Neonatal Intensive Care Unit

Clinical Guideline

Pneumothorax-Drainage Guideline

BACKGROUND

A Pneumothorax is a build-up of air in the pleural cavity with a potential to compromise gas exchange and/or the circulation. A chest drain is indicated when this compromise occurs, allowing for air to be withdrawn from the pleural cavity and enabling the lung to re-inflate, consequently improving the babies' condition/ventilation. It is important to recognise that not all pneumothoraces need drainage. There should be a sufficiently large collection of air or fluid in the pleural space for safe insertion of the drain therefore a needle thoracocentesis should be avoided prior to chest drain insertion unless there is an acute significant deterioration as may occur with a tension pneumothorax.

MAKING THE DIAGNOSIS

Suspect a pneumothorax if:

- Increase in respiratory distress and/or diminished chest movements
- Deterioration with desaturation
- Circulation may become compromised
- Blood gas shows hypoxia, respiratory and/or metabolic acidosis.

Clinical signs:

- May be minimal
- Sudden deterioration e.g. increased oxygen and decreasing oxygen saturations.
- Unequal or decreased air entry
- Asymmetrical chest movements
- Tachycardia
- Fall in blood pressure
- Transillumination with a cold light. Useful but can be unreliable in
  - Extremely low birth weight infants (may be “false-positive”)
  - Infants with increased thickness of the chest wall e.g. term infants and oedema
  - Infants with pulmonary interstitial emphysema (who may show a ‘false positive’ result)

CXR will confirm the diagnosis but in an emergency is usually too time consuming.
**Needle Aspiration of Chest**

Needle aspiration is an emergency procedure, to be done when there is significant acute cardiorespiratory compromise due to a pneumothorax. Care must be taken to avoid laceration of the lung or puncturing blood vessels. Insertion of a drain should be the preferred option in more stable babies where time permits.

**Equipment:**
- 21 gauge (green) or 23 gauge (blue) butterfly needle
- 3 way tap
- 10 ml syringe
- Alcohol skin wipe
- 1 pair sterile gloves

**Procedure:**
- Infant supine, prepare area with alcohol wipes
- Insert needle into the pleural space (directly over the top of the rib in the 2\textsuperscript{nd} or 3\textsuperscript{rd} intercostal space in the mid-clavicular line) until air is aspirated into the syringe, then expel air through the 3-way stopcock

**Ongoing Care:**
Following needle aspiration insertion of an intercostal catheter is usually required for ongoing management.
Insertion of Cook® Fuhrman Pigtail Pleural Drain using Seldinger Approach.

Indications: Pneumothorax, Pleural Effusion or chylothorax.

This is our unit’s preferred method;
- 6.0Fr/15cm -use for >1501gms
- 5.0Fr/15cm -use for <1500gms

Both catheters have 6 side ports

Advantages of Pigtail drains:
- Less traumatic insertion and fewer complications.
- Suitable for very preterm babies

Disadvantages
- May kink or obstruct due to its softer consistency.

Preferred drain site: 4th to 6th intercostal space, above a rib (to avoid injury to intercostal vessels which run under the rib) and in the mid to anterior axillary line, well clear of the nipple.

Components of pleural drain pack (see Fig1 below)
1) 18 G introducer needle (c)
2) J-wire guide (a)
3) Dilator (d)
4) Radiopaque pigtail catheter with 1cm markings (First marker at 7cm)
5) 3-way stopcock (f)
6) Multipurpose tubing adapter (g)
You will also need
- 5ml syringe
- Mosquito artery or similar forceps
- A sterile procedure pack e.g. long line pack
- Sterilising skin preparation e.g chlorhexidine
- Duoderm to secure drain to skin
- Tegaderm or similar occlusive dressing

Inform parents/guardians at soonest opportunity.
Ensure adequate analgesia and sedation e.g. Morphine bolus +/- Midazolam.
This procedure should either be performed by, or under the direct supervision of an experienced operator. It is ideal to have a skilled assistant.

1) Sterile Glove and gown as per unit guideline for aseptic technique.
2) Position the patient supine with procedure side raised at about 30-40 degrees.
3) Identify and mark the insertion site 4th to 5th intercostal space, above a rib (to avoid injury to intercostal vessels which run beneath the rib) in the anterior axillary line, stay well clear of the nipple.

4) Sterilise the skin site as per unit guideline

5) The use of a transparent sterile drape enables continued visibility of landmark

6) Lignocaine 0.5%-1% local infiltration (not more than 0.3mls/kg)

7) Assemble access needle (c) & syringe and attach mosquito forceps 1cm distal to needle tip to reduce risk of advancing needle too far into chest cavity (Fig3).

8) Slowly insert needle with attached forceps at 90 degree angle to the rib. Angle anteriorly for pneumothorax, gently aspirating until air is obtained. If draining a pleural effusion, aim posteriorly and gently aspirate until fluid is obtained. Stop and hold steady as soon as either air or fluid is aspirated.

9) Remove the syringe and advance soft J end of J-Wire guide (a), using its white plastic introducer (b) through the needle hub until the silver mark on the wire just enters the needle hub (Fig 2) at a length of about 12cm (Note that the J wire is very long, be aware of contamination and use your assistant). If resistance is felt when inserting the J-wire guide, stop and remove both the wire guide and needle.

10) Remove the access needle gently and hold on to the J-wire guide where it exits the chest wall as soon as the needle tip is out. This is to avoid accidentally removing the J-wire guide.

11) Advance the dilator (d) over the wire using a twisting action to pass through the chest wall. This only needs to go in 1-1.5cm. Then withdraw the dilator, again securing the J-wire to avoid inadvertently removing it.

12) Feed the pigtail catheter (e) with the coiled porthole end first over the J-wire guide and advance into the chest cavity with a gentle twisting motion, up to the first black mark (7cm) for the extreme preterm babies & at the 2nd-4th mark for bigger babies based on measurement of targeted position. Remove the J-wire guide gently.

13) Support pigtail catheter on a small bed of sterile gauze and use steri-strips and duoderm to anchor pigtail to the skin.

14) Place Tegaderm dressing over insertion site, pinching it across the length of the catheter. Tegaderm on its own does not adequately secure the catheter as it often becomes loose from leaking pleural fluid.

15) Connect catheter to drainage unit using tubing adapter (g) and 3 way stopcock f).

16) Request CXR to confirm position of catheter and document findings.

17) If a further drain is required, try to avoid using the same entry site in case a track has been created which may then take the catheter via an unanticipated route.
Fig 1 Layout of contents of Cook Fuhrman pleural drain pack

Fig 2 Mark to show maximum insertion point of j-wire guide into access needle

Fig 3 Forceps 1cm from tip of access needle to limit insertion length
Catheter - Trocar Chest Drain Insertion

EQUIPMENT:

1. Sterile chest drain pack
2. Sterile gloves, gown and drapes

Non sterile tray containing:

1. Trochar + cannula size 8 x 2 size 10 x 2
2. “T” extension with luer lock
3. 3 way stop-cock (connector)
4. 1 Vygon connector
5. 10 ml syringes x 2
6. 1 ml syringe x 2
7. Needles 25g (orange) x2
8. “Butterfly” needle 23g (Blue) x2
9. Disposable scalpel x 1
10. Disposable scissors x 1
11. 3/0 black silk sutures x 2
12. Heimlich chest drain valve x 2 (For transport use)
13. Sentinel Seal chest drainage unit

ALSO:

Steristrips x 2
Tegaderm x 2
Chlorhexidine aqueous solution (Pink 0.05%)
Bottle of sterile water
Extra swabs x 3
Extra dressing towel x 2

NB Have low pressure suction pump available
PROCEDURE:

- Inform parents where possible
- Sterile gown and gloves
- Aim to maintain the infant's temperature. Place the infant with the affected side uppermost and the arm extended above the head. Ensure limbs are adequately restrained.
- Monitor infant's heart rate and oxygen saturation level
- The intercostal catheter ("ICC", "chest drain") is usually inserted in the 4th or 5th intercostal space in the anterior axillary line. This corresponds to a point 1-2cm lateral to and 0.5-1cm below the nipple. The incision must be well clear of the nipple. Mark location with pen.
- Prepare the field with 0.05% chlorhexidine (pink solution)
- Select intercostal catheter size

<table>
<thead>
<tr>
<th>Infants</th>
<th>&gt; 1500g</th>
<th>10 or 12 Fr</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 1500g</td>
<td>8 or 10 Fr</td>
</tr>
<tr>
<td>&lt;1000g</td>
<td></td>
<td>8 Fr</td>
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</tbody>
</table>

- Place sterile drape in position
- Infiltrate the insertion site with 1% Lignocaine (up to 0.3mls/kg). If baby is ventilated and on a morphine infusion can also give a bolus dose of 100 micrograms per kg, which can be repeated if needed.
- Using small scalpel blade make a 1cm wide incision through the skin and subcutaneous tissue
- The preferred technique is as follows. Using straight mosquito forceps to bluntly dissect away the subcutaneous tissue and intercostal muscles, the parietal pleura is reached. Aim to 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. At this point the hiss of air escaping the pleural space may be heard.
- Remove the trocar from the ICC and grasp the distal end with the curved artery forceps. Direct the tip anteriorly as well as superomedially so that the tip lies beneath the anterior chest wall. Advance the ICC into the pleural space 2 - 4 cm, depending on the baby's size.
- Connect the ICC via connector to an underwater seal drainage system (Sentinel Seal) or a Heimlich valve and note whether the fluid is swinging and/or bubbling. Condensation within the catheter may be seen when within the pleural space.
- Place a single stitch through the wound so that the skin is drawn snugly around the ICC. Purse string stitches are not used as they leave an unsightly scar. Wrap the ends of the suture around the ICC several times and tie securely.
• Secure the ICC to the chest wall with Duoderm and Tegaderm. Note that Tegaderm alone does not provide adequate fixation. Secure positioning is important to minimize trauma to intrathoracic structures and ensure patient comfort.

Ongoing Care:
• Check the tube position and resolution of the pneumothorax by transillumination and x-ray.
• Assess the need for ongoing analgesia based on physiological and behavioural responses associated with pain.
• Record hourly clinical observations as well as the following:
  - checking the tubing for kinks
  - bubbling and/or swinging in tubing and drainage set
  - the set pressure is correct,
  - ensure chest drain and all connections are secure and not under tension
  - ensure suction remains on/off as necessary

Removal criteria:
The decision to clamp off and/or remove a chest drain should be discussed with the consultant.
• Indications for removal include:
  ▪ Lung re-expansion on x-ray
  ▪ No signs of an air leak for 24 hours.
  ▪ Bubbling in the collecting tube has subsided.
  ▪ Respiratory rate is comfortable.
  ▪ Normal breath sounds are present.
  ▪ Drainage slows down or stops.

Procedure for removal:
Modified from guidelines written by H. Hatter and E. Leonard (GOSH 2014).

The aim is to remove the drain(s) with minimal risk of air entrainment. If there are two drains to be removed, remove the lower drain first followed by the higher drain.

• Position the child so you have clear and easy access to the drain.
• It is often requested that the drain is taken off suction for a few hours before removal. However suction can be left on for removal if necessary.
• Using the units hand washing and infection control guidelines, get all necessary equipment ready and bring the trolley close to the patient.
• Expose and clean the drain site.
• Prepare the appropriate dressings.
• If the infant is crying intra-thoracic pressure is elevated and it is therefore a good time to remove the drain (Bell, 2001).
• Use one hand to withdraw the drain rapidly (within one second). It is sometimes easier to pull the drain vertically so that the drainage holes are pulled out almost together.
• When the drain is out the forefinger and thumb of the other hand to press the skin edges of the drain site together. Alternatively if the skin cannot easily be pinched a finger should press down from above the site directly over the hole.
• Assess the drain site and leave it exposed if possible.
• Apply the prepared dressing if necessary. If needed apply a stitch and dress the site.
• Settle the child.
• Document the procedure.
• Dispose equipment in accordance with the waste management guidelines.
• A chest x-ray should not be done routinely but request this if clinically indicated.
• Regular observations of vital signs will continue for four hours.
Complications and their management

- If it is felt that the heart or liver may have been perforated by the drain, immediately turn off the 3 way stopcock and do NOT remove the drain. Inform the consultant and order an urgent CXR. Ultrasound may be helpful in skilled hands. Attempt to stabilise the patient and consult with appropriate specialist surgical team

**Table 1 Causes of serious complications of chest drain insertion as per NPSA**

<table>
<thead>
<tr>
<th>1</th>
<th>Failure to follow manufacturer’s advice</th>
</tr>
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<tbody>
<tr>
<td>2</td>
<td>Anatomical abnormality</td>
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<tr>
<td>3</td>
<td>Poor technique</td>
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<tr>
<td>4</td>
<td>Too deep dilatation</td>
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<tr>
<td>5</td>
<td>Lack of knowledge</td>
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<tr>
<td>6</td>
<td>Patient’s condition</td>
</tr>
<tr>
<td>7</td>
<td>Failure to follow local guideline</td>
</tr>
<tr>
<td>8</td>
<td>Poor imaging</td>
</tr>
</tbody>
</table>

1 National Patient Safety Agency, UK

**Table 2 Complications of 133 pig tail chest drain in children [20]**

- Haemothorax (2%)
- Pneumothorax (2%)
- Hepatic perforation (1%)
- Others (20%)
  - failure to drain
  - dislodgment
  - kinking
  - loss of liquid ventilation fluid
  - empyema
  - disconnection
### Nursing staff

<table>
<thead>
<tr>
<th>ACTION</th>
<th>RATIONALE</th>
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</thead>
<tbody>
<tr>
<td>Inform parents of need for procedure – May have to be done in retrospect in not present</td>
<td>Re-assure and explanation of need for intervention</td>
</tr>
<tr>
<td>Wash hands open sterile packs onto aseptic field</td>
<td>Infection control/prevention of cross infection</td>
</tr>
<tr>
<td>Ensure baby is receiving adequate analgesia</td>
<td>For comfort and pain relief</td>
</tr>
<tr>
<td>Monitor general condition of baby including- record vital signs HR, Resps, Temp, SAO2 B/P</td>
<td>For recognition of any Improvement/deterioration in condition</td>
</tr>
<tr>
<td>Position baby as requested by Dr.</td>
<td>To aid correct insertion</td>
</tr>
<tr>
<td>Assist Dr. to secure the drain in position and attach T-Piece, 3 way tap, Vygon connector</td>
<td>To prevent displacement and further trauma</td>
</tr>
<tr>
<td>Attach Heimlich valve  <strong>OR</strong>  Set up Sentinel Seal chest drainage unit (see below)</td>
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<tr>
<td>If more than one drain is required, label each one with number in order of insertion</td>
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</tr>
<tr>
<td>Observe position of drains, “Fluttering” of the valve and any secretions present</td>
<td>To determine improvement or deterioration in condition</td>
</tr>
<tr>
<td><strong>Always</strong> “clamp” off drains if turning or lifting the baby, ensuring they are “unclamped” when baby is settled</td>
<td>For safety and comfort</td>
</tr>
<tr>
<td>Inform parents when procedure is completed</td>
<td>Parental re-assurance/reduce anxiety</td>
</tr>
<tr>
<td>“Spencer wells” forceps should remain at the cot-side in case of disconnection or malfunction</td>
<td>For safety</td>
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</table>
# NEONATAL CHEST DRAIN

## SENTINEL SEAL – Chest drainage unit (CDU) set-up

<table>
<thead>
<tr>
<th>ACTION</th>
<th>RATIONALE</th>
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</table>
| **Fill the underwater seal** :-  
  - Pull open blue door on the back of the unit and fill directly through opening to **line 1** (90ml)  
  - Fill to **line 2** if applying suction | Creates under water seal |
| **Close fill spout securely – Do not re-open** | To prevent loss of pressure |
| To adjust water level in the water seal chamber utilize water seal access port located behind water seal chamber using a luer lock or luer slip syringe. | There may be a need to withdraw or add water |
| **Fill the Patient assessment chamber (PAM)**:-  
  - Remove paper seal from port at top of unit.  
  - Fill patient assessment chamber to red line by pouring sterile water through round opening at top of unit (35ml), do not reseal. | Indicates progress of patient |
| **Connect the latex free tubing**:-  
  - Remove protective cover  
  - Cut clear tubing from back of unit to fit connector attached to 3 way tap | Drains of air and body fluids e.g. blood and serous fluid |
| If using suction attach line to suction regulator and set suction unit to min. 60mm hg | May need suction rather than just underwater seal |
| - While observing PAM, slowly turn suction regulator until fluid rises to prescribed vacuum level is reached. (when clamping patient tubing, the suction force direction of the patient will be indicated and can be set)  
  - Unclamp catheter.  
  - When you unclamp the patient catheter you may need to depress the negative pressure vent again as patient vacuum could be higher than suction force | Correct suction level is set and maintained |
<table>
<thead>
<tr>
<th>Patient assessment</th>
<th>Water Seal Chamber</th>
<th>Assessment and Management of Air Leak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Indicates patient air leak exists and lungs are not expanded. The greater the degree of bubbling and swinging, the greater the extent of air leak (pneumothorax) and the greater the degree of lung collapse</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>Indicates resolution of air leak and lung re-expansion (slight swinging may be seen). Be sure patient collection tubes are not kinked or obstructed; verify lung expansion.</td>
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<tr>
<td>No</td>
<td>Yes</td>
<td>Indicates a possible connection or system air leak. Momentarily pinch off the thoracic catheter. If bubbling continues, a connection leak exists. Secure all connections.</td>
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<tr>
<td>Yes</td>
<td>No</td>
<td>Can be associated with decreased lung compliance</td>
</tr>
</tbody>
</table>
### Competency:

**Setting up of Sentinel Seal Chest Drain Unit in the Neonate**

### Standard Statement:

The Registered Health Care Professional will be competent for assisting the doctor in the insertion of a Chest Drain and can perform the activities satisfactorily without supervision or assistance with acceptable speed and quality of work.

<table>
<thead>
<tr>
<th>No.</th>
<th>Element of Competency</th>
<th>Initial Assessment</th>
<th>Formative Assessment(s)</th>
<th>Summative Assessment</th>
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<tbody>
<tr>
<td></td>
<td>The Registered Health Care Professional must:</td>
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<td></td>
<td></td>
<td>Date</td>
<td>Self</td>
<td>Mentor</td>
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<tr>
<td>A</td>
<td>Discuss Neonatal Guideline for Chest drain</td>
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<td>B</td>
<td>Identify and discuss rationale for the need of Sentinel Seal Chest drainage Unit</td>
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<tr>
<td>C</td>
<td>Is able to set up the Sentinel Seal correctly i.e. Water seal, Patient Manometer, connection tubing to patient.</td>
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<tr>
<td>D</td>
<td>Understands how to connect to suction unit</td>
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<td>E</td>
<td>Knows where to position the drain and the safety checks that should be carried out</td>
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<tr>
<td>No.</td>
<td>Element of Competency</td>
<td>Initial Assessment</td>
<td>Formative Assessment(s)</td>
<td>Summative Assessment</td>
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<td>The Registered Health Care Professional must:</td>
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<td>(Please record ‘achieved’ or ‘not achieved’ as ‘A’ or ‘N’ and date and initial)</td>
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<tr>
<td>F</td>
<td>Understands what the manometer is, why it is important and what it is telling them.</td>
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<tr>
<td>G</td>
<td>Is able to demonstrate how to monitor the patient manometer and adjust the suction</td>
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<td>regulator on the Sentinel Seal accordingly in order to apply the right corrective</td>
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<td></td>
<td>action</td>
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<tr>
<td>H</td>
<td>Knows what is happening to the water seal and patient manometer for the following</td>
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<tr>
<td></td>
<td>indications: Baby Air Leak, System Air leak, Baby better, Blocked tubing or catheter,</td>
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<td></td>
<td>stiff lungs</td>
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<td>I</td>
<td>Is able to describe how to tell if there are dangerously high levels of negative</td>
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<td></td>
<td>pressure in the Sentinel Seal and what action should be taken to rectify the</td>
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<td></td>
<td>situation</td>
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<td>J</td>
<td>Understands why the suction port should not be occluded if the patient is on</td>
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<td></td>
<td>gravity drainage</td>
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<tr>
<td>K</td>
<td>Is able to change the Sentinel Seal from suction to gravity drainage</td>
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</tr>
</tbody>
</table>
References and Bibliography

Tyco/Healthcare/Kendall October 2007


NHS Forth Valley, West of Scotland Guideline Group (2012); Chest drain Insertion by Seldinger method.
Pneumothorax Nov 2014
Updated with Seldinger Pigtail drain insertion by Dr. T Otunla

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Reviewed 22/10/2014, updated by Dr T Otunla & Stephanie Thomas

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