insertion to ensure they are using the correct insertion technique.

The two techniques described below are the commonest method of PICC line insertion but there are many minor variations practitioners may come across.
Pre Procedure

Specific points to check with each line (prior to insertion attempt) are:

- What gauge cannula is required for the initial insertion (if not provided with the line)?
- Is the line inserted with or without a guide wire (Seldinger technique)?
- Is the line radio-opaque (with or without a guide wire)?
- Does the line require flushing before or after insertion?
- How is the line trimmed to the correct length?
- What is the exact fixation required for that specific device?

Before starting the procedure

- Inform parents/child and obtain consent (as appropriate)
- Prepare child for procedure with:
  - Topical local anaesthetic cream at insertion site
  - Play specialist pre-procedure preparation
  - Consider sedation (as per individual unit policy)
- Select appropriate site
  - Ante-Cubital Fossa
  - Long Saphenous Vein
  - Other large peripheral veins can be used.
- Measure the final length of the PICC line on the child from the selected insertion point to where the tip is to be placed.
  - The tip of a PICC line should never be placed next to a major organ e.g. inside the heart or next to the renal vein.
  - Confirm with local policy on how the final line tip placement is calculated.
- Prepare appropriate equipment:
  - Appropriate PICC line.
  - Additional cannulas or needles (if required).
  - Sterile dressing pack / procedure pack including gauze, scalpel and forceps.
  - Sterile gloves and gown.
  - Sterile swabs/alcohol based skin preparation fluid.
  - 3 way tap primed with either 0.9% sodium chloride or Heparin Saline (depending on local unit policy) and tap left in the 'off' position
  - Fixing material — either Streistrips® and Tegaderm® or specially designed PICC line fixation kits (if available)

Equipment:

It is important the find out the types of PICC lines available at the institution where you are working. Make sure all appropriate equipment is available for sterile technique.

Procedure

The procedure is best performed with an assistant to help open sterile packing etc. If done without assistance, care should be taken that all equipment is open and safe prior to commencing the procedure.
Preparation

- Wash hands and put on sterile gown and gloves
- Open dressing pack and PICC line
- Trim PICC line and guide wire to required length (ensure correct end of both line and wire, if using, are trimmed)
- Flush the PICC line and 3-way tap.
- Clean and drape the area of line insertion, ensuring limb is securely held by assistant other staff member.

Procedure - (1) – Seldinger technique

1. Insert the cannula or butterfly into the selected vein until it is clearly in place with a good blood flow.
2. Insert the guide wire (soft or rounded end first) into the cannula or butterfly and gently feed up the wire up inside the patient.
3. If resistance is felt, withdraw a few cm and re-advance slowly.
4. Once the guide wire has been inserted to the required length, withdraw the cannula or butterfly from the vein.
   a. Maintain haemostasis with gentle pressure over the insertion point once the cannula is removed.
   b. Do not let go of the guide-wire at any point.
5. Removed the cannula or butterfly from the guide wire.
   a. This can either be by pulling the cannula over the end of the guide wire.
   b. Or by using a special splitting cannula or butterfly (if provided)
6. If required insert a dilator over the end of the wire and to the insertion point, push gently but firmly inside the vein.
   a. A small cut to the skin may be required at this stage, using a sterile scalpel. Cut away from the guide-wire and DO NOT cut the guide wire.
7. Remove the dilator (if used) and again apply gentle pressure to maintain haemostasis.
8. Place the PICC line over the guide-wire and feed the PICC line up the guide-wire into the vein. Insert the PICC line to the required length. Always ensure you have hold of the distal end of the guide-wire.
9. Temporarily secure the external end of the PICC line with steristrips® or tape.
10. Ideally obtain a portable plain radiograph at this stage to confirm position, before removing the guide-wire.
Procedure (2) – Non-Seldinger technique

1. Insert the cannula or butterfly into the selected vein until it is clearly in place with a good blood flow.
2. Insert the PICC line internal tip inside the cannula or butterfly.
3. Using sterile forceps hold the PICC line approximately 5-10 mm away from the end of the cannula.
4. Gently advance the PICC line inside the vein, through the cannula, until the forceps meet the cannula.
5. Repeat the above; advancing the PICC line 5-10 mm a time until the PICC line is inserted to the required length.
6. If resistance is felt, withdraw a few mm and re-advance slowly.
7. If the PICC line still does not pass, and has already gone some way inside the body, it is worth trying to change the position of the limb in relation to the patient’s body (eg bending the knee or hip if inserting into the saphenous vein) as long as this can be done safely.
8. Once the PICC line has reached it’s final insertion point, remove the cannula or butterfly from the vein
9. Maintain haemostasis with gentle pressure over the insertion point once the cannula is removed.
10. Removed the cannula or butterfly from the PICC line.
11. This can either be by pulling the cannula over the end of the PICC line.
12. Or by using a special splitting cannula or butterfly (if provided)
13. Temporarily secure the external end of the PICC line with steristrips® or tape.
14. Ideally obtain a portable plain radiograph at this stage to confirm position, before finally securing the PICC line.

Post procedure

- Once position has been confirmed (or if this is not possible at this stage):
  - Remove the guide-wire (if using Seldinger technique)
  - Aspirate gently to confirm the line is inside the vein.
  - Re-flush to clean the line.
  - Fully secure the external line with available fixing material.
  - Remove drapes and tidy away equipment.
  - Ensure appropriate and safe disposal of sharps.

- If still needed (if it wasn’t possible earlier) arrange a plain radiograph to confirm position prior to use.

Suggestions for further discussion

- What options are there if insertion has failed?
- What are the potential complications?
- What fluids can be given through the line?
- How should the line be cared for to best maintain it.
- Can the line be used for blood sampling?
- How is the line removed?

Acknowledgements:

Guidelines prepared by the London Paediatric Simulation Group

References

1 Should heparin based flushing solutions be used in preference to saline to maintain the patency of indwelling intravascular catheters and cannulae? UK Medicines Information (UKMi) pharmacists www.nelm.nhs.uk

Giles Armstrong
SUPRAPUBIC ASPIRATION (SPA)

Indications:
- Any child (regardless of age) who is unable to void on request, who requires a urine specimen for the diagnosis or exclusion of UTI.
- NICE guidance recommends SPA if non-invasive urine collection not obtainable

Contraindications:
- Bleeding diathesis
- Abdominal distension
- Massive organomegaly

Pre procedure:

Equipment
- One assistant to hold the infant (not parent)
- Alcohol wipe
- Specimen jar for urine
- Ultrasound and gel if available
- 23G needle (25 G for premature infants)
- 3ml or 5 ml syringe
- Consider analgesia: topical anaesthetic cream should be used except where specimens are required urgently (eg prior to starting antibiotic treatment in a septic infant)

Procedure:
Where possible, ultrasound should be used to demonstrate if urine is present in the bladder.

1. Ask assistant to hold infant supine with legs extended
2. Ask parent to be ready to catch urine if the patient voids
3. Wipe the skin with an alcohol swab
4. Identify insertion point
   a. Midline
   b. Lower abdominal crease
5. Insert needle perpendicular to the skin, aspirating gently as you advance the needle.
6. If no success, withdraw the needle to just under the skin, and advance at an angle with the needle aimed more away from the pelvis.
7. If urine is obtained, remove needle and squirt urine into sterile urine jar
Post procedure:
- Place a plaster over the puncture site (optional)
- Clean up
- Explain outcome to parents and document results
- Warn parents that there may be a small amount of blood in the urine in the next day, but that they should re-present if there are large amounts or if they are concerned.

Suggestions for further discussion
- Procedure failure
- Complications: Complications of suprapubic aspirates are uncommon⁴. They include:
  - Macroscopic haematuria (not usually clinically significant)
  - Bladder haematoma (rare)
  - Bladder haemorrhage (very rare)
  - Intestinal perforation (rare — not usually clinically significant)
  - Anaerobic bacteraemia or abscess formation (very rare)
  - Suprapubic abscess formation

Acknowledgements:

Royal Children’s Hospital, Melbourne: SPA guideline

References (see http://www.rch.org.au/clinicalguide/cpg.cfm?doc_id=5299 for more extensive references)


⁴ Long E, Vince J: Evidence behind the WHO guidelines; what are appropriate methods for urine collection in UTI?; J Trop Paedtr; online May 21, 2007

Rebecca Hodgkinson & Alice Roueche
URETHRAL CATHETERISATION (FEMALE)

Indications

- **Diagnostic**
  - To obtain urinary sample for laboratory testing
  - As part of diagnostic tests eg: MCUG
- **Therapeutic**
  - To relieve urinary retention
  - To enable accurate measurement of urinary output
  - To enable instillation of medication into the bladder
  - Occasionally for long term use in urinary incontinence, retention

Contraindications

- Recent surgery or trauma to the lower urethral tract
- Immunocompromise
- Congenital abnormalities
- History of labial fusion or adhesions

Pre procedure

- Explain procedure and obtain informed consent from child and parents
- Enlist assistance from appropriate members of staff: nurse, play specialist
- Find appropriate location: private, clinical area, available equipment
- Prepare equipment and choose catheter size and type (see box 1) – it is not considered good practice to use feeding tubes as these have been shown to increase the risk of intra vesicle knotting of the catheter
- Prepare sterile field, wash hands using appropriate anti microbial solution, put on sterile gloves

<table>
<thead>
<tr>
<th>Age of child</th>
<th>Size of catheter</th>
<th>Short term use (&lt;28 days)</th>
<th>Long term use (&gt;28 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 years</td>
<td>6 ch</td>
<td>PTFE bonded latex</td>
<td>Silicone/hydrogel</td>
</tr>
<tr>
<td>2 – 10 years</td>
<td>8 ch</td>
<td>PTFE bonded latex</td>
<td>Silicone/hydrogel</td>
</tr>
<tr>
<td>10 – 14 years</td>
<td>10 ch</td>
<td>PTFE bonded latex</td>
<td>Silicone/hydrogel</td>
</tr>
<tr>
<td>14 years +</td>
<td>12 ch</td>
<td>PTFE bonded latex</td>
<td>Silicone/hydrogel</td>
</tr>
</tbody>
</table>

*Box 1: suggested approximate catheter sizes for age*

Procedure

- Enlist assistant’s help to ensure child is comfortable and positioned on bed with legs in ‘frog legs’ position
- With dominant hand, clean the urethral meatus with cleansing solution (0.9% saline) and discard swab
- With the non dominant hand, hold the labia open
- Insert the lubricated tip of the catheter into the urethral meatus and advance until urine can be seen in the tubing
At this stage, further advance the catheter to the hub before inflating the balloon with sterile water (usually 5ml volume) – this has been shown to avoid urethral damage.

Connect end of catheter to enclosed drainage system, taking samples as required.

Ensure system is secured, using tapes to child’s leg, allowing appropriate freedom of movement.

**Post Procedure**

- Clean up equipment
- Explain outcome to child and parents
- Ensure samples are labelled and sent to the lab for required tests
- Document procedure and outcome in child’s notes
- Thank assistants!

**Suggestions for further discussion**

- How does this differ for male catheterisation?
- What should you do if an older child refuses consent?
- What are the preferred methods for obtaining urine and why?
- What factors might make catheterisation difficult?

**Acknowledgements**

*Newcastle Children’s Hospital Clinical Guidelines*

*Institute of Child Health Guidelines on neonatal urethral catheterisation*
http://www.ich.ucl.ac.uk/clinical_information/clinical_guidelines/cpg_guideline_00144


3 Long E, Vince J; Evidence behind the WHO guidelines; what are appropriate methods for urine collection in UTI?; J Trop Paedtr; online May 21, 2007

Rebecca Hodgkinson & Alice Roueche
URETHRAL CATHETERISATION (MALE)

Indications

- Diagnostic
  - To obtain urinary sample for laboratory testing
  - As part of diagnostic tests eg: MCUG
- Therapeutic
  - To relieve urinary retention
  - To enable accurate measurement of urinary output
  - To enable instillation of medication into the bladder

Contraindications

- Recent surgery or trauma to the lower urethral tract
- Immunocompromise
- Congenital abnormalities

Pre Procedure

- Explain procedure and obtain informed consent from child and parents
- Enlist assistance from appropriate members of staff: nurse, play specialist
- Find appropriate location: private, clinical area, available equipment
- Equipment should include sterile pack and appropriate cleaning solutions, lubricant gel and choose catheter size and type – it is not considered good practice to use feeding tubes as these have been shown to increase the risk of intra vesicle knotting of the catheter
- Prepare sterile field, wash hands using appropriate anti microbial solution, put on sterile gloves

Procedure

- Enlist assistant’s help to ensure child is comfortable and positioned on bed with legs in ‘frog legs’ position
- With dominant hand, clean the urethral meatus with cleansing solution (0.9% saline) and discard swab. Retract the foreskin, if it is present to visualise the urethral opening at the time of cleaning. It is important to not fully retract the foreskin as it may not be easy to reduce.
- Use the syringe containing local anaesthetic gel and place a few drops on the urethral meatus, then instill a small amount into the meatal opening.
- Wait for anaesthetic gel to take effect
- Wash and dry hands and put on a new pair of sterile gloves
- Insert the lubricated tip of the catheter into the urethral meatus and advance until urine can be seen in the tubing. To straighten the first curve of the urethra, hold the penis upright.
At this stage, further advance the catheter to the hub before inflating the balloon with sterile water (usually 5ml volume) – this has been shown to avoid urethral damage. Care must taken here as catastrophic bleeding can occur where balloons have been inflated in the urethra.

- If there is any resistance, or if there is any bleeding, stop the procedure and seek further advice.
- Connect end of catheter to enclosed drainage system, taking samples as required
- Ensure system is secured, using tapes to child’s leg, allowing appropriate freedom of movement

Post Procedure

- Clean up equipment
- Explain outcome to child and parents
- Ensure samples are labelled and sent to the lab for required tests
- Document procedure and outcome in child’ notes
- Thank assistants!

Acknowledgements

- Newcastle Children’s Hospital Clinical Guidelines
- Male catheterisation. Wendy Naish. [www.clinicalsksills.net](http://www.clinicalsksills.net)
- Image from [www.google.co.uk](http://www.google.co.uk)

Mehrengise Cooper
LUMBAR PUNCTURE

Indications for lumbar puncture:

- Diagnostic Usage
  - Pyrexia of unknown origin
  - Symptoms/signs suggestive of
    - Meningoencephalitis
    - Sub-arachnoid Haemorrhage
    - Malignancy (for staging e.g. Leukaemia)
    - Metabolic Disease
    - Degenerative Disease
- Therapeutic Usage
  - Benign Intracranial Hypertension
  - Delivery of medication (e.g. chemotherapy)
  - Post haemorrhagic hydrocephalus

Contraindications for lumbar puncture:

- Clinical indications of raised intra-cranial pressure
- Severely ill patients with haemodynamic or pulmonary instability
- Soft tissue infection over lumbar spine
- Severe coagulopathy
- Severe thrombocytopenia

Pre procedure:

Ensure the following:

- the reason for LP is documented
- the LP is carried out as soon as it can be done safely in the course of the illness
- there are no contraindications
- parental agreement is obtained and documented
- older children are informed what the procedure involves and consent obtained if Fraser competent
- appropriate numbers of trained staff are available to assist including a play therapist if appropriate
- appropriate analgesia or anaesthetic is used
- appropriate facilities are available – i.e. side room, secure trolley/bed
- appropriate equipment is available
- decide on investigations required to be performed upon the CSF
Equipment:

- At least one trained assistant to hold the child
- Sterile gloves
- Sterile drapes and procedure tray
- Skin preparation: povidone iodine solution (Betadine) or chlorhexidine
- Local anaesthetic: lignocaine, 2ml syringe, 25G needle (in older children)
- CSF bottles (3) plus fluoride/oxalate bottle for glucose
- Spinal needle: 22G or 25G bevelled spinal needles with stylet (risk of spinal epidermoid tumour without stylet)
- Manometer where appropriate
- Plaster or OpSite spray

Procedure

Positioning: The child can be lying on their side or sitting up for the procedure. The instructions below are for a child lying on their side.

http://www.ndhc.nhs.uk/foi/content/parttwo/class08/docs/ClinGuide/LUMBAR%20PUNCTURE%20IN%20ADULTS%20AND%20CHILDREN.pdf

Draw an imaginary line between the top of the iliac crests. This intersects the spine at approximately the L3-4 interspace (mark this if necessary). The conus medullaris finishes near L3 at birth, but at L1-2 by adulthood. Aim for the L3-4 or L4-5 interspace.

Preparation

- Wash hands and aseptically put on sterile gloves.
- Prepare the skin with chlorhexidine and set up sterile drapes.
- Allow adequate time for the skin preparation to dry.
- Take the tops off the tubes, ensuring that they remain sterile.
- Infiltrate the skin with 1% lignocaine using a 25G needle (as appropriate)
Lumbar puncture:


Video showing manometry (adult patient) available at [http://www.resusc.ca](http://www.resusc.ca)

- It is good practice to always measure the CSF pressure when performing a lumbar puncture. If this is to be done, ensure you have a manometer and that it can be connected to the needle.
- Many practitioners position the needle in the midline with the bevel pointing towards the ceiling (lateral decubitus position) or to the side (sitting).
- Pierce the skin with the needle and pause. Wait for the child to stop wriggling.
- Aim for the umbilicus (ie slightly cephalad).
- Advance the needle into the spinous ligament (increased resistance). Continue to advance the needle within the ligament until there is a fall in resistance.
- Remove the stylet. If CSF is not obtained, replace the stylet and advance the needle slightly then re-check for CSF.
- An alternative technique is to remove the stylet once the needle is in the ligament and advance very slowly without stylet watching for CSF to flow back. This has the advantage of making it harder to go unintentionally past the subarachnoid space. For further discussion of this topic see reference.
- If the needle meets resistance, withdraw the needle slowly whilst watching for CSF. If none is obtained, replace the stylet, re-orientate the needle and re-try.
- If blood stained fluid is obtained collect some for culture. If it clears it can be used for a cell count. If it fails to clear another attempt at a different level may be required.
- Insertion distance: Insertion distance has been correlated with height of child, and is approximately equal to 0.03 x height (cm).
- Once CSF flow-back is seen, the manometer can be attached to the needle and opening pressure recorded. Using the stopcock valve at the base of the manometer column, flow of CSF can be directed from the manometer into the sample tubes.
- If CSF is flowing, collect into 3 numbered sterile tubes (5-10 drops each is usually adequate) plus a glucose tube.
- Remove the needle.
- Apply brief pressure to the puncture site and cover with plaster or OpSite spray
- Send specimens urgently to the lab for microscopy and culture and protein and glucose measurement. Plasma glucose must be taken synchronously.

Post procedure

- There is no evidence for bed-rest reducing post-lumbar puncture headache
- Clean up including sharps disposal
- Documentation including results
- Communication with patient/parents
- Ongoing clinical care according to circumstance
• Thank team!

Suggestions for further discussion

• Possible results & implications
• Failed procedure
• Communication with parents
• Complications

Acknowledgements:

Royal Children’s Hospital, Melbourne LP guidelines and related Leeds PCT guidelines

Guidelines prepared by Sarah West, Paediatric PRHO at St Mary’s Hospital London 2004.


3 Baxter A et al; Local Anesthetic and Stylet Styles: Factors Associated With Resident Lumbar Puncture Success Pediatrics 2006; 117; 3: 876-881

4 F Craig, J Stroobant, A Winrow, H Davies: Depth of insertion of a lumbar puncture needle Archives of Disease in Childhood 1997;77:450;


Rebecca Hodgkinson & Alice Roueche
**INSERTION OF NEONATAL CENTRAL VENOUS CATHETERS**  
**(LONG LINES)**

**Indications**
To provide prolonged access for:
- Parenteral nutrition
- High strength glucose infusions
- Inotropes.

**Equipment**
- Sterile drapes, tape measure, needle holder, suture scissors, various forceps, paediatric size dilator, gauze swabs and cotton wool ball.
- Sterile gown, sterile gloves x 2
- Chlorhexidine in 70% alcohol, a sachet of 0.9% Sodium Chloride
- Sterile central venous catheter pack - This will vary between Trusts depending on the make of the long line
- Sterile Steri-strip (6mm x 75 mm).
- Tegaderm (op-site 6 cm x 7 cm).
- 5 ml syringe, gauge 21 needles x 2, 10 ml 0.9% Sodium Chloride

**Method of Insertion**
- First, identify a large vein for the site of insertion (e.g., long saphenous vein, medial antebrachial vein, cubital vein, accessory cephalic vein, superficial temporal vein).
- Determine the length of the catheter to be inserted by measuring from the site of insertion to the xiphoid for the leg and sternal angle for the arm.
- Place the baby in a comfortable position. Ensure the baby is well stabilised for the procedure and covered with plastic as appropriate to prevent hypothermia and dehydration.
- The procedure is a sterile one. First wash hands and dry with a sterile towel and put on a sterile gown and gloves.
- Prime the catheter lumen with 0.9% Sodium Chloride and leave the 5 ml syringe on for flushing and then occlude the line using the white plastic clip to prevent air getting into the line. Cover the catheter with a piece of sterile gauze.
- Clean the identified leg or arm with the chlorhexidine in 70% alcohol and let it dry for 30 seconds – 1 minute.
  - The whole limb should be cleaned, from groin to toes, or arm pit to finger tips and the whole circumference.
  - To prevent chemical burns of the skin, clean away the antiseptic solution with 0.9% Sodium Chloride and let the limb dry fully.
• Place the sterile towels around the site of insertion and leave the leg or arm accessible for the procedure by placing it through a hole in a sterile towel.

• CHANGE YOUR GLOVES.

• Identify the vein and insert the needle or butterfly* into the vein until there is a good flow of blood.

• Use the non-tooth forceps to hold the catheter and thread the catheter slowly at 1 – 2 mm at a time until the desired length is obtained. Sometimes the threading of the catheter into the vein can be difficult. Be patient and keep pushing the catheter slowly at 1 to 2 mm at a time until the 5 cm mark is achieved. Once the 5 cm mark is reached, the catheter is making its way into the vein. Continue to insert it until the desired length is achieved.

• Flush the catheter slowly with 0.9% Sodium Chloride to ensure patency.

• Use the gauze swab to press the catheter at the site of entry and remove the butterfly or cannula.

• Press until bleeding stops. This may take up to 10 – 15 minutes.

• Use the Steri-strip to tape the catheter to the skin in a similar manner to that used to secure an IV cannula.

• Place a small piece of gauze underneath the catheter hub and use Steri-strips to tape the remaining catheter to the skin (if the catheter on the skin's surface is long make loops and use Steri-strips to tape on the skin). The insertion site should remain clearly visible and free from loops of catheter so if the catheter has to be withdrawn it can be done without removing all the Steri-strips etc.

• It is essential to wait until bleeding has stopped before applying the gauze or further dressings; failure to do this increases the risk of line infection.

• Use the Tegaderm to cover the site. Ensure all the catheter and the catheter hub are enclosed.

• Flush the catheter again to ensure the patency of the line and leave the syringe attached so the longline can be kept patent by connecting the syringe to a syringe pump.

• X-ray the baby to determine the tip of the catheter. Contrast is not required.

References


5. DOH Guidance for siting of long line. Review of Deaths of four babies due to cardiac tamponade associated with the presence of a central venous catheter. DOH, June 2001

Jenny Ziprin
INSERTION OF UMBILICAL LINES

1. Insertion of Umbilical Arterial Catheter

Indications
- For frequent measurement of arterial blood gases
- For continuous arterial blood pressure monitoring.
- For exchange transfusion.

Equipment
- Sterile cut-down set, including the following: sterile drapes, fine non-toothed forceps, blind end dilator, scissors and suture holder, artery forceps x 3, toothed forceps, tape measure, gauze and cotton wool.
- Sterile gown, sterile gloves.
- Umbilical arterial catheter.
- 3-way tap, umbilical tape, silk suture

Appropriate solution to prepare skin e.g. 0.05% chlorhexidine gluconate aqueous solution - This may differ within Trusts. Aqueous chlorhexidine should be used to avoid burns to the abdomen.
- 5 ml syringes, 10 ml of 0.9% Sodium Chloride, scalpel.
- Zinc oxide tape.

This diagram shows the fetal circulation together with the umbilical arteries and vein.
As shown there are two arteries and one vein.
Method of Insertion

1. Place the baby in the supine position. Ensure the baby is well stabilised for the procedure.
2. Determine the length of the catheter to be inserted by measuring the baby (Appendix 1).
3. The procedure is an aseptic one. First wash hands and dry with a sterile towel and put on a sterile gown and gloves.
4. Attach the 3-way tap to the catheter. Prime the catheter with 0.9% Sodium Chloride using the 5 ml syringe. Do not leave the catheter open to the atmosphere; close the 3-way tap to prevent air entering the line. Cover the catheter with sterile gauze/towel or leave in the plastic packaging.
5. Clean the umbilical cord area with the cleaning solution. To prevent chemical burns of the skin, clean away the antiseptic solution with 0.9% Sodium Chloride.
6. Place the sterile towels around the umbilicus, leaving the feet and head exposed. Observe the baby closely during the procedure for vasospasm in the leg or signs of distress.
7. Tie an umbilical tape around the base of the umbilical cord, tight enough to minimise blood loss but loosely enough so that the catheter can be passed easily through the vessel. Cleanly cut the umbilical cord with the scalpel, leaving a stump of 1–2 cm.
8. Identify the arteries – there are two arteries and one vein; the arteries have relatively thick walls and a small lumen when compared with the vein. They are usually located at 4 and 7 o'clock.
9. Using the curved artery forceps, grasp the umbilical cord to hold it upright and steady.
10. Using fine forceps and a blunt-ended dilator, gently tease open the artery.
11. Once the artery is sufficiently dilated, gently insert the catheter and advance the catheter slowly.
12. Gently insert the UAC into the artery to the required length. Blood should flow back freely.
13. Obstruction may be encountered at:
   a) 1 - 2 cm: This is where the vessels turn downwards. Try turning the umbilical stump towards the baby's head.
   b) 4 - 5 cm: This is probably due to spasm and kinking of the artery at the origin of the iliac vessels. The use of gentle sustained pressure should overcome this.
14. Secure the catheter as shown in Appendix 2.
15. Inspect the baby's legs for any new discoloration. If the leg or toes are blue or white, remove the catheter.
16. X-ray the chest and abdomen to confirm the UAC position. If the UAC is in the artery, the catheter will dip down first towards the pelvic bone then turn upwards as it enters the iliac artery, finally lying to the left of the spine. A high UAC should lie at the level of the diaphragm (T6-T10 vertebrae on CXR) and a low UAC between L3 and L5. Never leave a UAC at the level of L1, ie opposite the origin of the renal arteries.

Appendix 1

High umbilical catheters are preferred. The level of insertion should be at the level of T6 – T10. Many charts exist to aid placement however most do not address the baby below 28 weeks or less than 1000g. Charts are often not at hand at cot side. One can estimate the length to which to insert the catheter without a chart by measuring the following:

1. The distance between the insertion of the umbilical cord to the groin where the femoral pulse is palpable (distance a).
2. The distance between the insertion of the umbilical cord to the level of the sternum parallel to where the 4th rib joins the sternum (distance b).
3. add to the following

\[(2 \times \text{distance } a) + \text{distance } b\]

This is the length the catheter should be inserted from the insertion of the cord into the baby.

4. To this distance should be added the length of umbilical cord which remains after the catheter has been inserted. This length will vary depending on how far the cord has been cut from its point of insertion.

Appendix 2

The catheter should be fixed securely without direct fixation to the baby's skin in order to prevent skin damage. The process involves both the physical securing of the catheter and ensuring good haemostasis. The following are required to satisfactorily fix either an umbilical arterial or venous catheter:

- Black silk suture
- Needle holder
- Scissors
- White zinc oxide tap.

Method of fixation

1. Pass the suture though the cord inserting the needle to its full length in order to take a "good bit of tissue". Make sure you avoid puncturing either of the 2 arteries, vein or any catheter inserted. The suture should be placed near the catheter you are fixating. Pull the suture through leaving a piece of about 5cm in length so as to be able to tie knots. Tie a secure knot which will anchor this suture firmly to the cord.

2. Loop the suture around the base of the catheter where it passes into the cord, tie a "half hitch" knot and then knot again immediately to secure the catheter at is base and prevent slippage. Ensure there is no slack in the suture.

3. Repeat the process described in step 2 about 0.5cm further up the catheter again ensuring there is no slack in the suture.

4. Repeat the process described in step 3 about 0.5cm further up the catheter again ensuring there is no slack in the suture. (This knot should be tied about 1 cm from the insertion of the catheter into the cord). Figure 1.

5. Pull gently on the catheter to check the sutures are secure.

6. Cut the suture leaving "tails" of about 1cm only.

7. From this point the procedure does not need to be sterile.

8. Cut a piece of small piece white zinc oxide tape (1cm in length).

9. Holding the suture taught wrap the white zinc oxide tape around the catheter placing it approx 0.4cm from the insertion into the cord over the knots tied in steps 3 and 4 keeping the "tails" of the suture free. Figure 2.

10. Pull gently on the catheter to check the fixation is secure.

11. A short length of white zinc oxide tape is vital so that if the catheter needs to be repositioned it can easily be undone.
12. If securing more than one catheter you must ensure that the suture used for each fixation is totally separate from the other so that either can be repositioned without endangering the others fixation.

13. Before leaving the baby or allowing an X-ray to take place you must ensure haemostasis has been achieved. If needed tie another cord tie around the cord.

14. If in doubt ask for help in securing the catheter and ensuring haemostasis.

NOTE: Do not use “Steri Strips” to secure a catheter they do not stick firmly and place the baby at risk of haemorrhage and catheter slippage.
2. Insertion of Umbilical Venous Catheter

Indications

- For central venous pressure monitoring.
- Immediate access for intravenous fluids during emergency.
- For exchange transfusion and partial exchange transfusion can be inserted up to 1 week of age.
- For administration of fluids in small babies.

Equipment

- Sterile cut-down set, including the following: sterile drapes, fine non-toothed forceps, blind end dilator, scissors and suture holder, artery forceps x 3, toothed forceps, tape measure, gauze and cotton wool.
- Sterile gown, sterile gloves.
- Umbilical venous catheter.
- 3-way tap, umbilical tape, silk suture.
- Appropriate solution to prepare skin eg 0.05% chlorhexidine gluconate aqueous solution - This may differ within Trusts. Aqueous chlorhexidine should be used to avoid burns to the abdomen.
- 5 ml syringes, 10 ml of 0.9% Sodium Chloride, scalpel.
- Zinc oxide tape.

Method of Insertion

1. Place the baby in the supine position. Ensure the baby is well stabilised for the procedure.
2. Determine the length the catheter is to be inserted by measuring the length from the xiphoid to the umbilicus and add the length of the remaining umbilical cord. This length is the length the venous line should be inserted.
3. The procedure is an aseptic one. First wash hands and dry with a sterile towel and put on a sterile gown and gloves.
4. Attach the 3-way tap to the catheter. Prime the catheter with 0.9% Sodium Chloride using the 5 ml syringe. Do not leave the catheter open to the atmosphere, close the 3-way tap to prevent air entering the line. Cover the catheter with sterile gauze/towel or leave in the plastic packaging.

5. Clean the umbilical cord area with the 0.05% chlorhexidine gluconate aqueous solution*. To prevent chemical burns of the skin, clean away the antiseptic solution with 0.9% Sodium Chloride.

6. Place the sterile towels around the umbilicus, leaving the feet and head exposed. Observe the baby closely during the procedure for vasospasm in the leg or signs of distress.

7. Tie an umbilical tape around the base of the umbilical cord, tight enough to minimise blood loss but loosely enough so that the catheter can be passed easily through the vessel. Cleanly cut the umbilical cord with the scalpel, leaving a stump of 1 - 2 cm.

8. Identify the umbilical vein, which is thin walled, larger than the two arteries, and is close to the periphery of the stump.

9. Using fine forceps and a blunt-ended dilator, gently tease open the vein.

10. This may differ within Trusts. Aqueous chlorhexidine should be used to avoid burns to the abdomen.

11. Insert the catheter until blood flows easily. Occasionally the umbilical vein is kinked and advance of the catheter is blocked at 1 – 2 cm beyond the abdominal wall. Gentle traction on the cord usually relieves this. If obstruction occurs at more than 2 cm and only partly gives way to pressure, the catheter is probably either wedged in the portal system or coiled up in the portal sinus. Withdraw the catheter partway and reinsert.

12. Aim to place the UVC above the diaphragm in the IVC.

13. Secure the catheter as described above in appendix 2.

14. Tighten the tape around the umbilical cord following insertion of UVC, this prevents bleeding from the vessels as the blood pressure and perfusion improve.

15. Inspect the baby’s legs for any new discolouration. If the legs or toes are blue or white, remove the catheter.

16. Obtain a chest and abdominal x-ray to verify the position of the catheter.

17. Document the procedure fully in the notes including date, time, ease of insertion, length inserted and X-ray confirmation of position.

References
1. Dunn PM. Arch Disease Child 1966;41: 69

This X-Ray demonstrates the normal positions of both UAC and UVC.

Jenny Ziprin