

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

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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 ${\rm manner}^1$

2. Undertaken by¹

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

3. Indications²

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 confusion³.

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.

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 pneumothorax¹⁸.

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[°] 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 placement⁴.

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 infant⁵.



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

12. Locate the essential landmarks²

- 4th or 5th intercostal space in the anterior axillary line
- Approximately 1-2 cm lateral to an 0.5-1 cm below the nipple



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 <u>anterior axillary line to mid axillary</u> <u>line</u> through the 4th or 5th intercostal space⁶.
- The mid-clavicular line should be avoided especially in female infants⁶.
- 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

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
- 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



- 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 (TcCO₂), therefore adjustments may be required to ventilation and FiO₂ 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 levels⁹.
- 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 the Roberts' pump with the suction pressure set to -50mmHg (-5cmH₂O). This low negative pressure will assist drawing the remaining air from the chest cavity as long as the tube remains clear of fluid.
- 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 midline⁸
- 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

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- Effect of procedure on the infant
- Explanation of the procedure is given to parents if not previously given
- Signature, printed name and designation.

33. Ensure that if not informed before, the parents are updated about the need for the chest drain and its function explained.

7. Potential Complications

- Bleeding from damaged intercostal, mammary, pulmonary or axillary vessels³
- Intercostal nerve damage⁴
- Phrenic nerve damage leading to eventration of the diaphragm^{11,12,13}
- Thoracic duct injury- where the drain is in the mediastinum⁷
- Puncture of the spleen, liver or heart⁷
- Lung damage bronchopleural fistula⁷
- Oesophageal perforation¹⁴
- Cardiac tamponade¹⁵
- Loss of consciousness if fluid is removed too quickly⁷
- Secondary infection⁴
- 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 <u>may</u> 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.
- 6. Ensure that the Low Pressure suction device (Robert's pump) is working effectively and that the desired negative pressure is maintained ($-5cmH_2O$).
- 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.
- 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

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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
- 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 over the incision to form a seal.
- 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.



References

- 1. NPSA (2008) Rapid Response Report: Risks of chest drain insertion. NPSA/2008/RRR003. [IV]
- 2. MA, Eichelberger MR. (1993) Thoracostomy tubes. In: Fletcher MA, McDonald MG. *Atlas of Procedures in Neonatology.* JB Lippincott. Philadelphia. [IV]
- 3. Finnbogason T, Bremmer S, Ringertz H. (2002) Side markings of the neonatal chest x-ray: two legal cases of pneumothorax side mix up. *European Radiology*.April;12(4):938-41. [III]
- 4. Gomella TL. (1994) Procedures. In:Gomella TL, Cunningham MD, Eyal FG. Neonatology 3rd Ed. Prentice-Hall International. London. [IV]
- 5. Department of Health (2001) The *EPIC* Project: Developing national evidence-based guidelines for preventing healthcare associated infections. *Journal of Hospital Infection.* 47(supplement):S3-S4 (6-34). [IV]
- Rainer C, Gardetto A, Frühwith M, Trawöger R, Meirer R, Fritsch H, Piza-Katzer H. (2003) Breast deformity in adolescence as a result of pneumothorax drainage during neonatal intensive care. *Pediatrics*.January;111(1):80-86. [III]
- 7. Harling E. (2000) Diagnostic and therapeutic procedures. In: Boxwell G. *Neonatal Intensive Care Nursing.* Routledge. London. [IV]
- 8. Davies MW, Dunster KR. (2003) Inserion distance of neonatal intercostal catheters using a 10 French Argyle® trocar thoracic catheter. *Critical Care and Resuscitation*.5:103-105. [III]
- 9. Batton DG, Hellmann J, Nardis EE. (1984) Effect of pneumothorax induced systemic blood pressure alterations on the cerebral circulation of newborn dogs. *Pediatrics.* 74:350. [IIb]
- 10. Cartlidge PH, Fox PE, Rutter N. (1990) The scars of newborn intensive care. *Early Human Development*.January;21(1):1-10. [III]
- 11. Kirpalani H, Mernagh J, Gill G. (1999) *Imaging of the Newborn Baby.* Churchill Livingstone. Edinburgh. [IV]
- 12. Williams O, Greenough A, Mustfa N, Haugen S, Rafferty GR.(2003) Extubation failure due to phrenic nerve injury. *Archives of Disease in Childhood Fetal and Neonatal Edition*.88:F72-F73. [III]
- 13. Arya H, Williams J, Ponsford SN, Bissenden JG. (1991) Neonatal diaphragmatic paralysis caused by chest drains. *Archives of Disease in Childhood* April;66(4 Spec No):441-2. [III]



- 14. Cairns PA, McClure BG, Halliday HL, McReid M.(1999) Unusual site for oesophageal perforation in an extremely low birth weight infant. *European Journal of Pediatrics*. February;158(2):152-3. [III]
- 15. Quak JM, Szatmari A, van den Anker JN. (1993) Cardiac tamponade in a preterm neonate secondary to a chest drain. *Acta Paediatrica*.. May;82(5):490-1. [III]
- Pacharn P, Heller DN, Kammen BF, Bryce TJ, Reddy MV, Bailey RA, Brasch RC. (2002) Are chest radiographs necessary following thoracostomy tube removal? *Pediatric Radiology.* February;32(2):138-42. [III]
- 17. Van den Boom J; Battin M.(2007) Chest radiographs after removal of chest drains in neonates: clinical benefit or common practice? *Archives Dis in Child Fetal & Neo Ed.* 2007 Jan;92(1):46-8.
- Bruschettini, M., Romantsik, O., Zappettini, S., O'Donnell, C. and Calevo, M., (2019). Needle aspiration versus intercostal tube drainage for pneumothorax in the newborn. *Cochrane Database of Systematic Reviews*, Available at: http://cel.webofknowledge.com/full_record.do?product=CEL&search_mode=CitingA rticles&qid=1&SID=F6ydWilEUcW3TswfhFc&pReturnLink=&pSrcDesc=&page=1&UT =WOS:000437219600015&doc=5 (Accessed 25/10/21)

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