Pulmonary Embolism

Pathophysiology	• A thrombus in another area of the body **embolizes to the pulmonary vasculature via the RV and PA**. • Blood flow distal to the embolus is obstructed, causing **increased PVR, PA pressure, and RV pressure**. If severe, acute **cor pulmonale** can occur. • Blood flow decreases in some areas, **dead space** is created where there is **ventilation but no perfusion**. • **Hypoxemia and hypercarbia** occur and drive **tachypnea**. If dead space is large, signs are more overt (SOB). PE and DVT are on a continuum.

Pulmonary Embolism (cont)

Source	• Most PE arise from **thromboses of deep veins** of lower extremities above the knee (iliofemoral DVT). • Can also arise from deep veins of pelvis. • Calf vein thrombi have a low incidence of embolizing to the lungs, but they can progress into the proximal veins and increase the risk of PE. • Upper extremity DVT is rare (seen in IVDU). • **Fat emboli** from long bone fractures, amniotic fluid emboli during or after delivery, air emboli (trauma, lines), septic emboli (IVDU), schistosomiasis.
Sympotms	• Not a reliable indicator of the presence of PE. • **Dyspnea (73%), cough (37%), pleuritic chest pain (65%), hemoptysis (13%)**. • Only 1/3 of patients will have signs and symptoms of a DVT. • Syncope seen in large PE.

Pulmonary Embolism (cont)

Signs	• **Tachypnea** (70%), rales (51%), **tachycardia** (30%), S4 (24%), increased P2 (23%). • Shock with rapid circulatory collapse in massive PE. • Others include low-grade fever, decreased breath sounds, and dullness on percussion.
Risk Factors for DVT and PE.	• Age>60, **malignancy**, prior history, hereditary, **hyper coagulable states**, prolonged immobilization, cardiac disease (esp. CHF). obesity, **nephrotic syndrome**, major surgery (esp. pelvic or orthopedic), major trauma, pregnancy, and estrogen use.

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Pulmonary Embolism (cont)

Prognosis	• PE is usually clinically silent. • Recurrences are common, which can lead to **chronic pulmonary HTN and chronic cor pulmonale**. • When undiagnosed, mortality approaches 30%. • When PE is diagnosed, mortality is 10% in first 60 minutes. Of those who survive initial event, 30% will die of recurrent PE if untreated. • Most are recurrent in the first few hours. • Treatment with **anticoagulation** decreases mortality to 2-8%.
Diagnosis	• If suspected PE, stabilize with **IVF and O2**. {{nl}• }If PE is likely, **start anticoagulation before diagnostic tests**. • If PE is unlikely, get testing first. • If the patient has contraindications to anticoagulation, get testing first and then **consider IVC filter**.

Testing

D-Dimer	• **Specific fibrin degradation product** whose levels can be elevated in PE or DVT. • Sensitive (90-98%). • If results are normal and clinical suspicion is low, PE is very unlikely. • **Specificity is low**, as it can be **elevated in MI, CHF, pneumonia, and postop**. • Any cause of clot or increased bleeding can elevate D-Dimer.

Testing (cont)

Venous Duplex Ultrasound	• If positive, **treat with IV heparin**. • False positives will lead to anticoagulation in patients without PE. • If negative, the test is of very little value and the patient may still have a PE (up to 50% of patients with PE).
Echocardiogram	• **Acute massive PE** is accompanied by **RV dilation and failure due to RV outflow obstruction and increased PVR**. • The **dilated RV pushes the septum towards the LV**, causing further **decrease in LV preload and CO**. • This shows up as **dilated RV cavity and hypokinesis of the RV free wall** with sparing of the apex (**McConnell's sign**).
Helical CT	• **>90% sensitivity and good specificity**. • Can visualize very small clots (>2mm). Can miss clots in small sub segmental vessels. • **Test of choice**. • If negative and high clinical probability of PE, there is a 5% incidence of PE. • Contraindicated in patients with renal insufficiency because of **IV contrast**.

Testing (cont)

CXR	• Usually normal. **Atelectasis or pleural effusion** may be present. • Mainly useful to exclude competing diagnoses. • Hampton's hump or Westermark's sign are rarely present
V/Q Scan	• Important when there is a contraindication to helical CT. • Results can either be normal, low-probability, intermediate-probability, or high-probability. • A normal V/Q scan rules out PE and no further testing is needed. • A high probability scan is **very sensitive for PE** and indicates treatment with heparin. • If low or intermediate probability, clinical suspicion determines next step. • If high, pulmonary angiography is indicated.
Arterial Blood Gas	• Not diagnostic. • **PaO2 and PaCO2 are low** (latter due to hyperventilation) and **pH is high**. • **Typically respiratory alkalosis**. • **The A-a gradient is usually elevated**. A normal A-a gradient makes PE less likely but does not exclude it.

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Testing (cont)

Pulmonary Angiography	• **Gold standard**. Definitively diagnoses or excludes PE. • But the test is invasive. **Contrast is injected into the PE branch after percutaneous catherization of the femoral vein**. • Consider when noninvasive testing is equivocal and risk of anticoagulation is high, or if the patient is unstable and embolectomy may be required. Rarely performed due to 0.5% mortality.
Rules Out PE	Normal or low-probability V/Q scan or helical scan and low clinical suspicion, negative pulmonary angiogram (definite), and negative D-Dimer with low suspicion
Wells Criteria	Symptoms and signs of DVT (3 points), alternative diagnosis less likely than PE (3 points), HR>100 (1.5 points), immobilization >3 days or surgery in last 4wks (1.5 points), previous DVT or PE (1.5 points), hemoptysis (1 point) and malignancy (1 point). If >4, PE is likely.

Testing (cont)

Indications for Treatment	intraluminal defects in central, segmental or lobular PAs on helical CT (or high probability with a scan) and clinical suspicion, DVT diagnosed with clinical suspicion, and positive pulmonary angiogram (definitively proves PE).

Treatment

Oxygen Therapy	• To correct **hypoxemia**. • Severe hypoxemia or respiratory failure requires intubation and mechanical ventilation.
Heparin	• Either unfractionated or LMWH (enoxaparin) to prevent recurrence. • Prevents further clot formation but **does not lyse existing emboli or diminish thrombus size**. • Start immediately based clinical suspicion. Do not wait for studies if high. • Give one bolus, followed by infusion for 5-10days. • Goal aPTT of 1.5-2.5x normal. • Acts by **promoting antithrombin III**. • Contraindications include active bleeding, uncontrolled HTN, recent stroke, and HIT. • LMWH has less complications but NOT used in ESRD.

Treatment (cont)

Warfarin	• For long-term treatment. **Can start with heparin on day 1**. • Goal INR is 2-3. Continue for 3-6 months depending on risk factors. • Some patients with significant risk for recurrence (malignancy, hyper coagulable state) should receive lifelong therapy.
Thrombolytic Therapy	• Streptokinase, TPA. • **Speed up lysis of clots**. • Does not improve mortality rates. • Should be considered for use in patients with **massive PE** who are **unstable**, and patients with **evidence of RHF.**
IVC Filter	• Have not been proven to reduce mortality. • Patients are at a higher risk of recurrent DVT but lower risk of recurrent PE. • Complications include filter migration or misplacement, filter erosion and perforation of IVC, and IVC obstruction due to filter thrombosis. • Indicated for patients with contraindications to anticoagulation, complication of current anticoagulation, failure of adequate anticoagulation evidence by recurrence, and low pulmonary reserve (high risk of death due to PE).

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Treatment (cont)

NOACs	Fondaparinox is an injectable factor Xa inhibitor. Rivaroxaban is an oral factor Xa inhibitor. Neither can be used in severe CKD (GFR<30). Epixaban is approved for use in CKD.

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