UAB SICU PNEUMOTHORAX/HEMOTHORAX MANAGEMENT PROTOCOL
Updated 1/20/2022

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)

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)
   - 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 patients with OPTX have been safely observed in several prospective studies (1,2,5).
2. Any pneumothorax ≤35mm on CT or ≤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 for PTX (7,8)
   - This means a 10% failure rate**. Thus, 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).
-

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 SICU Attending, adequate pain control & sedation should be provided to the patient.
2. Although data to support prophylactic antibiotics are limited, given our high incidence of empyema, it is our practice to administer antibiotics 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 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.

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 5^{th} 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/water seal, volume of output (mL/24Hrs), and presence/absence of air leak
- Daily am CXRs will be obtained on all patients who have a chest tube in place
- Patients should have chest tube placed to water seal at 24 hours from placement if no air leak present regardless of output.
    - CXR to be obtained 4 hours after water seal.
    - No change in level of care until confirmatory CXR obtained.
- Assess daily for possible removal (see criteria below)
- **For all patients with hemothorax, at 24-48 hours after chest tube placement**, must evaluate for retained hemothorax with an upright CXR (see Figure 2 below)

ASSESSMENT FOR REMOVAL:

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

- For PTX:
    - Complete resolution
        OR
    - Small (<35mm on CT or < 20% on CXR) AND stable (unchanged on ≥2 images)
- For HTX:
    - No residual effusion
        OR
    - 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. (i.e., persistent drainage >200ml, persistent air leak, or inability to clear effusion/hemothorax on CXR).

CHEST TUBE REMOVAL PROCEDURE

- The chest tube must be on water seal for a minimum of 4 hours, and a CXR confirming above criteria afterwards
    - This is to allow for sufficient time to transpire to ensure that a slowly reoccurring pneumothorax is not missed (14, 15).
    - 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:

- Remove the sutures around chest tube while holding chest tube steadily in place.
- Instruct the patient to perform Valsalva maneuver.
- Withdraw the chest tube quickly while simultaneously covering entrance site with Vaseline gauze.
- Tape 4 X 4 gauze over entire entrance site ensuring that no air is able to leak into the chest tube wound.
- Order a CXR four (4) hours following chest tube removal.

EVALUATION FOR RETAINED HEMOTHORAX

(See Figure 2)

- Any abnormality present on upright CXR 24-48 hours after placement is an indication to proceed with CT chest (contrast vs non-contrast per attending discretion).
    - 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
    - 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).
        - TPA requires Thoracic or Interventional Pulmonology consultation and approval
        - Utilize the MIST-2 trial dosing (21).

DEFINITIONS/OTHER NOTES

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 Houndsfield 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 allows 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 PATIENT'S 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

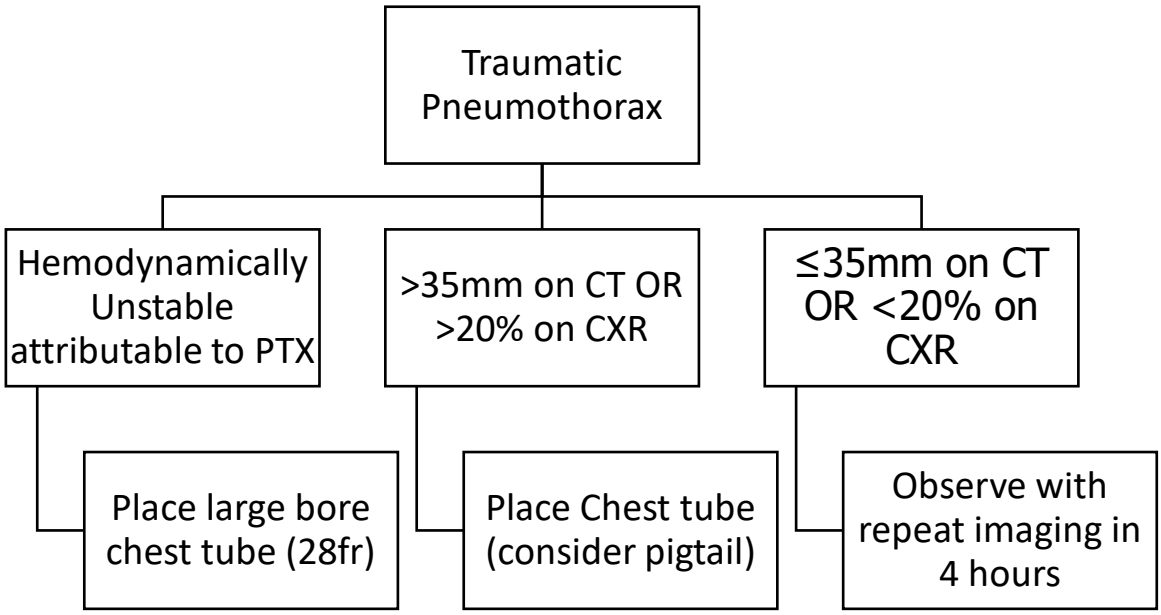
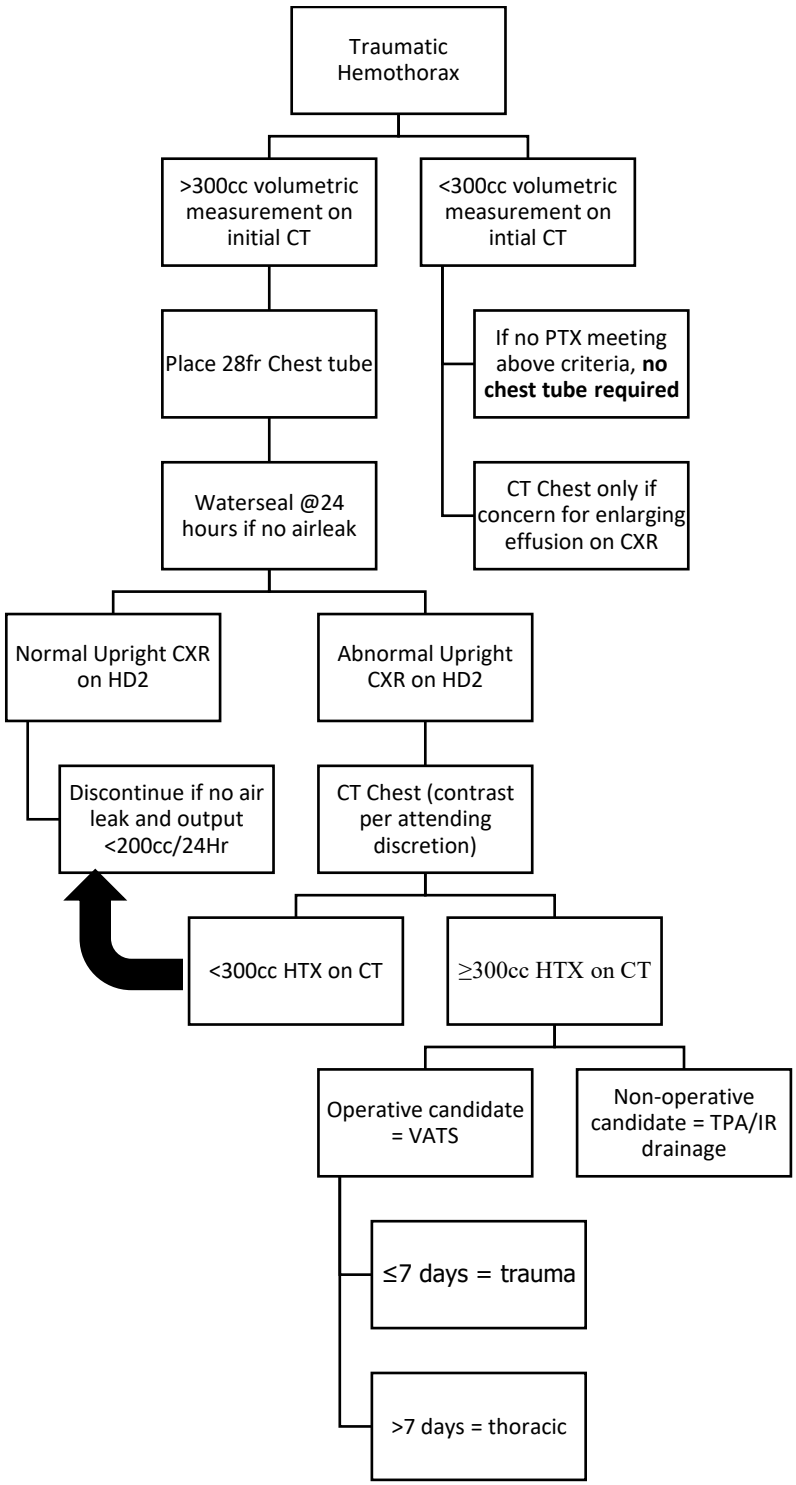


Figure 2: Algorithm for Management of Traumatic Hemothorax

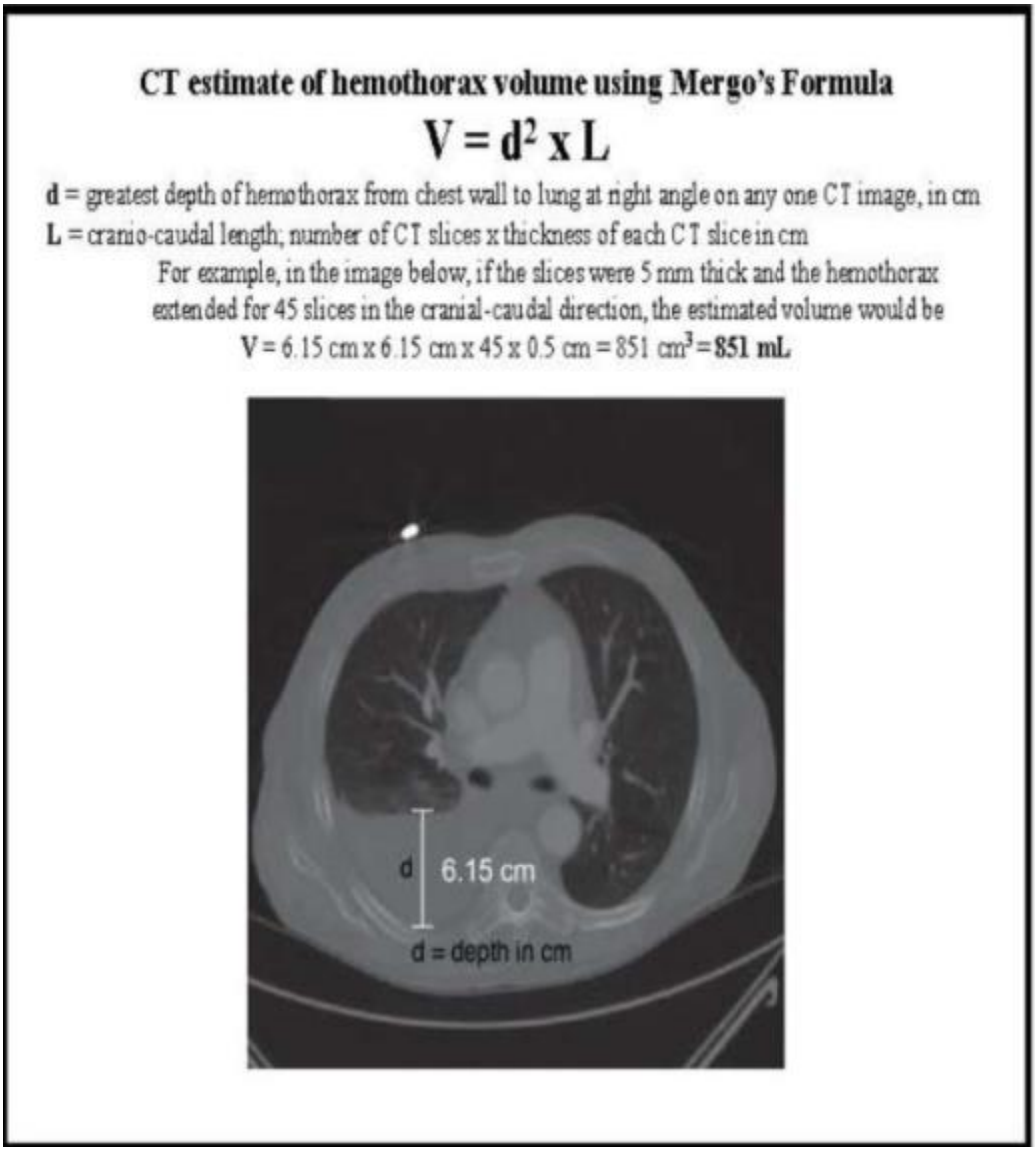


Appendix A: Volumetric Calculation of Hemothorax

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

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

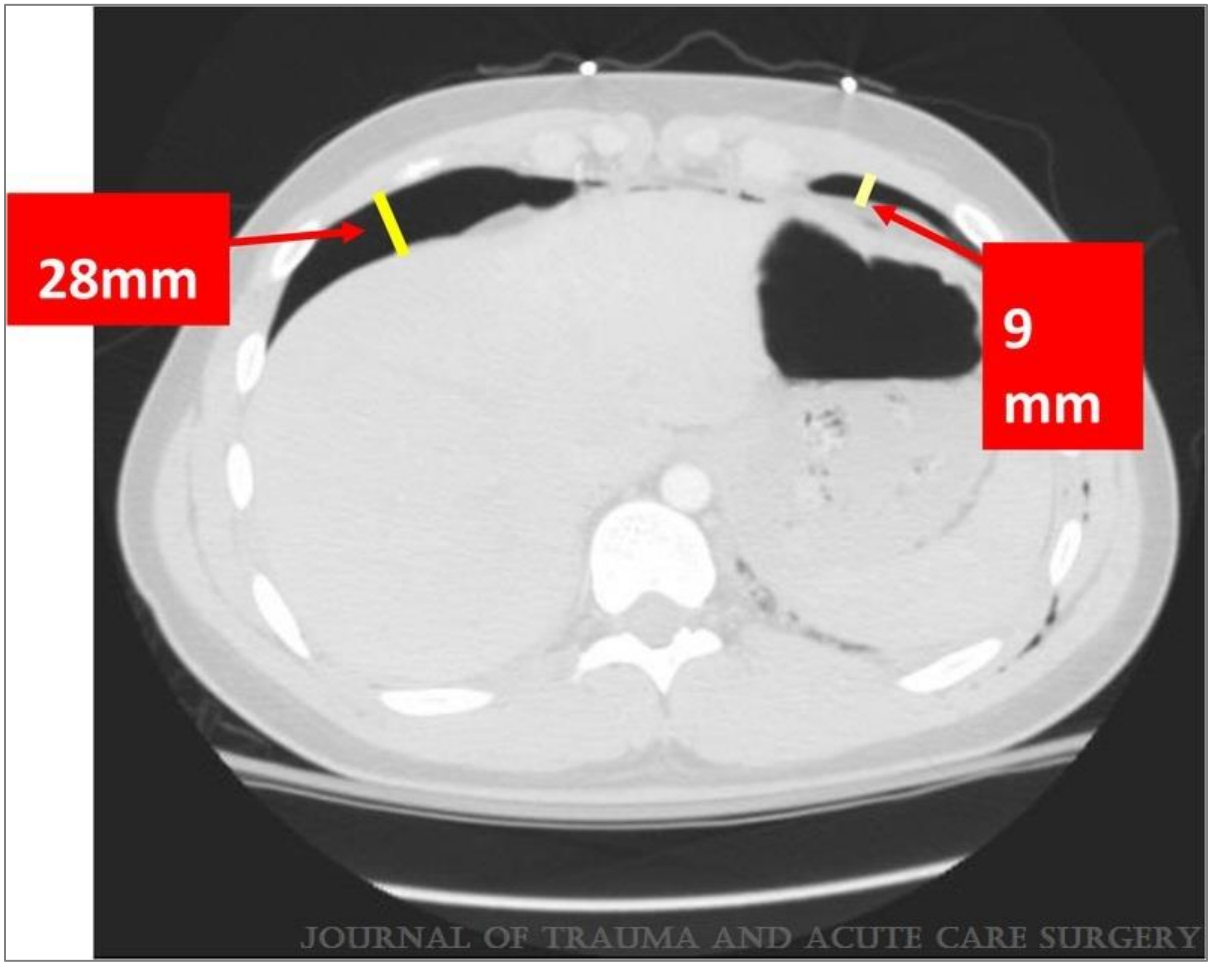
L = craniocaudal length of the HTX obtained by multiplying the number of slices where hemothorax is present by the thickness of the CT cuts in cm



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., Schroeppel, 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.



de Moya, M., Brasel, K. J., Brown, C., Hartwell, J. L., Inaba, K., Ley, E. J., Moore, E. E., Peck, K. A., Rizzo, A. G., Rosen, N. G., Sperry, J., Weinberg, J. A., & Martin, M. J. (2022). Evaluation and management of traumatic pneumothorax: A Western Trauma Association critical decisions algorithm. The journal of trauma and acute care surgery

REFERENCES

Occult PTX

1. Enderson BL, Abdalla R, Frame SB, Casey MT, Gould H, Maull KI. Tube thoracostomy for occult pneumothorax: a prospective randomized study of its use. J Trauma. 1993
2. Brasel KJ, Stafford RE, Weigelt JA, Tenquist JE, Borgstrom DC. Treatment of occult pneumothoraces from blunt trauma. J Trauma. 1999
3. Blunt traumatic occult pneumothorax: is observation safe?--results of a prospective, AAST multicenter study. Moore et al. J Trauma. 2011 May;70(5):1019-23
4. Occult pneumothoraces in critical care: a prospective multicenter randomized controlled trial of pleural drainage for mechanically ventilated trauma patients with occult pneumothoraces. Kirkpatrick et al. J Trauma Acute Care Surg. 2013 Mar;74(3):747-54
5. Johnson G. Traumatic pneumothorax: is a chest drain always necessary? J Accid Emerg Med. 1996
6. Tawil I, Gonda JM, King RD, Marinaro JL, Crandall CS. Impact of positive pressure ventilation on thoracostomy tube removal. J Trauma. 2010

PTX Observation

7. Cropano C, Mesar T, Turay D, King D, Yeh D, Fagenholz P, Velmahos G, de Moya M. Pneumothoraces on computed tomography scan: observation using the 35 millimeter rule is safe. Panam J Trauma Crit Care Emerg Surg. 2015;4(2):48–53.
8. Bou Zein Eddine S, Boyle KA, Dodgion CM, et al. Observing pneumothoraces: the 35-millimeter rule is safe for both blunt and penetrating chest trauma. J Trauma Acute Care Surg. 2019

Prophylactic Antibiotics

9. Ayoub F, Quirke M, Frith D. Use of prophylactic antibiotic in preventing complications for blunt and penetrating chest trauma requiring chest drain insertion: a systematic review and meta-analysis. Trauma Surg Acute Care Open. 2019
10. Presumptive antibiotic use in tube thoracostomy for traumatic hemopneumothorax: an Eastern Association for the Surgery of Trauma practice management guideline. Moore FO et al. J Trauma Acute Care Surg. 2012
11. Sanabria A, Valdivieso E, Gomez G, Echeverry G. Prophylactic antibiotics in chest trauma: a meta-analysis of high-quality studies. World J Surg. 2006

Chest Tube Size

12. Does size matter? A prospective analysis of 28‐32 versus 36‐40 French chest tube size in trauma. Inaba et al. J Trauma Acute Care Surg. 2012: 72 (2): 422-427
13. Kulvatunyou N, Erickson L, Vijayasekaran A, Gries L, Joseph B, Friese RF, O'Keeffe T, Tang AL, Wynne JL, Rhee P. Randomized clinical trial of pigtail catheter versus chest tube in injured patients with uncomplicated traumatic pneumothorax. Br J Surg. 2014

Chest Tube Removal

14. Prospective Randomized Trial of Thoracostomy Tube Algorithms. Martino, et al. J Trauma. 1999 Mar; 46 (3): 369-373.
15. How long should you wait for a chest radiograph after placing a chest tube on water seal? A prospective study. Schulman CI et al. J Trauma. 2005 Jul;59(1):92-5

Current Management Guidelines

16. de Moya, M., Brasel, K. J., Brown, C., Hartwell, J. L., Inaba, K., Ley, E. J., Moore, E. E., Peck, K. A., Rizzo, A. G., Rosen, N. G., Sperry, J., Weinberg, J. A., & Martin, M. J. (2022). Evaluation and management of traumatic pneumothorax: A Western Trauma Association critical decisions algorithm. *The journal of trauma and acute care surgery*
17. Mowery, N. T., Gunter, O. L., Collier, B. R., Diaz, J. J., Jr, Haut, E., Hildreth, A., Holevar, M., Mayberry, J., & Streib, E. (2011). Practice management guidelines for management of hemothorax and occult pneumothorax. The Journal of trauma

Retained HTX

18. 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., Schroeppel, 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
19. Demetri, L., Martinez Aguilar, M. M., Bohnen, J. D., Whitesell, R., Yeh, D. D., King, D., & de Moya, M. (2018). Is observation for traumatic hemothorax safe?. The journal of trauma and acute care surgery
20. Kulvatunyou, N., Bauman, Z. M., Zein Edine, S. B., de Moya, M., Krause, C., Mukherjee, K., Gries, L., Tang, A. L., Joseph, B., & Rhee, P. (2021). The small (14 Fr) percutaneous catheter (P-CAT) versus large (28-32 Fr) open chest tube for traumatic hemothorax: A multicenter randomized clinical trial. The journal of trauma and acute care surgery
21. Rahman, N. M., Maskell, N. A., West, A., Teoh, R., Arnold, A., Mackinlay, C., Peckham, D., Davies, C. W., Ali, N., Kinnear, W., Bentley, A., Kahan, B. C., Wrightson, J. M., Davies, H. E., Hooper, C. E., Lee, Y. C., Hedley, E. L., Crosthwaite, N., Choo, L., Helm, E. J., … Davies, R. J. (2011). Intrapleural use of tissue plasminogen activator and DNase in pleural infection. The New England journal of medicine