

STANDARDIZED PROCEDURE
NEONATAL / PEDIATRIC CHEST TUBE PLACEMENT
(Neonatal, Pediatric)

I. Definition

To place a tube in the pleural space to decompress a tension pneumothorax or fluid accumulation in order to allow adequate lung expansion for ventilation.

II. Background Information

A. Setting:

Inpatient neonatal / pediatric patients or outpatient during Emergency Transport of neonatal / pediatric patients.

If appropriate, implement procedural support, if available- make sure Child Life is involved, and use age appropriate language and age appropriate developmental needs with care of children

B. Supervision

The necessity of the procedure will be determined by the Advanced Health Practitioner (AHP) in verbal collaboration with the attending physician or his/her designee. Ideally, the procedure will first be verbally discussed with the Attending Physician or Fellow, but if time does not permit for that, such as an emergency, then the Attending or Fellow is to be notified as soon as possible after the procedure.

Direct supervision is necessary until competency is determined and the minimum number of procedures is successfully completed, as provided for in the protocol. After that time, the attending physician or his/her designee must be available.

Designee is defined as another attending physician who works directly with the supervising physician and is authorized to oversee the procedures being done by the AHP.

C. Indications

1. Tension pneumothorax
In an acute emergency, needle aspiration should be performed if the patient's cardiopulmonary status is unstable. After an emergency needle aspiration has been performed, a thoracotomy tube should be inserted
2. Lung collapse with ventilation / perfusion abnormalities
3. Bronchopleural fistula
4. Pleural effusions
5. Postoperative hemothorax
6. Chylothorax
7. Empyema

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D. Precautions/Contraindications

1. Smaller air or fluid collection without significant symptoms
2. Spontaneous pneumothorax that, in the absence of lung disease, is likely to resolve without intervention

The AHP will notify the physician immediately under the following circumstances:

1. Patient decompensation or intolerance to the procedure
2. Outcome of the procedure other than expected

E. General Information

The incidence of spontaneous pneumothorax in the newborn is variously described as between 2-10%, with an incidence of up to 40% in infants requiring mechanical ventilation. Significant respiratory compromise may result from the presence of air or fluid in the intrapleural space. Tension pneumothorax must be rapidly diagnosed and treated to avoid possible death from compromise to ventilation and circulation.

A variety of factors may predispose to the development of pneumothorax including hyaline membrane disease, aspiration syndromes (especially meconium aspiration), hypoplastic lungs (as in diaphragmatic hernia) pneumonia, acute lung injury, bronchiolitis, asthma, as well as the positive pressure ventilation often necessary in these conditions. Symptoms may vary from irritability and restlessness to apnea, pleuritic pain, respiratory distress (tachypnea, grunting, retracting, and flaring), and in severe cases, cyanosis, decreased blood pressure with a narrow pulse pressure, bradycardia, and shock. There are often decreased breath sounds on the affected side, and in tension pneumothorax, the PMI may shift to the side opposite the affected side. If transillumination is available, increased light transmission on the side of a pneumothorax may be seen in smaller children and infants. Definite diagnosis can be made by x-ray. An AP alone may not be adequate, since the lung margins may not be visible. Hyperlucency of the hemithorax thought to be affected with pneumothorax is suggestive, just as diffuse increased density of the hemithorax thought to be affected with pleural effusion is suggestive. If doubt persists, a lateral decubitus or cross table lateral x-ray may be helpful. If a pneumothorax is suspected, the patient should be lying on his side with the suspect side up during the lateral decubitus x-ray. If pleural effusion is suspected, the patient should be placed with the suspect side down. In this way, layering out of the air or fluid may occur so that a lung margin is seen separated from the chest wall by the air or fluid in the intrapleural space.

A chest tube should be inserted whenever intrapleural air or fluid causes significant respiratory compromise and may present a life-threatening emergency. Needle aspiration should be performed immediately if the child's cardiopulmonary status is compromised.

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III. Materials

1. Morphine Sulfate or other pain medication
2. 1% Lidocaine, 1 ml syringe with 25 gauge needle
3. ChloroPrep
4. Sterile gloves, masks, and hat (gown optional)
5. Sterile tray to include:
 - a. 4 x 4's
 - b. 2 x 2's
 - c. Drapes
 - d. Curved mosquito hemostat
 - e. Curved Kelly clamp
 - f. Scissors
 - g. Needle holder
6. Sterile thoracotomy tube, 12F for infants greater than 1500 grams and 10F for infants less than 1500 grams, or Sterile percutaneous safety pneumothorax system, or Sterile 8.5 French pigtail catheter
7. Scalpel
8. 4-0 silk suture on cutting needle
9. Petroleum-soaked gauze
10. Underwater sealed drainage system or a "Heimlich" valve.

IV. Neonatal / Pediatric Chest Tube Insertion

A. Pre-treatment evaluation

1. Monitor the patient's cardiorespiratory status & oxygen saturations throughout the procedure.
2. Premedicate patient for pain control. Assess need for further medication throughout the procedure.
3. Position the patient supine with the affected side slightly elevated and the arm on the affected side restrained superiorly (over the head) or anteriorly.

B. Set up (if applicable)

1. Gather necessary supplies

C. Patient Preparation

1. If time permits, inform the patient/family of the treatment plan, otherwise notify them after the procedure is completed.

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2. Locate the site for insertion. In case of pleural fluid collection, if feasible, use ultrasonography to locate the optimal site for chest tube placement. In pediatric patients this should usually be the fourth or fifth intercostal space in the mid-to-anterior axillary line. The nipple usually lies in the fourth intercostal space and can be used as a handy reference point. A more anteriorly placed insertion runs greater risk of hitting great vessels, thymus or heart (especially on the left). A more inferiorly placed incision runs greater risk of hitting the liver or spleen. Avoid placing tube in nipple area, especially in girls, as this can cause asymmetrical breast tissue development.

D. Procedure

Chest Tube Insertion – Standard Method

1. Perform time out with all appropriate steps.
2. Don cap, mask, sterile gloves, and if there is time, a sterile gown.
3. Keeping the pleural tube sterile, measure the approximate length of the tube needed to reach the desired site from the point of the skin entry site. Note the appropriate length. If the tube has only one or two holes additional holes may be added.
4. Prep the skin with ChloroPrep. Allow to dry.
5. Sterile drapes should be placed on the surface near the baby and to cover the unprepared skin near the incision site.
6. If time permits, infiltrate the skin with 1% Lidocaine, down to the rib and along the proposed insertion path of the tube.
7. Using the scalpel, make a small incision (0.5 cm) through the skin at the anesthetic wheal.
8. Using the curved mosquito clamp, bluntly dissect down to the underlying rib. Some people feel that carrying the dissection through the subcutaneous tissue provides a tunnel that assists in fixation of the tube and helps assure an adequate seal. This subcutaneous tunnel may be carried superiorly over the next rib, anteriorly (for pneumothorax) or posteriorly (for effusion) parallel to the ribs, or obliquely. This subcutaneous tunnel may not be necessary in the neonate and may make it more difficult to direct the tube parallel to the pleural surface and in the desired direction. Entering the pleural space directly under the skin incision is thus an alternative to the subcutaneous tunnel.

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9. With the clamp curved over the superior margin of the rib, pressure is applied until the clamp is forced through the intercostal muscle and parietal pleura. This is signaled by a sudden loss of resistance, and is often accompanied by an audible surge of air.
10. The intercostal (pleural) opening is enlarged slightly by spreading the clamp. The clamp is then removed.
11. Use either method a or b for insertion of the tube:
 - a. The tip of the chest tube (with trocar removed) is clamped firmly in the curve of the clamp with the clamp tip extending just beyond the tip of the catheter. If the infant is not on positive pressure ventilation, the tube should also be cross-clamped. The tube is advanced through the previously made tract into the chest. The tube should be directed parallel to the lung surface and chest wall to help avoid inadvertent insertion of the tube into the lung parenchyma. The tube should also be directed either anteriorly or posteriorly, as indicated, by turning the clamp.
 - b. If an Argyle tube is used, the trocar may be used as a guide, but must be withdrawn 1 cm from the tip of the tube and firmly cross clamped so that the sharp metal tip of the trocar does not slip beyond the tip of the tube and inadvertently puncture the lung. Bending the trocar into a slight curve may aid in directing the tube either anteriorly or posteriorly as indicated. The tube is then advanced through the previously made tract into the chest and in the appropriate direction. The cross clamp holding the trocar may then be removed.
12. The tube is held firmly while the clamp or trocar is withdrawn, then the pleural tube is advanced to the level of previously noted mark on the tube. Be sure to direct the tube during advancement so that it goes anteriorly for pneumothorax or posteriorly for pleural effusion.
13. The pleural tube should be immediately connected to underwater sealed drainage or to a one-way "Heimlich" valve to evacuate the pleural space. The cross-clamp, if present, can then be removed.
14. The skin incision should be closed with a silk suture.
15. Both ends of the silk suture are then wrapped around the tube several times and tied with a double knot approximately 5 cm from the skin.
16. Fixation of the tube can be accomplished by wrapping a small piece of petrolatum-soaked gauze around the tube at the skin to help seal the skin opening. A 2x2 sterile gauze square with a slit from the midpoint of one side to the center can be placed around the tube with the tube emerging from the center of the gauze. Place transparent occlusive dressing over the gauze. Secure tube with chevroned tape over occlusive dressing and stress loop distal to the chevron, taking care to tape in direction desired.

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Percutaneous Chest Tube Insertion – Method #1

If available, the percutaneous chest tube insertion is the preferred method. It is easier, less invasive, safer, and leaves less of a scar.

The “safety pneumothorax system includes a blunt, multi-side holed, spring-loaded inner cannula coaxially housed within a 16 gauge conventional sharp-beveled hollow needle. This entire assembly is housed within a tapered catheter, which is used as a standard small bore percutaneously placed thoracic catheter. As the needle and blunt cannula penetrate the chest wall, the blunt cannula is forced into the shaft of the needle. When the tip of the needle encounters low resistance, such as an area of pneumothorax or pleural effusion, the spring-loaded cannula automatically extends beyond the bevel, thus helping to protect the underlying tissue from inadvertent penetration. A color indicator in the needle housing identifies the position of the blunt cannula. A one-way valve in the needle housing allows air and fluid to escape from the needle, but prevents atmospheric air from entering the pleural space, thus guarding against further pneumothorax. The tapered catheter incorporates four distal side-holes to facilitate drainage”. (Package insert from the Argyle Safety Pneumothorax Procedure Tray)

1. Perform time out with all appropriate steps.
2. Don cap, mask, sterile gloves, and if there is time, a sterile gown.
3. Keeping the pleural tube sterile, measure the approximate length of the tube needed to reach the desired site from the point of the skin entry site. Note the appropriate length. If the tube has only one or two holes additional holes may be added.
4. Prep the skin with ChloroPrep. Allow to dry
5. Sterile drapes should be placed on the surface near the baby and to cover the unprepared skin near the incision site.
6. If time permits, infiltrate the skin with 1% Lidocaine, down to the rib and along the proposed insertion path of the tube.
7. Using the scalpel, make a very small nick through the skin at the anesthetic wheal.
8. Hold the safety pneumothorax system in one hand while using the other hand to stabilize the tube at the level of the skin. The color indicator should change color when the blunt cannula is in the retracted position and the sharp needle bevel is exposed. Apply firm constant pressure with the catheter pointing anteriorly for a pneumothorax or posteriorly for fluid, until the catheter enters the pleural space. This is felt by the sudden decrease in resistance and the visible change on the color indicator.

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9. Slowly advance the catheter the appropriate distance into the pleural space and withdraw the needle assembly.
10. Attach the chest tube to the appropriate drainage system or one-way Heimlich valve.
11. Suture the chest tube securely to the skin.
12. Dress insertion site as in the above procedure with petroleum-soaked gauze.

Percutaneous Chest Tube Insertion – Method #2 – Pigtail insertion

The pigtail catheter is a percutaneous chest tube used for drainage of pleural effusions or pneumothorax. It is easier, less invasive, and a reliable alternative to the standard chest tube. The pigtail catheter package includes the following: 8.5 French pigtail catheter that is 15 cm long and has a adaptor at the end for connecting to the underwater sealed drainage system, 18 gauge needle, plastic dilator, and J-tip guide wire that is designed to decrease the potential for lung injury. The pigtail has six holes along the shaft that curl to the inside when the catheter is in place. The catheter is placed using the Seldinger technique which is described below.

1. Perform time out with all appropriate steps.
2. Don cap, mask, sterile gloves, and if there is time, a sterile gown.
3. Keeping the pleural tube sterile, measure the approximate length of the tube needed to reach the desired site from the point of the skin entry site. Note the appropriate length.
4. Prep the skin with Chloraprep. Allow to dry
5. Sterile drapes should be placed on the surface near the baby and to cover the unprepared skin near the incision site.
6. If time permits, infiltrate the skin with 1% Lidocaine, down to the rib and along the proposed insertion path of the tube.
7. Insert the 18 gauge needle with syringe attached into the skin and aspirate for fluid or air to verify placement.
8. Remove the syringe and send for studies if fluid is present. Care must be taken to occlude the lumen when the syringe is removed to prevent air embolus
9. Straighten the J tip of the guide wire and insert into the needle. Advance guide wire about 2-3 cm beyond the tip of the needle. Do not trim the length of the guide wire or withdraw against the needle bevel since it may cause sheering of the wire.

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10. With a firm grip, hold the guide wire in place as the needle is withdrawn. (Should there be significant chest wall edema, the puncture site may be enlarged prior to withdrawing the needle. This is done by placing the cutting edge of the scalpel away from the needle and making a small cut)
11. Insert dilator over the guide wire to dilate the subcutaneous tissues. Gently roll the dilator between thumb and forefinger using clockwise/counterclockwise motions to advance the dilator. Maintain a firm grasp on the guide wire during this maneuver.
12. Remove dilator while maintaining the guide wire in stable position.
13. Straighten the pigtail catheter tip and insert over the guide wire using the same twisting motion used during step 11. Advance until all holes are in the chest plus 1-2cm further.
14. Slowly withdraw the guide wire while holding the pigtail firmly in place. As the guide wire is withdrawn the pigtail will curl against the chest wall and be parallel with the lung.
15. The pigtail is then immediately connected to underwater sealed drainage or to a one-way “Heimlich” valve to evacuate the pleural space.
16. Suture the chest tube securely to the skin.
17. Dress insertion site as in the above procedure with petroleum soaked gauze.

E. Follow-up treatment

1. The position of the chest tube and resolution of the intrapleural air or liquid is checked by x-ray (AP and cross table lateral). Tube should be pulled back if it crosses the mediastinum.
2. Discuss need for post-procedure antibiotics with attending physician

F. Termination of treatment

The chest tube will be discontinued in the event that it is no longer needed, or thought to be occluded.

G. Potential Complications:

1. Infection may be introduced if sterile technique is not observed.
2. Bleeding from trauma to the intercostal vessels is usually slight and clinically insignificant.

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3. Persistence of the pneumothorax may occur if the tube is not properly positioned to drain, or if the air leak from the lung is too great to be drained adequately by one tube.
4. Perforation of the lung by a trocar has been reported in neonates with stiff lungs secondary to RDS. The incidence of lung perforation appears to be much lower when the trocars are not used. Perforation of the lung should be suspected by x-ray position and by prolonged vigorous air leak.
5. Fatal myocardial perforation, severing of the phrenic nerve, liver trauma with hemoperitoneum, tears of subclavian vessels with significant blood loss, and thymic trauma with hemorrhage have all been reported in extremely rare instances and again, with the use of trocars for insertion. Damage to the heart, thymus, great vessels, liver and spleen should be avoidable by proper skin incision and avoidance of trocars to penetrate the chest wall and pleura.

IV. Documentation

A. Documentation is in the electronic medical record

1. Documentation of the pretreatment evaluation and any abnormal physical findings.
2. Record the time out, indication for the procedure, procedure, type and size of tube used, method used, EBL, the outcome, how the patient tolerated the procedure, medications (drug, dose, route, & time) given, complications, and the plan in the note.

B. All abnormal findings are reviewed with Attending or supervising physician

V. Competency Assessment

A. Initial Competence

1. The AHP will observe the procedure in its entirety at least once. Under the direct supervision of the attending physician the AHP will perform neonatal / pediatric chest tube insertion successfully **three** times and will be evaluated for competence and technical skill.
2. The AHP will demonstrate knowledge of the following:
 - a. Medical indication and contraindications of neonatal / pediatric chest tube insertion.
 - b. Risks and benefits of the procedure
 - c. Related anatomy and physiology
 - d. Consent process (if applicable)
 - e. Steps in performing the procedure
 - f. Documentation of the procedure

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- g. Ability to interpret results and implications in management.
- 3. The AHP will ensure the completion of competency sign off documents and send them directly to the medical staff office.

B. Continued proficiency

- 1. The AHP will demonstrate competence by successful completion of the initial competency.
- 2. Each candidate will be initially proctored and signed off by an attending physician. AHPs must perform this procedure at least **three** times per year. In cases where this minimum is not met, the AHP must demonstrate skill with this procedure in a simulation or skills lab, or the attending, must again sign off the procedure for the AHP. The AHP will be signed off after demonstrating 100% accuracy in completing the procedure.
- 3. Demonstration of continued proficiency shall be monitored through the annual evaluation.
- 4. A clinical practice outcomes log is to be submitted with each renewal of credentials. It will include the number of procedures performed per year and any adverse outcomes. If an adverse outcome occurred, a copy of the procedure note will be submitted.

VII. RESPONSIBILITY

Questions about this procedure should be directed to the Chief Nursing and Patient Care Services Officer at 353-4380.

VIII. HISTORY OF POLICY

Initial policy approved 1986 by CIDP and EMB

Revised 4/89, 1/93, 5/01, 7/03, 12/05, 6/08, 2/11

Revised most recently July 2012 by Subcommittee of the Committee for Interdisciplinary Practice

Reviewed most recently July 2012 by the Committee on Interdisciplinary Practice

Approved most recently July 2012 by the Executive Medical Board and the Governance Advisory Council.

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