Pulmonary Embolism: Diagnosis and Treatment

W. B. Davis
No Disclosures
A negative D-dimer can exclude PE in low risk patients?

1. True

2. False
Which of the following would you not use as sole initial therapy in PE?

1. IV unfractionated heparin
2. Rivaroxaban
3. Warfarin
4. Enoxaparin
5. Fondaparinux
What is best treatment duration for PE provoked by surgery?

1. 3 months
2. 6 months
3. 12 months
4. lifetime
Pulmonary Embolism

- Common
- Often fatal
- Rapid diagnosis and treatment greatly reduce mortality
PE is the great mimic of other pulmonary diseases

- Sudden death
- Inferior MI
- Acute asthma
- Heart failure
- Radiographic paralyzed hemidiaphragm
- Hemoptysis suggestive of bronchiectasis, lung cancer or lung hemorrhage syndrome
- Atelectasis
- Pneumonia, uni- or multilobar
- Malignant pleural effusion
- Large rounded mass suggestive of lung cancer
- Long term dyspnea suggestive of COPD
- Primary pulmonary hypertension
Prevalence of Pulmonary Embolism in Acute Exacerbations of COPD*
A Systematic Review and Metaanalysis

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Background: Nearly 30% of all exacerbations of COPD do not have a clear etiology. Acute pulmonary embolism (PE) can exacerbate respiratory symptoms such as dyspnea and chest pain. COPD patients are at a high risk for PE due to a variety of factors including limited mobility, age, and comorbidities, the prevalence of PE during exacerbations is uncertain.

Aims: A systematic review of the literature was performed to determine the prevalence of PE in acute exacerbations of COPD in patients who did and did not require hospitalization. The literature search was performed using MEDLINE, CINAHL, and EMBASE supplemented by hand searches of bibliographies. Only cross-sectional or prospective studies were included.
Signs and Symptoms Not Helpful in Diagnosis

- Dyspnea
- Pleuritic chest pain
- Cough
- Hemoptysis
- Tachypnea
- Rales
- Tachycardia
- $S_4$
- Loud $S_2P$
- Shock
Wells Prediction Score

Canadian (Wells) prediction score

Variable and score
- DVT symptoms and signs — 3.0
- PE as likely as or more likely than alternative diagnosis — 3.0†
- Heart rate >100 beats/min — 1.5
- Immobilization or surgery in previous 4 wk — 1.5
- Previous DVT or PE — 1.5
- Hemoptysis — 1.0
- Cancer — 1.0

Total score:
- <2.0 — low pretest probability
- 2.0 to 6.0 — moderate pretest probability
- >6.0 — high pretest probability

Dichotomized Wells score:
- ≤4 — PE unlikely
- >4 — PE likely
ABG’s

• Hypoxemia and respiratory alkalosis
ABG’s

- Hypoxemia and respiratory alkalosis
- $pO_2$ 60  $pCO_2$ 32  pH 7.49
ABG’s

- Hypoxemia and respiratory alkalosis
- Can have normal pO$_2$
ABG’s

• Hypoxemia and respiratory alkalosis
• Can have normal $pO_2$
• Can have normal A-a DO$_2$
ABG’s

- Hypoxemia and respiratory alkalosis
- Can have normal pO$_2$
- Can have normal A-a DO$_2$
- Not helpful in diagnosis
BNP and Troponin

• Lack sensitivity/specificity for PE
BNP and Troponin

- Lack sensitivity/specificity for PE
- ↑ BNP or ↑ Troponin are associated with increased mortality
Sinus Tachycardia
S1Q3T3

- S-waves in lead I
- Q-waves in lead III
- Inverted T-waves in lead III

ems12lead.com
EKG

- **Common**
  - Sinus tachycardia
  - NSSTT wave changes

- **Massive PE**
  - Precordial T wave inv.
  - Atrial arrhythmias
  - RBBB
  - $S_1Q_3T_3$
Right Diaphragm Elevation
Pleural Effusion
Hampton’s Hump (Pulmonary Infarct)
Chest X-ray

• May be normal
Chest X-ray

- May be normal
- Usually abnormal in course of PE
Chest X-ray

- May be normal
- Usually abnormal in course of PE
- Not diagnostic
Chest X-ray

- May be normal
- Usually abnormal in course of PE
- Not diagnostic
- Alerts physician to need for definitive tests
D-dimer
D-dimer

- Degradation product of cross-linked fibrin
- Elevated in DVT/PE
- Elevated in non-thrombotic conditions like infection, malignancy, DIC, etc
D-dimer

• What is probability of obtaining a negative D-dimer test if DVT/PE is not present?
D-dimer

• A negative D-dimer test can be very powerful
D-dimer

• A negative D-dimer test can be very powerful

• Can be a “stand alone” test in excluding PE in patients with low pretest probability
A negative D-dimer can exclude PE in low-risk patients?

1. True

2. False
V/Q Scan
V/Q Scan

- Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED)
V/Q Scan

- Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED)
- Diagnostic accuracy greatest when V/Q scan combined with clinical probability
**PIOPED – Incidence of PE (%)**

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<th>Low clin prob</th>
<th>Int clin prob</th>
<th>High clin prob</th>
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<td>High prob VQ</td>
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</table>

PIOPED, *JAMA* 1990; 263:2753
V/Q Scan

- High clinical probability with high-probability V/Q scan – 95% likelihood
- Low clinical probability and low-probability V/Q scan had only 4% likelihood
- Normal V/Q scan excludes PE
CT angiogram

- High sensitivity and specificity
- Readily available
- Safe
- Rapid
- Often diagnoses other entities
- Technology is improving
CTA vs V/Q in PE: JAMA 298:2743-2753, 2007; 1400 patients

- CTA diagnoses more patients with PE (19.2%)
  - Sensitivity = 94.1%
  - Specificity = 93.6%
  - Positive PV = 95.5%
  - Negative PV = 96.2%
  - 1.4 to 31.8 mSv radiation from 64 slice detector, causing breast cancer in 1/143 20 year old women

- V/Q diagnoses fewer patients with PE (14%)
  - Sensitivity = 80.8%
  - Specificity = 73.8%
  - Positive PV = 95.5%
  - Negative PV = 75.9%
  - 0.28 to 0.9 mSv radiation from V/Q scans but a higher overall radiation in pregnancy to the fetus
When to use V/Q scan?

- CT angio not available
- Morbid obesity
- Kidney disease
- Contrast allergy
- Marked discordance between clinical probability and CT angio results
PE Algorithm

Determine if "PE unlikely" or "PE likely"

PE unlikely
- D-dimer assay
  - <500 ng/mL: PE excluded
  - >500 ng/mL: Spiral CT pulmonary angiogram (CT-PA)

PE likely
- Spiral CT pulmonary angiogram (CT-PA)
  - Negative: PE excluded
  - Positive: PE confirmed
Algorithm if CT Angio not available

- Well’s criteria (low, intermediate, high)
- D-dimer
- V/Q scan
- If answer unclear, pulmonary angiogram or serial leg ultrasound
• Patient has hypotension or shock
Cardiac Echo

- Patient has hypotension or shock
- CT angio shows bilateral PE
Right Ventricular Dilatation
Cardiac Echo in Massive PE

- ↑ size of RA or RV
- ↓ RV function
- Tricuspid regurgitation
- RV thrombus
Which of the following would you not use as sole initial therapy in PE?

1. IV unfractionated heparin
2. Rivaroxaban
3. Warfarin
4. Enoxaparin
5. Fondaparinux
Case 1

- 30 yo AAF
- 6 weeks of progressive SOB
- Worsening SOB on day she came to ED
- Pain in right medial thigh
- Not on OCP’s, no recent surgeries
Case 1

- Resting heart rate 128
- No hypoxemia, BP is normal
- Troponin I 0.02 ng/ml
- BNP 187 pg/ml
- D-dimer not done
- Bedside cardiac echo shows RV dilatation
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Dichotomized Wells score:

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A CT angiogram was performed
In addition, the CT shows extensive DVT in right leg. What would you do?

1. Exoxaparin 1mg/kg Q12 hours
2. Unfractionated heparin by IV protocol
3. Place IVC filter
4. Lytic therapy
5. CT surgery consult
6. Strict bed rest
ACCP Guideline 5.6.1.1

In patients with acute PE associated with hypotension (e.g. systolic BP < 90), who do not have a high bleeding risk, we suggest systemically administered thrombolytic therapy over no such therapy (Grade 2 C).
In most patients with acute PE not associated with hypotension, we recommend against systemically administered thrombolytic therapy (Grade 1C).
In selected patients with acute PE not associated with hypotension and with a low bleeding risk whose initial clinical presentation, or clinical course after starting anticoagulant therapy, suggests a high risk of developing hypotension, we suggest administration of thrombolytic Rx (Grade 2 C)
Thrombolytic Therapy

- Accelerates the lysis of acute emboli
- Decreases PA pressures
- Improves RV function
- No clinical trial has been large enough to conclusively demonstrate an improvement in mortality
Family history is positive for multiple relatives dying with PE. What would you do now?

1. Screen for thrombophilia
2. Screen for occult cancer
3. Anticoagulate for 6-12 months
4. Place a vena cava filter
5. Anticoagulate for life
Other Therapies for Massive PE

1. Catheter directed thrombolysis
2. Surgical embolectomy
Catheter Directed Thrombolysis
Other Therapies for Massive PE

1. Catheter directed thrombolysis

2. Surgical embolectomy
Case 2

- 67 yo WF came to ED with chest pain
- Pulse 120, RR 30, 100/78
- $O_2$ sat 87% on RA
- Ultrasound shows large DVT right leg
- Bedside echo shows dilated RV
Case 2

- Pt. is on clopidogrel 75 mg per day since stroke 2 years ago
What would you do next?

1. Lytic therapy with TPA
2. IV heparin by protocol
3. IVC filter
4. Stop clopidogrel
5. IV heparin + IVC filter
She was transferred to the MICU, heparin was initiated and a vena cava filter was inserted

- Clopidogrel was stopped
- Initiation of warfarin was delayed in favor of prolonged therapeutic anticoagulation with unfractionated heparin
- She was kept at strict bedrest
- By the second ICU day her heart rate was 85, blood pressure was 130/80 mm Hg and room air arterial saturation was 94%
What is best treatment duration for PE provoked by surgery?

1. 3 months
2. 6 months
3. 12 months
4. lifetime
ACCP Guideline 6.1

In patients with PE provoked by surgery, we recommend treatment with anticoagulation for 3 months over treatment of shorter duration, treatment of longer period (6-12 months), or extended therapy (Grade 1B).
Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines