

Guideline

Stabilisation and transfer of an infant with a pneumothorax

1 Scope

For use within the Paediatric and Neonatal Decision Support and Retrieval Service (PaNDR) for the East of England.

2 Purpose

To provide safe, efficient and practical guidance for management of infants with pneumothorax during stabilisation and transfer.

3 Definitions

CXR chest x-ray
NICU neonatal intensive care unit
PCO₂ the partial pressure of carbon dioxide in the blood

4 Introduction

Pulmonary air leak occurs more frequently in the newborn period than at any other time of life. It occurs when air escapes from the lungs into the extra-alveolar spaces. It begins with the rupture of an over distended alveolus. Over distension may be due to generalised air trapping or uneven distribution of gas. The air dissects along the perivascular connective tissue sheath into the pleural space resulting in pneumothorax. The incidence depends upon the birth weight, presence of lung disease, and the method of detection. The incidence is higher in preterm infants, who often have pulmonary disease.

A pneumothorax diagnosed as an incidental finding on CXR may not require active drainage, but when associated with clinical deterioration, it may require expedient drainage. The incidence of pneumothorax is dramatically lower since the advent of surfactant, but air leaks still occur in 5-10% of babies with neonatal lung disease.

A pneumothorax may be an emergency when the air collection is under pressure (a tension pneumothorax). When it causes an acute clinical deterioration, it is necessary to drain the pneumothorax by needle aspiration and/ or chest drain insertion.

5 Clinical presentation

- Respiratory distress
- Increasing oxygen requirement and/or PCO₂
- Reduced air entry on the affected side
- Hypotension
- Tachycardia or bradycardia
- Acute cardiorespiratory collapse

Tension pneumothorax occurs when intrapleural pressure is greater than atmospheric pressure.

Following respiratory deterioration, a full clinical assessment should be carried out which includes the symmetry of breath sounds and chest movement.

In intubated infants, the following mnemonic may be helpful to identify the cause of an acute deterioration:

- D – Displacement
- O – Obstruction
- P – Pneumothorax/ pulmonary haemorrhage
- E – Equipment failure

If a pneumothorax is suspected, transilluminate using a cold light. This is unreliable in term babies, when an urgent chest x-ray may be required. If a tension pneumothorax is suspected however and the cardiorespiratory status is significantly compromised, proceed directly to needle thoracocentesis and/ or chest drain insertion.

6 Management

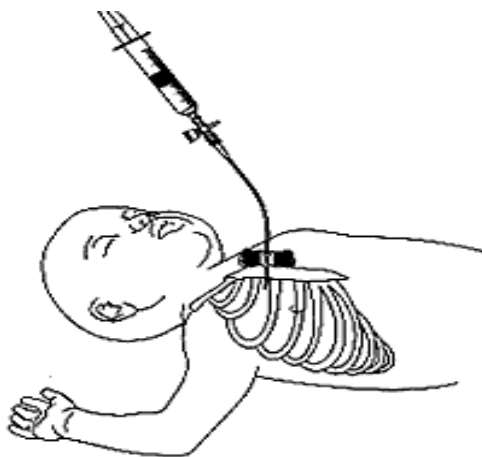
A small to moderate-sized pneumothorax may not require drainage but the threshold for inserting a chest drain should be lower in an infant requiring transfer than on the NICU. Whilst a pneumothorax can often be safely observed and managed expectantly in the NICU setting, an unstable air leak will be challenging to manage in the ambulance.

Ensure that a recent chest X-ray has been performed and that the PaNDR consultant has been fully involved in risk assessing whether drainage is required prior to transfer. A higher concentration of oxygen may be used to 'wash out' nitrogen and if drainage is required, consideration should be given to appropriate analgesia, sedation +/- muscle relaxation.

For urgent decompression a needle thoracocentesis should be performed using a butterfly needle connected to a three way tap. Following needle aspiration, insertion of an intercostal catheter is usually required for ongoing management. This is particularly important for infants requiring transfer when an unstable air leak could be very problematic.

7 Equipment for needle thoracocentesis

- Butterfly needle
 - 25G for < 32 weeks or < 1500g
 - 23G for > 32 weeks or > 1500g
- 3 way tap
- 10 ml syringe
- 70% Isopropyl alcohol swab
- One pair sterile gloves



8 Performing needle thoracocentesis

- Position infant supine, prepare skin with alcohol wipe
- Insert needle perpendicular to the chest wall into the pleural space (directly over the top of the rib in the 2nd or 3rd intercostal space in the mid-clavicular line) until air is aspirated into the syringe. Expel air via the 3-way tap
- Minimize movement in the needle to avoid lacerating the lung or puncturing blood vessels
- As a temporary measure the distal end of the butterfly can be placed into a bottle of sterile water to form an underwater seal whilst equipment is found for a chest drain.

9 Drainage

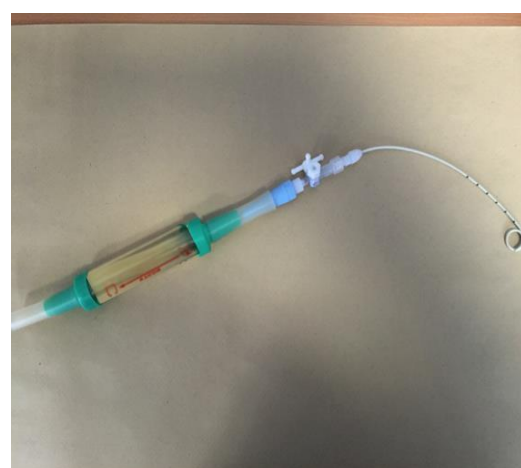
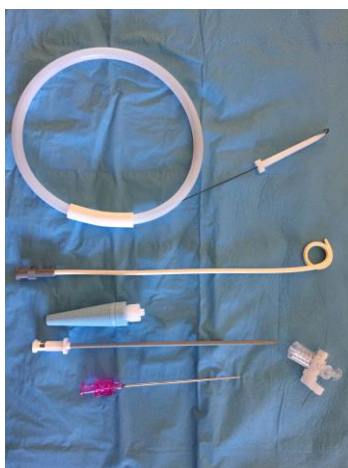
The preferred drain is a Fuhrman pigtail catheter, but the alternative remains a trocar catheter. The insertion procedure will be described for both. Once the catheter has been inserted it is immediately connected to either a one way valve (Heimlich valve) or an underwater seal drainage system (with or without active suction).

10 General technique for insertion of chest drain

- If a chest drain is required the infant is likely to first require intubation in order to stabilise sufficiently for the procedure
- Appropriate sedation +/- muscle relaxation should be considered
- Infiltrate the insertion site with 0.3ml/kg of 1% Lignocaine
- Remember to maintain infant's temperature
- Monitor heart rate and saturation levels and ensure infant can still be partly visualised after draping to create a sterile field
- Prepare equipment
- Position the infant with the affected side uppermost and the arm extended above the head (a nappy cloth roll may help maintain a good position). Ensure limbs are adequately restrained
- Wash and gown
- Clean skin using the local cleaning solution available e.g. 0.05% chlorhexidine for premature infants and 0.5% for term infants
- Locate position for drain – palpate ribs and feel for intercostal spaces. Drains should be inserted at the 4th to 5th intercostal space, between the mid and anterior axillary line. 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
- Drape dressing towel over baby making a small hole in towel to expose site.

11 Equipment for insertion of a pigtail drain

- 15 cm long polyurethane Pigtail catheter with six side ports
 - 8.5 Fr. for > 1500g
 - 6 Fr. for < 1500g
- Gown and sterile gloves
- Dressing pack
- Cleaning fluid as per local unit (eg 0.05% chlorhexidine for premature infants, 0.5% chlorhexidine for term babies)
- Extension tubing
- Heimlich Flutter valve
- Steri-strips and transparent dressing
- 20ml syringe/ 10 ml syringe
- 3 way tap
- Sterile scissors
- Bottle of sterile water
- Flexible funnel – if temporarily connecting to under water seal
- Consider if a suture will be required to secure the drain with scalpel and forceps



12 Inserting a pigtail drain

- Insert the needle (with a syringe attached) into the skin perpendicular to the chest wall
- Advance the needle through the infiltrated skin, gently aspirating until air is obtained (verifying placement)
- Holding the needle steady, remove the syringe and thread the guidewire through the needle (via the white plastic tip) ensuring that the guidewire is inside the chest, not inserting further than the mark on the wire. If resistance is felt consider if the needle is still located in the appropriate site
- Holding some gauze to the skin, carefully remove the needle ensuring that the guidewire remains in the chest
- Thread the dilator (about 1cm) to increase the size of the opening by sliding this over the guidewire and using a gentle twisting movement. Should this be problematic, a small incision can be made next to the dilator to allow it to advance through the chest wall
- Remove the dilator, again leaving the guidewire in the chest and feed the pigtail catheter over the guidewire with the holes facing up. Advance to 1st to 2nd black line for a premature infant, 4th to 5th for a term infant. Remove the guidewire. Once in the pleural space, aim to direct the drain anteriorly towards the midline to optimise drainage of the pneumothorax which will accumulate anteriorly in a supine infant
- Secure the pigtail catheter with steri-strip to skin and apply tegaderm ensuring drain is placed down against the body, taking care that the drain is not kinked
- Connect to the extension tubing, 3-way tap and the end Heimlich valve ensuring the valve is placed correctly (please see image) and is below the level of drain
- Reassess and arrange an urgent x-ray.

13 Equipment for insertion of a trocar drain

- Argyle 10Fr sterile intercostal catheter
- Sterile surgical instrument pack
- Size 11 scalpel blade
- 3/0 black silk suture on a curved edge needle
- Skin preparation
- 1% Lignocaine, syringe and needle
- Underwater seal drainage system or a Heimlich valve
- Sterile gown, gloves and drapes
- Semi-occlusive dressing, tapes.



14 Inserting a trocar drain

- Use a scalpel to make a small cut in the skin at the insertion point, parallel to the line of the rib
- Gently use artery forceps to make hole for drain, separating the muscle layer. Push through to the intercostal space feeling a small “give” – there may be a slight gush of air
- **Remove trocar from drain prior to insertion** and insert drain into prepared hole. Aim drain up towards opposite shoulder. Using a pair of forceps may help to steady the drain during insertion
- Suture in place but do not use purse string suture as this may cause significant scarring
- Apply transparent dressing ensuring drain is placed down against the body
- Connect to the extension tubing, 3-way tap and Heimlich valve ensuring the valve is placed correctly (please see image) and is below the level of drain
- Reassess and urgent x-ray if on neonatal unit.

15 Attaching the Heimlich flutter valve



The connections between the drain and the Heimlich valve

The Heimlich valve has a picture of the lungs which should be connected onto the side of the drain.

16 Use of low suction during transfer

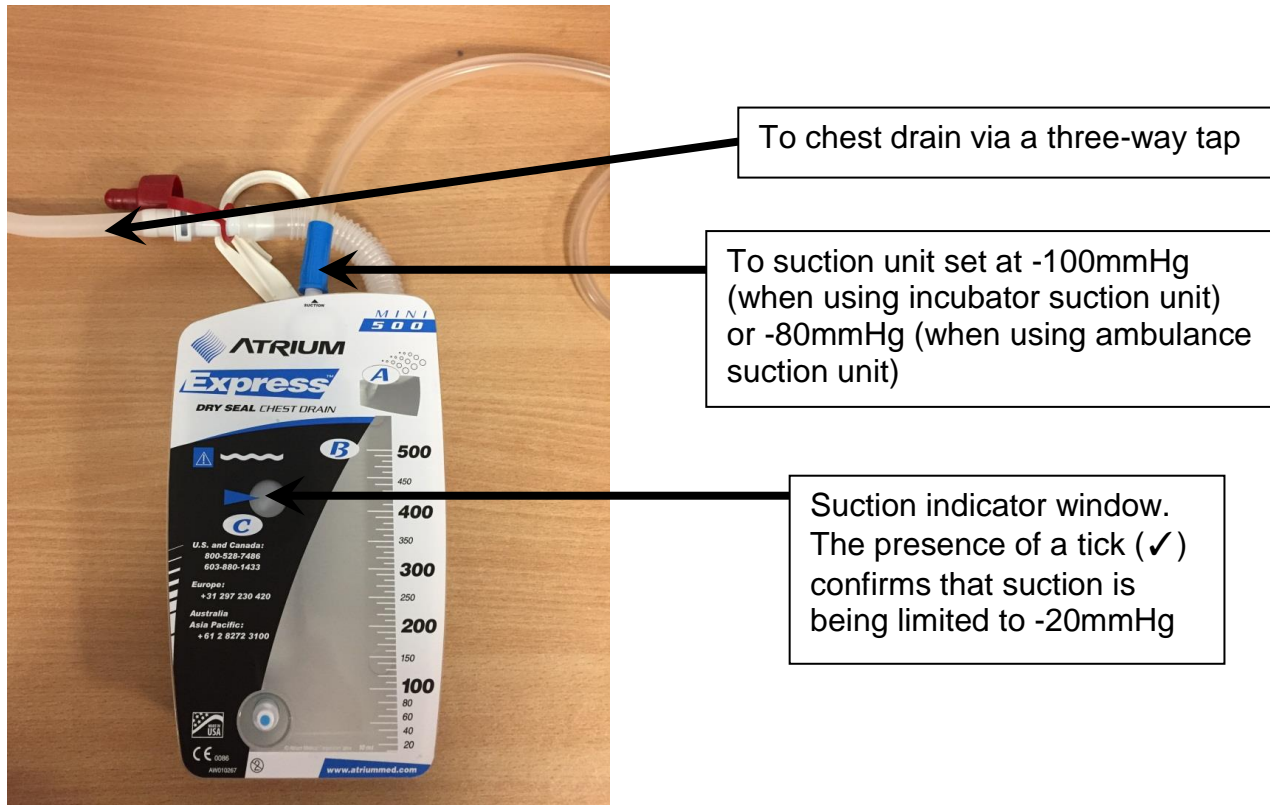
For some infants with a chest drain in situ the Heimlich flutter valve may not be completely effective in enabling ongoing drainage of any intrapleural air, causing a re-accumulation of the pneumothorax during transfer. This may cause the infant to destabilise. It may therefore be beneficial to put the chest drain on continuous suction.

Continuous suction should be performed by turning the three way tap off to the infant, removing the Heimlich flutter valve, and attaching the chest drain via the three way tap to the Atrium Express Mini 500 unit. This Atrium Express Mini 500 unit requires a suction pressure of -80mmHg or above to function effectively – the blow off valve will ensure that the negative pressure does not exceed -20mmHg. It should therefore be attached to the incubator suction unit at -100mmHg. The three way tap should be turned back on to the infant to allow continuous suction. On arrival to the ambulance, the suction unit can be changed across to the ambulance SAM suction unit, which should be set at -80mmHg.

The Atrium Express Mini 500 is vital when using suction as it has a blow-off valve to ensure the continuous low suction does not exceed -20mmHg. With the chest drain attached to suction, the chest drain should show a tick sign ✓ in the suction indicator window (see picture). This confirms that the chest drain is working appropriately. The ✓ should **always** be visible when the baby is connected to the chest drain. If it is not visible the circuit and suction must be checked carefully, and if needed, replaced; it may be a sign that either the suction is not working or that the circuit is allowing too high a suction pressure to reach the baby. The Atrium Express Mini unit should only be used when suction

is required, and should **never** be placed in series with the Heimlich flutter valve as it has potential to disrupt its mechanism of action.

The use of suction should be discussed on a case-by-case basis with the covering consultant.



17 Pneumothorax during transit

If a new pneumothorax is suspected during a transfer, the procedures described above will have to be adapted due to the limitations of being within a vehicle. Liaise with the covering PaNDR consultant for advice/support. Stop the ambulance in a safe place, take down the side of the transport incubator and increase the heater (on the incubator and in the ambulance). For suspected re-accumulation of a pneumothorax, check that the dressing has not become dislodged, the drain has not slipped out and the 3-way tap is correctly aligned to enable drainage. Attempt to aspirate the pneumothorax via the 3-way tap and consider replacing the Heimlich valve with the Atrium Express Mini 500 suction unit if continuous suction has not already been used.



18 Monitoring compliance with and the effectiveness of this document

The effectiveness of the document will be monitored by review of any reported incidents via the lead nurse for risk. These incidents will be shared with the team and consideration given to adjusting the guideline if concerns are identified.

19 References

- Neonatal ehandbook, www.health.vic.au
- www.uptodate.com
- emedicine.medscape.com
- Newborn services clinical guideline, Auckland, New Zealand:
<http://www.adhb.govt.nz/newborn/Guidelines/Respiratory/Pneumothorax/PneumothoraxOverview.htm>
- Pneumothorax management NTS guideline:
<https://londonnts.nhs.uk/wpcontent/uploads/2015/02/Pneumothorax-Management-NTS-Guideline.pdf>

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