Pulmonary Thromboembolism: Diagnosis and Imaging
Goals for Presentation

- Learn why Pulmonary Embolism (PE) is a diagnostic juggernaut
- Learn an algorithm for radiologic evaluation of PE
- Learn advantages and disadvantages of each modality for evaluation of PE
- Use algorithm to work through an actual case
Pulmonary Embolism: Facts and Figures

- most often associated with DVT in popliteal, femoral, or iliac veins
- PE is the 3rd most common cause of death in Americans (when CV causes are separated)\(^1\)
- only 30% are diagnosed antemortem
- treated, mortality rate: 2.5%
- untreated, mortality rate: 18.5%

Image from:
A Diagnostic Nightmare
(and not just for 3rd years)

Clinical Presentation²:  
- Chest Pain (70%)
- Tachypnea (70%)
- Cough (40%)
- Tachycardia (33%)
- SOB (25%)
- Syncope (5%)

Differential Dx:  
- MI, CHF, Aortic Dissection, Acute Asthma, COPD, PTX, Pneumonia, Pericarditis, Myocarditis, MSK

Good luck honing your dx
Ingredients for a Proper Dx

- Clinical Suspicion
  - Signs and Sxs
  - Risk Factors
  - Lab Tests

IMAGING
Algorithm for PE evaluation

Clinical Suspicion of PE

CXR

Normal

Abnormal

V/Q scan

CT Angiography

Normal/Low Probability

High Probability

Intermediate Probability

Negative

Positive

Alternative Dx

Inconclusive

No PE

PE

Still Unsure?

Angiography

PE

No PE
Clinical Suspicion

- Signs and Symptoms: dyspnea, pleuritic chest pain, cough most common
- Risk Factors for hypercoagulability:
  - Inherited
  - Acquired and Persistent: Age, APA, CA, Obesity
  - Acquired and Transient: OCs, Surgery, Trauma
- Tests
  - ABGs: hypoxemia, Increased Aa Gradient
  - ECG: stereotypic S1Q1T3 pattern
  - D-dimer: high sensitivity/specificity not reproducible yet in clinical studies
Algorithm for PE evaluation

Clinical Suspicion of PE

- **CXR**
  - Normal
    - V/Q scan
      - Normal/Low Probability
        - No PE
      - High Probability
        - PE
      - Intermediate Probability
    - Abnormal
      - No PE
      - PE

- **CT Angiography**
  - Negative
    - Still Unsure? → Angiography
  - Positive
    - PE
  - Alternative Dx
    - No PE
  - Inconclusive

Alternative Dx
Westermark’s Sign: Relative Oligemia (~10%/97%)\(^1\)

Hampton’s Hump: Wedge-Shaped Radioopacity (22%/82%)\(^1\)

Other findings:
- Cardiomegaly (in 27% of PE)
- Pleural Effusion (23%)
- Elevated Hemidiaphragm (20%)
- Pulmonary Artery Large (19%)

Adv: Eliminate other diagnoses

Disadv: Not sufficiently sensitive

Image from: [http://80-content.nejm.org.ezp2.harvard.edu/content/vol345/issue18/images/large/05f1.jpeg](http://80-content.nejm.org.ezp2.harvard.edu/content/vol345/issue18/images/large/05f1.jpeg)
Algorithm for PE evaluation

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Intermediate Probability

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No PE

Inconclusive

No PE

PE
V/Q Scan

Normal

High Probability of PE

## V/Q Scan: Scoring

<table>
<thead>
<tr>
<th>Normal (&lt;5%)</th>
<th>Low (&lt;19%)</th>
<th>Intermediate (20-80%)</th>
<th>High (&gt;80%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Normal Q</td>
<td>• Small Q defects</td>
<td>• 1-3 moderate mismatched Q defects</td>
<td></td>
</tr>
<tr>
<td>• 9% of PE are normal</td>
<td>• Nonsegemental Q defects</td>
<td>• Single large mismatched Q defect</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Diffuse matched V &amp; Q defects c nl CXR</td>
<td>• &gt;2 large segmental mismatched Q defects (V and CXR nl)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 41% sens, 97% spec</td>
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</table>
V/Q Scan: Advantages & Disadvantages

Advantages: High specificity at high probability; easy to read

Disadvantages: Not sensitive, even at high probability; no other dxs tested; 45 min long
Algorithm for PE evaluation

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CT Angiography

Sensitivity: 88-100%
Specificity: 75-97%

Advantages: Speed; r/o other processes; often done incidentally; less expensive than V/Q

Disadvantages: poor at visualizing subsegmental PE (5% of total)

Algorithm for PE evaluation

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- CXR
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  - Abnormal

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CT Angiography
- Negative
  - Still Unsure?
  - PE
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- Inconclusive

Angiography
Pulmonary Angiography: The Gold Standard

Advantages: Gold Standard for diagnosis; Interventional Pulmonary Embolectomy

Disadvantages: Long; Invasive; $$$; limited availability

Patient C.I.

• C.I. is a 36 y.o. male who was airlifted to the BIDMC following a head-on MVA with a stationary pole.

• He sustained multiple left-sided rib fractures with lung contusion, fractures of the maxillary sinus, bilateral orbital fractures, and potential fractures of the ethmoid sinuses.

• On HD#6, he experienced acute hypotension—SBP in the 60s—and his oxygen sats dropped to 50% (on 100% O2). After neosynephrine was administered, a CXR was obtained.
Portable CXR, AP View

Possible Westermark’s Sign

Left pleural effusion
CT Angiography

Image Courtesy of Dr. Elvira Lang, BIDMC, Boston, MA
CT Angiography

Image Courtesy of Dr. Elvira Lang, BIDMC, Boston, MA
CTA Reconstruction

Image Courtesy of Dr. Elvira Lang, BIDMC, Boston, MA
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- PE
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PE
Conventional Angio: RL, Early Arterial Phase
Conventional Angio: RL, Middle Arterial Phase
Conventional Angio: RL, Venous Phase
Conventional Angio: LL, Late Arterial Phase

Image Courtesy of Dr. Elvira Lang, BIDMC, Boston, MA
Conventional Angio: LL, Venous Phase
A Percutaneous Pulmonary Thrombectomy was then performed.

• Guidewire to site of blockage.
• Telescope guiding catheter over the guidewire.
• Telescope suction catheter over the guiding catheter.
• Advance the suction catheter over the guiding catheter to the clot.
• Apply suction by attaching a 30mL syringe to the guiding catheter and suck it out.
Angio: RL, Post-Embolectomy

Before

After

Image Courtesy of Dr. Elvira Lang, BIDMC, Boston, MA
Angio: Post-Embolectomy
CXR, AP: 7 Hours post-Embolectomy

Return of vessel shadows in right middle and upper lobes

Left lower lobe partial collapse, evidenced by focal opacity of the left lower lobe region and deviation of the mediastinum to the left
Two months later

Images Courtesy of Dr. Elvira Lang, BIDMC, Boston, MA
Conclusions

• Diagnosis of PE is not easily done clinically, even with the help of biochemical tests

• “Failure to be diagnosed is the greatest threat to patients with PE.”¹

• Utilization of CXR, V/Q scan, CT Angiography, and Conventional Angiography are extremely helpful in diagnosis

• Burn the algorithm into your cerebri
References


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