

UAB TRAUMA PNEUMOTHORAX/HEMOTHORAX MANAGEMENT PROTOCOL

Updated 3/20/2022

PURPOSE:

1. To describe the indications for chest tube placement
 2. To describe the criteria for the observation of pneumothoraces (PTX)
 3. To describe the management of observing pneumothoraces
 4. To describe the procedure for placing a chest tube
 5. To describe the management of a chest tube
 6. To describe the procedure for removing a chest tube
 7. To describe the process for re-imaging patients with hemothorax (HTX) to evaluate for retained hemothorax (rHTX)
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INDICATIONS FOR CHEST TUBE PLACEMENT

(See Figures 1 and 2)

1. Hemodynamically Stable Patient:
 - Any Hemothorax (HTX) visible on CXR or >300mL on CT (See Appendix A for Volumetric calculation)
 - Significant subcutaneous emphysema on CXR
 - Any Pneumothorax >35mm on CT or >20% on CXR (See Appendix B for pneumothorax calculation)
2. Hemodynamically Unstable Patient:
 - Any patient deemed to have an abnormal physiology that is the result of a PTX (diagnosed via eFAST/CXR/lack of breath sounds) - the PTX should be drained.
 - Any patient deemed to have an abnormal physiology that is the result of a HTX, the HTX should be drained
 - Err on the side of placing a tube

INDICATIONS FOR OBSERVATION OF PTX

(See Figure 1)

1. Occult pneumothorax (OPTX)
 - Occult pneumothorax is defined as a pneumothorax that is detected by chest CT scanning, but not routine supine screening CXR
 - Most blunt trauma patients with OPTX have been safely observed in several prospective studies (1,2,5).
2. Any pneumothorax ≤ 35 mm on CT or $\leq 20\%$ on CXR, regardless of positive-pressure ventilation
 - The 35mm rule (Appendix B) has a NPV of 95.7 % and a PPV 90.8% to predict successful observation in both blunt and penetrating PTX (7,8)
 - This means a 10% failure rate. Thusly repeat imaging must be obtained/

Note:

- Positive pressure ventilation does not increase failure rate for observation of PTX (2,4) and is not associated with PTX recurrence (6).
- Pulmonary contusion and number of rib fractures are not associated with failure (3)

MANAGEMENT PROTOCOL FOR OBSERVATION OF PTX

1. Repeat Imaging: Chest Xray obtained 4 hours after initial CXR or
2. If minimal expansion on follow-up XR, re-assess algorithm for placement of chest tube (>35mm, >20%)
 - a. If chest tube placed, follow Chest Tube Management Protocol
 - b. If continued observation, plan for repeat Chest Xray in 4 hours (consider admission)

Contra-indications for continued observation: Respiratory distress, Development of HTX, persistent tachycardia, unexplained hypotension

MANAGEMENT PROTOCOL FOR CHEST TUBE SIZE

- Determination of large bore chest tube (28Fr) versus pigtail thoracostomy tube (14fr) is at attending discretion and includes consideration of pathology (HTX vs PTX), hemodynamic status, etc.
 - Inaba et al demonstrated no difference between smaller chest tubes (28-32Fr) when compared to larger chest tubes (36-40Fr) (11).
 - Kulvantunyou et al published an RCT using 14Fr pigtails for PTX and found no difference in ability to drain the PTX and better pain Scores (13).
 - Kulvantunyou et al published an RCT using 14Fr pigtails for HTX and found similar failure rates (11% PCs vs. 13% chest tubes) and better pain scores (20)

PROCEDURE FOR LARGE BORE CHEST TUBE PLACEMENT

1. If possible, and with permission from the attending trauma surgeon, adequate pain control & sedation should be provided to the patient.
 2. Prophylactic antibiotics should be administered prior to incision or as soon as possible post-procedure (9,10)
 - Ancef 2grams vs Clindamycin 300mg if penicillin allergy
 3. The patient is to be prepped and draped appropriately for sterile chest tube placement.
 4. The preferred location for chest tube placement is the 5-6th intercostal space at the anterior axillary line. In practice, this corresponds to the inframammary fold.
 - Do not use the nipple as a landmark as it may not necessarily have a stationary location depending on the patient's body habitus.
 5. Wide local anesthetic infiltration should be performed, if possible, to include an attempt to reach the parietal pleural surface.
 6. A skin incision will be created sharply below the intended entry level of the thoracic cavity
 7. Create a subcutaneous tunnel by dissecting upward from the incision to above the rib (using either curved Mayo scissors or a Kelly clamp)
 8. Enter the chest cavity using slow controlled pressure. Once the instrument has penetrated the pleura, it should be opened widely and withdrawn to create an adequate sized tract to place a gloved finger.
 9. Digital inspection will be performed to ensure appropriate location (thoracic cavity) and to verify no adhesions are present which would hinder CT placement.
 10. A 28Fr or larger chest tube will be directed into the chest with the tip of the tube ideally positioned in the posterior apical location.
 11. The chest tube will be connected to the Pleur-Evac and secured into position with an appropriate suture, followed by application of a sterile occlusive dressing.
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PROCEDURE FOR PIGTAIL THORACOSTOMY TUBE PLACEMENT

1. Steps 1-5 as above
2. Optional: Use Bedside ultrasound to localize an optimal window for tube placement.
3. Insert an 18 gauge needle with attached saline-filled syringe, immediately above the 5th rib, and continuously aspirate while slowly advancing.
4. Immediately terminate advancement once air/fluid encountered
5. Advance a guidewire into the pleural space and withdraw the needle, in a classic Seldinger fashion.
6. Make a small incision ("nick") through the skin and the subcutaneous tissues, dilate the tract
7. Thread the Pigtail catheter over the guidewire, while maintaining control of the wire during advancement.
8. Remove the guidewire
9. Connect the catheter to a Pleur-Evac, confirm with air leak/tidaling/fluid drainage
10. Suture the catheter in place, and apply sterile dressing

CHEST TUBE MANAGEMENT

(See Figure 2)

INITIAL MANAGEMENT:

- All chest tubes will remain in place for a minimum of 24 hours.
- All chest tubes will be placed to 20cm water suction via the thoracic drain apparatus (Pleur-Evac).

DAILY MANAGEMENT:

- Documentation and reporting of chest tubes will include: Suction/waterseal, volume of output (mL/24Hrs), and presence/absence of airleak
- Daily am CXRs will be obtained on all patients who have a chest tube in place
- Patients should have chest tube placed to waterseal at 24 hours from placement if no air leak present regardless of output.
 - o CXR to be obtained 4 hours after waterseal.
 - o No change in level of care until confirmatory CXR obtained.
- Assess daily for possible removal (see criteria below)
- **Hospital day 2:** Evaluate all patients with hemothorax on admission for retained hemothorax with an upright CXR. (see Figure 2 below)
 - o Risk of retained HTX after chest wall injury is >40% in patients with a HTX volume >300cc on initial CT, with 15% increase in risk of HTX for each 100mL (18).
 - o Maintain high index of suspicion for retained hemothorax in patients with a penetrating mechanism of injury, as they have 2X increased risk for retained HTX (18).

ASSESSMENT FOR REMOVAL:

The chest tube is considered ready for removal only after all of the following (3) conditions have been met:

- For PTX:
 - o Complete resolution
 - o OR
 - o Small (<35mm on CT or < 20% on CXR) AND stable (unchanged on ≥ 2 images)
- For HTX:
 - o No residual effusion
 - o OR
 - o Small hemothorax (<300mL)
- < 200 ml of pleural drainage evacuated over the preceding 24 hour period
- Absence of air leak on valsalva maneuver or forceful cough

**Failure to meet criteria for removal of the chest tube after 72hrs of chest tube placement should prompt an evaluation for VATS. (ie persistent drainage >200ml, persistent air leak, or inability to clear effusion/hemothorax on CXR).

CHEST TUBE REMOVAL PROCEDURE

- The chest tube must be on waterseal for a minimum of 4 hours, and a CXR confirming above criteria afterwards
 - o This is to allow for sufficient time to transpire to ensure that a slowly reoccurring pneumothorax is not missed (14, 15).
 - o There is NO NEED to wait more than 4 hours to obtain the next CXR to determine whether a tube should be discontinued.
- Chest tube removal procedure:
 - o Remove the sutures around chest tube while holding chest tube steadily in place.
 - o Instruct the patient to perform Valsalva maneuver.
 - o Withdraw the chest tube quickly while simultaneously covering entrance site with vaseline gauze.
 - o Tape 4 X 4 gauze over entire entrance site ensuring that no air is able to leak into the chest tube wound.
 - o Order a CXR four (4) hours following chest tube removal.

EVALUATION FOR RETAINED HEMOTHORAX

(See Figure 2)

- If the patient had a hemothorax on initial CT, perform upright CXR only. Any abnormality present on CXR on hospital day 2 is an indication to proceed with CT chest (contrasted vs noncontrast per attending discretion).
 - o If HTX >300cc on CT Chest, proceed with VATS.
 - Persistent retained hemothorax after placement of a thoracostomy tube should be treated with early VATS, not a second chest tube (17)
 - VATS should be done in the first 3 to 7 days of hospitalization to decrease the risk of infection and conversion to thoracotomy (17). **Within 72 hours is preferred.**
 - If >7 days since injury, consider thoracic surgery consultation for VATS
 - o In patients with prohibitive surgical risks, intrapleural thrombolytic therapy may be used to improve drainage of subacute (6-13 days), loculated, or exudative collections(17).
 - By attending approval only, utilize the MIST-2 trial dosing (21).

DEFINITIONS

Retained Hemothorax: Any intra-thoracic fluid collection seen on non-contrasted CT chest prior to HD 5 in the setting of a patient with known prior hemothorax will be assumed to be retained hemothorax OR any heterogeneous fluid collection with Hounsfield unit readings on CT of 35 to 70 on any hospital day.

Suction: The water level in the suction chamber must be monitored daily and kept at the appropriate level by adding sterile water to counteract the normal evaporative losses that will diminish the effective intrapleural suction force of the chest tube. There is no need to adjust the amount of suction at the wall as the amount of effective interpleural suction force is determined

by the water level in the Pleur-Evac container. Generally this is at 20cmH₂O, however can be modified up to 40cm H₂O and down to 10cmH₂O. This should only be utilized in unique situations. Otherwise standard suction is 20cmH₂O.

Water-Seal: Disconnecting the chest tube reservoir apparatus from wall suction constitutes placement of the patient on water seal. This allow air to exit from the pleural space on exhalation and prevent backflow of air or fluid into the pleural cavity on inhalation.

Tube Clamping: The chest tube should never be clamped except when interrogating the system to determine where an air leak may be originating from. AT NO TIME SHOULD A CLAMP BE LEFT ON A PATIENTS CHEST TUBE OR PLEUR-EVAC TUBING WHILE UNATTENDED; doing so in a patient with a residual pleural leak, even if small, can lead to a tension pneumothorax and resultant cardiac arrest.

Figure 1: Algorithm for management of traumatic Pneumothorax

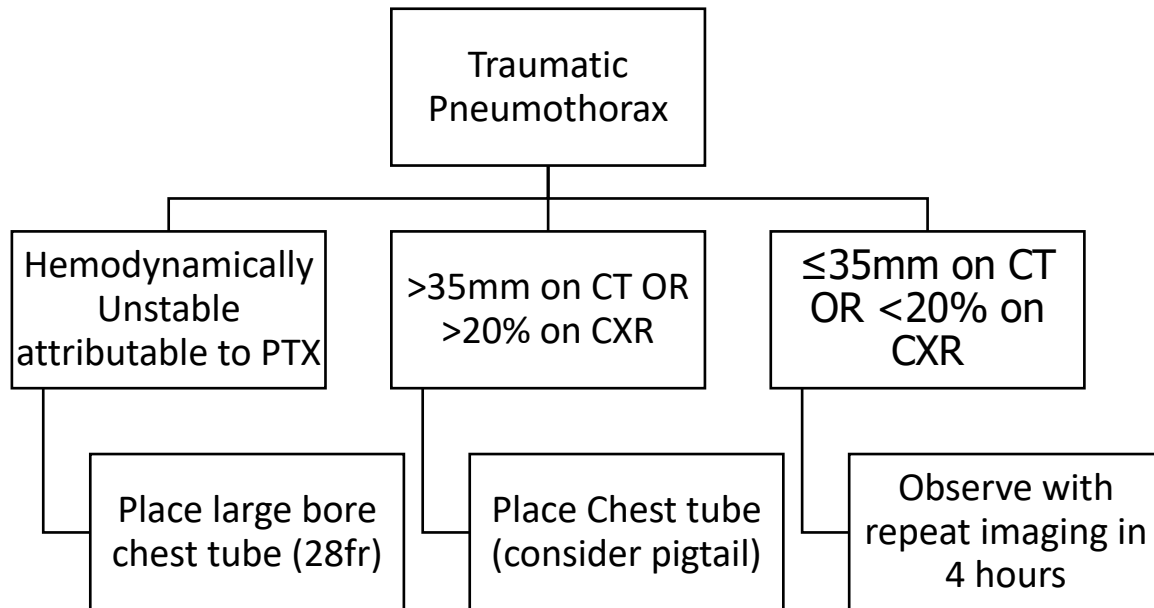
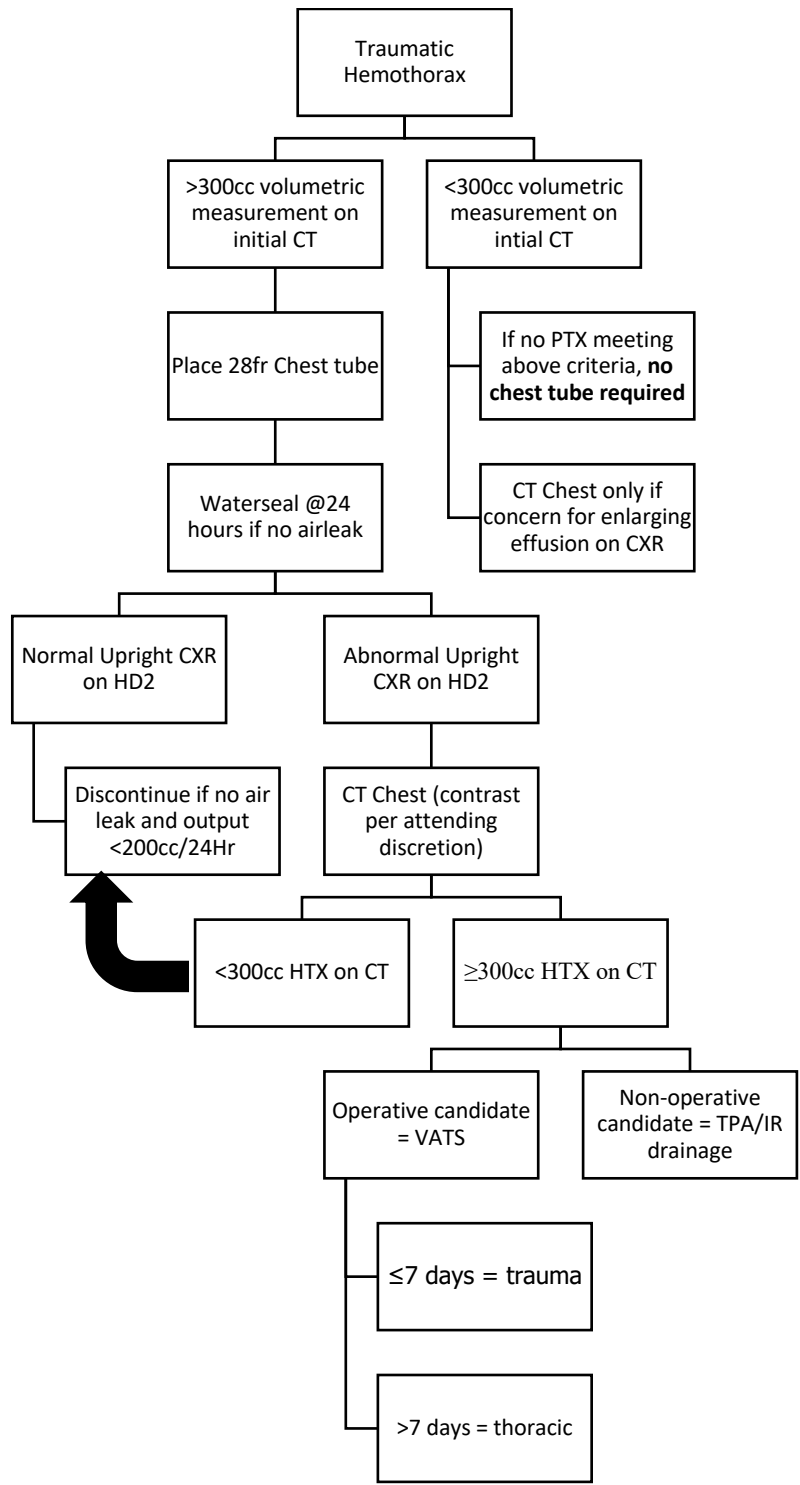


Figure 2: Algorithm for Management of Traumatic Hemothorax



Appendix A: Volumetric Calculation of Hemothorax

$$V[\text{in mL}] = d^2 \times L$$

D = greatest depth of HTX from chest wall to lung on any CT image in cm

L = craniocaudal length of the HTX obtained by multiplying the number of slices where hemothorax is present by the thickness of the CT cuts in cm


CT estimate of hemothorax volume using Mergo's Formula

$V = d^2 \times L$

d = greatest depth of hemothorax from chest wall to lung at right angle on any one CT image, in cm
L = crani-caudal length; number of CT slices x thickness of each CT slice in cm

For example, in the image below, if the slices were 5 mm thick and the hemothorax extended for 45 slices in the cranial-caudal direction, the estimated volume would be

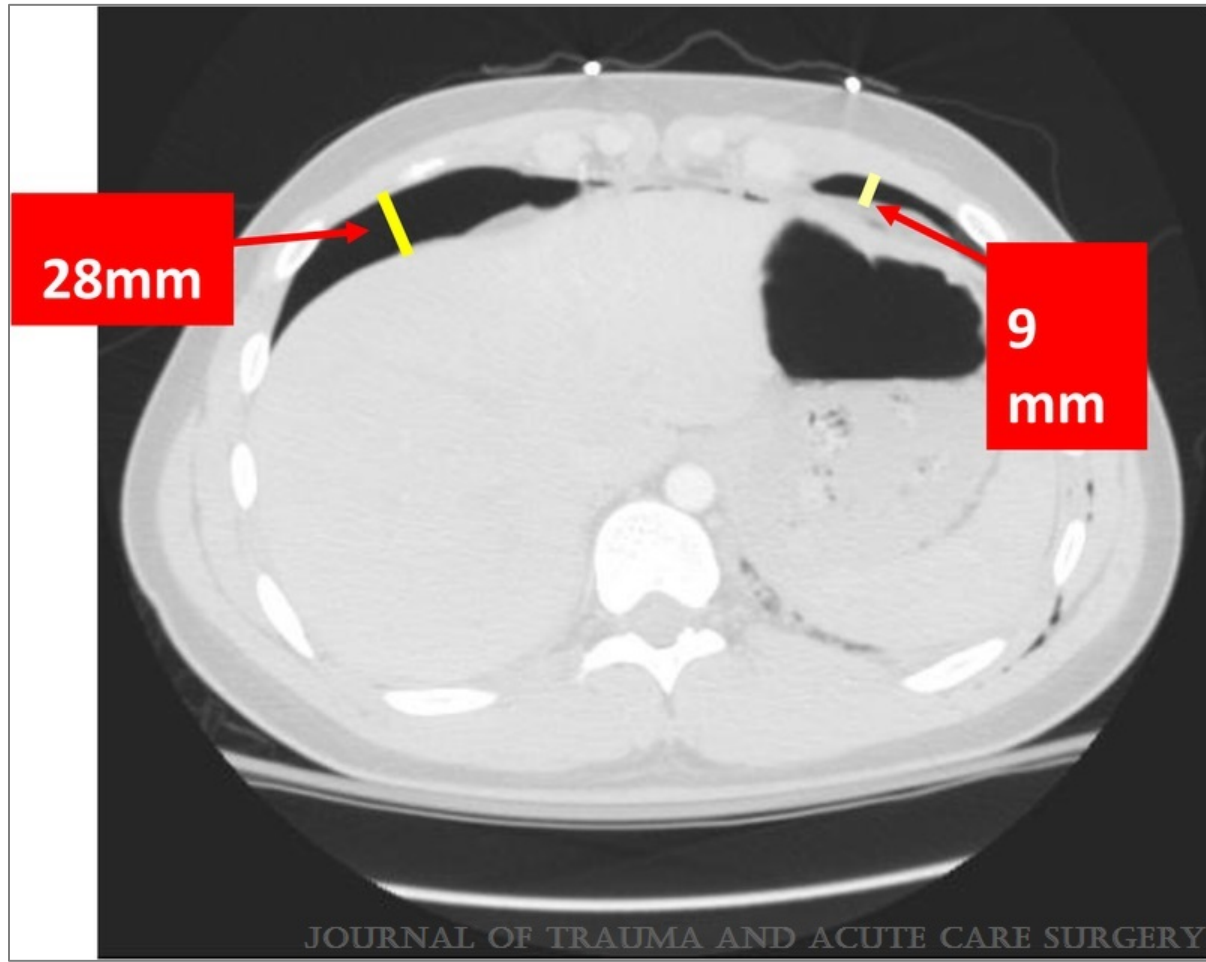
$V = 6.15 \text{ cm} \times 6.15 \text{ cm} \times 45 \times 0.5 \text{ cm} = 851 \text{ cm}^3 = \mathbf{851 \text{ mL}}$



Prakash, P. S., Moore, S. A., Rezende-Neto, J. B., Trpcic, S., Dunn, J. A., Smoot, B., Jenkins, D. H., Cardenas, T., Mukherjee, K., Farnsworth, J., Wild, J., Young, K., Schroepfel, T. J., Coimbra, R., Lee, J., Skarupa, D. J., Sabra, M. J., Carrick, M. M., Moore, F. O., Ward, J., ... Cannon, J. W. (2020). Predictors of retained hemothorax in trauma: Results of an Eastern Association for the Surgery of Trauma multi-institutional trial. *The journal of trauma and acute care surgery*

Appendix B: Measurement of Pneumothorax

Measurement of pneumothorax on chest CT scan with a line in the largest air pocket on axial imaging drawn perpendicular or radial to the chest wall.



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