

Chest procedures & intraosseous insertion

Key Teaching Objectives

Each candidate should receive practical instruction on the following:

1. Needle thoracocentesis
2. Chest drain insertion
3. Intraosseous access and infusion including EZ-IO use

2 participants per procedure rotating every 10/20 minutes. 3 instructors, one per skill.

Revise indications for and complications of each of the manoeuvres.

Equipment Required

Plastic thorax models x 3 (Paediatric sizes)

Sleek tape to be applied directly to the outside of the ribs to mimic the pleura

Limbs & Things Skin Pad cut to shape x2. One for each hemi-thorax with each group using a single fresh hemi-thorax

Printed instructions for assembling the skeleton models to guide assembly - available online under APLS Course Materials

Needle thoracocentesis:

Alcohol swabs x 2

IV cannulae x 2

5 mL syringes x 2

Chest drain insertion:

5 mL syringes x 2

21g needles x 2

Disposable scalpel x 2

Curved artery forceps x 2

Straight artery forceps x 2

Chest drains x 2

Slide set – showing landmarks and ways of securing chest drain

Intraosseous access:

Intraosseous trainer or ALS baby with leg pads

5 mL syringes x 2

Intraosseous needles x 3

Intraosseous trainer [Humerus and tibia]

EZ-IO Driver x 3

EZ-Connect® extension tubing

EZ-IO needle sets

3-way tap

Environment

Overall environment + set by one instructor - no longer than 5 minutes

The room should be divided into three stations:

Needle thoracocentesis (10 min)

Intraosseous needle insertion (10 min)

Chest drain insertion (20 min)

Set

"During this session we will revise and practice: Needle thoracocentesis, chest drain insertion and intraosseous needle insertion".

Check who's done procedures – may influence who you pair with whom.

Once divided into 3 groups, minimise discussion till after Stage 2 – ensure time for candidate practice.

Dialogue

This station is taught using the 4-part technique described in the Preface to Practical Procedures. The following techniques should be taught:

Needle Thoracocentesis

1. Identify the second intercostal space in the midclavicular line on the side of the pneumothorax (the *opposite* side to the direction of tracheal deviation).
2. Swab the chest wall with alcohol swab.
3. Attach syringe to cannula.
4. Insert cannula into chest wall, just above rib below, aspirating all the time.
5. If air is aspirated, remove the needle, leaving the plastic cannula in place.
6. Discuss that the cannula needs to be taped, whilst preparations are made for chest drain insertion.

Chest Drain Insertion

1. Decide on insertion site (consider showing slides, including triangle of safety).
2. Swab chest wall with alcohol swab.
3. Use local anaesthetic and discuss need for parenteral analgesia eg fentanyl, ketamine.
4. Make a 2 - 3 cm skin incision along the line of the intercostal space, just above the rib below. (This may be too big in a small infant. The incision size should reflect size of child and size of drain, but note that usually candidates make an incision that is **too small**.)
5. Bluntly dissect through the subcutaneous tissues just over the top of rib below and puncture parietal pleura with tip of artery forceps.
6. Put a gloved finger into incision and clear the path into pleura if possible (only possible in larger children and should not be attempted if the operator's finger is clearly too large for the space between the ribs).
7. Ensure that stylet has been removed from catheter. Clamp tip of chest drain tube with straight artery forceps and advance into pleural space using gloved finger as guide.
8. Ensure tube is in pleural space by listening for air movement, and by looking for fogging of tube during expiration.
9. Discuss underwater seal/Heimlich valve and securing drain (show slide).

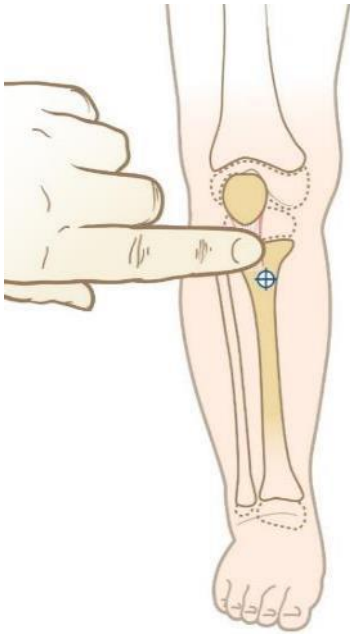

Intraosseous Insertion

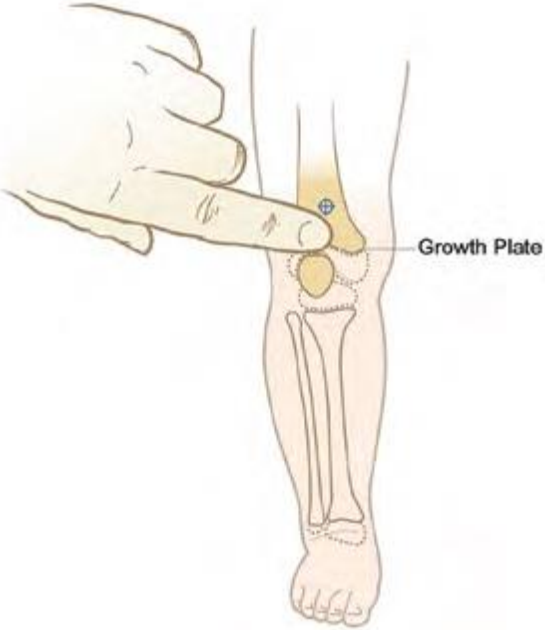
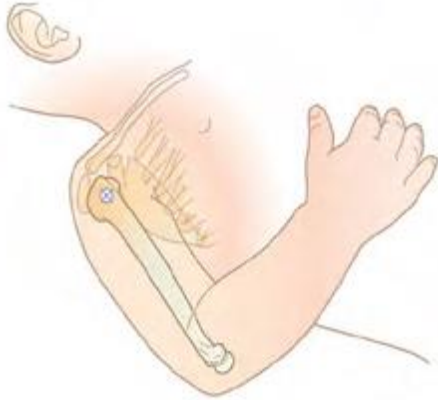
Indications: Vascular access in an infant or child where peripheral intravenous access has failed and emergency medications and fluids are time critical.

Contraindications:

- Fracture of target bone
- Infection at area of insertion
- Inability to identify landmarks
- IO access or attempted IO access in target bone within previous 48 hours
- Prosthesis or orthopedic procedure near insertion site

The landmarks for the upper and lower tibial, lower femoral and humerus sites are shown below. The proximal tibia is the recommended site in paediatrics due to the easier identification of the landmarks.

Proximal Tibial	Distal Tibia
 <p data-bbox="145 1615 708 1854">Insertion site is approximately 1 cm medial to the tibial tuberosity, or just below the patella (approximately 1 cm) and slightly medial (approximately 1 cm), along the flat aspect of the tibia.</p>	 <p data-bbox="834 1630 1345 1787">Insertion site is located approximately 1-2 cm proximal to the most prominent aspect of the medial malleolus.</p>

Distal Femur	Proximal Humerus
 <p>The insertion site is approximately 1 cm proximal to the superior border of the patella and approximately 1-2 cm medial to midline.</p>	 <p>The insertion site is above the surgical neck, on the most prominent aspect of the greater tubercle.</p> <p><i>See below for more detailed instructions for locating site</i></p>

A. Using a handheld needle

Note: The handheld technique is the preferred technique in neonates

1. Identify the infusion site
2. Clean the skin over the chosen site
3. Insert the needle at 90° to the skin, emphasise the rotational motion
4. Continue to advance the needle until a give is felt as the cortex is penetrated, a clear give is felt
5. Attach the 5 ml syringe and aspirate or infuse to confirm correct positioning with as minimal movement as possible. Flush with 2-5 mls 0.9% sodium chloride.

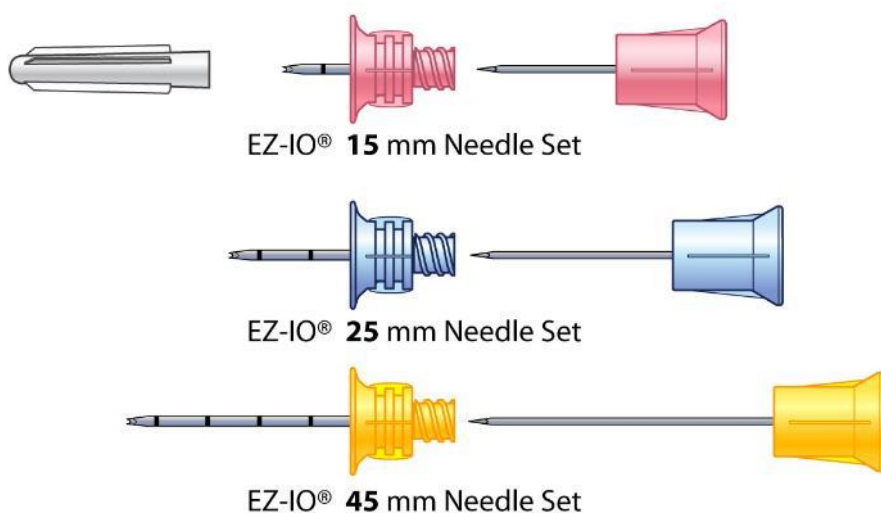
B. Using a Powered Device

The EZ-IO drill is a powered device which enables rapid insertion of an intraosseous needle. The same landmarks are used as for manual insertion and the procedure is less painful for the conscious victim due to its rapidity.

The EZ-IO needles are in three sizes:

- 15 mm needle – may be suitable for neonates and young infants
- 25 mm needle – for infants and younger children
- 45 mm needle – for older children and use for humeral access at any age

With the needle set inserted through the soft tissue and touching bone, the 5 mm mark (at least one black line) must be visible outside the skin for confirmation of adequate needle set length prior to drilling.



The procedures for insertion is as follows:

- Universal precautions. Prime connection line.
- Identify the infusion site and clean
- Choose appropriate size needle and attach to drill - it will fix magnetically.
- Hold the drill and needle at 90 degrees (humeral site - 45 degrees) to the skin surface and push through the skin without drilling, until bone is felt
- Push the drill button and drill continuously and push until there is loss of resistance - there is a palpable give as the needle breaches the cortex.
- Remove drill and unscrew trochar (holding the needle in place with as minimal movement as possible)
- Aspirate marrow if possible
- Use EZ-Stabilizer® Dressing to secure needle and stabilize the extremity
- Attach pre-prepared (primed with NS) connection tube and flush with 2-5 mls 0.9% sodium chloride
- Proceed with required therapy.

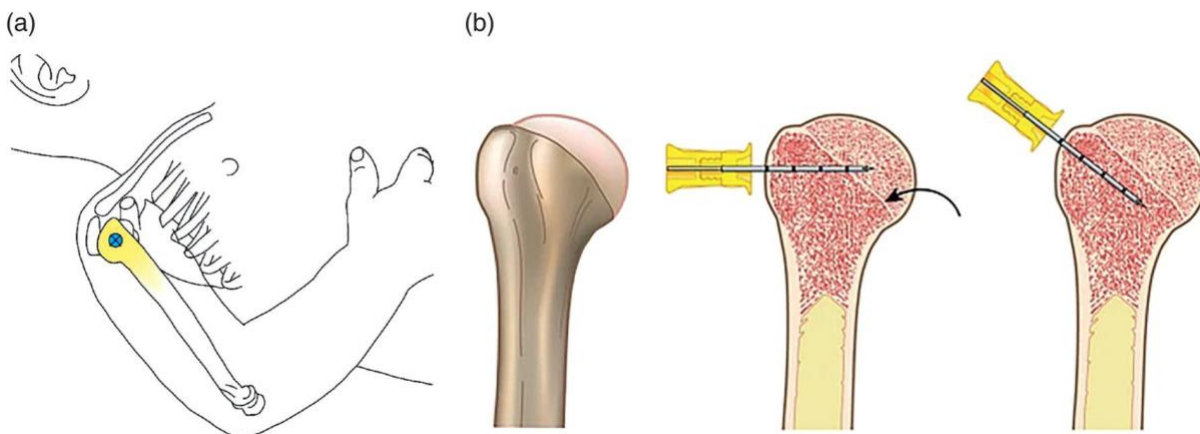
Verify placement/patency prior to all infusions. Compartment syndrome, which can result from undetected infiltration/extravasation, is a serious complication. The IO insertion site should be monitored frequently for signs of infiltration/extravasation."

Intraosseous Fluid Infusion

- Fluid will not run through the IO by gravity
- Attach a 3 way tap to the primed connection piece. To this tap attach the filled 50 ml syringe and a fluid giving set attached to a bag of 0.9% sodium chloride
 - Turn the tap so fluid is drawn into the syringe from the bag
 - Turn the tap so the fluid bolus can be pushed though the cannula

It should be noted that rapid infusion of fluid may be painful for the conscious patient and if this proves to be the case 0.5mg/kg of 2% lignocaine may be infused slowly to combat this.

Humeral access

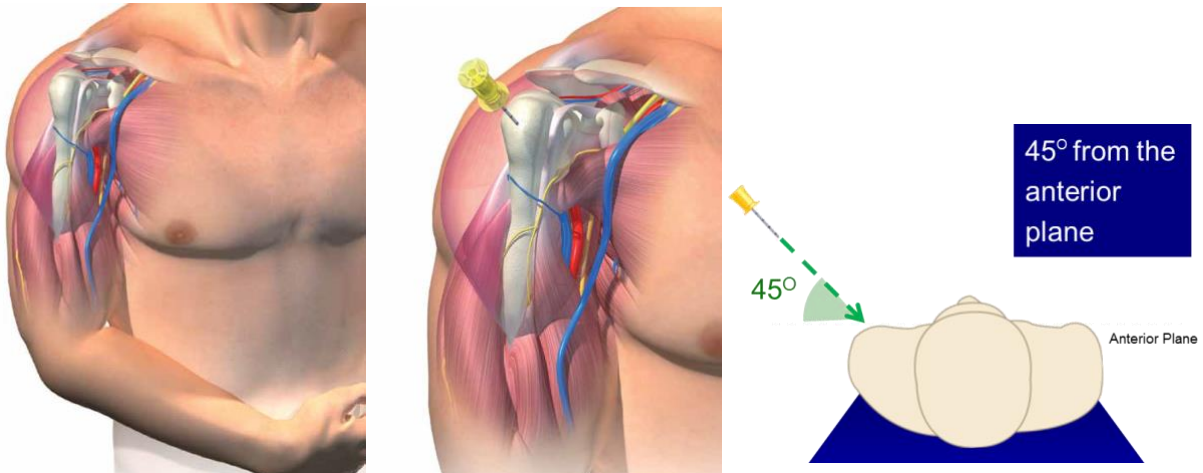


1. Place the patient's hand over the umbilicus: Causes medial rotation of elbow and humerus. Provides greater prominence of insertion site.
2. Place your palm on the patient's shoulder anteriorly.
 - a. The area that feels like a "ball" under your palm is the general target area.
 - b. You should be able to feel this ball, even on obese patients, by pushing deeply.
3. Place the ulnar aspect of your hand vertically over the axilla and the ulnar aspect of your other hand along the midline of the upper arm laterally.
4. Place your thumbs together over the arm; this identifies the vertical line of insertion on the proximal humerus.
5. Palpate deeply up the humerus to the surgical neck. This may feel like a golf ball on a tee – the spot where the "ball" meets the "tee" is the surgical neck.
6. The insertion site is above the surgical neck, on the most prominent aspect of the greater tubercle.
7. Follow steps 4-11 of the procedure using a powered device as in the tibial access section except instead of a 90⁰ angle, place needle at a 45⁰ angle – see image above.

Humeral access

Place the patient's hand over the umbilicus: Causes medial rotation of elbow and humerus

Adduct the arm: Provides greater prominence of insertion site



Finally

Advise candidates to familiarise themselves with the equipment and its location in their own institution for all these techniques on their return to their place of work.

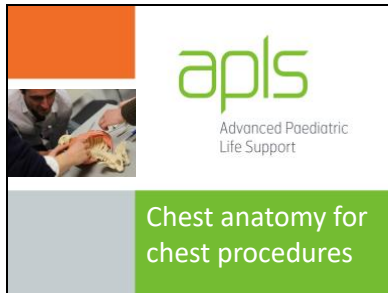
Closure

Final questions. Summary of 3 procedures.

Assessment Technique

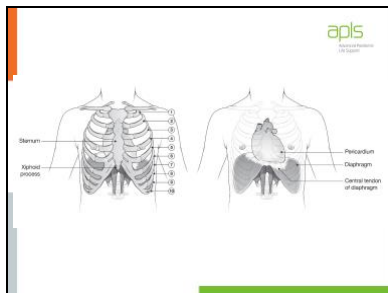
A record of candidates' performance during the station should be kept for faculty reference.

Slide 1



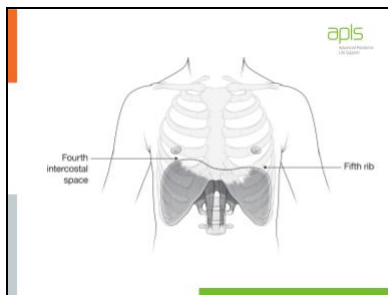
These slides are aimed at ensuring that anatomical knowledge is correct and that we are teaching our candidates to do procedures in the right place. The techniques are not hard, but choosing the right anatomical landmarks is poorly done.

Slide 2



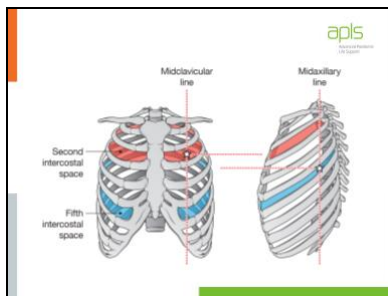
The central tendon of the diaphragm is attached to the back of the xiphisternum, and the fibrous pericardium is fused to this.

Slide 3

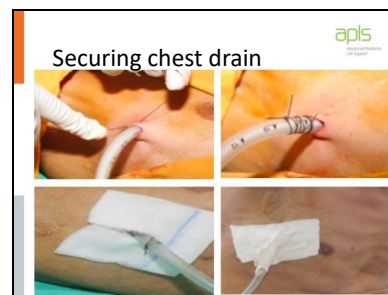


The domes of the diaphragm in expiration sit at the 4th interspace on the right and the 5th rib on the left at the front of the chest. That means that chest tubes need to be inserted well above that level to get into the correct space away from the heart, mediastinum and major vessels.

Slide 4



Important anatomical points are that the ribs slope downwards so the level of the rib at the front of the chest is very different from the back. The second rib space (for needle thoracocentesis) allows access into a safe area within the thoracic cavity. It is almost at the same level as the 5th IC space in the mid-axillary line (for ICC insertion) as the intention is to get into the same safe area. Ideally an ICC in the 4th IC space would be ideal but it is hard to get that high in the axilla. A common mistake is to think the 2nd space MCL is too high, and the 5th space is too low which will lead to difficulty and risk of complication if performing a chest procedure (ICC or finger thoracostomy).



Intercostal catheters

Requirements for safe insertion

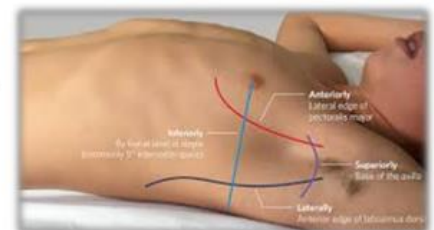
- Familiarity with the equipment available in your institution
- Developing the skill through training and practice
- Selecting the right patient

Large bore ICC	Small bore ICC
Most common type used in children	Most common catheter used in neonates
Considered more effective in critical trauma – for rapid air and blood evacuation	Should be considered in stable trauma - can drain both air and blood
Open surgical approach	Seldinger technique
More invasive and painful	Less invasive and well tolerated
More scarring	Less scarring



Finger Thoracostomy

- Invasive procedure used to **decompress a possible tension pneumothorax** urgently (as an alternative to needle thoracocentesis)
- Involves **rapid sharp incision down to rib, 5th or 4th IC space**, anterior to mid-axillary line, and **blunt penetration of the rib space and pleura** by a gloved finger.
- **Withdrawal of the finger then allows rapid release** of a tension pneumothorax or on occasion a tension haemothorax



Indications	Cautions and Considerations
High suspicion of tension haemo/pneumothorax, with critical clinical instability	Used inappropriately in spontaneously breathing patient causes 'open pneumothorax' and may collapse lung
As part of Traumatic Cardiac Arrest (TCA) where tension haemo/pneumothorax may be responsible	Not as management for any pneumothorax, and should always have ICC placed after procedure
For urgent intervention in a deteriorating ventilated patient where tension haemo/pneumothorax may be the cause	Likely more effective in the school age child, and significantly more difficult and less appropriate in infants

