Hepatic Hydrothorax: Complete Opacification of a Hemithorax

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Core Radiology Clerkship
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Agenda

1. Patient presentation
2. Menu of available tests
3. Differential diagnosis for white out of a hemithorax
4. Review the pathogenesis and evaluation of hepatic hydrothorax
5. Intervention
6. Summary
Index Patient Presentation

- Woman in her mid 50’s called 911 complaining of two days of progressive dyspnea and increasing abdominal girth
- When EMS arrived, O2 saturation was in the 80’s. She was placed on a Non-rebreather (NRB) at 15L/minute and brought to the ER
- On arrival in the ER, she was unable to speak in complete sentences.
Index Patient: Initial Plain Film

- What is your wet read?
- What are you concerned about?
- What is your preliminary differential diagnosis?
- What types of information would be helpful in organizing your differential?

Continue to see a labeled image with findings highlighted
Index Patient:
Basic Interpretation of initial Plain Film

There is complete opacification of the left hemithorax

**More findings will be discussed in subsequent interpretations of this image**
Index patient:
Further History

More History:
- HCV Cirrhosis (MELD score of 13 on admission)
  - Says she ran out of some of her medications several days ago
- Hypothyroidism
- Depression
- MSSA spinal osteomyelitis s/p C2-3 laminectomy

Review Of Systems:
(+) Chills, abdominal pain, cough with post-tussive emesis
(-) Fevers, chest pain, hemoptysis, diarrhea, rashes, urticaria, sick contacts
Index Patient: Medications

- Furosemide 40mg daily
- Lactulose 20g/30ml TID
- Spironolactone 150mg Daily
- Tramadol 50mg daily prn pain
- Omeprazole 20mg BID
- MVI daily
Index Patient:
Physical Exam

Vital Signs: T98.2 HR 82 BP 132/61 RR 22 O2Sat 100% 15L NRB 87% RA

General: AOx3, speaking in full sentences, mild respiratory distress

HEENT: + Scleral icterus

Lungs: No air movement L hemithorax, dull to percussion ¾ the way up. Basilar crackles on right.

CV: RRR, normal S1 S2, no murmurs

Abd: +BS, soft, tender to percussion over epigastrum, + splenomegaly

Extrem: 1+ edema in lower extremities

Skin: No rashes or jaundice
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Menu of Tests:
Initial Evaluation of Respiratory Illness

The American College of Radiologists’ Expert Panel on Thoracic imaging has released guidelines for imaging in a patient older than 40 presenting with acute respiratory illness, which they define as as one of the following

- Cough
- Sputum production
- Chest pain
- Dyspnea

Recommended Tests:
- CXR (score of 8, usually appropriate)
- CT (score of 4, maybe appropriate)

ACR Expert Panel on Thoracic Imaging 2008
Index Patient:
Official Read of Initial Plain Film

Official Read:
Complete opacification of left hemithorax with slight shift of midline structures to the right
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Differential Diagnosis: White-out of a Hemithorax (based on imaging alone)

**Common:**
- Atelectasis
- Consolidation
- Pleural Effusion
- Post-pneumonectomy fibrothorax

**Uncommon:**
- Adenomatoid malformation of lung
- Agenesis of a lung
- Cardiomegaly
- Diaphragmatic Hernia
- Eventration of diaphragm
- Fibrosis of lung or pleura
- Hematoma of chest wall
- Mediastinal or Pulmonary Mass
- Pleural mesothelioma

Reeder and Felson 1993
How to Pare Down this Differential

Look at the mediastinal structures and ask yourself whether they have been pulled towards the abnormal lung, or pushed away from it.

**Pulled:**
For example
- Lung collapse
- Pneumonectomy

**Pushed:**
For example
- Diaphragmatic Hernia
- Pleural Effusion

Adapted from Davies 2009
Companion Patient 1:
An example of “pull” on plain films

Frontal Chest X Ray-- PACS BI DMC
Lateral Chest X Ray-- PACS BI DMC

Continue to see annotated images...
Companion Patient 1: An example of “pull” on frontal plain film

- Trachea deviated towards the affected hemithorax

- Left ventricle and left mediastinal border pulled towards affected lung

- Left diaphragm visible with normal costophrenic angle
Companion Patient 1: An example of “pull” on lateral plain film

- Normal Vertebrae with negative spine sign
- Anterior and posterior heart borders well visualized
- Left hemidiaphragm clearly seen with normal costophrenic angle. No right hemidiaphragm seen.
Companion Patient 1: An example of “pull” on Axial CT

Notice the following:
- Rightward displacement of heart
- Obliteration of right lung field
- Abdominal contents in right hemithorax
Companion Patient 1: An example of “pull” on Axial CT

Notice the following:

- Rightward displacement of heart
- Obliteration of right lung field
- Abdominal contents in right hemithorax
Companion Patient 1:
An example of “pull” on Axial CT

Notice the following:
- Liver in right hemithorax at level of mid left lung field
Companion Patient 1: View on coronal reconfiguration of CT

- Patient after right total pneumonectomy
- No residual lung, fibrosis of right hemithorax
- Invasion of right hemithorax by abdominal contents
Companion Patient 2: An example of “push” on plain film

Frontal and lateral plain films-- both PACS BIDMC

Continue to see annotated images...
Companion Patient 2: Demonstration of "push" on plain film

- Trachea deviated away from affected hemithorax
- Right atrium and right mediastinal border pushed away from affected hemithorax
- Right diaphragm visible with normal costophrenic angle

Frontal plain film-- PACS BIDMC
Companion Patient 2: An example of “push” on plain film

- Air-fluid level
- Right diaphragm
  - No left diaphragm visible

Lateral plain films-- PACS BIDMC
Companion Patient 2:
Worsening of “push” one year later

Frontal and lateral plain films-- both PACS BIDMC

Continue to see annotated images...
Companion Patient 2: Worsening of “push” one year later

- Trachea deviated further away from affected hemithorax
- Right atrium and right mediastinal border pushed further away from affected hemithorax
- Right diaphragm visible with normal costophrenic angle
Companion Patient 2: Worsening of “push” one year later

No more air fluid level as lung completely opacified.

- Right Diaphragm clearly visualized, no left diaphragm seen

Lateral plain films-- PACS BI DMC
Our Index Patient: Applying the Push-Pull Framework

You have now seen an organizational model for thinking about the differential of opacification of one hemithorax—breaking things into “push” versus “pull” categories based on the position of the mediastinum relative to the affected hemithorax.

Let’s return to our index patient, apply this framework, and see what category she belongs in.
Our Index Patient:
Plain Film Labeled to show “Push”

- Trachea deviated away from affected lung
- Right atrium and right mediastinal border pushed away from affected lung
- Right diaphragm visualized with normal costophrenic angle
Index Patient: Diagnosis

Our index patient demonstrates a “push” type opacification, consistent with an infiltration of the left hemithorax by a space-occupying process.

The patient was ultimately diagnosed with hepatic hydrothorax. Let’s now review the pathogenesis, workup, and management of hepatic hydrothorax.
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Hepatic Hydrothorax: Definition and Epidemiology

• Pleural effusion >500ml occurring in the setting of liver disease and in the absence of other potential causes of pleural effusion
• Occurs in 5-12% of patients with cirrhosis¹
  – BEWARE: 18%-30%² of pleural effusions in cirrhotics are NOT due to hepatic hydrothorax
• 85% Right sided, 13% Left, 2% bilateral
  – Due to location of diaphragmatic defects¹

¹ Roussos et al. 2007
² xiol et al. 2001
Hepatic Hydrothorax: Pathogenesis of Ascites

**Liver Disease:**
- Decreased SVR
- Splanchnic vasodilation
- Sodium and water retention due to decreased circulating blood volume

**Ascites**

Roussos et al. 2007
Hepatic Hydrothorax:
Pathogenesis of Pleural Effusion

Liver Disease:
- Decreased SVR
- Splanchnic vasodilation
- Sodium and water retention due to decreased circulating blood volume

Portal HTN

Effusion!

**Ascites**

Roussos et al. 2007
Hepatic Hydrothorax: Radiographic Evidence for Transdiaphragmatic Leak of Ascites

- $^{99}$T-colloid injected into peritoneal cavity
- Passage into pleural space confirms transdiaphragmatic leak
  - 6 showed $^{99}$T in left pleura only
  - 1 in right pleura only
  - 1 bilateral

Bhattacharya et al. 2001
Hepatic Hydrothorax: Spontaneous Bacterial Empyema (SBEM) as a Potential Complication

• Complicates ~13% of pleural effusions associated with cirrhosis
  – This is similar to the rate of Spontaneous Bacterial Peritonitis (SBP)

• Signs/Symptoms
  – Fever
  – Pleuritic pain
  – Encephalopathy

Fortunately our patient exhibited none of these signs or symptoms
SBEM: Further Information

• Pathogenesis unclear
  – 45% occur in absence of bacterial peritonitis
  – May be that a transient bacteremia leads to pleural infection

• Causal Organisms
  – E. Coli, Streptococcus Sp., Enterococcus, Klebsiella

• Risk factors
  – Low pleural total protein
  – High Child-Pugh Score
  – Low levels of C3 in pleural fluid

Roussos et al. 2007
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Hepatic Hydrothorax: Pathophysiologic Approach to Understanding Treatment Options

As above, the pleural effusion in hepatic hydrothorax occurs as a result of liver disease, leading to accumulation of fluid in the splanchnic circulation, which leads to ascites, which can then cross the diaphragm to reach the pleura.

Treatment approaches can thus be thought to target the following:
1) Liver function
2) Accumulation of fluid and resultant portal hypertension
3) Transmigration of fluid across the diaphragm
Hepatic Hydrothorax: Options for Treatment

1. Improving Liver Function
   - Transplant

2. Reducing fluid accumulation
   - Reduce volume
     - Sodium Restriction
     - Diuretics
   - Reduce portal HTN—relieve pressure build up
     - Transjugular Intrahepatic Portosystemic Shunt (TIPS)

3. Preventing fluid migration across the diaphragm
   - Repair of defects in tendinous portion of diaphragm
   - Pleurodesis

Roussos et al. 2007
Hepatic Hydrothorax: Role for Therapeutic Thoracentesis

Thoracentesis is mandatory in patients with suspected hepatic hydrothorax for two reasons:

1. To diagnose or exclude infection
2. To rule-out alternative etiologies of effusion

Roussos et al. 2007

Additionally, one can compare thoracentesis fluid to paracentesis fluid to strengthen the argument for peritoneal origin of fluid

Alberts et al. 1991
Companion Patient 3: Ultrasound Guided Thoracentesis of a Pleural Effusion

The dotted line illustrates a potential path that could be taken by a needle when performing a thoracentesis to drain a right sided pleural effusion. Findings and anatomical landmarks are labeled in the image.

Heffner, 2003
Our index patient: 
Pleural Fluid Analysis

1L of serosanguinous fluid was drained. It proved to be benign—there were no laboratory signs of SBEM, which was consistent with her clinical presentation.

<table>
<thead>
<tr>
<th>Component</th>
<th>Result</th>
</tr>
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<tbody>
<tr>
<td>WBC</td>
<td>115/ul</td>
</tr>
<tr>
<td>Total Protein</td>
<td>0.7g/dl</td>
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<tr>
<td>Glucose</td>
<td>110mg/dl</td>
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<tr>
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<td>No Growth</td>
</tr>
<tr>
<td>Anaerobic Culture</td>
<td>No Growth</td>
</tr>
<tr>
<td>Fungal Culture</td>
<td>No Growth</td>
</tr>
</tbody>
</table>
Our Index Patient:
Plain Films after Thoracentesis

Frontal and lateral plain films-- both PACS BIDMC

Continue to see annotated images...
Our Index Patient:
Frontal Plain Film after Thoracentesis

- Trachea now midline
- Heart borders now clearly visible
- Right and left hemidiaphragms now clearly visible
Our Index Patient:
Lateral Plain Film after Thoracentesis

- Trachea and both mainstem bronchi clearly visible
- Anterior and posterior heart borders well-defined
- Both hemidiaphragms are now visible without blunting of costophrenic angles
Hepatic Hydrothorax: Refractory pleural effusions

You have learned that pleural effusions in the setting of hepatic hydrothorax should be drained by thoracentesis, for both diagnostic and therapeutic reasons.

In some cases, effusions rapidly re-accumulate after thoracentesis. In such cases, one may be tempted to place a chest tube to allow continuous drainage of the effusion. However, chest tube placement is ill-advised, as you will see.
Refractory Pleural Effusions: Why not place a Chest Tube?

Chest tube placement can lead to protein loss, electrolyte abnormalities, and excess mortality

Retrospective cohort study of all patients with hepatic hydrothorax who had a chest tube placed:

- 17 patients, Mean MELD score of 14
  - 16 had at least one complication
  - 12 had more than one complication
  - Two deaths in hospital, four more within 3 months of discharge
- Most frequent complications were
  - Acute kidney injury (11/17)
  - Pneumothorax (9/17)
  - Empyema (5/17)

Runyon et al. 1986

Orman et al. 2009
Presentation Summary: Radiology Teaching Points

• You have learned that a plain film of the chest is the best initial radiologic study for workup of respiratory illness in adults, and that CT of the chest can also be appropriate in some situations.

• You have learned that CT and ultrasound can be helpful for estimating the size of a pleural effusion, and for guiding thoracenteses.

• You have reviewed a long differential diagnosis for complete white out of one hemithorax, and learned to group and organize these conditions based on whether they “push” or “pull” on the mediastinum.
Presentation Summary: Hepatic Hydrothorax Teaching Points

• You have learned the pathogenesis of hepatic hydrothorax, and seen the radiologic evidence for transdiaphragmatic migration of peritoneal fluid.

• You heard about Spontaneous Bacterial Empyema, an important potential complication of a pleural effusion in hepatic hydrothorax.

• You have reviewed the options for medical, radiologic, and surgical management of hepatic hydrothorax.
References


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