

Dilemmas In Pulmonary Medicine

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Diagnosis of Pulmonary Embolism

An Evidence-based Approach

24 year old female G₁P₀ @ 34 weeks. Progressive lower extremity edema for several weeks. Shortness of breath for 2 days. No chest pain or cough.

Exam: HR 112, RR 16, BP 100/70, SaO₂ = 94%

Calves swollen and tender, lungs clear, no murmur

CXR: small lung fields. EKG: sinus tachycardia

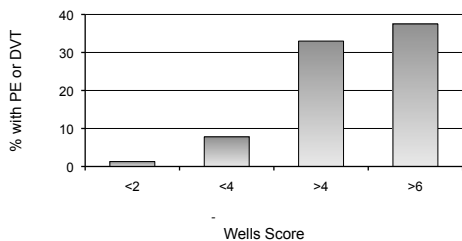
- What is the likelihood of a pulmonary embolus?
 - A. Low
 - B. High
- What test should be ordered next?
 - A. D-dimer
 - B. CT pulmonary angiogram
 - C. Ventilation-perfusion scan
 - D. Surface echocardiogram

Pulmonary Embolism Clinical Probability Assessment

Wells Criteria:	Points
- Signs or Sx of DVT (swelling, pain)	3
- Alternative Dx less likely	3
- HR > 100	1.5
- Immobilization or surgery in prior 4 wks	1.5
- Previous VTE	1.5
- Hemoptysis	1
- Malignancy	1

Wells PS. Thromb Haemost. 2000;83:416-20

Wells Criteria Prediction of PE or DVT



Wells PS. Thromb Haemost. 2000;83:416-20

Pulmonary Embolism Clinical Probability Assessment

- | | |
|--|-----------------------------------|
| • 24 year old female | • HR 112, RR 16, BP 100/70 |
| • G1P0 @ 34 weeks | • SaO ₂ = 94% (Denver) |
| • Uncomplicated pregnancy | • Calves swollen. Not tender |
| • Lower extremity edema for several weeks. Now worse | • Lungs clear, heart normal |
| • Shortness of breath x 2 days | • CXR |
| • Dry cough. No pleurisy | - Small lung fields |
| | - Basilar atelectasis |
| | • ABG normal |

Wells Score = 4.5

- Signs & sx of PE (3 points)
- HR > 100 (1 point)

CT angiography (CTA) Pros and Cons

Advantages:

- Direct visualization of emboli
 - Gives estimation of clot burden
- Evaluation of alternative diagnoses
 - CT scan will yield alternative dx in up to 1/3 of patients*
- Quick

Disadvantages:

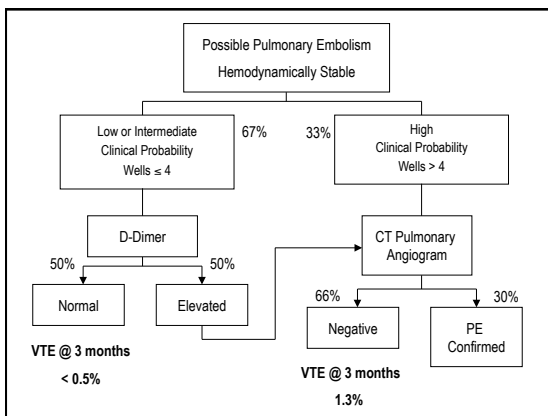
- Patient needs to be able to lie flat and hold his/her breath
- Reader expertise required
- Contraindicated in renal failure
- Expensive
 - Up to 25% of patients will have an incidental finding that requires follow-up*

CTAs ordered in the emergency department are more than twice as likely to find an incidental pulmonary nodule or adenopathy than a PE.

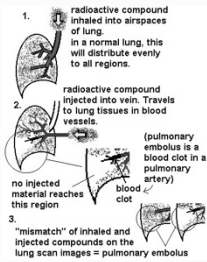
Effectiveness of a Multi-step Algorithm Christopher Study Investigators

- Prospective cohort study
- Evaluated 3306 patients in 12 centers in the Netherlands
- Studied the effectiveness of managing suspected PE with a simple algorithm:
 1. Clinical probability (modified Wells score)
 2. D-dimer
 3. Multidetector CT scan
- Patients were followed for 3 months after initial testing

JAMA 2006;295:173



Ventilation Perfusion Scan (VQ Scan)



- Useful in patients with renal dysfunction
- Used where CT scan is not available
- Less accurate in patients with cardiopulmonary disease
- Compared to CT, VQ delivers lower radiation dose to mother but higher dose to fetus. CT preferred in pregnancy

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Acute Exacerbations of COPD

Focus on Underlying Cause

65 year old female with severe COPD brought to ED with 2 days of worsening dyspnea, wheezing

- Dry, non-productive cough. No fever. No sick contacts
- Pulmonary hypertension, spiculated lung mass
- Moderate distress, HR 122, SaO₂ 85%, wheezing
- CXR - hyperinflated but otherwise clear
- Steroids, bronchodilators given

What is the next best step?

- A. Obtain sputum sample, start ampicillin/sulbactam IV
- B. Check a D-dimer
- C. CT scan to look for PE (assume renal function ok)
- D. Check a BNP level to rule out congestive heart failure

Pulmonary Embolism in Patients with Unexplained Exacerbation of COPD

- Prospective single center study
- Evaluated 211 consecutive patients with acute COPD exacerbations of unknown origin
- Inclusion criteria - hospitalization
- Exclusion criteria
 - Fever
 - Increased sputum volume or purulence
 - Recent rhinorrhea or sore throat
- Evaluation
 - CTA, lower extremity dopplers
 - clinical probability assessment

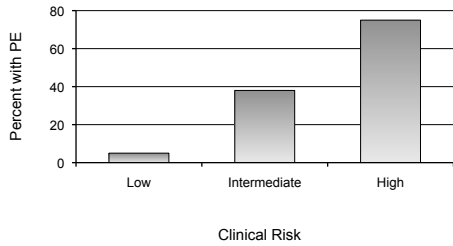
Tillie-Leblond. *Ann Int Med.* 2006;144:390-396

Pulmonary Embolism in Patients with Unexplained Exacerbation of COPD

- Pulmonary embolism present in 25% of patients
- Risk factors
 - Severity of COPD
 - History of malignancy
 - Previous history of DVT or PE
- Decrease in PaCO₂ from baseline present in 25%
- 55% of those with PE also had positive LE dopplers

Tillie-Leblond. *Ann Int Med.* 2006;144:390-396

Clinical Probability Scoring Predicts PE



Tillie-Leblond. Ann Int Med. 2006;144:390-396

PE and COPD Exacerbations Additional Pearls

- 25% prevalence of PE in unexplained exacerbations of COPD has been verified by 2 other studies
- D-dimer levels are not influenced by COPD
- B-type natriuretic peptide (BNP) levels are elevated with right ventricular dysfunction
- Troponin elevation is significantly associated with RV dysfunction

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Non-Invasive Ventilation

Indications and Use

65 year old female with COPD. Brought to ED by family. Minimally responsive. Head CT and tox screen negative. CXR shows RLL infiltrate. Poor air movement. PaCO₂ = 95. SaO₂ 92% on 8L

What is the next best step?

- A. Rapid sequence intubation
- B. CPAP (8cm H₂O pressure)
- C. Bilevel (IPAP 10, EPAP 5)

Noninvasive Positive Pressure Ventilation

NIPPV

- Continuous positive airway pressure (CPAP)
- Bi-level (BIPAP)
- Ventilatory assistance with controlled FIO₂ through a tight fitting mask (nasal or face)
- Most effective with alert, oriented and cooperative patient
- Successful in hypoxemic and hypercapnic failure (CHF and COPD exacerbations)

Noninvasive Positive Pressure Ventilation
Goals of Care

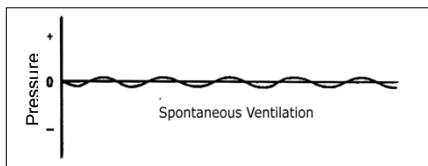
- Decrease work of breathing
- Improve oxygenation (PaO_2)
- Improve ventilation (PaCO_2)

Noninvasive Positive Pressure Ventilation
Interfaces

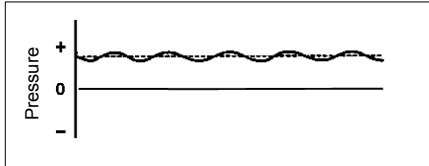
- Partial face mask
- Nasal mask
- Full face mask



Modes of Ventilation
Point of Reference - spontaneous respiration



Modes of Ventilation
CPAP



No machine-assisted breaths provided
Patient regulates respiratory rate and tidal volume

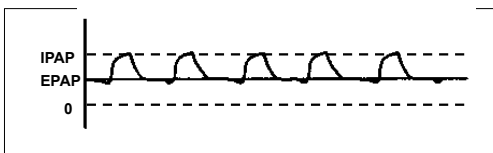
Modes of Ventilation
CPAP

- Improves oxygenation
- Can improve atelectasis
- Great for CHF - pushes fluid out of the alveolus
 - Reduces the need for intubation
 - May reduce mortality (10% vs 16% for control)
- Start with CPAP 6-8 mmHg, FiO2 100%
 - Titrate to patient comfort and oxygen saturation

Gray et al. N Engl J Med 2008; 359:142

Modes of Ventilation
Bilevel

- Biphasic pressure support
- Inspiratory pressure (IPAP) during inhalation
- Expiratory pressure (EPAP) during exhalation
- Flow triggered



Modes of Ventilation
Bilevel - Setting up the machine

Start with low pressures to allow patient to adjust to the machine

- IPAP 8 cm H₂O
- EPAP 4 cm H₂O
- FiO₂ 100%

Titrate IPAP and EPAP upward incrementally

Goal is to reduce work of breathing and improve O₂, CO₂

- Bedside assessment is most important

Time intensive. Requires 20-30 mins at the bedside

Can dial in backup respiratory rate and minute ventilation

NIPPV
COPD Exacerbations

- Highest quality data comes from pts that have hypercapnic respiratory failure
- NIPPV decreases:
 - Mortality (11% vs 21% for standard care)
 - Intubation rate (16% vs 33%)
- Can be given as a brief trial for patients with CO₂ narcosis
- Bilevel preferred over CPAP
 - Adjust EPAP to minimize air trapping

NIPPV
Cardiogenic Pulmonary Edema

- Best data are with CPAP (vs Bilevel) and in patients with co-existing hypercarbia
 - Clear reduction in rates of intubation, hospital LOS
 - May reduce mortality
- Contraindicated for patients with cardiogenic shock, acute MI
- Brief trial is generally sufficient (will know if it is going to work in under 10 minutes)

NIPPV

Use in other scenarios

- Acute hypoxemic respiratory failure
 - Failure rates > 60%
 - Worth a try if there is a quickly reversible cause
 - Secretions often a problem in patients that have pneumonia
- Immunocompromised patients
 - Decreased mortality, intubation rates, ICU length of stay
 - Putative mechanism is reduced rates of secondary infection (i.e. VAP)
- Asthma exacerbations - no data to support NIPPV

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Key Concepts

1. Clinical probability drives decision making in diagnosing pulmonary embolism.
2. A low clinical probability coupled with negative D-dimer effectively rules out PE. A high clinical probability or positive D-Dimer requires further testing.
3. Pulmonary embolism should be ruled out as a cause of COPD exacerbations if no infectious symptoms are present.
4. Non-invasive ventilation should be used as an initial therapy for hemodynamically stable patients with respiratory failure from CHF and COPD.
