Massive Hemothorax

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Demographics

- Massive hemothorax (MH) is defined as the acute accumulation of > 1500 mL (or >1/3 a patient's blood volume) of blood in a pleural cavity.
- This diagnosis is immediately life threatening and should be managed in the primary survey.
- Most patients present after penetrating trauma. The diagnosis may also present after blunt trauma, although this is less common. Many other etiologies of massive hemothorax have also been described (see below).

Clinical Presentation

- The diagnosis of MH is suggested in the trauma patient when shock is associated with the physical findings of a hemothorax which include hypoxia, decreased unilateral breath sounds and dullness to percussion (although the latter of these is hard to elicit or rarely performed). Neck veins are generally flat related to hypovolemia but are occasionally distended if blood accumulation has cause a shift in the mediastinum and therefore tension physiology.
- Specific etiologies of MH include bleeding from the chest wall (particularly in lacerated intercostal vessels associated with rib fractures or iatrogenic injuries), bleeding from the lung parenchyma, bleeding from the ipsilateral internal mammary artery, bleeding from major thoracic vasculature (including the pulmonary vessels and the proximal branches of the aortic arch) or may represent decompression from an acute cardiac injury.
- Iatrogenic MH has also been reported following a variety of procedures (e.g.: tube thoracostomy, central line insertion, nerve blocks and rib/sternal plating) and this generally represents injury to the intercostal bundle with subsequent intrapleural accumulation of blood.

Evaluation, Imaging and Initial Management

- Standard chest radiograph is the gold standard for diagnosis. Any accumulation of fluid that obscures a large portion of the hemithorax is concerning for the presence of a MH. If the patient also presents in shock, tube thoracostomy should be pursued as part of the initial primary survey in an attempt to quantify the accumulation.
- For the skilled surgeon-sonographer, surgeon performed ultrasound is an expeditious way to diagnose a hemothorax, especially one that is sizable. A lower frequency curvilinear probe may be used one to two rib spaces above the left and right upper quadrant views to ascertain if there is fluid above the diaphragm. Often one can see collapsed lung parenchyma floating within the accumulated blood.
- Immediate tube thoracostomy should be performed in patients suspected to have a MH. If the diagnosis is established (> 1500 mL on initial placement) or if the patient has ongoing hemorrhage (> 200 mL/hour for 3 consecutive hours), thoracotomy should be

performed for hemorrhage control. If < 1500 mL are returned, follow-up plain radiographs should be taken immediately to confirm complete evacuation of the hemothorax and appropriate tube thoracostomy placement. If a significant amount of blood remains in the chest and the patient remains in shock, operative intervention is indicated.

- In addition to early evacuation, MH is treated with early and aggressive resuscitation. Like any other patient with significant hemorrhage, early consideration should be given towards activation of the institutional massive transfusion protocol and TEG directed or empiric high fixed ratio component therapy.
- Recent data supports the use of smaller bore tube thoracostomies (28 Fr or smaller) although some institutions still favor larger bore tubes (36 Fr).

Indications for Thoracotomy

- Standard indications for immediate thoracotomy include > 1500 mL on initial placement of a tube thoracostomy, ongoing hemorrhage as represented by > 200 mL/hour for 3 consecutive hours, or large volume residual hemothorax after tube placement, especially in the patient with ongoing shock or need for large volume resuscitation.
- Patients with retained hemothoraces should be considered for early Video Assisted Thoracoscopic Surgery (VATS) if they do not have evidence of ongoing bleeding/hemodynamic compromise and chest CT within 72 hours shows > 300-500cc of retained blood. If VATS is unsuccessful in complete clot extraction, the procedure may need to be converted to an open thoracotomy to completely evacuate the hemothorax and avoid the morbid complications of empyema and fibrothorax.

Pre-operative Preparations

- Most patients with a MH requiring thoracotomy are in extremis; standard preparations for the exsanguinating trauma patient should be available.
- Choice of incision is dictated by the severity of physiologic derangement and the presumed etiology of the MH. In the partially resuscitated patient, this can be a complex and difficult decision. Anterior thoracotomies allow for the most flexibility if the diagnosis is uncertain as they can be extended without repositioning. They do not provide the best exposure to posterior structures and to the anterior mediastinum. The latter exposure can be improved by dividing the sternum ("clamshell").
- Most patients will undergo an anterior or anterolateral thoracotomy so the patient should be placed supine with their arms extended. A longitudinal roll under the ipsilateral shoulder should be considered for better exposure to posterior structures which are often difficult to adequately access with the anterior approach.
- Standard thoracotomy equipment with vascular trays should be available. Additional adjuncts for hemorrhage control may include GIA staplers, rummels, clips, and sutures; all should be readily available.

- Patients with significant hemorrhage should be resuscitated using standard Damage Control Resuscitative techniques based on institutional capabilities and protocols. Bypass capabilities should also be available.
- Auto-transfusion of fresh blood collected from a tube thoracostomy or during a thoracotomy should be considered if appropriate equipment is available.

Operative Techniques and Intraoperative Considerations

- During thoracotomy for MH, early hemorrhage control is essential. Based on the etiology, hemorrhage control may be accomplished by balloon tamponade, packing, vascular ligation, shunting, parenchymal resection, or may require formal or distal control of major thoracic vasculature. These specific techniques will be described in other sections of the curriculum (see modules on Open Pneumothorax, Cardiac Injury, Pulmonary Parenchymal Injury, Thoracic Vascular Injury).
- In the exsanguinating trauma patient, incisions should be generous.
- Considerations in patients undergoing an emergent resuscitative thoracotomy include decompression of the pericardium, cross clamping of the aorta, hilar clamping/twisting and pleural packing.
- Prior to thoracotomy closure, 1-2 tube thoracostomies depending on extent of bleeding and injury should be placed under direct vision; this often includes a straight chest tube positioned to the apex posteriorly and a right angle chest tube lying over the diaphragm deep into the sulcus.

Postoperative Management

- It is imperative that full evacuation of the hemothorax is documented on subsequent chest radiograph. If concern remains over the adequacy of drainage, cross sectional imaging with CT scanning should be obtained.
- Undrained collections should prompt further intervention, with early VATS (within 72 hours) preferred in most centers in stable patients.
- Tube thoracostomies should be removed when output is less than 200cc/day.

Complications

- The main complication of MH is the high morbidity and mortality associated with exsanguinating hemorrhage; additionally complications may include inadequate drainage, infectious complications, and postoperative pain.
- Inadequate drainage of the pleura leads to increased risk of fibrothorax, empyema and need for decortication. If retained blood products remain in the pleural cavity after operative intervention, early reoperation should be considered. It is a matter of debate as to the exact amount of blood that may be left in the pleural cavity. Therefore, aggressive attempts to clear the pleural cavity as completely as possible are still warranted. In the author's practice, any retained blood products visible on plain radiograph generally

warrants further intervention, generally in the form of an early VATS. Other authors suggest a trial of thrombolytic therapy via the chest tube to facilitate evacuation of retained blood. If any intervention is delayed more than 72 hours, a patient may require open thoracotomy and decortication. Furthermore, a sizable proportion (~15-20%) of trauma patients that come to thoracotomy require repeat thoracotomy for complications of the procedure.

- Thoracotomy complications include re-bleeding, wound infection, wound dehiscence, sternal dehiscence or infection (if the sternum is divided), pleural space infections and other less common complications, including persistent air leaks, pneumatocele and chylothorax. Early re-bleeding should be treated promptly with transfusion, correction of any existing coagulopathy and repeat thoracotomy if persistent. On the other hand, many of the less common complications can be managed expectantly with supportive care. Repeat thoracotomy is occasionally useful for persistent air leaks but in the early post-operative period may be technically challenging.

Suggested Readings

- Dubose et al. Development of posttraumatic empyema in patients with retained hemothorax: Results of a prospective, observational AAST study. *J Trauma Acute Care Surg.* 73: 752-7, 2012.
- Mowery et al. Management of Hemothorax and Occult Pneumothorax: An EAST Practice Management Guideline. *J Trauma* 70: 510-8, 2011.
- Holcomb JB. Damage Control Resuscitation. *J Trauma* 62:S36-7, 2007.
- Sisley A et al. Rapid detection of traumatic effusion using surgeon-performed ultrasonography. *J Trauma* 44(2):291-7, 1998.
- Inaba K et al. Does size matter? A prospective analysis of 28-32 versus 36-40 French chest tube size in trauma. *J Trauma Acute Care Surg.* 72: 422-7, 2012.