PLEURAL EFFUSIONS

An Update in Evaluation and Management

Shruti Patel, MD
Pulmonary & Critical Care
OVERVIEW

- Anatomy and physiology
- Diagnosis of an effusion
- Investigation of the pleural fluid
- Recent updates in management
OVERVIEW

• Anatomy and physiology

• Diagnosis of an effusion

• Investigation of the pleural fluid

• Recent updates in management
stage 14  stage 22

bronchi

developing lungs
Starling’s Law: \( (P_c - P_i) - \sigma(\Pi_c - \Pi_i) \)
Increased hydrostatic pressure gradient
Decreased oncotic pressure gradient
Increased capillary or pleural permeability
Injured blood vessels or thoracic duct
Ascites

Lymphatic obstruction
OVERVIEW

• Anatomy and physiology

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### CLINICAL PRESENTATION

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Physical Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleuritic chest pain</td>
<td>Discrepancy in size of hemi-thorax</td>
</tr>
<tr>
<td>Non-productive cough</td>
<td>Decreased intercostal spaces</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>Dullness to percussion</td>
</tr>
<tr>
<td></td>
<td>Decreased tactile fremitus</td>
</tr>
<tr>
<td></td>
<td>Decreased breath sounds</td>
</tr>
</tbody>
</table>

• 50mL - meniscus on lateral CXR
• 200mL - meniscus on PA CXR
• 500mL - obscures the diaphragm

OVERVIEW

• Anatomy and physiology

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• Recent updates in management
• Real-time US is better than delayed procedure

• “Dry taps” below the diaphragm

Table 3 -- Complications of Diagnostic Procedures

<table>
<thead>
<tr>
<th>Complication</th>
<th>Needle-Catheter (n=15)</th>
<th>Needle (n=13)</th>
<th>Sonography-Guided (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumothorax</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Dry tap</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hematoma</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pain</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Physician's decision

Proposed puncture site: 172 (67%)

Number of investigations: 255

DPC refused (no site): 83 (33%)
**QUANTIFICATION OF PLEURAL FLUID**

- Ventilated patients
- Semi-recumbent position
- Maximum distance between visceral and parietal pleura (Sep)
- Measured at base of lung at end-expiration

\[
\text{Pleural Fluid (mL)} = 20 \times \text{Sep (mm)}
\]

*mean error 158 +/− 160 mL*

**DETECTION OF PNEUMOTHORAX**

- Ultrasound more sensitive than CXR in detecting PTX
  - US vs. CXR in trauma patients (gold standard CT Chest)
    | % Identified | Sensitivity | Specificity |
    |--------------|-------------|-------------|
    | CXR          | 13/25       | 52%         | 100%        |
    | US           | 23/25       | 92%         | 99.4%       |
  - US vs. CXR in post-chest tube patients (gold standard CT Chest of aspiration of air)
    | % Identified | Sensitivity | Specificity |
    |--------------|-------------|-------------|
    | CXR          | 20/33       | 61%         | 89.9%       |
    | US           | 33/33       | 100%        | 99.2%       |

LIGHT’S CRITERIA

• Pleural protein/serum protein >0.5
• Pleural LDH/serum LDH >0.6
• Pleural LDH > 2/3 ULN serum LDH

*Any 1 of the 3 positive meets criteria for an exudate

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity for Exudate</th>
<th>Specificity for Exudate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light’s criteria (one or more of the following three)</td>
<td>98</td>
<td>83</td>
</tr>
<tr>
<td>Ratio of pleural-fluid protein level to serum protein level &gt; 0.5</td>
<td>86</td>
<td>84</td>
</tr>
<tr>
<td>Ratio of pleural-fluid LDH level to serum LDH level &gt; 0.6</td>
<td>90</td>
<td>82</td>
</tr>
<tr>
<td>Pleural-fluid LDH level &gt; two thirds the upper limit of normal for serum LDH level</td>
<td>82</td>
<td>89</td>
</tr>
<tr>
<td>Pleural-fluid cholesterol level &gt; 60 mg/dl (1.55 mmol/liter)</td>
<td>54</td>
<td>92</td>
</tr>
<tr>
<td>Pleural-fluid cholesterol level &gt; 43 mg/dl (1.10 mmol/liter)</td>
<td>75</td>
<td>80</td>
</tr>
<tr>
<td>Ratio of pleural-fluid cholesterol level to serum cholesterol level &gt; 0.3</td>
<td>89</td>
<td>81</td>
</tr>
<tr>
<td>Serum albumin level—pleural-fluid albumin level ≤ 1.2 g/dl</td>
<td>87</td>
<td>92</td>
</tr>
</tbody>
</table>

*LDH denotes lactate dehydrogenase.
### Table 5. Misclassification of Transudates by Various Criteria, Based on Characteristics of Pleural Fluid Obtained from 15 Patients with at Least 3 Thoracenteses

<table>
<thead>
<tr>
<th></th>
<th>First Thoracentesis</th>
<th>Second Thoracentesis</th>
<th>Third Thoracentesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleural fluid proteins (&gt;30 g/L)</td>
<td>3 (20)</td>
<td>5 (33)</td>
<td>9 (60)</td>
</tr>
<tr>
<td>Pleural fluid/serum proteins (&gt;0.5)</td>
<td>0 (0)</td>
<td>2 (13)</td>
<td>6 (40)</td>
</tr>
<tr>
<td>Pleural fluid lactic dehydrogenase (&gt;307 U/L)</td>
<td>0 (0)</td>
<td>3 (20)</td>
<td>4 (27)</td>
</tr>
<tr>
<td>Pleural fluid/serum lactic dehydrogenase (&gt;0.6)</td>
<td>1 (7)</td>
<td>5 (33)</td>
<td>7 (47)</td>
</tr>
<tr>
<td><strong>Light’s criteria</strong></td>
<td><strong>1 (7)</strong></td>
<td><strong>7 (47)</strong></td>
<td><strong>10 (67)</strong></td>
</tr>
<tr>
<td>Serum-pleural fluid albumin gradient (≤12 g/L)</td>
<td>1 (7)</td>
<td>1 (7)</td>
<td>3 (20)</td>
</tr>
<tr>
<td><strong>Serum pleural fluid proteins gradient (≤31 g/L)</strong></td>
<td><strong>1 (7)</strong></td>
<td><strong>1 (7)</strong></td>
<td><strong>3 (20)</strong></td>
</tr>
<tr>
<td>Pleural fluid cholesterol (&gt;60 mg/dL)</td>
<td>1 (7)</td>
<td>3 (20)</td>
<td>5 (33)</td>
</tr>
<tr>
<td>Pleural fluid/serum cholesterol (&gt;0.3)</td>
<td>3 (20)</td>
<td>2 (13)</td>
<td>5 (33)</td>
</tr>
<tr>
<td>Pleural fluid cholinesterase (&gt;1,390 U/L)</td>
<td>4 (27)</td>
<td>6 (40)</td>
<td>10 (67)</td>
</tr>
<tr>
<td>Pleural fluid/serum cholinesterase (&gt;0.27)</td>
<td>1 (7)</td>
<td>1 (7)</td>
<td>7 (47)</td>
</tr>
</tbody>
</table>
### CHF: PLEURAL FLUID NT-PRO-BNP LEVELS

<table>
<thead>
<tr>
<th>Biomarker</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT-proBNP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;1300</td>
<td>95.6 (89-98.8)</td>
<td>87.9 (79.4-93.8)</td>
<td>91.7 (86.7-95.3)</td>
</tr>
<tr>
<td>&gt;1500</td>
<td>93.3 (86.1-97.5)</td>
<td>89 (80.7-94.6)</td>
<td>91.2 (86-94.9)</td>
</tr>
<tr>
<td>BNP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;75</td>
<td>88.9 (80.5-94.5)</td>
<td>76.9 (66.9-85.1)</td>
<td>82.9 (76.6-88.1)</td>
</tr>
<tr>
<td>&gt;115</td>
<td>74.4 (64.2-83.1)</td>
<td>92.3 (84.8-96.9)</td>
<td>83.4 (77.2-88.5)</td>
</tr>
</tbody>
</table>

PLEURAL FLUID CELL COUNTS

- RBC counts
  - Serosanguinous: 5000-10,000
  - Bloody appearing: >100,000
    - Hemothorax: Hct >50% peripheral Hct
      *can estimate Hct by pleural RBC/100,000
    - Hemothorax: RBC >50% peripheral RBC count

- DDx bloody effusion:
  - Trauma
  - Malignancy
  - Pulmonary embolism
# PLEURAL FLUID CELL COUNTS

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Total # Effusions</th>
<th>% Effusions with &gt;10,000 WBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parapneumonic effusion</td>
<td>26</td>
<td>50</td>
</tr>
<tr>
<td>Malignancy</td>
<td>43</td>
<td>7</td>
</tr>
<tr>
<td>Pulmonary embolization</td>
<td>8</td>
<td>37</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Postmyocardial infarction syndrome</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>System lupus erythematosis</td>
<td>1</td>
<td>100</td>
</tr>
</tbody>
</table>

PLEURAL FLUID CELL COUNTS

- Neutrophils – inflammatory
- Eosinophils >10%
  - Air
  - Blood
  - Unusual causes:
    - Asbestos-related effusions
    - Churg-Strauss syndrome
    - Eosinophilic pneumonia
    - Drug reactions

- Lymphocytes >50%
  - Malignancy
  - Tuberculous pleuritis
  - Post-CABG surgery

- Mesothelial cells
  - Rare in tuberculous pleuritis
  - May need path review
OTHER PLEURAL FLUID STUDIES

- Cytology
  - 60% positive with 1 sample
  - 80% positive with 3 sample

- Flow cytometry
OTHER PLEURAL FLUID STUDIES

- Glucose <60
  - Parapneumonic effusion
  - Malignancy
  - Rheumatoid disease
  - Tuberculous pleuritis

- Amylase >ULN serum amylase
  - Pancreatitis
  - Esophageal rupture
  - Malignancy

- pH <7.2
  - Complicated parapneumonic effusion
  - Esophageal rupture
  - Rheumatoid arthritis
  - Tuberculous pleuritis
  - Malignancy
  - Hemothorax
OTHER PLEURAL FLUID STUDIES

- Tuberculosis
  - Adenosine deaminase
    * sens and spec >90%
  - Interferon-gamma

- Rheumatoid factor
  - >1:320 and >= serum

- ANA not useful

- Triglycerides
  - <50 normal
  - >110 chylothorax

- Cultures
  * inoculate at bedside
  * avoid cultures from chest tube
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TPA AND DNASE IN PARAPNEUMONIC EFFUSION

- 210 patients with parapneumonic effusion randomized to:
  - tPA alone
  - DNAse alone
  - tPA + DNAse
  - Placebo

- Outcomes:
  - Decreased effusion size
  - Decreased need for surgery
  - Decreased hospital LOS

CHEST TUBE SIZE

Chest tube drainage

- A small-bore catheter 10–14 F will be adequate for most cases of pleural infection. However, there is no consensus on the size of the optimal chest tube for drainage. (C)
- If a small-bore flexible catheter is used, regular flushing is recommended to avoid catheter blockage. (C)
- Chest tube insertion should be performed under imaging guidance wherever possible. (D)

Small bore catheter is adequate for most purposes

Hemothorax should be drained with large bore

MALIGNANT EFFUSIONS

TUNNELED PLEURAL CATHETER VS. PLEUREDESIS

- Recent follow up study of indwelling pleural catheters shows very low rate of infection.

TRANSDUATIVE EFFUSIONS

- Indwelling pleural catheter for CHF as palliative measure or awaiting transplant

- Outcomes:
  - Improved dyspnea
  - 47% catheter removed

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