HEALTH HOLDING

HAFER ALBATIN HEALTH CLUSTER
MATERNITY AND CHILDREN HOSPITAL

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| **Department:** | Neonatal Intensive Care Unit (NICU) | | |
| **Document:** | Multidisciplinary Policy and Procedure | | |
| **Title:** | Insertion of Chest Tubes for Drainage | | |
| **Applies To:** | All NICU Staff, Pediatric Surgeon, Respiratory Therapist and X-Ray Technicians | | |
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## 1. PURPOSE:

1.1 Evacuation of accumulated air or pleural fluid recognized by chest radiography and clinical examination.
1.2 Re-expand the lungs, restore the negative pressure to the pleural space, relief the respiratory distress associated with the collapsed lung due to pneumothorax or intrapleural fluid and improve ventilation and perfusion of the lungs.

## 2. DEFINITIONS:

2.1 Insertion of a tube inside the pleural cavity to drain accumulated air (pneumothorax) or fluid (pleural effusion), pus (empyema) or chyle (chylothorax), blood.
2.2 Water seal: Submerging the distal end of the tube that is connected to the patient's pleural space for 2cm under water creates a water seal. It provides a low-resistance, one-way valve that allows air to exit the chest while preventing air from being pulled back into the chest during breathing.

## 3. POLICY:

3.1 Indications
- 3.1.1 Evacuation of tension pneumothorax or pneumothorax that result in lung collapse with ventilation or perfusion abnormality.
- 3.1.2 Evacuation of pneumothorax that develop in infants receiving positive pressure ventilation, frequently, these air leaks are continuous and may result in tension pneumothorax if left untreated.
- 3.1.3 Evacuation of significant pleural fluid collections, postoperative hemothorax, empyema, chylothorax, extravagated fluid from a central venous line.

3.2 Contraindications:
- 3.2.1 Small air or fluid collection without significant respiratory distress or hemodynamic symptoms.
- 3.2.2 Spontaneous pneumothorax in the absence of lung disease is likely to resolve without intervention.

3.3 Pleural air collections are distinguished from other non-pleural intrathoracic air collections on radiograph e.g. Congenital Cystic Adenomatoid Malformation, lobar emphysema.
3.4 The procedure is done under complete aseptic technique.
3.5 Chest tubes are connected to a sterile underwater seal drainage system.

## 4. PROCEDURE:

4.1 Explain procedure to parents if available and if patient condition allows.
4.2 Identify the patient by using 2 patient identifiers (four name for Saudi or complete Name for Non-Saudi) and Medical Record Number and ensure the correct side of pneumothorax by clinical and review of radiologic examination.
4.3 Provide non-pharmacologic and pharmacologic pain management e.g. fentanyl bolus (even if baby is on opioid infusion).
4.4 Support the infant with artificial ventilation as required.

4.5 Functioning resuscitation equipment should be available at bedside.
4.6 Assess infant coagulation status clinically and by laboratory.
4.7 Assistant nurse:
- 4.7.1 Performs hand hygiene.
- 4.7.2 Assembles equipment on the same side of tube insertion.
- 4.7.3 Ensures patient thermoregulation.
- 4.7.4 Connects the baby to vital signs monitor and documents baseline heart and respiratory rates and $SpO_2$.
- 4.7.5 Prepares the drainage system.

4.8 Position infant so point of entry is the most elevated area of the chest; affected side elevated 60-75 degrees of the bed and supports the back with a towel roll. Secures arm across the head, with shoulder internally rotated and extended. This position allows air to rise to the point of tube entry into the thoracic cavity, and encourages the correct anterior direction of the tube.
4.9 Perform antiseptic hand wash and wear surgical mask, sterile gown and gloves.
4.10 Prepare the skin over the lateral portion of the chest (midaxillary to the midclavicular line) with povidone iodine antiseptic then with 70% alcohol (clean with sterile normal saline for very low birth weight infants). Drape the area, leaving a small opening at the insertion site.
4.11 Infiltrate the site with 0.1-0.2 ml of 1% lidocaine local anesthetic.
4.12 Make a small skin incision (0.5-1cm) at a point midway between midaxillary and anterior axillary lines in the fourth or fifth intercostal space parallel to the upper border of the rib to avoid lacerating the intercostal artery and vein. A horizontal line from the nipple is a good landmark for identifying the fourth intercostal space. Keep well away from breast tissue.
4.13 With a small curved hemostat, dissect the subcutaneous tissue overlying the rib. Make a subcutaneous track to the fourth ICS. Enter the pleural space with the closed hemostat. Listen for a rush of air to indicate pleural penetration. Spread the tips to widen the opening and leave the hemostat in place. Remove trocar from chest tube. Grasp the end of the tube with the tips of the mosquito hemostat (both tube and hemostat in parallel). Direct the chest tube through the skin incision, into the pleural opening, and between the opened tips.
4.15 Extreme cautious should be taken if using a trocar during tube insertion because of the greater likelihood for lung perforation. A trocar is used after dissecting to the pleura. Protect lung by clamping artery forceps perpendicular to the trochar 1 cm (or less in the extremely low birth weight) from its tip to avoid penetrating too deeply.
4.16 Use intercostal catheter size
- 4.16.1 For infants < l000gm; size 8 Fr.
- 4.16.2 For infants < l500gm; size 8 or 10 Fr
- 4.16.3 For infants > 1500 gm; size 10 or 12 Fr

4.17 After the pleural space has been entered:
- 4.17.1 For evacuating air:
  - 4.17.1.1 Direct the chest tube anteriorly and cephalad toward apex of thorax (midclavicle), and advance tip to midclavicular line (by rotating the curved points of the hemostat). Release the hemostat and advance the chest tube a few centimeters ensuring that all side holes are within pleural space. If a trocar is used, remove it once the pleural space is entered and advance the chest tube.
  - 4.17.1.2 Estimated length insertion of intra-thoracic portion of tube (skin incision site to mid-clavicle) is approximately 2 to 3 cm in a small preterm infant and 3 to 4 cm in a term infant.
- 4.17.2 For evacuating fluid:
  - 4.17.2.1 Direct the tube to enter the pleura posteriorly.
  - 4.17.2.2 Insert tube only deeply enough to place side holes within pleural space.

4.18 Attach the chest tube to underwater drainage system.
4.19 Observe for bubbling or oscillation of water column seen with every inspiration in the underwater seal compartment.
4.20 Secure chest tube to skin with suture and make airtight seal with chest tube. Tie ends of suture around tube in alternating directions, without constricting tube. Apply an occlusive sterile Vaseline gauze around

skin incision and cover it with tegaderm or a sterile split 2" x 2" dressing.

4.21 Do antero-posterior and lateral radiographs to confirm tube position; anterior or posterior and that the side holes are within the chest cavity.

4.22 **Complications:**

4.22.1 Trauma: Lung laceration or perforation, hemorrhage due to perforation of a major vessel (axillary, pulmonary, intercostal, internal mammary), puncture of liver, permanent damage to breast tissue, chylothorax.

4.22.2 Diaphragmatic paralysis or eventration from phrenic nerve injury.

4.22.3 Malposition of tube: Tube outside pleural cavity in subcutaneous placement, side hole outside pleural space, tip across anterior mediastinum.

4.22.4 Equipment malfunction:

4.22.4.1 Blockage of tube by proteinaceous or haemorrhagic material.

4.22.4.2 Leak in evacuation system, usually at connection sites.

4.22.4.3 Inappropriate suction pressures.

4.22.5 Infection: Cellulitis and inoculation of pleura with skin organisms including Candida. The risk of infection increases the longer the chest tube is in site.

4.22.6 Subcutaneous emphysema secondary to leak of tension pneumothorax through pleural opening.

4.22.7 Aortic obstruction with posterior tubes when the catheter tip is impinging on the aorta. May result in hypotension and may necessitate removal of the chest tube.

4.22.8 Consider the possibility that a rapid, complete evacuation may cause an abrupt increase in mean arterial blood pressure and cerebral blood velocity to undesirable high levels.

4.23 Water seal chest drain:

4.23.1 Water seal of any chest tube system is 2 cm water. The positive pressure created by the pneumothorax or fluid in the chest cavity will move air/fluid towards the lower pressure under water. The air will bubble through the water and leave the chest drain system through the atmospheric vent.

4.23.2 If suction is used, it creates sub-atmospheric pressure in the suction compartment, thus increasing the pressure difference between the pleural space and the drainage system, promoting higher rate of air or fluid evacuation. The water level in the suction chamber, (not the amount of vacuum applied and read on the vacuum gauge), determines the suction level that draws air out of the pleural space.

4.23.3 Suction level (set by water level in the suction chamber) is between 8-15cm $H_2O$ according to clinical condition and size of infant.

4.24 How to set the drainage system (appendices 7.1)

4.24.1 Keep the drainage system in the upright position and lower than the patient to ensure gravitational flow.

4.24.2 Fill underwater seal with sterile water to only 2cm level.

4.24.3 Fill suction compartment up to the ordered suction level.

4.24.4 Connect distal end of patient's tube to the drainage system prior to initiating suction.

4.24.5 Connect the suction line to suction port on top of drainage system. Slowly increase the suction until you see gentle bubbling in the suction-control chamber. Excessive bubbling is loud; besides disturbing the patient, it may cause rapid evaporation, which lowers the suction level.

4.24.6 Ensure that the suction control stopcock is in the open position at all times. Do not use it to control suctioning.

4.25 Observe the following during drainage:

4.25.1 Check for signs of any respiratory distress and document vital signs and $SpO_2$ every 2 hours.

4.25.2 Ensure all tube are well connected.

4.25.3 Check the water seal hourly for the following:

4.25.3.1 The water seal level should always remain at 2cm. If the water in the water seal evaporates, add water via the access point on the back of the chamber using a syringe. In the case of over filling this chamber water can be removed in the same manner.

4.25.3.2 Tidaling: The water seal level rises with spontaneous inspiration and falls with expiration. However, with mechanical ventilation, tidal fluctuations are the opposite. If there are no fluctuations in the level of water seal, suspect:

4.25.3.2.1 Tube is kinked, clamped.

4.25.3.2.2 There is a dependent fluid-filled loop in the tubing.

4.25.3.2.3 Tissue or adhesions are blocking the drain during expiration.

4.25.3.2.4 No more air is leaking into the pleural space as the lung is fully expanded.

4.25.3.3 Bubbling in the water seal(appendices 7.2)

4.25.3.3.1 Intermittent bubbling: corresponding to respirations in the water seal chamber indicates an air leak from the pleural space; it should resolve as the lung re-expands.

4.25.3.3.2 Continuous bubbling in the water-seal; suspect a leak in the system between patient and the water-seal. Loose connections cause air to enter the system.

4.25.3.3.3 To locate the leak's source, such as a loose connection or from around insertion site, assess the system from the insertion site back to the chest drain unit. Momentarily clamp the tube close to patient's chest:

4.25.3.3.3.1 If bubbling stops, air leak is inside the thorax or at the chest tube insertion site. Check tube dressing.

4.25.3.3.3.2 If bubbling still continues, gradually clamp tubing at various points; bubbling stops when you clamp between the air leak and water seal. Replace tubing or secure connections.

4.25.3.3.3.3 If you've clamped along the tube's entire length and still can't find the source, the drainage unit might be faulty; consider replacing it.

4.25.3.3.3.4 Air-leak meter monitors the magnitude of a patient air leak. The higher the numbered column through which the bubbling occurs, the greater the degree of air leak e.g. if bubbling is noted in first two columns of air-leak meter, document 'Air-leak 2.

4.25.4 Check the water level in the suction chamber (suction level):

4.25.4.1 Add sterile water when necessary to keep the water level at the ordered level. It is vital to have the correct level of water in the suction chamber at all times.

4.25.4.2 If the water level has dropped below the desired level, disconnect suction, open the vent plug and top up with sterile water and close again before reapplying suction. Or, add water via the access point on the back of the chamber using a syringe.

4.25.4.3 Ensure that the vent plug covering the suction chamber is secure at the beginning of every shift.

4.25.4.4 The need for suction should be reviewed by the medical team daily and the decision documented.

If suction is no longer needed, all suction tubing attached to the drain should be removed, not just turned off at the suction unit.

4.26 Precautions:

4.26.1 Water seal level higher than 2 cm $H_2O$ impedes pneumothorax drainage

4.26.2 Tension pneumothorax can result if:

a. If the suction tube from the drainage unit to the wall suction is attached, but suction being switched off. This will make a closed circuit, and in the presence of air, can cause tension pneumothorax.

b. If the stopcock located on the suction tube is closed.

4.26.3 Avoid milking the chest-tube because this can generate high negative pressures in the tube, cause tissue trauma and bleeding and does little to maintain chest-tube patency. If you see visible clots, gently squeeze hand-over-hand along the tubing and release the tubing between squeezes to help move the clots into the drainage unit.

4.26.4 Subcutaneous emphysema after initial period can occur if drainage holes migrate to outside pleural space or if the drain is blocked or kinked.

4.26.5 In the case of a build-up of negative pressure within the chest drain unit, to lower the height of the water seal and to lower chest drain vacuum pressure when connected to suction, depress the high negativity vent located on the top of the drain unit until the water seal column lowers to the desired level.

4.27 Modify positive pressure ventilator patterns to minimize risk of further air leaks e.g. decrease inspiratory time, decrease mean airway pressure, consider high frequency oscillatory ventilation.

4.28 Removal of Chest Tube Drainage:

4.28.1 Ascertain that tube is no longer needed and document absence of drainage for 24 hours.

4.28.2 Obtain radiograph. If no air collection, leave chest tube connected to under-water seal at 2cm $H_2O$ without suction for 12 hours. Do not clamp tube. Repeat chest X-Ray. If it shows no re-accumulation of air, remove the tube.

4.28.3 Give pain medication.

4.28.4 Assemble equipment for removal.

4.28.5 Perform hand hygiene and wear sterile gloves. Cleanse skin area of chest tube with povidone iodine and use sterile drape.

4.28.6 Release tape and suture holding tube in place. Leave wound suture intact if skin is not inflamed. To reduce the chance of introducing air into the pleural space, cover the chest wound with a small occlusive dressing while removing the tube.

4.28.7 After removing tube, approximate wound edges, use steri-strips and place petroleum gauze over incision. Cover petroleum gauze with dry, sterile gauze. Keep pressure on pleural wound until dressing is in place.

4.28.8 Close clinical observation after removal of drain to diagnose re-accumulation.

## 5. MATERIAL AND EQUIPMENT:

5.1 2 small curved hemostat.
5.2 Sterile gloves, sterile gown and face mask.
5.3 Sterile drapes.
5.4 Small size blade and handle
5.5 Proper chest tube sizes 8, 10, or 12 French.
5.6 Evacuation device.
5.7 Non-absorbable suture on small cutting needle,
5.8 Semi-permeable transparent dressing e.g. tagaderm.
5.9 Vaseline gauze.
5.10 Skin disinfectants; Povidone iodine, 70% alcohol, sterile normal saline.
5.11 Adhesive tape.
5.12 Low pressure suction unit.
5.13 Equipments needed for removal of chest tube

5.13.1 Antiseptic solutions.
5.13.2 Sterile gloves
5.13.3 Scissors.
5.13.4 Forceps.
5.13.5 Petroleum gauze cut and compressed to 2-cm diameter
5.13.6 Gauze pads 2 x 2 inches
5.13.7 Tape

## 6. RESPONSIBILITIES:

6.1 Physician
6.2 Pediatric Surgeon
6.3 All NICU Staffs
6.4 X-ray Technicians

## 7. APPENDICES:

7.1 Water seal drainage system
7.2 The image of bubbling in water seal

## 8. REFERENCES:


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8.4 Markham M. Pulmonary Air Leak. Manual of Neonatal Care, Cloherty, JP. Eichenwald 8.2016.482-490


## 9. APPROVALS:

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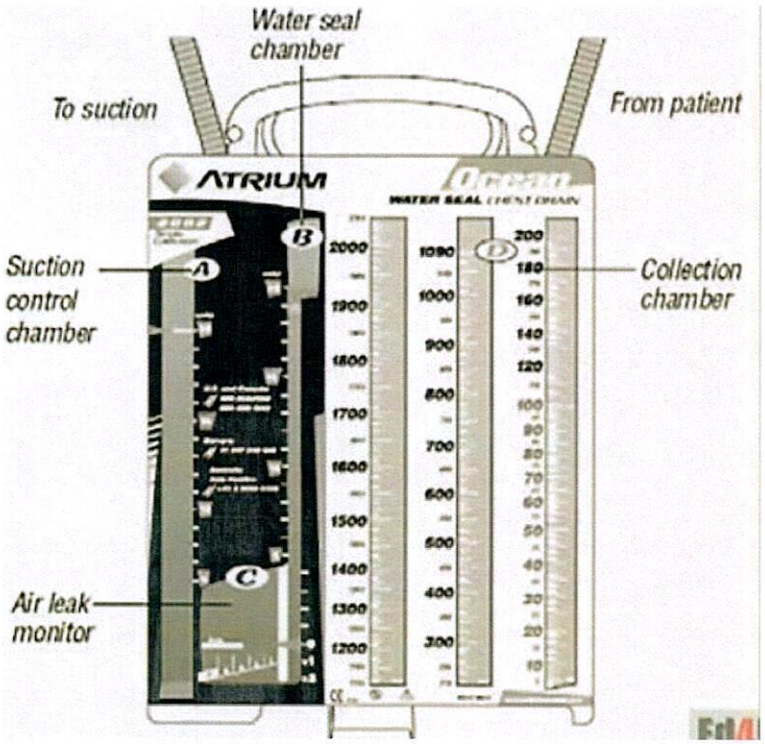
**Appendices 7.1: Water seal drainage system**




**Appendices 7.2: The image of bubbling in water seal**