MANAGEMENT OF LARGE PLEURAL EFFUSION

CHEST TUBE MANAGEMENT

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PATIENT PRESENTATION

- 62 year old male with PMH of DM and HIV
- Admitted on 4/26/10 with symptoms x 2 weeks
  - dysphagia
  - productive cough
  - shortness of breath
  - right-sided chest pain
- VS: T 97.9, BP 111/81, HR 103; WBC of 23
- CT chest: complex fluid collection in the posterior mediastinum tracking along the esophagus suggestive of a mediastinal abscess as well as right chest empyema
Contrast: OMNI
Gantry: 0°
FoV: 381 mm
Time: 800 ms
Slice: 2.5 mm
Pos: -227.75
FFS

F: STANDARD
mA: 240
120 kV
Image no: 90
Image 90 of 135

4/30/2010, 11:38:57 AM
Patient was started on unasyn and vancomycin
OR on 4/30/10
  ENT: neck exploration and I&D
  CT Surgery: esophagoscopy, right thoracotomy, decortication and debridement of peri-esophageal infection
Post-op week 1
  Intubated
  On sepsis protocol antibiotics
  On levophed drip – weaned off on POD7
  Increasing opacification over left lung field on CXRs
LARGE LEFT PLEURAL EFFUSION
LARGE LEFT PLEURAL EFFUSION

Contrast:
Gantry: 0°
FoV: 399 mm
Time: ms
Slice: 3 mm
Pos: 207.6
FFS

F: B
mA: 412
120 kV
Image no: 59
Image 59 of 115
5/7/2010, 2:12:37 PM
A left chest tube was placed at the bedside.

Patient lost 200cc of blood after the clamp was inserted into the pleura.

Patient became briefly hypotensive with SBP of 60 for several minutes, but bleeding stopped spontaneously.

Patient responded to resuscitation with crystalloids.

Hct dropped from 29 to 23 and patient received 2 Units PRBC.
HOSPITAL COURSE

- Hct remained stable at 27
- CT was putting out minimal serosanguinuous fluid
- Patient was not tolerating weaning off ventilator
- CT Chest and Abdomen
  - Chest tube entering left 7/8th intercostal space
  - Large splenic contusion
  - Left hemothorax
  - Large amount of simple abdominal fluid
  - Anasarca
On 5/20/10 patient had left VATs/thoracotomy with evacuation of hemothorax

Extubated POD1

Remaining hospital course complicated by GI bleeding requiring PRBC transfusions and PE

Patient received IVC filter

Discharged to a nursing home on 6/18/10
"Harris, when I said 'any questions' I was using only a figure of speech."
Pleural effusion results from perturbations of normal pleural fluid transport

Three mechanisms include:

- Abnormalities in Starling's equilibrium (e.g. CHF, hypoproteinemia, atelectasis)
- Increased capillary and mesothelial permeability (e.g. infection, cancer, autoimmune disease)
- Interference with lymphatic drainage (e.g. cancer, structural abnormalities)

Often, more than one mechanism is involved
History
- Respiratory symptoms or pain
- Extra-thoracic symptoms
- Duration of symptoms
- Previous medical conditions
- Risk factors for cardiopulmonary diseases or cancer

Physical exam
- Jugular venous distention and tachycardia (CHF)
- Lymphadenopathy, digital clubbing, and localized bone tenderness (lung cancer)
- Ascites (ovarian tumors or cirrhosis)
Lateral costophrenic angle blunted with 150 - 500 ml of fluid

Meniscus present if volume > 500 ml
Can detect an effusion as small as 5 ml.

A layering effusion that is at least 1 cm thick is accessible to thoracentesis.
- Less sensitive
- Increased homogeneous density of the lower hemithorax
- Loss of normal diaphragmatic silhouette
- Blunting of the lateral costophrenic angle, or apical capping
More reliable for detecting and localizing small (5 to 100 ml) or loculated pleural effusions

Particularly helpful for guiding thoracentesis for small-volume effusions
Characterizing loculated effusions

Differentiating pleural thickening or pleural masses from pleural effusion

Distinguishing between effusion and lung abscess

Guiding and monitoring closed drainage of effusions

May provide clues to the cause of the effusion (fluid-fluid level in acute hemorrhage, pleural thickening in PSI, diffuse irregular nodularity in pleural metastases)
Diagnostic thoracentesis is indicated if the cause of a pleural effusion cannot be explained by the clinical circumstances (e.g., CHF, recent surgical procedure)

Thoracentesis may also have therapeutic value (e.g., drainage of fluid may relieve dyspnea)

A large effusion can be drained without any special imaging guidance other than an upright lateral chest radiograph

Thoracentesis for a small or loculated effusion is best done with ultrasound guidance

Success rates are as high as 97%
**THORACENTESIS**

- **Absolute contraindications**
  - Lack of cooperation on the patient's part
  - Clinical instability
  - Severe coagulopathy
  - High-pressure ventilation

- **Relative contraindications**
  - Nonlayering effusion, loculations
  - Previous thoracic trauma, CT placement or surgery

- **Complications**
  - Pneumothorax occurs in 3% to 20% of patients, of whom approximately 20% require chest tube
BIOCHEMICAL ANALYSIS OF PLEURAL FLUID

- Light's criteria for identifying exudates
  - Pleural fluid-to-serum protein ratio higher than 0.5
  - Pleural fluid-to-serum LDH ratio higher than 0.6
  - Pleural fluid LDH concentration higher than two thirds of the upper limit of the serum reference range

- Exudative effusions: pneumonia, malignancy, infection, hemothorax, chylothorax, uremia, pancreatitis, esophageal perforation, etc

- Transudative effusions: CHF, cirrhosis, nephrotic syndrome, peritoneal dialysis, etc
pH and glucose levels may be used for risk stratification in patients with pleural space infection (PSI)

Other pleural fluid components
- Triglycerides, chylomicrons, and cholesterol (chylothorax)
- Amylase (esophageal perforation or pancreatitis)
- Rheumatoid factor (rheumatoid effusion)
- Antinuclear antibodies (lupus pleuritis)
- Carcinoembryonic antigen (malignancy)
- Adenosine deaminase (tuberculous pleurisy)
PLEURAL FLUID ANALYSIS

❖ Cell Counts
  o Neutrophilia points to acute inflammation
  o Lymphocytosis (> 50% of WBC) is indicative of malignancy, tuberculosis or chylothorax

❖ Microbiologic Tests
  o Gram staining and standard bacterial cultures
  o Acid-fast stains and mycobacterial cultures
  o Fungal, viral, and parasitic PSIs are uncommon

❖ Cytologic Tests
  o routinely performed whenever the cause of an effusion is unclear
PLEURAL BIOPSY

- Percutaneous pleural biopsy diagnostic yield
  - 57% for carcinoma, 75% for tuberculous pleurisy
- Video-assisted thoracoscopic surgery (VATS) diagnostic yield
  - 92% for malignancy, nearly 100% for tuberculous pleurisy
- VATS is also a therapeutic procedure -- pleurodesis, decortication, pleurectomy
- VATS procedure-specific complications
  - Hypoxemia, hemorrhage, prolonged air leakage, subcutaneous emphysema, empyema, (each 2%)
  - Mortality associated with diagnostic thoracoscopy ranges from 0.01% to 0.09%
Develops in as many as 60% of ICU patients

Drainage should be liberally employed to optimize the patient's hemodynamic and respiratory status and to detect PSI early

Thoracentesis can be done in critically ill ventilator-dependent patients with the help of bedside ultrasonography

Chest tube does not require ultrasonographic guidance and may be a safer choice for patients on high-pressure ventilation
Pleural effusion is associated with malignancy in 30% to 65% of patients

Approximately 75% of patients with malignant effusion have lung or breast cancer

Drainage
- Thoracentesis
- Chest tube placement
- VATS

Recurrence of malignant pleural effusion is best prevented by pleurodesis
Caused by a variety of factors, including pneumonia, trauma, and intra-thoracic procedures.

Has a wide clinical spectrum, ranging from a small parapneumonic effusion to empyema with respiratory compromise and sepsis.

Most common pathogens are *Staphylococcus aureus*, *Streptococcus pneumoniae*, enteric gram-negative bacilli, and anaerobes.

Approximately 30% to 40% of cultures are polymicrobial.
CHEST TUBE PLACEMENT SITE

- In the mid- or anterior axillary line
- Behind pectoralis major (to avoid having to dissect through this thick muscle)
- On expiration, the diaphragm rises to the 5th rib at the level of the nipple, and thus chest drains should be placed above this level
- Rib spaces are counted down from the 2nd rib at the sternomanubrial joint
- Practically, the highest rib space that can be easily felt in the axilla (usually the 4th or 5th) is the most appropriate
The area is prepped and draped appropriately

Skin, soft tissues and periosteum are anesthetized with lidocaine

Incision made along the upper border of the rib to avoid neurovascular injury

Using a curved clamp the track is developed by blunt dissection

Clamp is angled just over the rib and dissection continued until the pleura is entered
The area explored with a finger for pleural adhesions

Chest tube is mounted on the clamp and passed along the track into the pleural cavity

The tube is connected to an underwater seal and sutured and secured in place

The chest is re-examined to confirm effect

A chest X-ray is taken to confirm placement & position
CHEST TUBE MANAGEMENT RECOMMENDATIONS

- Chest tube is indicated for the treatment of pneumothorax, hemothorax, or pleural effusion

- Chest tube management must be individualized
  - Reason for chest tube placement
  - History of recent pulmonary resection
  - Mechanical ventilation

- Level 1 recommendation
  - Chest tube drainage should be $\leq 2\text{ml/kg/day}$ or $\leq 200 \text{ml/day}$ (whichever is less) before removal
A prospective randomized study was performed in a single institution with subsequent prospective consecutive validation. Patients (n = 139) after thoracic surgical procedures were randomized to three groups:

- **G-100** (< or = 100 mL/d, n = 44)
- **G-150** (< or = 150 mL/d, n = 58)
- **G-200** (< or = 200 mL/d, n = 37)

Additional 91 consecutive patients had chest tubes removed when drainage was less than 200 mL/d (G-val).

All patients had similar discharge and 60-day followup. Drainage time, hospital stay, and reaccumulation rate were registered.
## RESULTS

<table>
<thead>
<tr>
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<th>G-100</th>
<th>G-150</th>
<th>G-200</th>
<th>G-val</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage time (median days)</td>
<td>3.5</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Hospital stay (median days)</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Radiologic reaccumulation</td>
<td>9.1%</td>
<td>13.1%</td>
<td>5.4%</td>
<td>0.9%</td>
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<tr>
<td>Thoracenteses rates</td>
<td>2.3%</td>
<td>0.8%</td>
<td>2.7%</td>
<td>3.3%</td>
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</table>
Increasing the threshold of daily drainage to 200 mL before removing the chest tube did not markedly affect drainage, hospitalization time, or overall costs, nor did it increase the likelihood of major pleural fluid reaccumulation.

This volume (200 mL/d) could be recommended for chest tube withdrawal decision for uninfected pleural fluid with no evidence of air leaks.

Level 2 recommendations

- CTs can be removed equally safely at end-inspiration or end-expiration
- CTs may be safely removed on suction
- A brief trial of waterseal prior to CT removal may allow occult air leaks to become clinically apparent and reduce the need for CT reinsertion due to recurrent pneumothorax
- After pulmonary resection, small air leaks will resolve significantly more quickly if the CT is placed to water seal
REFERENCES

- Mutsaers S: Mesothelial cells: their structure, function and role in serosal repair. Respirology 7:171, 2002 [PMID 12153683]


SurgicalCriticalCare.net, EBM Guideline, Chest Tube Management, 10-25-2009

EVIDENCE DEFINITIONS

- Class I: Prospective randomized controlled trial
- Class II: Prospective clinical study or retrospective analysis of reliable data: includes observational, cohort, prevalence, or case control studies
- Class III: Retrospective study. Includes database or registry reviews, large series of case reports, expert opinion
LEVEL OF RECOMMENDATION DEFINITIONS

Level 1:
- Convincingly justifiable based on available scientific information alone -- usually based on Class I data or strong Class II
- Evidence if randomized testing is inappropriate; conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation

Level 2:
- Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion – usually supported by Class II data or a preponderance of Class III evidence

Level 3:
- Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.