East of England Neonatal ODN
(Hosted by Cambridge University Hospitals)

Clinical Guideline: Chest Drain Guideline

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For use in: EoE Neonatal Units
Guidance specific to the care of neonatal patients.

Used by: Medical Staff and Neonatal Nurse Practitioners

Key Words: chest drain, intrapleural, pneumothorax

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Approved by:

Neonatal Clinical Oversight Group	
Clinical Lead	**Sajeev Job**

Ratified by ODN Board:

Date of meeting	

Audit Standards:

1. **Where not clinically contra-indicated an x-ray is obtained prior to the insertion of the chest drain**
2. **An x-ray is obtained after the insertion of all chest drains.**
3. **The procedure is clearly documented in the infant's record.**

Insertion of an Intrapleural (Chest) Drain

1. Aim

To insert a chest drain using the Seldinger technique into the pleural space in a safe manner[1]

2. Undertaken by[1]

Medical staff trained and competent in the procedure
Advanced Neonatal Nurse Practitioners (ANNPs) trained and competent in the procedure

3. Indications[2]

Drainage of pneumothorax:

- Tension
- Bronchopleural fistula

Pneumothorax should be suspected with:

- Sudden deterioration with oxygen desaturation/ increased oxygen requirement/ agitation
- Increase in respiratory distress and/ or diminished chest movement
- Circulatory compromise (indicates mediastinal shift/compression)
- Hypoxia, respiratory and/or metabolic acidosis on blood gas

Drainage and/or diagnosis of a large pleural fluid collection

- Postoperative haemothorax
- Empyema
- Chylothorax

4. Equipment

Chest-drain trolley which contains the following equipment:
Sterile dressing pack
Sterile gloves
Sterile gown
Skin cleaning product according to local policy
Sterile water (cleaning the skin)
Scalpel with a straight blade
Seldinger type chest drain of the appropriate size (8.5F, 6.0F)
Under water drainage set
Steristrips
Clear dressing

Low-pressure suction from Robert's pump (or flutter valve if indicated)
Sterile water for chest drain bottle
Lidocaine 1%
2ml syringe
5ml syringe
10ml syringe
25G needle (orange)
3 way tap x 2

5. Chest X-ray

Where possible an x-ray should be obtained before any drain is inserted to confirm the underlying diagnosis. It is also important to ensure that the left and right radio-opaque side markers have been included in the film to avoid any potential confusion[3].

The chest can be transilluminated with a 'cold light' to diagnose a pneumothorax, but in the very preterm infant the whole of the thorax may light up and be suggestive of pneumothorax, and likewise in a more mature infant the chest may not transilluminate at all therefore chest x-ray is optimal.

However in the event of sudden deterioration, where signs of pneumothorax are evident and confirmed on transillumination of the chest wall, it may be necessary to insert the drain prior to obtaining the x-ray.

Similarly, a point-of-care lung ultrasound scan could be used to diagnose a pneumothorax, by identifying absence of pleural sliding, absence of B-lines and 'barcode' sign on M-mode. Lung POCUS has been shown to have increased specificity and sensitivity of diagnosing pneumothoraxes in neonates, compared to x-ray. Images should be reviewed by a clinician experienced in interpreting lung ultrasounds, prior to making any management decisions[19].

Routinely inserting a needle into the chest with a butterfly or cannula may reduce the need for chest drain insertion but there is insufficient evidence to establish the efficacy and safety of needle aspiration therefore it is not advocated but is recognised as necessary in certain instances where an infant is unstable with a pneumothorax[18].

6. Procedure

1. Collect the equipment and clean the trolley and dry

2. Wash hands and dry thoroughly.

3. Open the dressing pack and place all necessary equipment on the sterile field ready for use.

4. The chest drain pack should contain a needle, guide wire, dilator and pigtail catheter

5. Position the infant in a supine position with the arm of the affected side at a 90^0 angle or elevate the arm above the head. The affected side should be elevated off the bed by placing a towel under the baby's back. This will allow the air to rise to the point of insertion and encourages correct anterior placement[4].

6.Move any electrodes in the area where the drain is to be inserted to an alternate monitoring site

7. If the infant is ventilated a bolus dose of morphine should be given (50-100mcg/kg). If the infant is not ventilated then consideration should be given to appropriate analgesia for the infant or oral sucrose.

8. Wash hands and dry thoroughly.

9. Put on a sterile gown and gloves (Aseptic principles should be applied to technique).

10. Clean the pre-selected area with product according to local policy, allow drying. Ensure that there is no pooling of cleaning product under the infant[5].

11. Apply sterile drapes ensuring that the infant's colour can be observed.

12. Locate the essential landmarks[2]

- 4^{th} or 5^{th} intercostal space in the anterior axillary line, above a rib to avoid the intercostal neurovascular bundle.

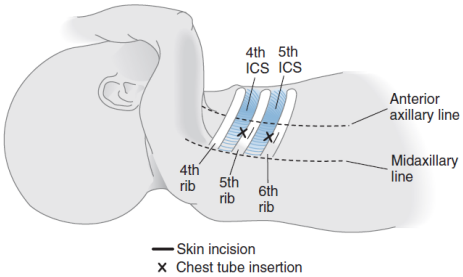


FIGURE 27–1. Recommended site for skin incision and chest tube insertion in the neonate: fourth and fifth intercostal space between the anterior and midaxillary line. ICS, intercostal space.

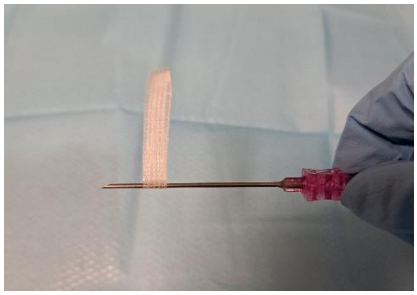
13 If the infant's condition and time allows local anaesthetic should be infiltrated a few minutes before the procedure to have full effect. Infiltrate the area around the anterior axillary line with Lidocaine 1% - 0.3ml/kg provides local anaesthesia in 1-2 minutes.

Always draw back on the syringe prior to infiltration to establish that a blood vessel has not been penetrated, to avoid insertion of local anaesthetic into a blood vessel. Start to infiltrate superficially and work down to the intercostal muscle and on into the parietal pleura.

14. It is helpful to measure the depth of the needle used to give local anaesthetic from skin to pleural cavity as this indicates the depth to insert the chest drain needle.

- The chest drain should ideally be placed in the anterior axillary line to mid axillary line through the 4th or 5th intercostal space[6].
- The mid-clavicular line should be avoided especially in female infants[6].
- The drain should be inserted over the superior aspect of the rib, so as to avoid the nerve and intercostal artery and vein, which lie just beneath the rib.
- For draining a pleural effusion the chest drain may need to be inserted in the mid or posterior axillary line as fluid gravitates towards the lower dependent areas.

15. Attach a syringe and 3 way tap to the needle in the chest drain pack. Place a Steri-strip 1cm from the bevelled end of the needle – this will act as a marker to ensure the needle is not advanced too far, and does not slip out.



16. Insert the needle at an angle of 90 degrees to the chest wall, slowing and gently, whilst aspirating on the syringe to the required depth. Be careful not to insert deeply, especially if pneumothorax is on the left. At the point air enters the syringe the needle is in the chest wall cavity. This should correspond to the measurement made at the time of infiltrating with Lidocaine.

17. Holding the needle firmly against the skin to prevent further movement remove the 3 way tap and the syringe and insert the guide wire into the needle and

advance the wire until the mark on the guide wire is just visible above the needle. There should be little resistance.

18. Remove the needle. At all times the wire must be held still, not advanced or withdrawn. It may be helpful to have an assistant scrubbed in to assist in the procedure and hold 'control' the wire.

19. Insert the dilator over the guide wire and using a rolling action advance this through the skin. Should this be problematic a small incision can be made next to the dilator to allow it to advance into the chest wall.

20. Remove the dilator and insert the pigtail catheter over the guide wire through the dilated track into the chest cavity until at least the 1st black mark on the chest drain has entered the chest.
    a. **1st – 2nd black mark for preterm babies**
    b. **3rd – 4th black mark for term babies**

21. Once the drain is inserted the guide wire can be removed

22. Once in the pleural space it is possible to direct the catheter anteriorly toward the midline to ensure drainage of the pneumothorax. This will ensure anterior placement of the tube and provide more effective drainage of the pneumothorax, which will accumulate in the anterior aspect of the thorax in an infant lying in a supine position.

23. If the drain is to be inserted for a haemothorax or chylothorax, the angle at which it is to be inserted should be lower to allow for efficient collection of the fluid, directed downward and posteriorly and the flow through the drain should be checked before suturing.

24. Prepare the underwater drain by filling the bottle with sterile water to the required level and placing in an upright position where it can easily be seen.

25. Attach the chest drain to the underwater drain tubing securely using the blue adaptor provided. The end of the underwater drain tubing may require cutting to fit the adaptor. (If the infant is for transfer to another hospital attach the drain to a flutter valve using the blue adaptor)

26. In the case of a pneumothorax ensure that the underwater drain bubbles or that there is a swing in the water level. If this does not happen the drain will need to be re-positioned prior to suturing.

27. If there has been a significant escape of air into the drain there may be noticeable improvements to the oxygen saturation and transcutaneous carbon dioxide levels ($TcCO_2$), therefore adjustments may be required to ventilation and FiO_2 levels. Too rapid a release of air may have a deleterious effect on the infant causing a rise in the mean BP and cerebral blood velocity to undesirable levels[9].

28. The drain is pig-tailed and does not routinely require stitching in place; it can be held in place with steristrips and a 'Tegaderm' dressing against the chest wall.

29. The tubing of the underwater drain should be secured to the bedding with a pair of artery forceps to further stabilize the drain.

30. If suction is indicated, attach the underwater drain to a low pressure suction system with the suction pressure set to -50mmHg (-5cmH_2O). This low negative pressure will assist drawing the remaining air from the chest cavity as long as the tube remains clear of fluid. The suction pressures should be prescribed or clearly

documented by the medical team before commencing, with consistency of the units used[20].

31. Ensure that the infant is left in a comfortable supported position for on-going care.

32. Clear away all equipment and dispose of sharps safely.

33. Obtain a chest x-ray to confirm:
    - The chest drain position
    - Check that free air has been released
    - That the perforations of the drain are within the pleural space
    - That the tip of the tube does not pass the midline[8]

34. The infant may need to be prescribed on-going analgesic support.

35. Record the procedure in the medical notes including:
    - Date and time of insertion
    - Indications for the procedure
    - Blood loss if any
    - Type and size of chest drain used
    - Confirmation of chest drain position on x-ray
    - Effect of procedure on the infant
    - Explanation of the procedure is given to parents if not previously given
    - Signature, printed name and designation.

36. Ensure that if not informed before, the parents are updated about the need for the chest drain and its function explained. It is also important to highlight that the infant cannot have skin to skin whilst the drain is in situ, but techniques to ensure FiCare is in place (containment holding, mouth care, reading to baby, talking to baby, etc).

7. Potential Complications

- Bleeding from damaged intercostal, mammary, pulmonary or axillary vessels[3]
- Intercostal nerve damage[4]
- Phrenic nerve damage leading to eventration of the diaphragm[11,12,13]
- Thoracic duct injury- where the drain is in the mediastinum[7]
- Puncture of the spleen, liver or heart[7]
- Lung damage - bronchopleural fistula[7]
- Oesophageal perforation[14]
- Cardiac tamponade[15]
- Loss of consciousness - if fluid is removed too quickly[7]
- Secondary infection[4]
- Constant bubbling may indicate a leak in the system, a dislodged chest drain, a leaking connection or a bronchopleural fistula.

8. Care of an Infant with a Chest Drain

1. Observe the infant's physiological signs hourly and report any changes to the medical team. Monitor chest movement and ensure air entry remains equal.

2. Analgesia should be given as prescribed and pain assessments undertaken to ensure that the infant remains comfortable.

3. Ensure that the chest drain bottle is kept below the level of the infant at all times to prevent flow back of fluid/blood into the pleural cavity.

4. Observe the drain for bubbling and record hourly on the ITU chart. There shouldn't be any looping of the tubing as fluid contained within the loop may cause an air-lock.

5. If the infant has a chest drain in post thoracic surgery – the drain may **not** need to be on suction – in this case a 'swing' may be observed as inspiration takes place. The swinging will stop once the lung has fully expanded or when the tube becomes blocked. In cases of drainage of fluid, the level and characteristics of the fluid drained should be recorded hourly, replacement therapy might be required.

6. Ensure that the low pressure suction device is working effectively and that the desired negative pressure is maintained at -50mmHg (-5cmH2O), as prescribed/ documented.

7. Ensure that there is a clamp in or near the incubator at all times in case of disconnection. The junction of the drain and drainage tubing should be checked regularly for a tight seal. If disconnection occurs seek medical assistance immediately.

8. The tube should not be clamped except while drainage bottle are changed or while the infant is being moved into the transport incubator and the drainage bottle changed for a flutter valve – but the clamps should be removed as soon as it is safe to do so.

9. Assess and document the colour and amount of any drainage. Record the amount in bottle on changing.

10. Changing the bottle is an aseptic non-touch procedure. Only fill the bottle to the level indicated – this will enable any drainage to be clearly seen.

11. If the infant requires moving – i.e. during cares or repositioning there should be two people in attendance – to ensure that there is no pulling on the chest drain or dislodgement.

12. The infant should not be taken out of the incubator for a cuddle while the chest drain remains in situ, especially for a pneumothorax. This should be explained to parents, and other options for providing close contact should be discussed such as:

containment holding, mouth care, reading to baby, talking to baby, etc). However, considerations can be made for stable babies who have long term drains/ drains to remove fluid where they may be placed on parent's knees on a pillow – this will need to be a MDT decision to ensure drains are not pulled/ dislodged.

13. If the dressing becomes soiled it should be changed. If the wound looks infected a swab should be taken for MC&S.

14. Keep the parents of the infant aware of their current condition and give them further information as needed about the function of the chest drain and why their infant requires it.

Procedure for the Removal of an Intrapleural (Chest) Drain

1. Aim

The aim is to remove the chest drain in a safe manner and prevent re-accumulation of air into the pleural space.

2. Indications

- Pneumothorax resolved on x-ray
- Chest drain underwater seal has no bubble or swing for >24 hours
- No further drainage of fluid for >24 hours
- Removal of surgical drain on consultant instruction

3. Equipment

Sterile dressing pack
Sterile gloves
Skin cleaning product according to local policy
Sterile water (cleaning the skin)
Universal container
Sterile scissors
Steristrips
IV 3000/Tegaderm

4. Procedure

1. Wash hands and dry thoroughly.

2. Collect equipment and clean the trolley.

3. Open the dressing pack and place all necessary equipment on the sterile field ready for use.

4. Position the infant in a supine position with the arm raised to allow easy access to the drain.

5. Consider analgesia.

6. Loosen the dressing around the drain.

7. Wash hands and dry thoroughly.

8. Put on sterile gloves (Aseptic principles should be applied to technique).

9. Remove the old dressing and steristrips (Apeel wipes may be useful).

10. Slowly withdraw the chest drain, covering the entry site with sterile gauze as the drain is removed.

11. Place the drain tip onto the sterile field.

12. Place tegaderm firmly over the incision to form a seal, preventing air entering pleural cavity and re-accumulation.

13. The tip of the drain should be put into the universal container and cut off with the sterile scissors. If sepsis is suspected the tip is then sent for MC&S to microbiology and treatment commenced.

14. Clear away all equipment ensuring that sharps are disposed of in a safe manner.

15. The infant should be closely observed for any signs of re-accumulation or clinical deterioration.

16. Arrange for a chest x-ray if there is any deterioration or if there is a specific request for an x-ray by the senior medical team[16,17]

17. Record the procedure in the medical notes including:
    - Date and time
    - Procedure undertaken
    - Blood loss if any
    - Effect on the baby
    - Result of x-ray if taken
    - Signature, printed name and designation

Insertion of ICC with trocar:
The insertion of ICC with trocar should only be an option in cases of significant pleural effusion or when local staff is not confident/experienced with the insertion of pigtail chest drains.

Procedure:

Size 10-12F is used in babies >1500g
Size 8-10F in those <1500g.

Remove the trocar from the catheter and clamp the proximal end with an artery forceps. Before placing the sterile drapes, superimpose the ICC over its projected course (i.e. medially and towards the apex of the lung) to estimate how far the ICC needs to be inserted.

Using a small (number 11) scalpel blade make a 0.5cm incision through the skin and subcutaneous tissue.
Using straight mosquito forceps to bluntly dissect away the subcutaneous tissue and intercostal muscles, the parietal pleura is reached. Open the parietal pleura by blunt dissection. At this point the hiss of air escaping the pleural space may be heard.

Grasp the distal end of the ICC with curved artery forceps. Advance the ICC into the pleural space directing the tip anteriorly as well as superomedially (for a pneumothorax) or posteriorly (for pleural effusions).

Connect the ICC to a sealed underwater suction apparatus, remove the proximal clamp on the ICC, and note whether the fluid is swinging and/or bubbling.

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Exceptional Circumstances Form

Form to be completed in the **exceptional** circumstances that the Trust is not able to follow ODN approved guidelines.

Details of person completing the form:	
Title:	Organisation:
First name:	Email contact address:
Surname:	Telephone contact number:
Title of document to be excepted from:	
Rationale why Trust is unable to adhere to the document:	
Signature of speciality Clinical Lead: Date:	Signature of Trust Nursing / Medical Director: Date:
Hard Copy Received by ODN (date and sign):	Date acknowledgement receipt sent out:

Please email form to: kelly.hart5@nhs.net requesting receipt.
Send hard signed copy to: Kelly Hart