SUBJECT: Pneumothorax in NICU

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KEYWORDS: Air leak, dry seal chest drain, emergency needling, ICC (intercostal catheter), pneumothorax, RDS (respiratory distress disease)

Disclaimer:
It should be noted that this document reflects what is currently regarded as a safe and appropriate approach to care. However, as in any clinical situation there may be factors that cannot be covered by a single set of guidelines, this document should be used as a guide, rather than as a complete authoritative statement of procedures to be followed in respect of each individual presentation. It does not replace the need for the application of clinical judgment to each individual presentation.
RATIONALE:
A pneumothorax is an accumulation of gas in the pleural cavity that is usually associated with deterioration in the infant's condition. This is a potentially life threatening emergency. Rapid recognition and effective management of the infant suffering a pneumothorax may significantly reduce mortality and morbidity rates. The long-term sequelae of hypoxia and ischemia may be reduced with appropriate treatment.

A pneumothorax can be an isolated finding in an infant with respiratory distress, or may be associated with other forms of lung disease e.g. respiratory distress syndrome (RDS) or meconium aspiration syndrome (MAS).

OUTCOMES:
1. Air will be evacuated from the pleural space and negative pressure will be restored to enable the lung to re-expand.
2. Pain relief is provided to ensure the infant recovers as quickly as possible with minimal discomfort.
3. The “5 moments of hand hygiene” will be observed to minimise contamination
4. The infant will maintain heart rate, oxygen saturation and respiratory rate within normal limits.
5. Parents will be informed, educated and supported throughout procedures.

CLINICAL PRESENTATION:
- Sudden or unexplained deterioration with desaturation.
- Increase in respiratory distress and / or diminished or asymmetrical chest movements
- Fall in oxygen saturation / unexplained increase in oxygen requirement
- Circulation may become compromised eg hypotension
- Blood gas may show hypoxia, hypercarbia, respiratory and / or metabolic acidosis.
- Unequal or decreased air entry
- Displaced heart beat
- Occasionally some infants do not have a sudden deterioration and may only be picked up on x-ray. This is more likely on HPCPAP or HFOV.

Confirmation can be obtained by:

- Cold light transillumination demonstrating accumulated air, especially in small preterm infants
- Chest x-ray will confirm diagnosis and /or effectiveness of treatment

PNEUMOTHORAX IS AN EMERGENCY AND IS POTENTIALLY LIFE THREATENING

Following clinical presentation and confirmation by cold light source, steps are taken to evacuate the air and re-expand the lung. Depending upon infant’s condition, there are several ways of achieving this:
1. Emergency needle aspiration; and/ or,
2. Insertion of an intercostal catheter.
Emergency Needle Aspiration
This procedure may be the only requirement to treat a pneumothorax but more commonly will provide temporary alleviation of a pneumothorax. The infant will then be assessed to determine if an insertion of an intercostal catheter (ICC) is required.

Equipment required.
- 1x 23g or 25g butterfly needle (blue) or a 22g or 24g cannula
- 1x alcohol swab
- 1x 3-way tap
- 1x 10ml syringe
- sterile gloves

Procedure
- Connect butterfly needle / cannula to the 3-way tap and syringe. The 3-way tap allows for aspiration of free air into the syringe and emptying the syringe while maintaining a closed system.
- Increase oxygen as required.
- Raise head of bed
- Position infant supine and identify puncture site
- Clean area of puncture site with alcohol swap
- Insert butterfly needle/ cannula into the pleural space (directly over the top of the rib in the 2nd or 3rd intercostal space in the mid clavicular line or into axillary 4th space) until air is aspirated into the syringe, then expel air through the 3-way tap.
- When free air is obtained, stabilize the needle / cannula and continue aspiration until preparations for insertion of an ICC are complete or until the air leak is evacuated.
- Monitor infant’s heart rate and oxygen saturation continuously
- Maintain infant temperature
- RN assist medical officer / NNP as required

INTERCOSTAL CATHETER PLACEMENT AND MANAGEMENT:

It is the responsibility of the Medical Officer, Nurse Practitioner (NP) or Transitional nurse practitioner (TNP) to place an Intercostal Catheter (ICC). It is the responsibility of the nursing staff member caring for the infant to assist with placement of the ICC, to provide ongoing management and pain assessment and relief.

Site Selection
Determined by the medical officer or NP, and depends upon the area of air accumulation. There are 2 sites –
• Anteriorly through the second or third intercostal space in the mid clavicular line.
• Laterally through the fourth, fifth or sixth intercostal space in the mid to anterior axillary line. This should be well lateral to the nipple to avoid the breast area.

Catheter Selection
Several different intercostal catheters are available. These are:

Cook Catheter ™  7.0fr (25cm long for <1000g)
                 8.5fr (25cm long for >1000g)
                 10.2fr (25cm long)

Argyle catheter ™ 10fr (3.3mm width and 23 cm long)
                  12fr (4.0mm width and 23cm long)

The Cook™ catheters tend to be the preferred product, with the Argyle™ used for emergency backup and for thick fluid drainage.

Insertion of an Intercostal Catheter

Equipment required (intercostal catheter trolley).

• Large dressing trolley
• Large plastic drape
• Large sterile drape
• Mask, sterile gown, gloves and hat
• Dressing pack
• Paediatric instrument kit
• Fenestrated drape and/or clear plastic drape
• Intercostal catheter
• Disposable drainage system (Oasis / Atrium™ system see instructions for setting up below)
• Cook™ Multipurpose tubing adaptor with luer lock
• Scalpel blade
• local anaesthetic (lignocaine 1%), needle and syringe
• Chlorhexidine solution 2%, Povidone for infants <1000g infant skin cleaning solution
• catheter fixation device or steri-strips
• safety pins
• tape
Procedure

- Observe universal precautions
- Give sucrose orally prior to local anaesthetic. Morphine may be given for ongoing pain relief.
- Insertion of an ICC is a sterile procedure-wear mask, gown, hat and gloves (see CPG: Aseptic Technique in NICU JHCH_NICU_03.01)
- Increase oxygen as required
- Continually monitor infant’s heart rate and oxygen saturation
- Raise head of bed
- Position infant as required throughout procedure. Place the infant with the effected side uppermost and the arm extended above the head.
- Nurse the infant in a Giraffe Omnibed™ and apply a temperature probe to avoid temperature instability during the procedure.
- The intercostal catheter is inserted in the 4th or 5th intercostal space in the anterior axillary line. This corresponds to a point at least 2 cm lateral and below the nipple. The incision must be well clear of the nipple.
- Clean with appropriate cleaning solution and allow to dry prior to insertion - Chlorhexidine solution 2 if >1000 grams or Povidone solution if <1000 grams.
- Select intercostal catheter size
- Place sterile fenestrated drape or clear plastic drape in position
- Infiltrate the insertion site with 1% lignocaine (dose depending on size of infant). An alternative practice is to infiltrate with local anaesthetic before preparing and draping the field in order to allow longer time for anaesthetic to take effect.
- Using small (No 11) scalpel blade make an incision through the skin and subcutaneous tissue. Position blade parallel to rib and avoid multiple ‘slashing’ movements.
- Use a straight mosquito forcep to bluntly dissect a passage just above a rib border in order to avoid the neurovascular bundles running below each rib. Open the parietal pleura by blunt dissection and at this point the hiss of air escaping the pleural spaces may be heard.
- Remove the trocar from the ICC and grasp the distal end with curved artery forceps. Advance the ICC into the pleural space 3-5cm and use the 1-3cm marking on the catheter to direct the tip anteriorly as well as superomedially so that the tip lies beneath the anterior chest wall.
- Connect the ICC to the underwater seal drainage system, and note whether fluid is swinging and / or bubbling. Fogging within the catheter (Argyle™ only, as Cook™ are white) may be seen when within the pleural space.
- The position of the ICC should be maintained to ensure adequate drainage of the pleural space. Should the catheter become dislodged, drainage may be interrupted. The closed nature of the drainage system is rendered ineffective, and the patient may be compromised.
- The ICC is stabilised by securing it to the chest with the catheter fixation device from the Cook’s ICC pack. It should be trimmed to accommodate the size of the infant’s chest. Alternatively steri-strips may be used. Purse string sutures are not used where possible due to poor long-term cosmetic result. Sutures should only be used to shorten the incision. Tubing is attached to the bed linen with the use of tapes and safety pins to limit mobility of the tube.
- RN to assist medical officer /NP as required and will also wear a gown, mask and hat
- The disposal of sharps is the responsibility of the practitioner performing the procedure, using appropriate sharps container.
- Details of the ICC insertion should be noted on the observation flow sheet and documented in the progress notes using the white paediatric procedure record sticker.
Observation of the closed system should be documented hourly, noting drainage and bubbling in tubing and chamber.

Inform and explain to parents the procedure:

Fig. 1 Atrium Express™ Chest Drain set-up

Connecting a Cook™ ICC catheter

1. With sterile scissors cut end of Atrium™ drainage tubing to remove clear adaptor and discard.

2. Insert Cook™ multipurpose adaptor (blue) into drainage tubing (with white end facing out).

3. When ICC inserted connect the white end of the multipurpose adaptor (blue) to the three way tap that has been connected to the Cook™ catheter as shown in Fig 2.
Preparing ATRIUM EXPRESS™ Dry Seal Chest Drain System

The water seal drainage system is comprised of a one piece, 3 chamber set-up, which separates the functions of fluid collection, water seal (which serves as a simple one way valve), and suction control.

Equipment:
- Sterile oasis / atrium drainage pack
- Clean suction tubing
- Cook’s™ multipurpose tubing adaptor with luer lock
- Sterile scissors

Procedure for setting up Atrium Express™ dry seal chest drain system:
1. Open Atrium pack

2. Draw up solution from ampoule supplied and insert into suction port at the back of system –see Figure 4 & 5 (fluid will fill to 2cm line)
3. With sterile scissors cut end of drainage tubing to remove clear adaptor and discard.
4. Insert Cook™ multipurpose adaptor (blue) into drainage tubing (with white end facing out)
5. Assist with insertion of intercostal catheter (as above)
6. Attach suction tubing to suction port on drainage system and attach other end to the wall suction
7. Set drain suction to –10cm water by moving the rotary dial – located behind (A) on left side of drain
8. Set wall suction at required setting at –10 kPa (80mmHg)
9. Watch bellows (E) expanding when suction is operating
10. Observe (C) for active bubbling
11. Monitor drainage at (D)

Note: Refer to Figure 3 for location of A, C, D & E

Ongoing monitoring
- Secure ICC to bed linen with tape and safety pin, ensuring no tension is on catheter.
- Leave infant clean, dry and comfortable.
- Record procedure on observation chart and in progress notes.
- Post insertion x-ray to ensure ICC placement is correct and effective.
- Inform and reassure parents as soon as possible.
- Observe ICC and drainage system hourly and document.
- If the infant is being transported a Heimlich™ valve may be required.
- The requirement for ongoing pain management is based on an assessment using the PIPP score.

Removal of Intercostal Catheter

Equipment Required
- Trolley and sterile drape
- Dressing pack
- Sterile gloves
- Sterile scissors
- Sterile specimen container (if required)
- Steri strips
- Suture material (if required)

Procedure (May be undertaken by an MO, NP, TNP or experienced RN)
- Inform parents of procedure, explain and reassure.
- Observe aseptic technique
- Position infant with affected side uppermost.
- Remove all dressings and steri-strips, and clean area.
- If catheter tip is to be saved and sent to pathology, have container ready.
- Remove catheter carefully and gently.
- Steri-strip wound site as needed. If site is gaping, have medical officer or NP review, and suture as necessary.
- Leave infant clean, dry and comfortable.
- Dispose of used drainage system as indicated.
- Document procedure on observation chart and white sticker in the progress notes.
• Assist with post ICC removal x-ray.

REFERENCES:
Lippincott, Williams & Wilkins (7th Edition)
(9th Ed)
Mosby Co, (7th Ed)
ATRIUM EXPRESS Dry Seal Chest Drain System Product Information leaflet

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