Management of PNEUMOTHORAX

Relevant protocols / Links

<table>
<thead>
<tr>
<th>Protocol</th>
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</tr>
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</table>

1. Air leaks

Air leak is characterised by air or gas leaking out of the normal pulmonary airspaces. Air leaks develop from an abnormal distribution of gas and subsequent alveolar over distension and rupture. The escaping gas flows to the point of least resistance.

Air leaks may develop gradually or occur suddenly. The degree of respiratory compromise is dependent upon the location of the air leak and the amount of air contained in that leak.

An infant may have more than one form of air leak.
<table>
<thead>
<tr>
<th>Air Leaks</th>
<th>Clinical Presentation</th>
<th>Chest Radiograph Findings</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pneumothorax</strong></td>
<td>If symptomatic, see: • Tachypnea &lt;br&gt;• Grunting &lt;br&gt;• Retractions &lt;br&gt;• Cyanosis</td>
<td>May not show any changes, or may show air in pleural space</td>
<td>Management may be conservative and can include oxygen, nitrogen washout and /or use of the lateral position with affected side up &lt;br&gt;Insertion of intercostal drain</td>
</tr>
<tr>
<td><strong>Tension pneumothorax</strong></td>
<td>Tachypnoea &lt;br&gt;Grunting/retractions &lt;br&gt;Cyanosis &lt;br&gt;Hypotension &lt;br&gt;Decreased breath sounds &lt;br&gt;Chest asymmetry &lt;br&gt;Shift in point of maximal impulse</td>
<td>Pocket of air compressing the lung - mediastinal shift may/may not be evident</td>
<td>Immediate insertion of intercostal drain &lt;br&gt;Urgent needle aspiration may be necessary if the infant is severely compromised</td>
</tr>
<tr>
<td><strong>Pulmonary interstitial emphysema</strong></td>
<td>Increased oxygen requirements &amp; CO2 retention &lt;br&gt;Reduced compliance</td>
<td>Small dark bubbles of air outside the tracheobronchial tree but trapped within the lung tissue</td>
<td>Positive-pressure ventilation &lt;br&gt;High-frequency ventilation &lt;br&gt;Optional: selective main stem bronchus intubation</td>
</tr>
<tr>
<td><strong>Pneumomediastinum</strong></td>
<td>Generally asymptomatic &lt;br&gt;Tachypnoea &lt;br&gt;Occasional precursor to pneumothorax</td>
<td>“Spinnaker sail sign” as thymus gland is elevated by air in the mediastinum</td>
<td>Usually none required &lt;br&gt;Insertion of mediastinal drains</td>
</tr>
<tr>
<td><strong>Pneumopericardium</strong></td>
<td>Distant/absent heart sounds &lt;br&gt;Bradycaardia &lt;br&gt;Diminished/absent pulses &lt;br&gt;Marked hypotension &lt;br&gt;Cyanosis and/or pallor &lt;br&gt;Reduced ECG voltage &lt;br&gt;Rare in the absence of mechanical ventilation.</td>
<td>Halo of air surrounding and compressing the heart &lt;br&gt;Decreased heart size</td>
<td>Urgent needle aspiration usually required</td>
</tr>
<tr>
<td><strong>Pneumoperitoneum</strong></td>
<td>Distended abdomen and lung expansion may be compromised &lt;br&gt;If it occurs in combination with pneumothorax it is unlikely to be an acute abdomen.</td>
<td>Dark layer over the abdomen &lt;br&gt;Blurring or obscuring of normal bowel pattern</td>
<td>Usually none required &lt;br&gt;Optional: insertion of soft catheter into the peritoneum</td>
</tr>
</tbody>
</table>

(Armstrong 2002)
1.1 Pneumothorax

A pneumothorax is the presence of air in the pleural space, between the viscera and pleural layers of the lung (Fernandes, 2009). This potential space is normally absent of air and fluid. The frequency of spontaneous pneumothorax is approximately 1% of live births and only 10% of these infants demonstrate signs of respiratory distress. It is estimated that 15-20% of pneumothoraces are bilateral (Diwakar, 2003).

Risk factors include:
- Positive pressure ventilation including nCPAP;
- Prolonged and / or difficult resuscitation
- Meconium aspiration syndrome;
- Respiratory Distress Syndrome
- Pulmonary hypoplasia;
- Diaphragmatic hernia;
- Pneumonia
- Transient tachypnoea of the newborn
- Thoracic surgery

(Armstrong 2002; Fernandes 2010; Reuters 2007; Singh & Amin 2005)

Clinical Features:
- Asymptomatic: an infant may have decreased air entry to the affected side, usually air leak is unilateral
- Symptomatic: sudden or gradual in onset where the infant may demonstrate restlessness, irritability or apnea. There may be evident mild to severe tachypnoea, respiratory distress and/or cyanosis
- Decrease in blood pressure
- Mediastinal shift
- Hyper inflated thorax
- Unequal air entry
- Chest asymmetry

(Diwakar 2003)
**Diagnosis**

1. *Clinical signs* Pneumothorax is the most common air leak managed in the NICU and should be suspected in any infant with risk factors (listed above), and a sudden onset or deterioration in respiratory distress including diminished breath sounds, tachypnoea, apnoea, bradycardia, hypoxia, hypercarbia and / or change in cardiovascular status. The diagnosis of an air leak is not made on clinical signs alone and the following are also utilised to aid diagnosis.

2. *Transillumination:* this can be performed by the RN or medical staff using a high-intensity fibre-optic or cold light. The procedure is non invasive and painless. In theory the light is readily be dispersed by air in the pleural space especially in the preterm infant. However use of transillumination in term infants, infants with generalised oedema or infants with pulmonary interstitial emphysema as the light can be diffused for reasons other than pneumothorax. Use both history (risk factors) and clinical signs when interpreting this test.

3. *Antero-posterior chest x ray:* This provides the definitive diagnosis with air seen in the anterior pleural space, atelectasis, flattening of the diaphragm (on the affected side) and mediastinal shift with displacement of the heart. The lateral chest x-ray can be used to confirm correct placement of intercostal tubes and better isolate pockets of air.

The left lateral decubitus x-ray is used to confirm air in the peritoneal cavity.

(Armstrong 2002; Fernandes 2010; Hoffer & Ablow, 1984)

**Emergency Management of Pneumothorax**

1. *Needle aspiration:*

   This procedure is normally attended to by a Medical Officer (Neonatal Registrar/ staff specialist) for the emergency evacuation of air from the pleural space.

   **Equipment required:**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Sterile equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• aqueous chlorhexidine 0.015% (less than 27 weeks)</td>
<td></td>
</tr>
<tr>
<td>• alcohol wipes</td>
<td>• dressing pack</td>
</tr>
<tr>
<td></td>
<td>• gloves</td>
</tr>
<tr>
<td></td>
<td>• three-way tap</td>
</tr>
<tr>
<td></td>
<td>• 23/25Fg butterfly needle</td>
</tr>
<tr>
<td></td>
<td>• 10ml / 20ml syringe</td>
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</tbody>
</table>
Procedure:
- The site of insertion is prepared using appropriate antiseptic solution
- The needle is attached to a three-way tap and the 10ml syringe – see diagram 1.
- The needle is inserted into the 2nd intercostal space in the mid clavicular line of the affected lung – see diagrams 2 & 3.
- Once the needle is in the pleural space, air should be easily aspirated into the syringe, the air is emptied by turning the three way tap off to the baby and expelling the syringe. The three-way tap is maintained closed to ensure further air is not introduced into the pleural space – see diagram 4.
- Following this procedure the insertion of an intercostal catheter is usually required for the ongoing management of the pneumothorax (see below).
- Document the needle aspiration procedure and patient observations on the observation chart (MR 582 or NICU chart) and case history notes (MR 45).

![Diagram 1](image1.png)  
Diagram 1 – needle aspiration system  
(NETS Neonatal Handbook Victoria)

![Diagram 2](image2.png) ![Diagram 3](image3.png)  
Diagram 2  
Mid clavicular line  
Diagram 3  
Insertion needle 2nd intercostal space
### Insertion of an Intercostal Catheter:

The objective of pleural drainage is to remove air/fluid from the pleural space to allow return of normal pulmonary function. This procedure is performed by or under the supervision of an experienced clinician (staff specialist, neonatal fellow, senior registrar or nurse practitioner / transitional nurse practitioner).

#### Equipment required:

<table>
<thead>
<tr>
<th>Equipment</th>
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<tbody>
<tr>
<td>Trolley cleaned with mild detergent wipe</td>
<td>Sterile green gown, gloves and sheet</td>
</tr>
<tr>
<td>Aqueous chlorhexidine 0.015% (unopened bottle)</td>
<td>Surgical instrument pack</td>
</tr>
<tr>
<td>Ampoule 1% Xylocaine &amp; sucrose (if appropriate)</td>
<td>Dressing pack</td>
</tr>
<tr>
<td>Suction tubing - long</td>
<td>Surgical blade</td>
</tr>
<tr>
<td>Suction port with manometer</td>
<td>Intercostal catheter (Fg10 or Fg12)</td>
</tr>
<tr>
<td>Toothless clamps x 2</td>
<td>2 Tegaderm® dressings &amp; Steristrips ®</td>
</tr>
<tr>
<td>Protective goggles</td>
<td>Straight connector</td>
</tr>
<tr>
<td>Intercostal catheter (Fg10 or Fg12)</td>
<td>Assorted needles / syringes</td>
</tr>
<tr>
<td>Atrium® Oasis Dry Suction Water Seal system (includes sterile water)</td>
<td></td>
</tr>
</tbody>
</table>

Inform parents and discuss procedure as soon as practical

**Procedure**

- Position infant supine with affected side slightly elevated
- Request the Proceduralist order a bolus dose of morphine
- Clean and set up procedure trolley using aseptic technique
- Open the sterile green sheet and place on trolley
- Add all sterile equipment
- The Proceduralist gowns and gloves – use of protective glasses and mask is mandatory when infant is nursed on an open care system

RPA Newborn Care September 2012,
For revision September 2015
Primary author Mr. Noel McNamara RN
• The skin is prepared with the aqueous chlorhexidine 0.015% solution.
• All infants are to have local anaesthetic prior to insertion of drain
• Xylocaine is infiltrated into the tissues at the insertion site
• The skin is usually incised at the anterior axillary line between the 3\textsuperscript{rd} & 4\textsuperscript{th} intercostal space.
  For the anterior pneumothorax which is difficult to drain, a catheter can be placed at the mid clavicular line between the 1\textsuperscript{st} & 3\textsuperscript{rd} intercostal space.
  For a pleural effusion, the catheter is generally placed placed in the mid-axillary line between the 4\textsuperscript{th} & 5\textsuperscript{th} intercostal space and directed towards in a posterior direction.
• Forceps are used to open the site and allow the insertion of the intercostal catheter.
• The catheter is introduced into the pleural space.
• When the intercostal catheter is in position attach the sterile tubing and the Oasis Dry Suction System to the infant prior to connecting system to wall suction.

Possible Complications of Intercostal Catheter insertion include:
• Lung perforation
• Haemorrhage
• Cardiac tamponade
• Phrenic nerve damage

(Hourihane & Crawshaw 1995)

Dressing of the intercostal catheter insertion site
• The skin around the insertion site needs to be completely dry and free of blood before application of Steristrips® and Tegaderm® dressing to secure catheter
• Ensure the insertion site is visible and the skin is not puckered by the Steristrips® or Tegaderm® dressing
• Ensure the drainage system is secured to the infant’s bedding so there is no traction on the catheter dressing or connections

Set up of the Atrium® Oasis Dry Suction Water Seal System

<table>
<thead>
<tr>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Fill Water Seal chamber:</strong> Twist off water bottle supplied and insert tip into suction port located on the top left hand corner. Squeeze contents (45mls) into Chamber B until fluid reaches the 2cm line in Chamber C. The water will turn blue. During operation additional water may be added using a needle &amp; syringe via the grommet on the rear of the device – fill to 2cm line Chamber C.</td>
</tr>
<tr>
<td>2. <strong>Dry suction regulator A:</strong> The suction regulator comes preset to -20cms H\textsubscript{2}O. Check setting is -20cms H\textsubscript{2}O and adjust if required</td>
</tr>
<tr>
<td>3. Connect system to the infant prior to connecting to wall suction</td>
</tr>
<tr>
<td>4. Connect suction tubing from suction port to wall suction unit and adjust negative pressure until the bellows expand to the $\Delta$ mark E (-20cms H\textsubscript{2}O). The bellows will not expand until suction is applied. The wall suction unit will need to be set at -80mmHg / -5kpa or higher for -20cms H\textsubscript{2}O to be reached.</td>
</tr>
<tr>
<td>5. Ensure the system is always positioned below the infant and ensure secure all connections are visible</td>
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</tbody>
</table>

(Atrium 2011)
Suction port – tubing to wall attached here

Attaches to intercostal catheter
**Nursing management**

*Immediately after procedure*

Ensure the infant is clean, dry and comfortable
Perform a set of observations and ensure respiratory effort is improving
Inform parents that procedure is completed and invite parents to see their infant (if available)
Ensure chest x ray has been ordered
The procedure should be documented in the case history notes (MR 45) and the green procedure label – Insertion of Intercostal Catheter.

**Observations – immediate and ongoing**

- Check all connections are secure and there is no tension on the catheter - secure tubing to the cot sheet with safety pin
- Ensure patient clamp is released
- Avoid dependent loops or kinking of tubing
- Ensure the intercostal catheter is secure
- Place the drain in a stable position – do not place on the floor
- Check the wall suction is at or above -80mmHg / -5kpa or higher
- Document the position of the bellows is at the Δ mark E – increase wall suction if required
- Check water level is at 2 cms in **Chamber C** to ensure proper operation – do not over fill
- Measure and document the level of bubbling in **Chamber C**. *Bubbling right to left* will confirm patient air leak.
  - *Continuous bubbling* – persistent air leak. This may occur with high ventilator rate including high frequency oscillation but *ensure* there is no leak in the system – check and secure all connections. Inspect dressing for any sign of catheter dislodgement.
  - *Intermittent bubbling* – confirms the presence of an intermittent leak
  - *No bubbling* – no air leak that is air leak has resolved or the system is obstructed with blood or fibrin. *Confirm tube clamp is open*
- Document the level of air leak in **Chamber C** - 1. (Low) to 5 (High)
- Record the volume of drainage as appropriate, for example chylothorax will require at least 4th hourly measurement of volume in **Chamber D**.

**Ongoing Nursing Management**

In addition to the above observations and documentation

- With the use of the Atrium Dry Suction System, the circuit is not changed unless it is full, drainage tubing is obstructed by fibrin or as clinical circumstances demand

- Should obstruction be suspected:
  - ensure tubing clamp has been released
  - check for kinking or compression of tubing
  - gently "milk" the tube (not a routine practice)
  - reposition the infant
  - inspect dressing in case the catheter has been accidentally dislodged
Other observations include:
Continuous cardiorespiratory monitoring – 3 lead ECG & SpO2%
Assessment of pain / discomfort and appropriate management
Consider use of a Pain Management Tool PIP score
+/− Invasive blood pressure monitoring
+/− Transcutaneous O2 / CO2 monitoring
Thermal management as per relevant protocols
Hourly documentation of the drainage system – as above, including the type, colour and volume of any drainage
Hourly inspection of the intercostal catheter insertion site
- colour (pink/erythema)
- dressing (intact/secure)
- discharge

Auscultate air entry before and after endotracheal suction, if there is deterioration in respiratory and cardiovascular status. Notify medical officer of any concerns.

Positioning of the infant with an Intercostal Catheter

• When moving the infant remember that it is a Two Person procedure. This to ensure the intercostal catheter is not dislodged during repositioning.

• The drainage tubing is secured to the bedding, therefore undo the safety pin prior to moving the infant and resecure it after attending to the infant i.e. when repositioning the infant or preparing the infant for X-ray.

• Document the position of the catheter following any repositioning

• Avoid any tension on the catheter when repositioning the infant or during procedures

• A pair of toothless clamps must be readily accessible at the bed side should accidental disconnection occur.

Clamping of the intercostal catheter Chest Drains
• This will be ordered by the staff specialist to ensure air does not re accumulate before final removal of the intercostal catheter. Use the tubing clamp and position same as close as possible to the catheter.

• The catheter itself must be clamped during a drainage system change (keep this time to a minimum as the infant may quickly deteriorate if unstable).

• The catheter will also require clamping in an emergency situation such as accidental disconnection or malfunction of the drainage system.
Removal of the Intercostal Catheter

When a pneumothorax has resolved on chest x-ray and the system has ceased bubbling, the staff specialist will order the tubing clamped before removal of the catheter - observe for any increased respiratory effort during this time. Increase in respiratory distress may indicate re accumulation of air.

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<td>Surgical blade</td>
</tr>
<tr>
<td>Protective goggles</td>
<td>Tegaderm® dressing &amp; Steristrips ®</td>
</tr>
<tr>
<td>Sucrose for pain management</td>
<td>Water Seal system (includes sterile water)</td>
</tr>
</tbody>
</table>

Procedure
- Consider type of analgesia required
- Routine hand wash
- The Tegaderm dressing is removed, and the area dried.
- The ICC is removed by the registrar or NNP and the site of insertion is dressed with Steristrips and a Tegaderm dressing is applied.
- The infant’s haemodynamic status is closely observed and respiratory function assessed.
- A CXR is attended to 2-4 hours following the removal of the ICC.
- The procedure is documented on the Infant Flow Chart and Progress notes using green procedural sticker.
- Observe and document observations before and after ICC removal
- Observe the wound site for erythema or any discharge from the ICC insertion site;
- Heart rate, Sp02, respiratory Rate / effort, tidal volume, air entry,
- Blood gas analysis as required / ordered.
References


