Deep Venous Thrombosis and Pulmonary Embolism (VTE)

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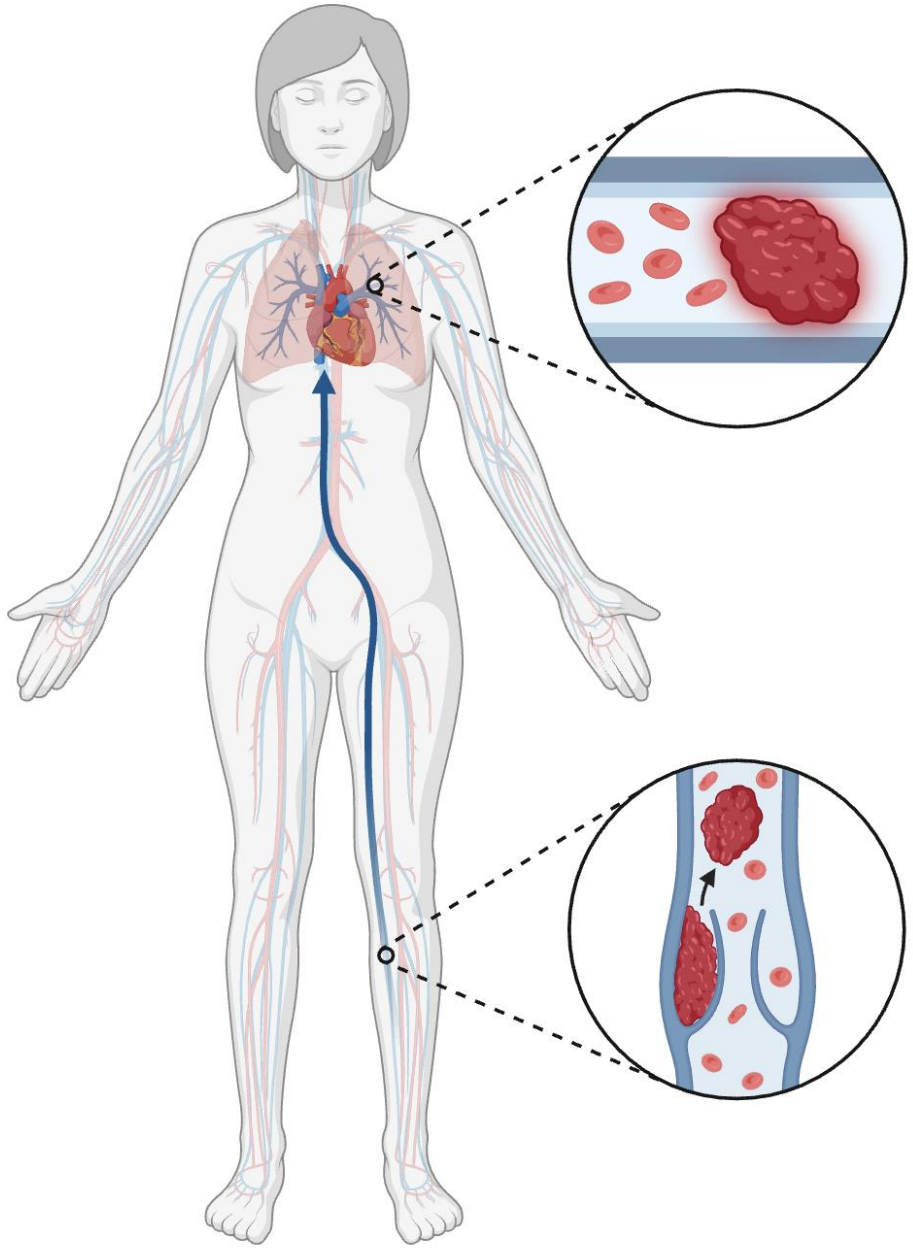


Learning Objectives

1. Define and classify DVT and PE.
2. Recognize risk factors for DVT and PE.
3. Identify common signs/symptoms associated with DVT and PE.
4. Determine the pretest probability of pulmonary embolism using Wells' criteria.
5. Select the most suitable diagnostic test for pulmonary embolism based on the patient's VTE risk profile and individual clinical characteristics.
6. Describe treatment considerations and options for VTE.
7. Understand the factors that go into decision-making regarding duration of anticoagulation for VTE.

Pre-test Question 1

1. How do we evaluate a patient's pretest probability for pulmonary embolism?

    1. Virchow's score
    2. Well's criteria
    3. Count the number of risk factors for a PE
    4. All of the above

Pre-test Question 2

1. What is a long term complication of VTE?

    1. Post-thrombotic syndrome
    2. Recurrence of VTE
    3. Bleeding events on anticoagulation
    4. CTEPH (chronic thromboembolic pulmonary hypertension)
    5. All of the above

Outline

- Definition
- Epidemiology
- Presentation
- Pathogenesis
- Diagnosis
- Treatment

- Clinical Interest
- Cases

Case #1

Mrs. S
Age: 32
Background: Sarah is a healthy elementary school teacher with no significant past medical history, except for being on oral contraceptive pills (OCPs) for the past six years. She recently returned from a 9-hour international flight and noticed mild swelling and discomfort in her right calf the next day.

Presentation:
Sarah visits her primary care physician complaining of a dull ache in her right calf that has worsened over the past two days. She also notices mild swelling and warmth, but denies chest pain, shortness of breath, or dizziness.

Vitals:
BP 118/72, HR 88, RR 16, SpO2 99% on room air

Case #2

Mr. M
Age: 65
Background: Michael is a retired accountant who was recently diagnosed with non-small cell lung cancer (NSCLC) Stage IIIA two months ago. He has started chemotherapy but has been feeling increasingly fatigued. He has a history of hypertension. Over the past few days, he has noticed a gradual onset of shortness of breath but initially attributed it to chemotherapy side effects as his oncologist told him this would occur with the anemia that develops from treatment.

Presentation:
Michael presents to the emergency department after experiencing worsening dyspnea with mild exertion and a sudden episode of dizziness while walking to the bathroom. He denies leg swelling but admits to occasional mild calf discomfort.

Vitals:
BP 105/60, HR 115, RR 24, SpO2 91%

Case #3

Mr. J
Age: 58
Background: John is a construction worker with a history of HTN, obesity, and a recent knee replacement surgery two weeks ago. He has been relatively immobile since the surgery, spending long hours resting in bed.

Presentation:
John is rushed to the emergency department by EMS after suddenly collapsing at home while trying to get out of bed. His wife reports that earlier in the day, he had been complaining of sharp chest pain, worsening shortness of breath, and lightheadedness. Upon arrival, he is pale, diaphoretic, and barely responsive.

Vitals:
BP 78/45, HR 128, RR 32, SpO2 82% via NRB

Clinical Interest/Importance

Every healthcare professional will encounter patients affected by VTE

The clinical presentation of VTE can be highly variable and is often nonspecific, which complicates and underscores the importance of making an accurate diagnosis

Significant morbidity and mortality associated with VTE

Epidemiology-United States

~1 million patients affected by VTE yearly	• Accounts for ~100,000 deaths in the USA yearly. • Sudden death is the first symptom in about 25% of patients with PE.
Leading cause of preventable hospital death	• >1/3 of VTE cases are related to recent hospitalization and most of these occur following discharge. • 70% of cases of healthcare-associated VTE are preventable!
1/5 cases of VTE are related to cancer	• Among patients with cancer, survival rates are lower for those with VTE.
Women are five times more likely to experience a VTE during pregnancy, childbirth, or the 3-month period after delivery	• PE is one of the most common causes of pregnancy-related death in the United States.
1/3 of patients with a VTE will have a recurrence within 10yrs	

Prevalence of DVT in Africa

- Systematic review
- 21 studies
- Prevalence of DVT
  - 2.4-9.6% post-operative patients
  - 380-448/100,000 births/year pregnant and post-partum patients (0.5%)
- Prevalence of PE 0.14-61.5%, mortality rate 40-61.5%
- 32-75% of patients were at risk of VTE and as low as 34% received VTE prophylaxis

Danwang C et al. Epidemiology of venous thromboembolism in Africa: a systematic review. J Thromb Haemost 2017; 15: 1770–81.

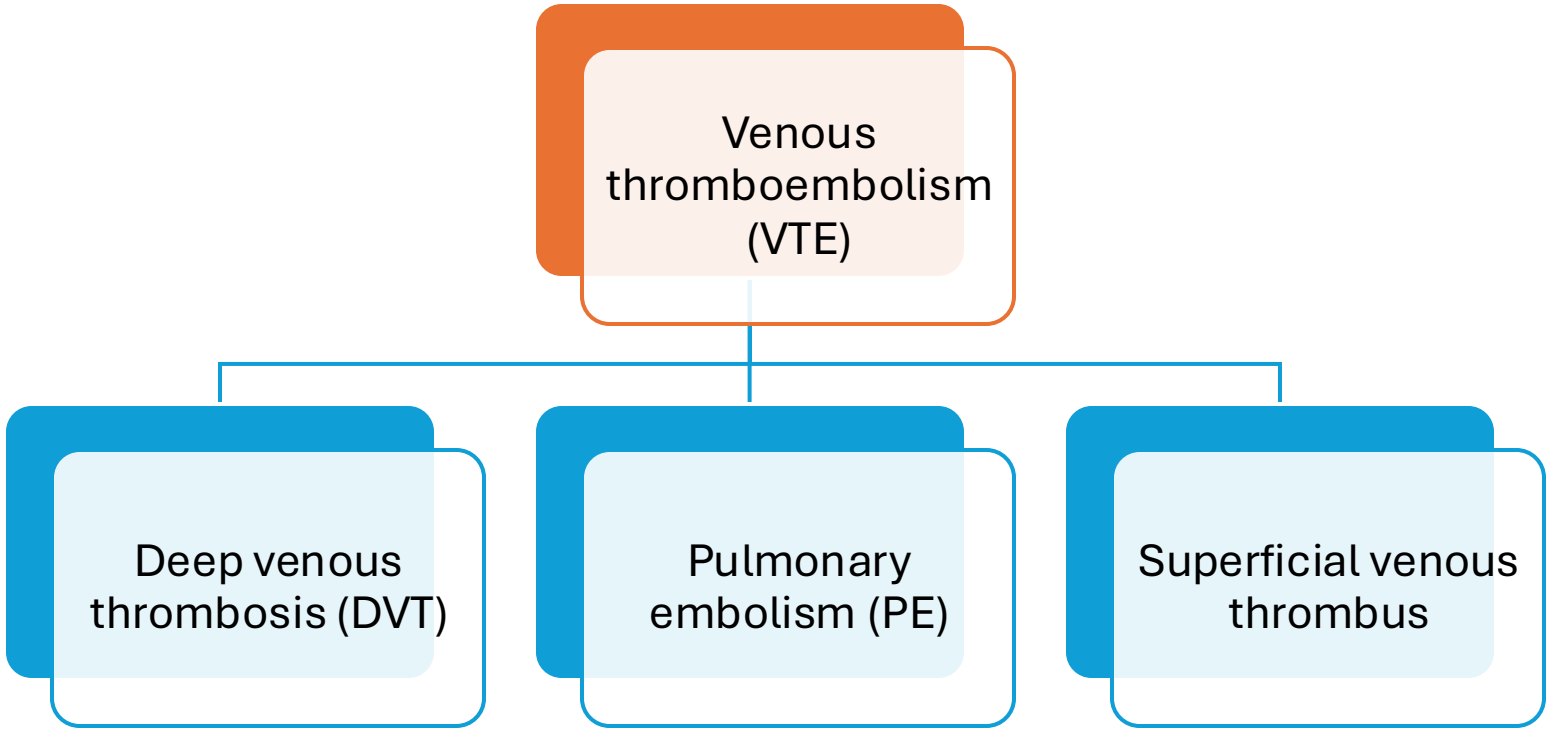
Prevalence of DVT in Zambia

- Descriptive, cross-sectional study of 296 patients
- Admitted for at least 7 days
- Lower extremity compression ultrasound to evaluate for DVT
- 85% asymptomatic

Variable	DVT (n = 33)	No DVT (n=263)	P
Age, years, mean (SD)	42.1 (12.7)	42.0 (16.8)	0.98
Male, n (%)	15 (45.5)	125 (47.5)	0.82
BMI, mean (SD)	18.73 (4.0)	20.6 (4.7)	0.03
Total days of immobility, mean (SD)	24.0 (12.8)	21.8 (11.9)	0.33
HIV+, n (%)	23 (69.7)	150 (57.0)	0.16
Haemoglobin, g/dL, mean (SD)	8.6 (8.1)	9.4 (3.5)	0.44
Platelet count, mean (SD)	197 (17)	231 (137)	0.17
Primary Diagnosis	20 (60.6)	83 (31.6)	0.002
Tuberculosis	6 (18.1)	45 (17.1)	0.88
Heart failure	2 (6.0)	21 (8.0)	0.70
Renal failure			

Mwandama et al. Prevalence of DVT, Zambia. Medical Journal of Zambia, Vol. 43 (4): 224 - 230 (2016).

Definition


Venous thromboembolism (VTE)
Deep venous thrombosis (DVT)
Pulmonary embolism (PE)
Superficial venous thrombus

Definition

DVT

- Thrombus forms in a deep vein, usually in the legs or pelvis.
- Generally form in lower extremity vein, but can happen in upper extremity and neck veins especially in setting of IV catheters.

PE

- Obstruction of the pulmonary artery or one of its branches by any material (eg, thrombus, tumor, air, or fat) that originated elsewhere in the body.
- Bland thrombus is by far the most commonly embolized material.

Definition

Temporal association

- Acute
- Subacute
- Chronic

Clinical stability

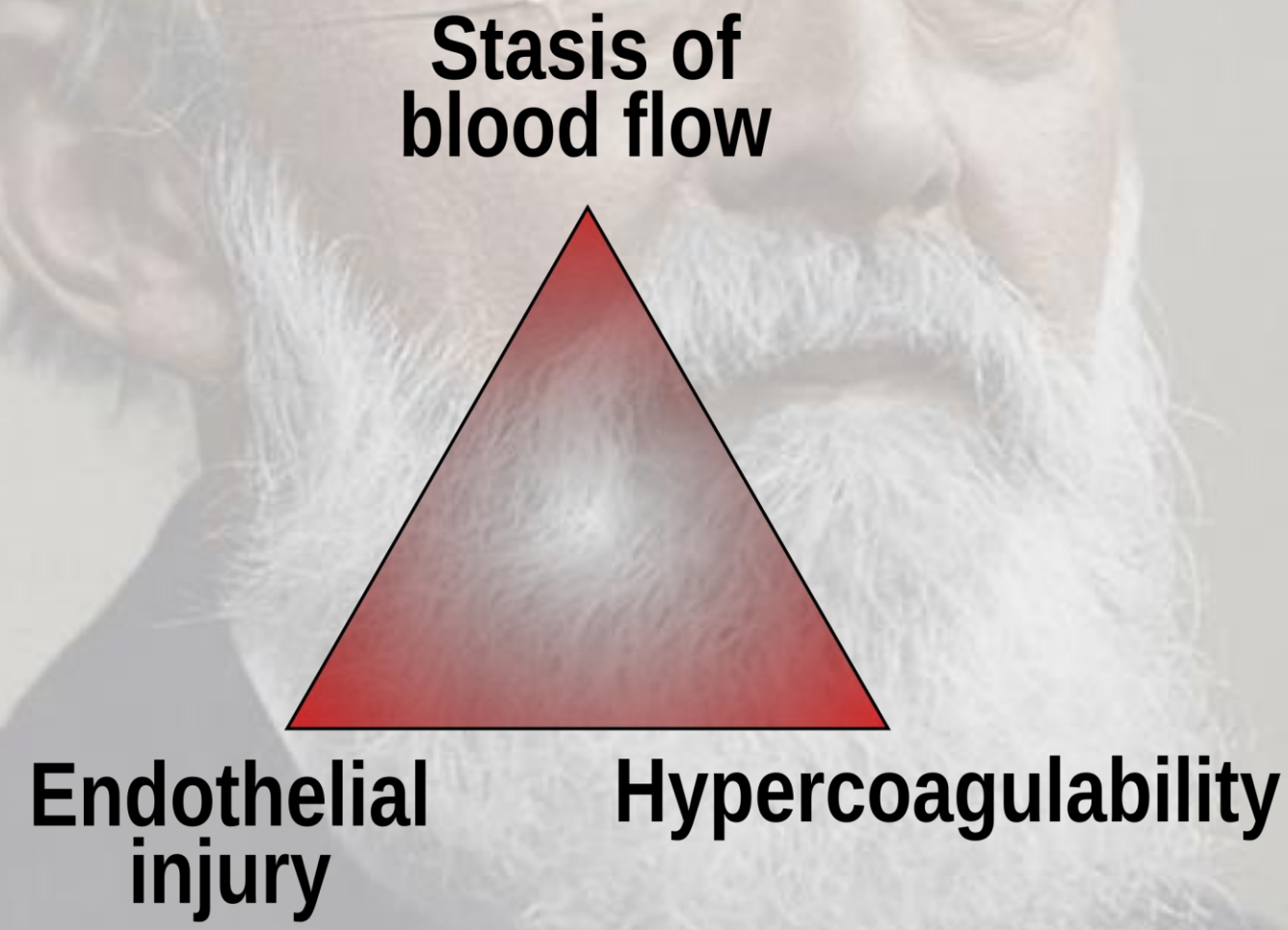
- Hemodynamically stable:
  - Low risk – hemodynamically stable with no right heart strain
  - Submassive – hemodynamically stable but with signs of right heart strain
- Hemodynamically unstable: Previously referred to as massive PE (with hypotension defined as SBP <90mmHg)

Anatomic location

- Saddle (ie. thrombus that crosses between the right and left main pulmonary arteries)
- Lobar
- Segmental
- Subsegmental

Pathogenesis

Virchow's Triad



Pathogenesis

Virchow's Triad

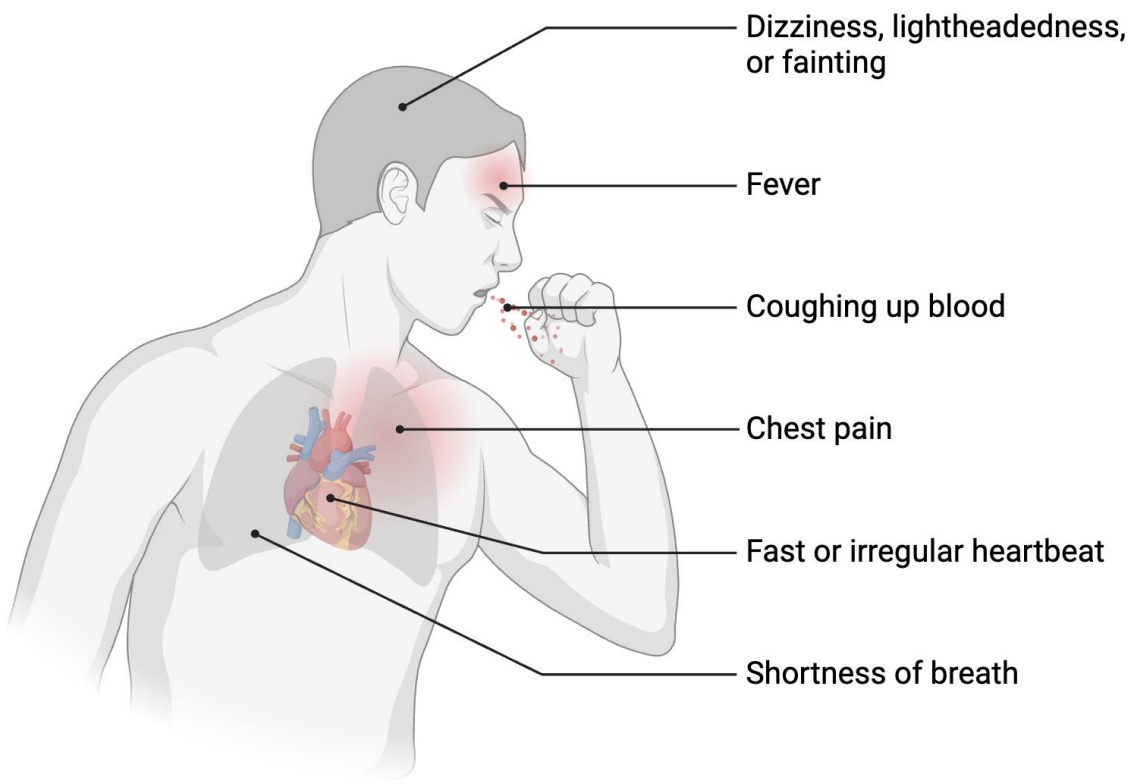
Endothelial injury	Stasis of flow	Hypercoagulability
• Ischemia • Drugs • Chemotherapy • Radiation therapy	• Vascular compression/infiltration by tumor/mass • Endoluminal tumor growth • Blood hyperviscosity (eg. erythrocytosis or leukocytosis) • Portal venous hypertension • Dehydration • Prolonged immobility • Older age	• Acquired factors • Hereditary factors

Pathogenesis

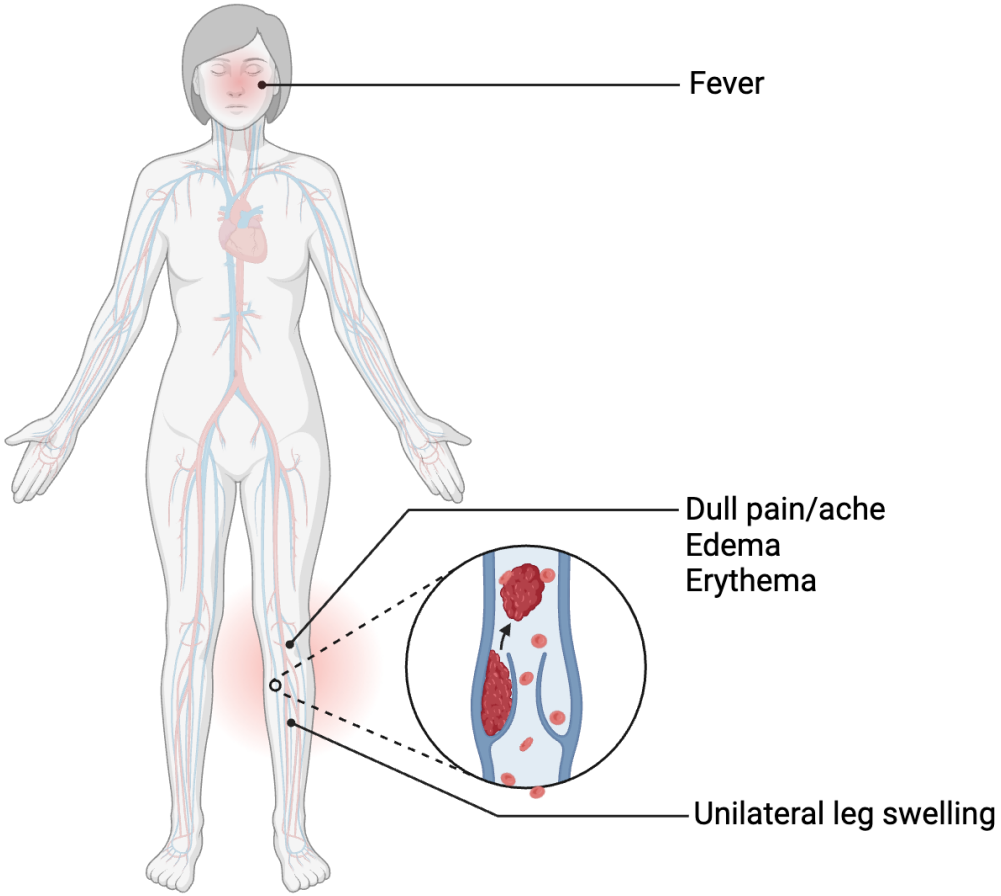
Acquired Risk Factors	Inherited Risk Factors
Immobilization (eg. prolonged bed rest, long travel)	Factor V Leiden mutation
Recent surgery (especially orthopedic, abdominal, or pelvic)	Prothrombin gene mutation (G20210A)
Cancer (especially metastatic and hematologic malignancies)	Antithrombin III deficiency
Pregnancy and postpartum period	Protein C deficiency
Hormone therapy (eg. oral contraceptives, HRT)	Protein S deficiency
Obesity	Dysfibrinogenemia
Smoking	High levels of Factor VIII
Trauma (especially fractures of the pelvis or lower extremities)	Hyperhomocysteinemia
Heart failure	
Nephrotic syndrome	

Clinical Presentation

Symptoms of Pulmonary Embolism



Symptoms of Deep Venous Thrombosis



Clinical Presentation

	DVT	PE
Symptoms	**Unilateral leg swelling** – Often gradual onset, but can be sudden	**Dyspnea (typically sudden-onset)** – Most common symptom
	Pain – Dull, aching, or cramping, usually in the calf or thigh	**Pleuritic chest pain** – Sharp, worse with inspiration
	Erythema – Mild redness or warmth over the affected area	**Hemoptysis** – Uncommon but suggests pulmonary infarction
	Tenderness – Especially along the deep venous system (calf, popliteal fossa, thigh)	**Cough**
	Homan's sign – Calf pain with dorsiflexion of the foot (historical, not reliable)	**Palpitations**
Signs	**Asymmetric leg edema** – Measured calf circumference >3 cm difference	**Tachypnea**
	Dilated superficial veins – Due to venous congestion	**Tachycardia** – Most common physical exam finding
	Low-grade fever – Can be present but nonspecific	**Hypoxia** – Not always present!
		Hypotension – Suggests massive PE with right heart strain
		Jugular venous distension (JVD) – Right ventricular dysfunction
		Unilateral lower extremity swelling – If associated DVT is present

Diagnosis

The diagnostic process should begin with an evaluation of the pretest probability for pulmonary embolism, which then guides the selection of further appropriate tests.

Traditionally, this assessment has been performed using the Wells' criteria for pulmonary embolism.

Clinical Symptom/sign	Points
Clinical symptoms of DVT (e.g. leg swelling, pain with palpation)	3
Other diagnosis less likely than pulmonary embolism	3
Heart rate > 100	1.5
Immobilization (≥ 3 days) or surgery in previous four weeks	1.5
Prior DVT/PE	1.5
Hemoptysis	1.0
Active malignancy (treated in the last 6mos)	1.0

Risk	0-1 = low 2-6 = moderate >6 = high

Diagnosis

- EKG
- CXR
- D-dimer
- Lower extremity ultrasound (US)
- CT Angiogram
- Ventilation-Perfusion (V/Q) scan
- Pulmonary arteriography
- Echocardiogram

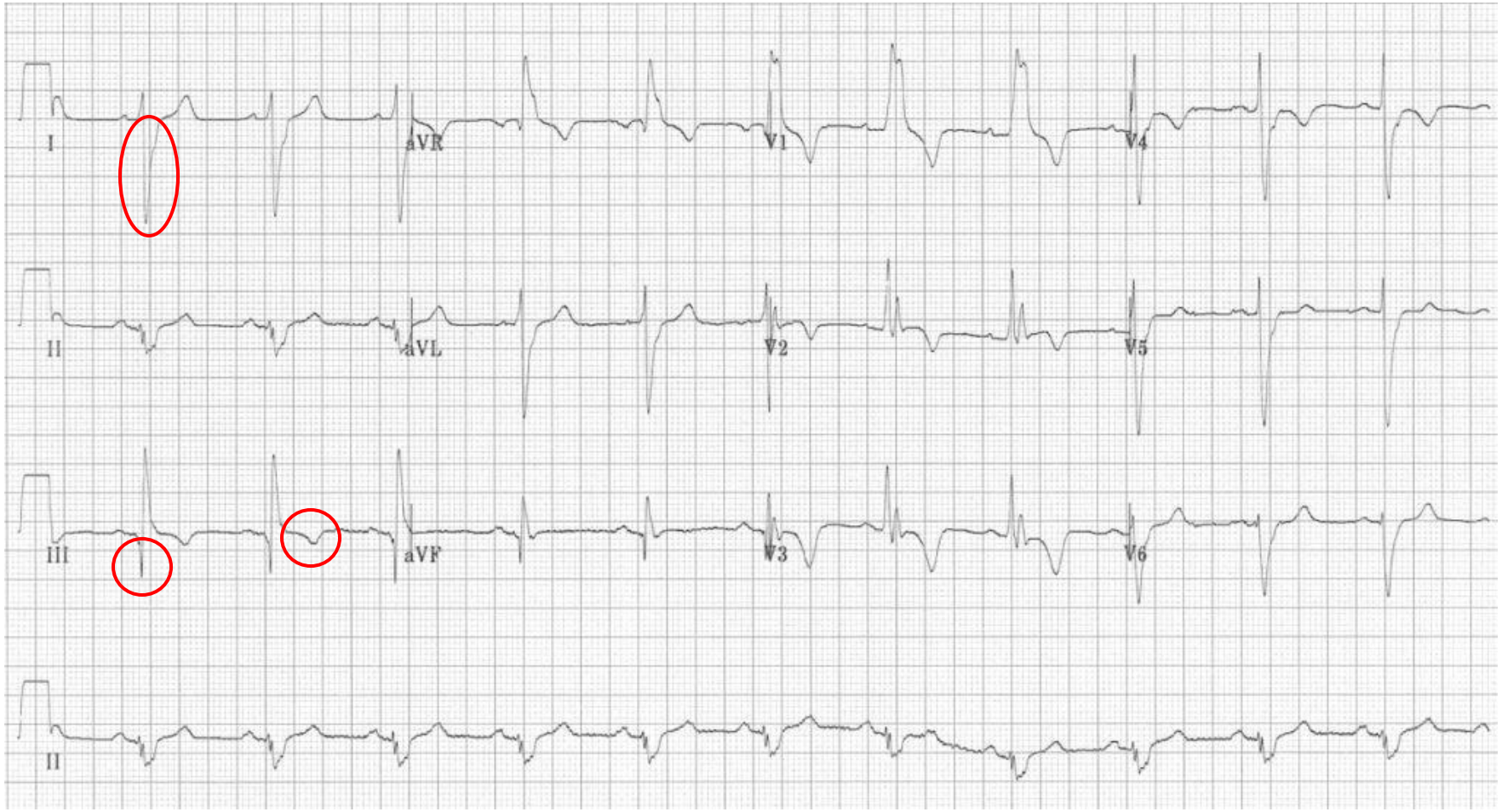
Diagnosis

EKG

- **Sinus tachycardia** – the most common abnormality (seen in ~50% of patients with PE)
- **Complete or incomplete RBBB** (18%)
- **Right ventricular strain pattern** – T wave inversions in the right precordial leads (V1-4) ± the inferior leads (II, III, aVF)
- **Right axis deviation** (16%)
- **Dominant R wave in V1** – a manifestation of acute right ventricular dilatation
- **Right atrial enlargement** (P pulmonale) – peaked P wave in lead II > 2.5 mm in height (9%)
- **S1Q3T3 pattern** – deep S wave in lead I, Q wave in III, inverted T wave in III (20%)
  - This "classic" finding is neither sensitive nor specific for PE.
- **Atrial tachyarrhythmias** – AF, AFL, atrial tachycardia (8%)
- **Non-specific ST segment and T wave changes** – including ST elevation and depression

Diagnosis

EKG – S1Q3T3

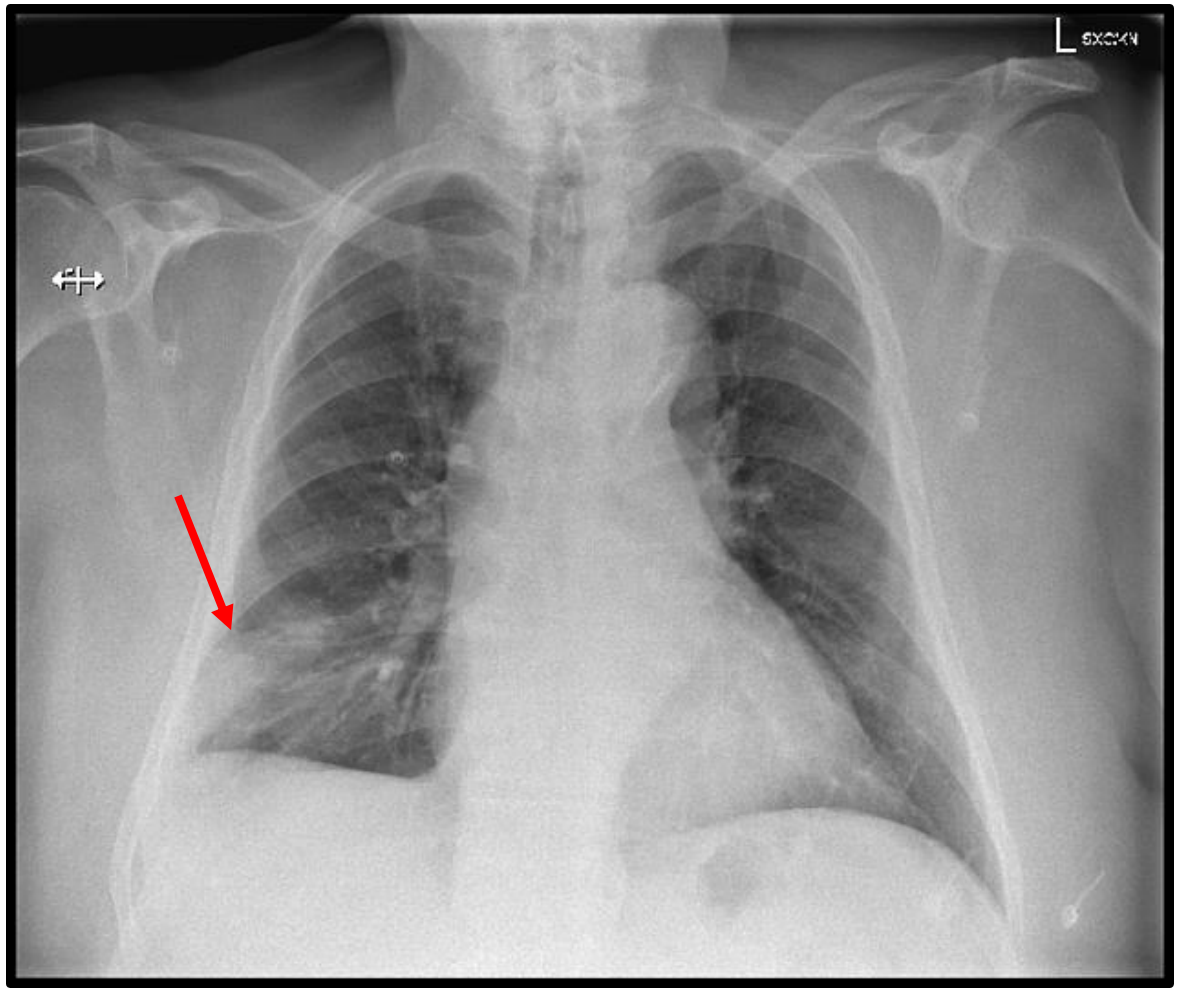


Diagnosis

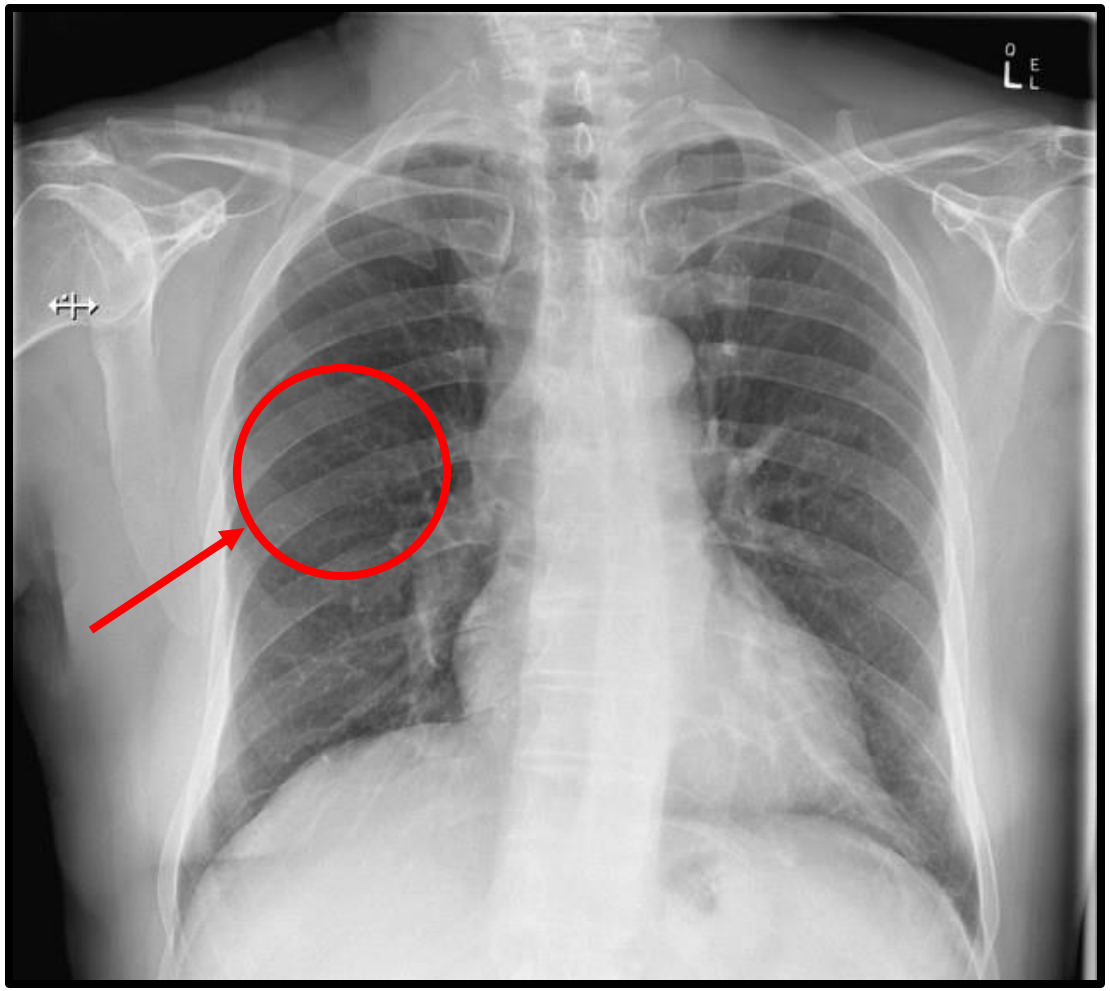
CXR

- Generally clear
- Findings otherwise may demonstrate:
  - Atelectasis
  - Pleural effusion
  - Decreased pulmonary vascularity
- Westermark's sign (focal oligemia)
- Hamptons hump (wedge shaped consolidation in periphery)

Diagnosis



Hampton's hump - dome-shaped, pleural-based opacification in the lung most commonly due to pulmonary embolism and lung infarction



Westermark's sign - focal peripheral hyperlucency secondary to oligemia resulting in a collapsed appearance of vessels distal to the occlusion

Diagnosis

D-dimer

- Fibrin degradation product that is formed when cross-linked fibrin is broken down by plasmin, serving as a marker of ongoing coagulation and fibrinolysis.
- D-dimer levels are primarily used as a *rule-out* test in patients with low pretest probability for VTE due to their high sensitivity but low specificity.
- A positive value does not confirm VTE and would require further testing.
- Should not be obtained in a patient with high probability of pulmonary embolism.

Case #1

Sarah
Currently taking OCPs
Recent prolonged travel on international flight
Experiencing right calf discomfort/pain & edema

Wells' score = 4.5 (intermediate probability of VTE)

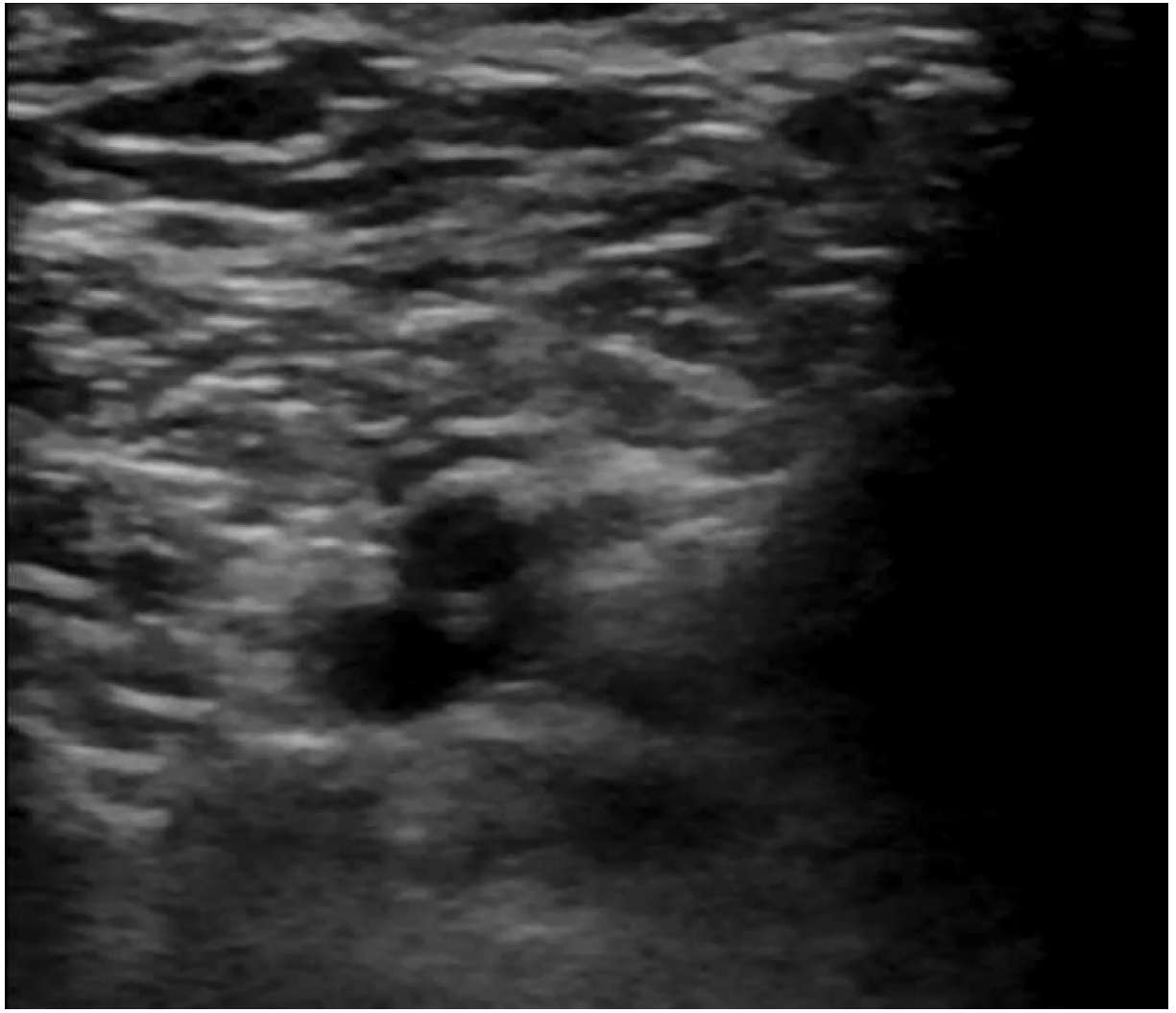
D-dimer = 6,000 (LLN <500)

Additional testing is necessary!

Diagnosis

Duplex ultrasonography

- Non-invasive imaging modality
  - Provides anatomical imaging of lower extremity veins along with doppler ultrasonography, which assesses blood flow
- Highly sensitive test (~95%) for detecting DVT
  - Lack of vein compressibility is a highly reliable sign of thrombosis
  - Color doppler flow demonstrates absent or diminished flow in the presence of a thrombus
- Valuable tool for initiating treatment, particularly when additional testing is not feasible or is unnecessary
- Does not detect PE

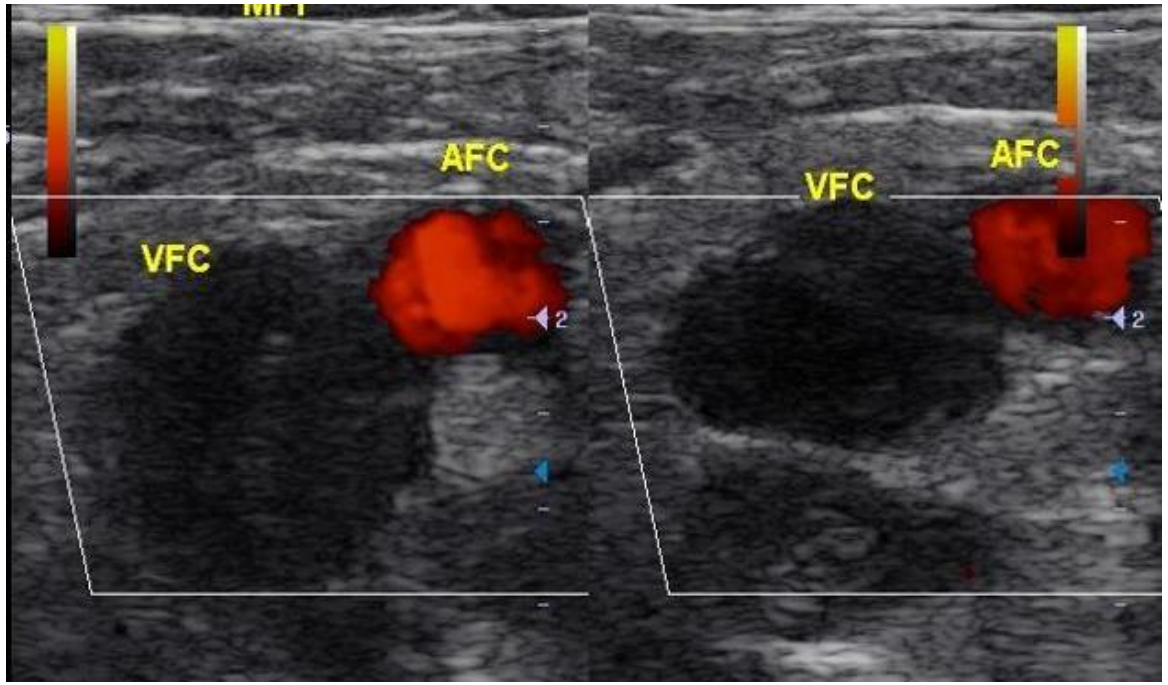


Normal Exam

Diagnosis

Duplex ultrasonography

- Non-invasive imaging modality
  - Provides anatomical imaging of lower extremity veins along with doppler ultrasonography, which assesses blood flow
- Highly sensitive test (~95%) for detecting DVT
  - Lack of vein compressibility is a highly reliable sign of thrombosis
  - Color doppler flow demonstrates absent or diminished flow in the presence of a thrombus
- Valuable tool for initiating treatment, particularly when additional testing is not feasible or is unnecessary
- Does <u>not</u> detect PE



Rest Compression

Case #1

Sarah

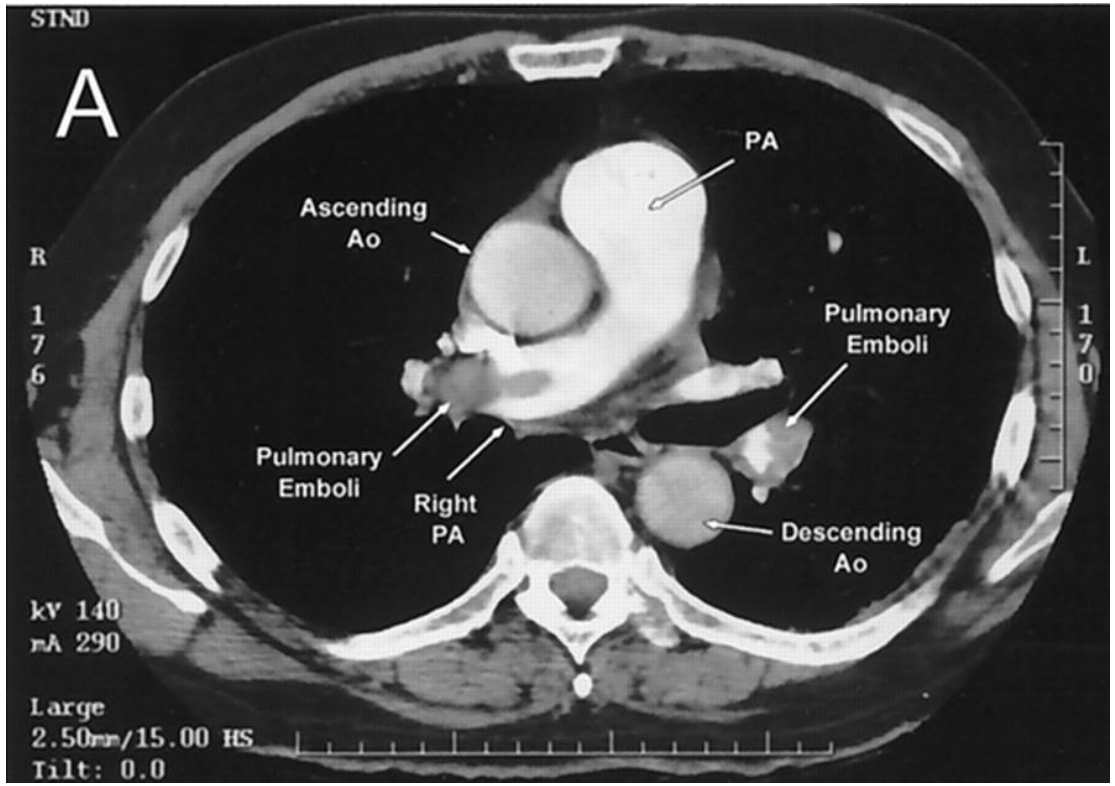
Duplex US is positive for DVT in the R common femoral vein. Her PCP discusses the risks/benefits of starting her on an oral anticoagulant to take at home along with instructions to discontinue her OCP in the interim. She is discharged from clinic. Two months later, she comes back for an interval check up and is doing well without any continued symptoms.

Diagnosis

CT angiography

- <u>CTA is considered the gold standard imaging modality for diagnosing PE</u>
  - High sensitivity (90-95%) and specificity (95-98%)
- Thrombus appears as a filling defect within contrast-filled vessels

- **Benefits**
  - Rapid availability in most healthcare settings
  - Identifies alternative causes of symptoms:
    - Pneumonia, pulmonary edema, etc
  - Provides comprehensive chest imaging in a single scan
- **Limitations of CTA**
  - Radiation exposure (caution in pregnancy & young patients)
  - Contrast-induced kidney injury risk (especially in renal impairment or contrast allergy)
  - Not feasible for unstable patients due to imaging constraints



Case #2

Michael
Recently diagnosed lung cancer.
Developed dyspnea and dizziness when ambulating to bathroom today.

Wells' score = 5.5 (intermediate probability of VTE)

Best test of choice is CTA.

Diagnosis

CT angiography

Case #2

Michael
CTA was positive for a left mainstem PE. He was advised to be admitted to the hospital and was started on an IV Heparin gtt and monitored for 48hrs. Vital signs were improving and he reported less dyspnea and was discharged on an oral anticoagulant home at this time.

Case #2

Michael
Recently diagnosed lung cancer.
Has stage IV chronic kidney disease.
Developed dyspnea and dizziness when ambulating to bathroom today.

Wells' score = 5.5 (intermediate probability of VTE)

Best test of choice is VQ scan.

Diagnosis

VQ scan

- Nuclear medicine study assessing ventilation (airflow) and perfusion (blood flow) – mismatches indicative of PE
- Useful when CTA is contraindicated (e.g., contrast allergy, renal insufficiency, pregnancy)

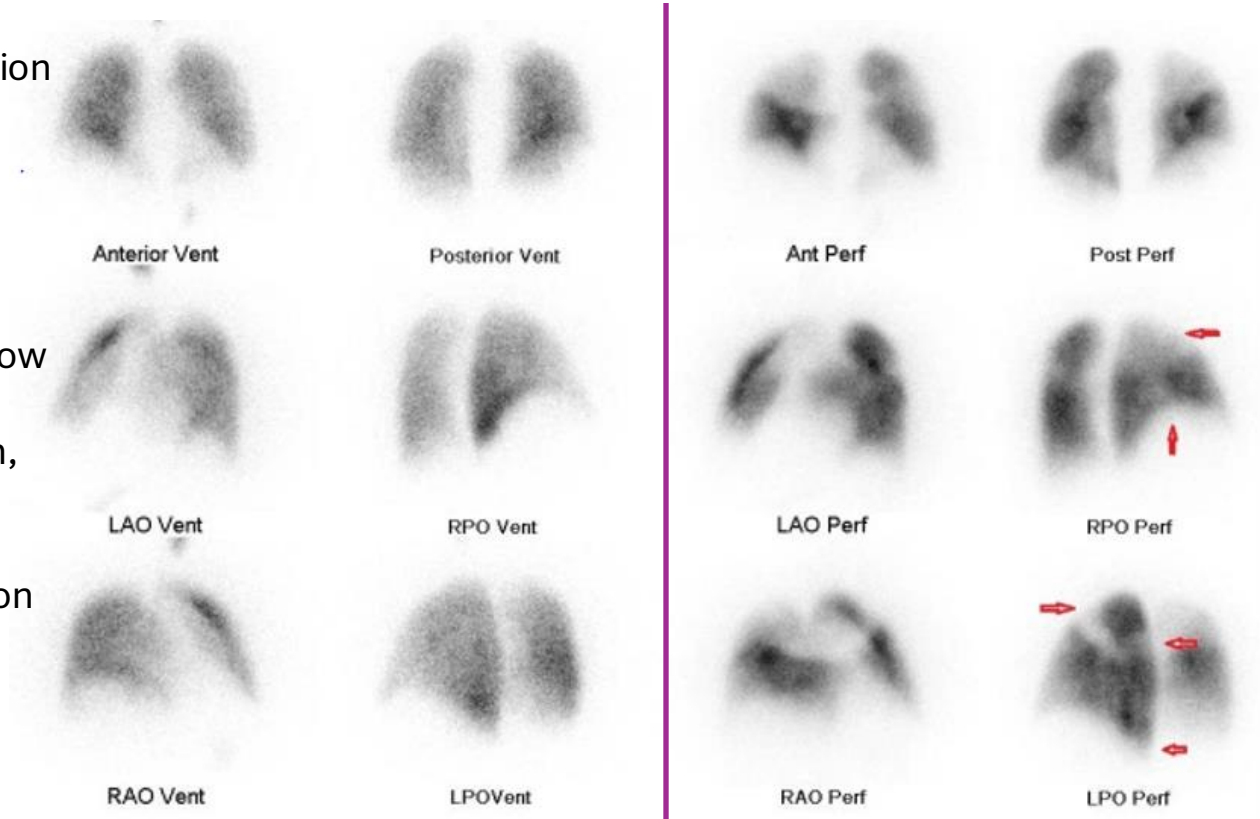
Phases of a V/Q Scan

- Ventilation phase: Patient inhales a radioactive gas, mapping airflow distribution
- Perfusion phase: IV injection of Tc-99m macroaggregated albumin, mapping pulmonary blood flow

- PE diagnosis = perfusion defect without a corresponding ventilation defect (V/Q mismatch)
- Matched defects suggest alternative diagnoses

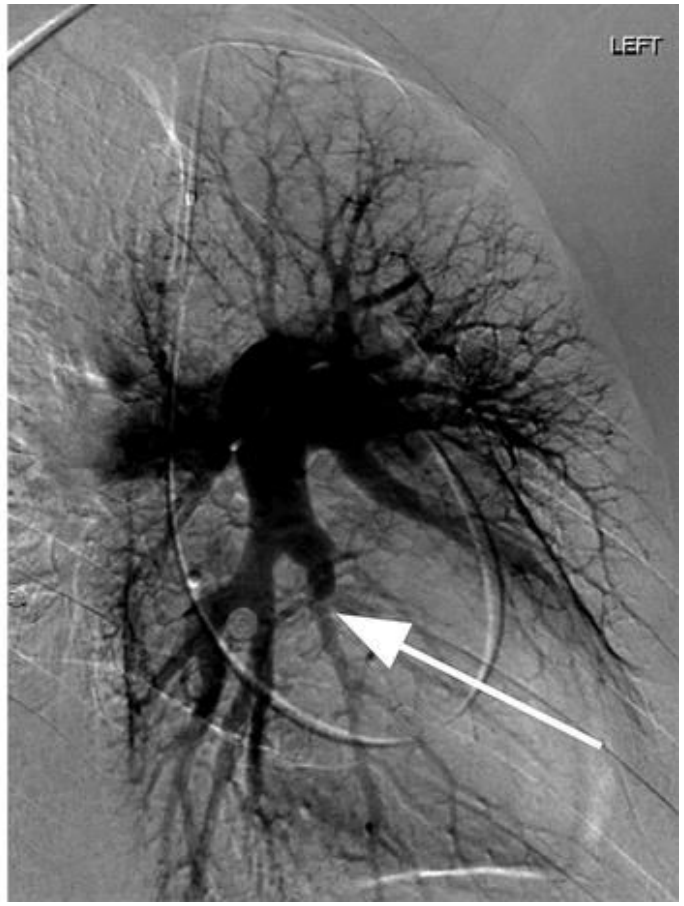
Limitations of V/Q Scanning

- Interpretation categorized as low, intermediate, or high probability
- Requires correlation with clinical pretest probability
- High rate of non-diagnostic tests, limiting definitive diagnosis



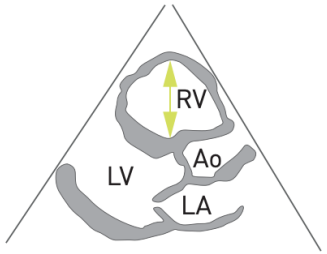
Diagnosis

Pulmonary angiography

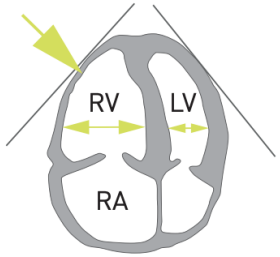


Diagnosis

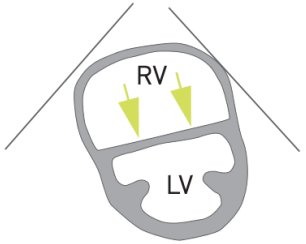
Echocardiography



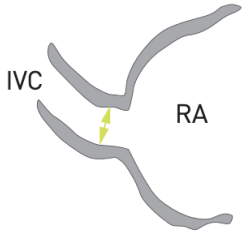
a) Enlarged right ventricle, parasternal long axis view



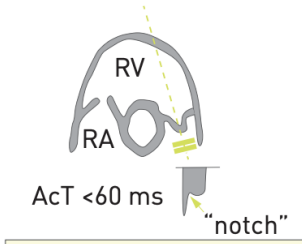
b) Dilated RV with basal RV/LV ratio >1.0, and McConnell sign (arrow), four chamber view

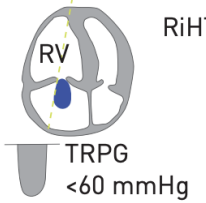


c) Flattened intraventricle septum (arrows) parasternal short axis view

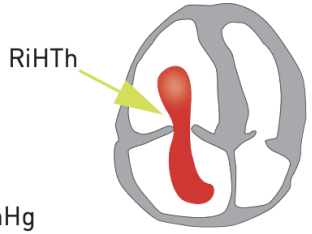


d) Distended inferior vena cava with diminished inspiratory collapsibility, subcostal view

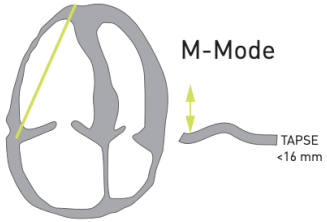




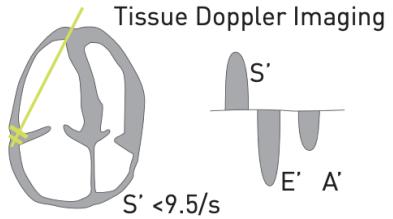
e) 60/60 sign: coexistence of acceleration time of pulmonary ejection <60 ms and midsystolic "notch" with mildly elevated (<60 mmHg) peak systolic gradient at the tricuspic valve



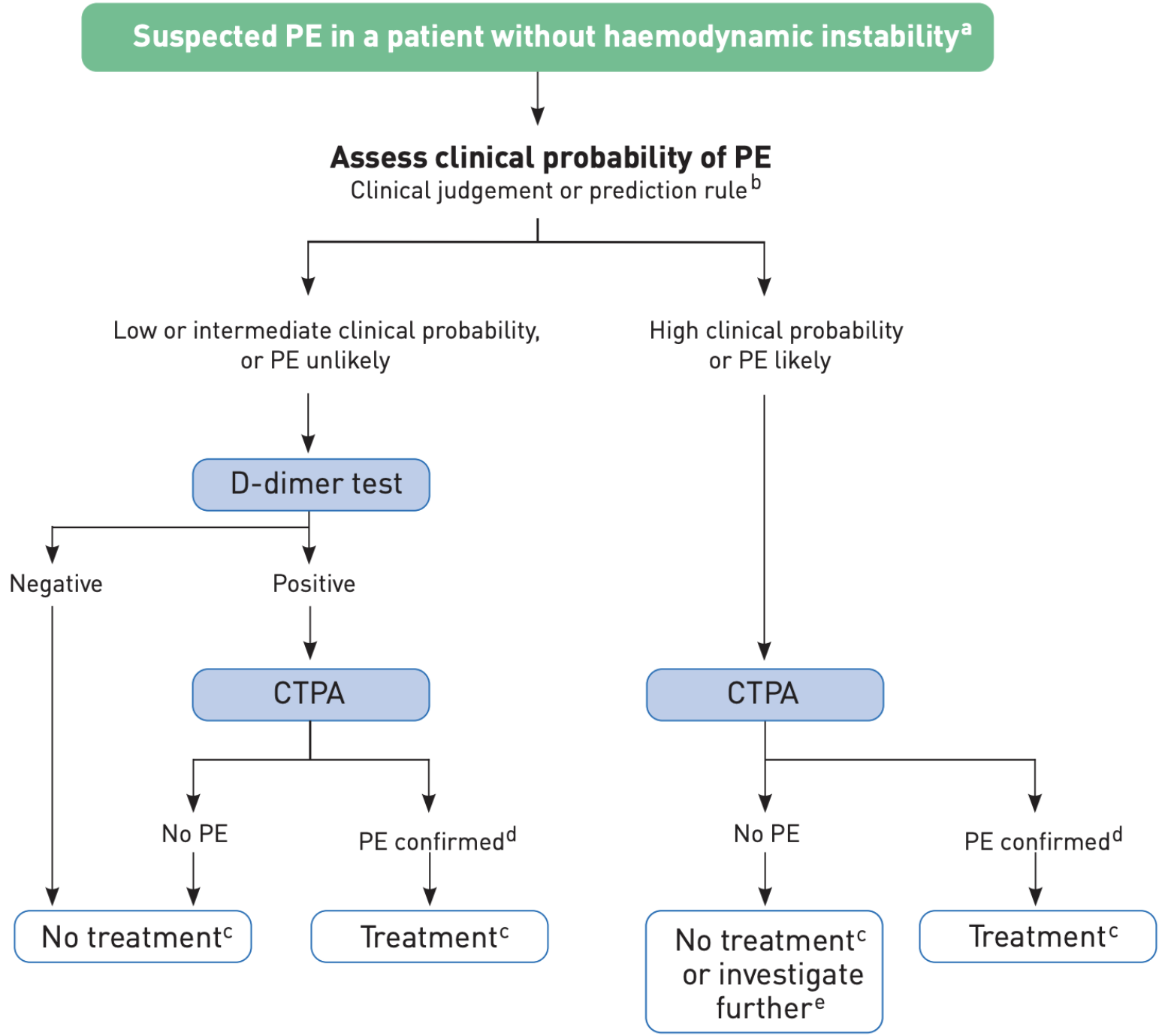
f) Right heart mobile thrombus detected in right heart cavities (arrow)

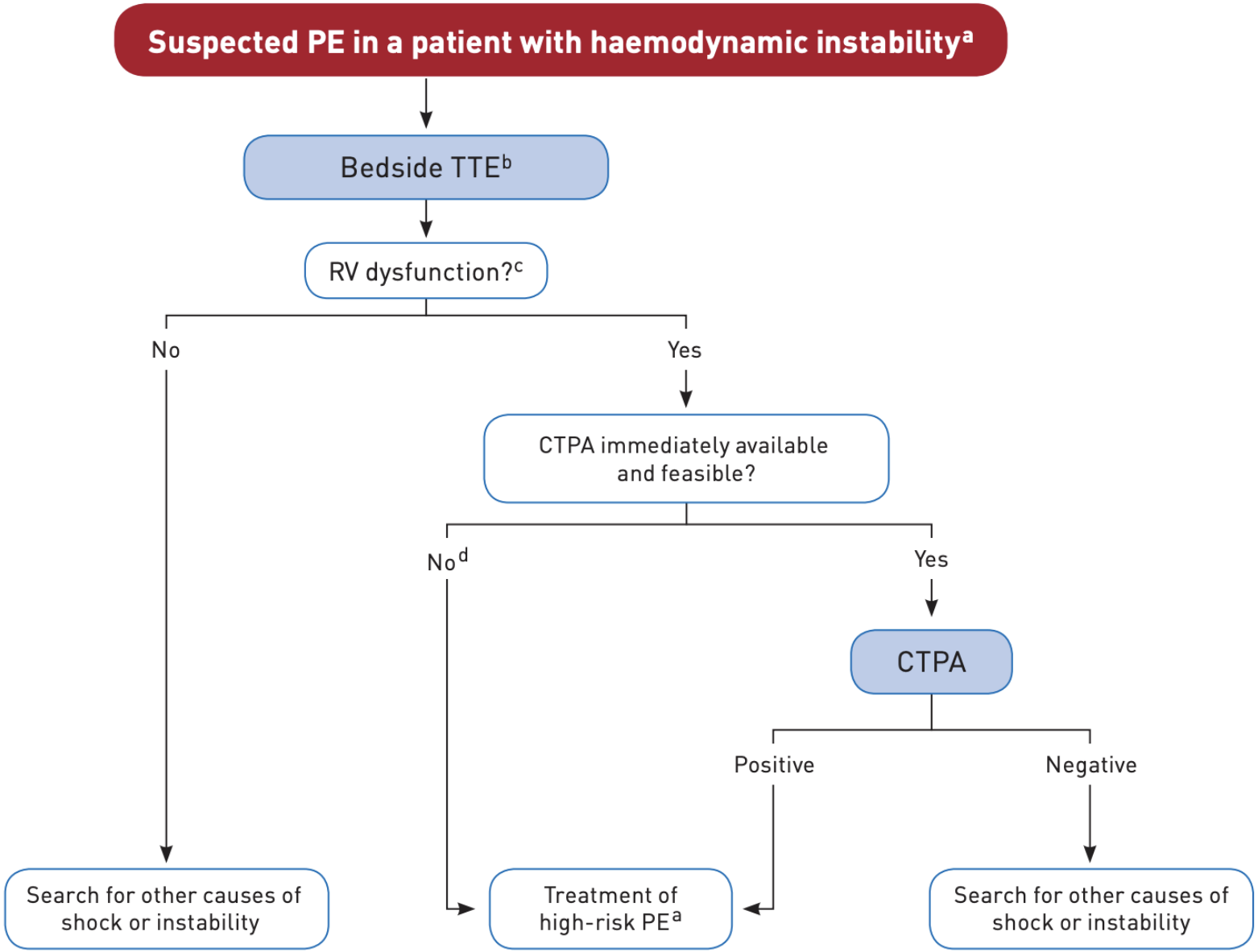


g) Decreased tricuspid annular plane systolic excursion (TAPSE) measured with M-Mode (<16 mm)



h) Decreased peak systolic (S') velocity of tricuspid annulus (<9.5 cm/s)


Suspected PE in a patient without haemodynamic instability[a]
Assess clinical probability of PE
Clinical judgement or prediction rule[b]
Low or intermediate clinical probability, or PE unlikely
High clinical probability or PE likely
D-dimer test
Negative
Positive
CTPA
CTPA
No PE
PE confirmed[d]
No PE
PE confirmed[d]
No treatment[c]
Treatment[c]
No treatment[c] or investigate further[e]
Treatment[c]


Suspected PE in a patient with haemodynamic instability[a]
Bedside TTE[b]
RV dysfunction?[c]
No
Yes
CTPA immediately available and feasible?
No[d]
Yes
CTPA
Positive
Negative
Search for other causes of shock or instability
Treatment of high-risk PE[a]
Search for other causes of shock or instability

Treatment

- Medical therapy
- IVC filter
- Thrombolytic therapy (IV Alteplase)
- ECMO
- Surgical embolectomy
- Catheter-directed therapies

Case #3

John
Recent knee replacement surgery 2wks prior and has been immobile.
Chest pain, worsening dyspnea, and lightheadedness.
Suddenly collapsed at home.

Vitals:
BP 78/45, HR 128, RR 32, SpO2 82% via NRB

Too unstable to get to scanner. Emergently admitted to ICU and started on therapeutic anticoagulation. Multi-disciplinary meeting held to determine additional treatment strategies.

Treatment – Medical therapy

Treatment Option		Benefits	Risks/Limitations	Additional Considerations
Unfractionated Heparin (UFH)		- Rapid onset and offset - Easily reversible with protamine sulfate - Preferred in patients with renal impairment	- Requires continuous IV infusion - Needs frequent monitoring (aPTT) - Higher risk of heparin-induced thrombocytopenia (HIT) - Variable dosing	- Short half-life makes it for patients requiring procedures - Reaching 'therapeutic' levels can take hours - Safe to use in pregnancy
Low-Molecular-Weight Heparin (LMWH)		- Predictable pharmacokinetics allowing fixed dosing - Subcutaneous administration; can be administered in outpatient setting - Lower risk of HIT compared to UFH	- Primarily renally cleared - In severely obese patients, monitoring of therapeutic levels is required	- Safe to use in pregnancy
Direct oral anticoagulants (DOACs)	*Direct Thrombin Inhibitors* 1. *Dabigatran*	- Oral administration with fixed dosing and minimal monitoring - Predictable effects	- Contraindicated in patients with renal dysfunction - Requires initial parenteral anticoagulation for VTE treatment - Cost considerations	- Specific reversal agent (idarucizumab) is available, aiding in the management of bleeding events
	Factor Xa Inhibitors 1. Rivaroxaban 2. Apixaban 3. Edoxaban	- Oral administration with fixed dosing and minimal monitoring - Some agents can be used as single-agent therapy without parenteral bridging	- Dose adjustment needed in patients with renal dysfunction - Cost considerations - Must consider drug-drug interactions	- Specific reversal agent (andexanet alfa) is available, aiding in the management of bleeding events
Warfarin (Coumadin)		- Long history of use with extensive clinical experience - Oral administration	- Requires frequent INR monitoring and dose adjustments - Numerous drug and dietary interactions - Slow onset and offset - Variable response among patients	- Specific reversal agents with four-factor prothrombin complex concentrate (4F-PCC)and vitamin K administration

Treatment – IVC filter

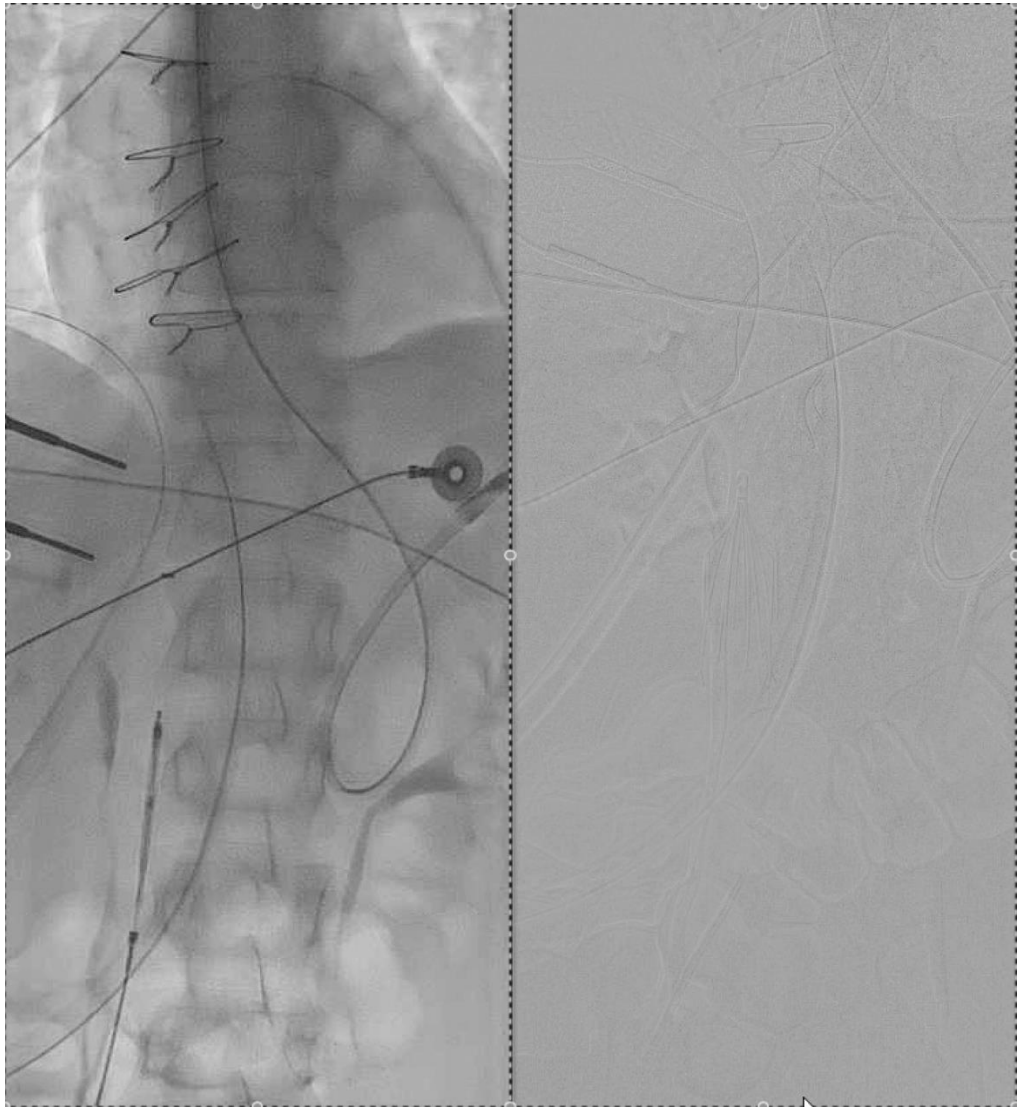
Placed into the IVC
Allows blood to pass, prevents large embolism from traveling

Utility

- When there is an absolute contraindications to anticoagulation (high risk of bleeding)
- Major bleeding as a result of anticoagulation
- Massive PE and concurrent DVT with possibility that another PE could be fatal
- ?Recurrent embolism despite adequate therapy

Drawbacks

- Increases risk of subsequent DVT
- Not shown to improve survival
- Limited high-quality data
- Insertion site complications

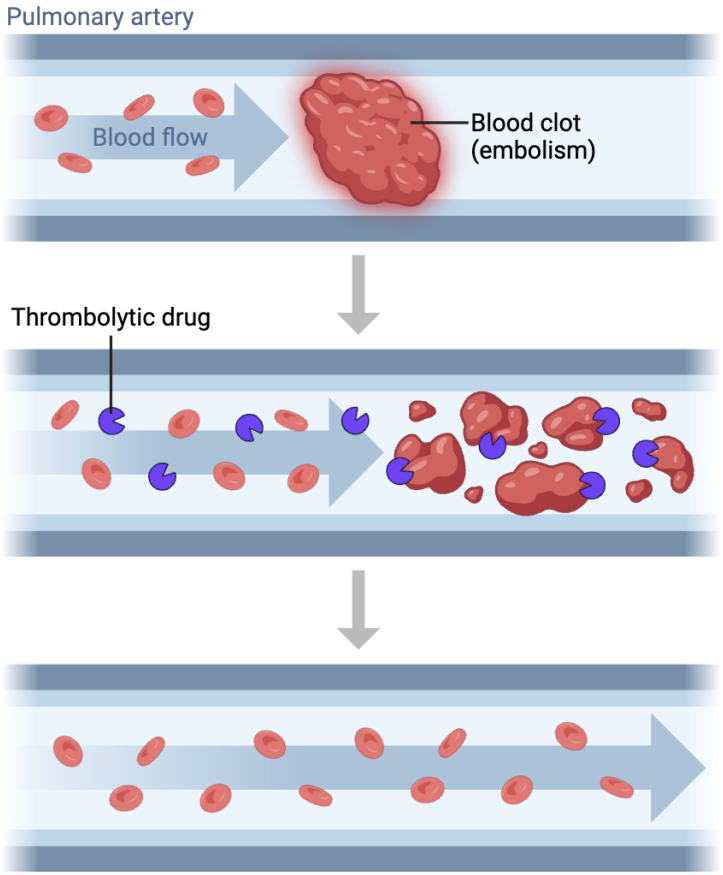


Treatment – Thrombolytic therapy

- Alteplase = recombinant tissue plasminogen activator (tPA) that works by converting plasminogen to plasmin, the enzyme responsible for breaking down fibrin clots

- For patients with a hemodynamically unstable PE, Alteplase can quickly reduce the clot burden, improve blood flow, and relieve right heart strain

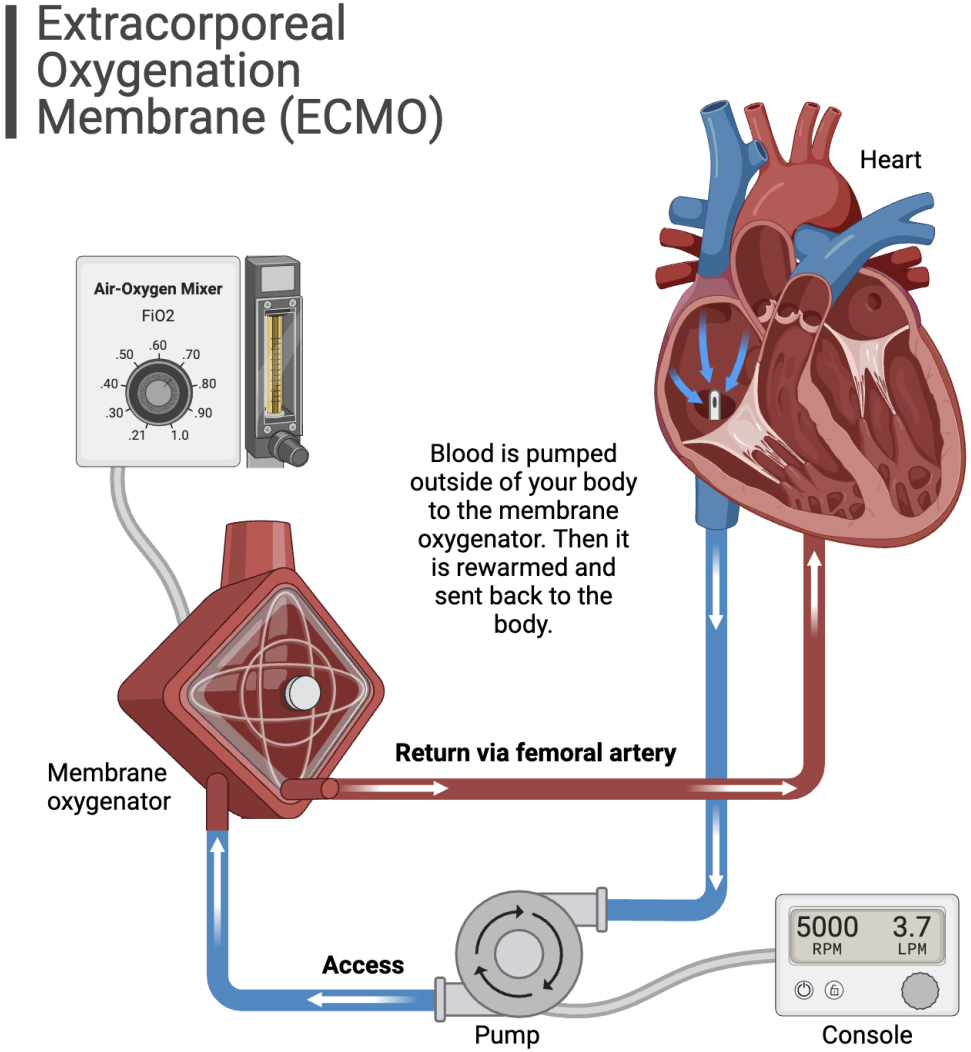
- Major risk is bleeding!!!
- Contraindicated in patients with recent surgery, active bleeding, or a history of hemorrhagic stroke



Thrombolytics are "clot-busting" drugs that break up and dissolve blood clots that block pulmonary arteries (embolism)

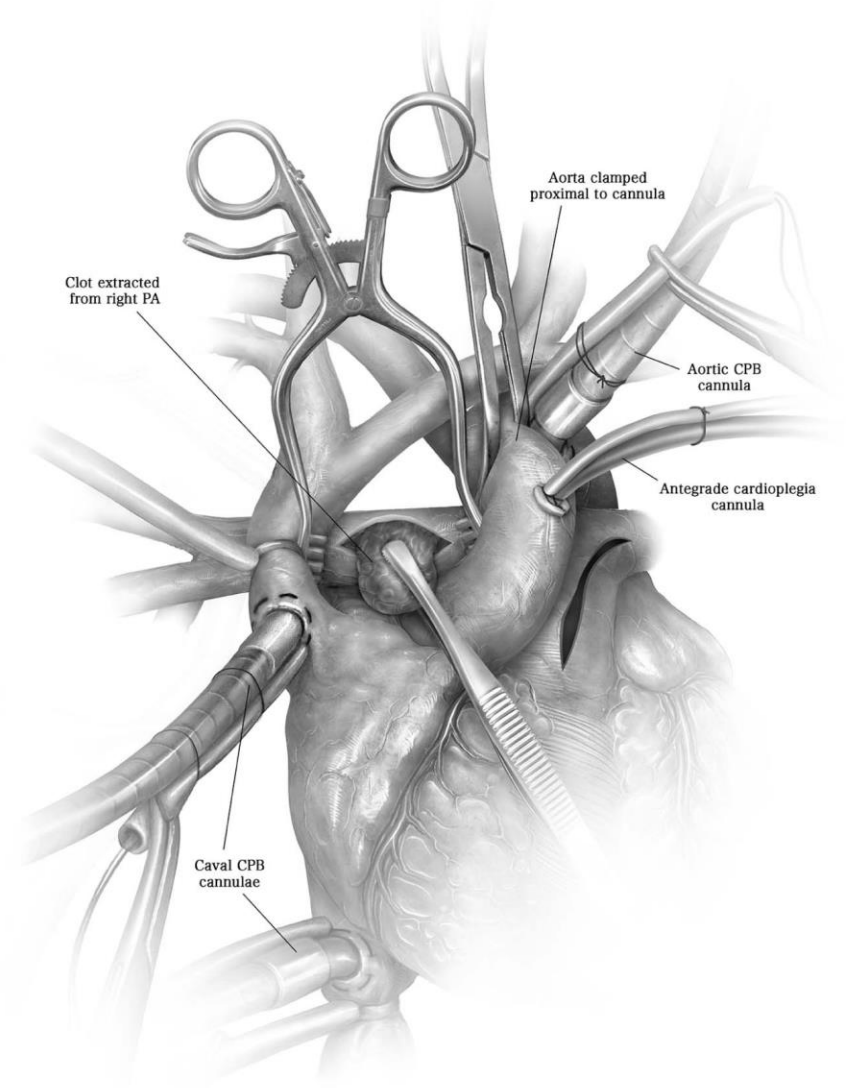
Treatment – ECMO

- Divert blood from the patient's circulation, oxygenating it outside the body using an artificial lung, and then returning the oxygen-rich blood back to the patient
- Bypasses the compromised pulmonary or cardiac function
- Very invasive & resource intensive
- Major risks include bleeding, infection, and vascular complications



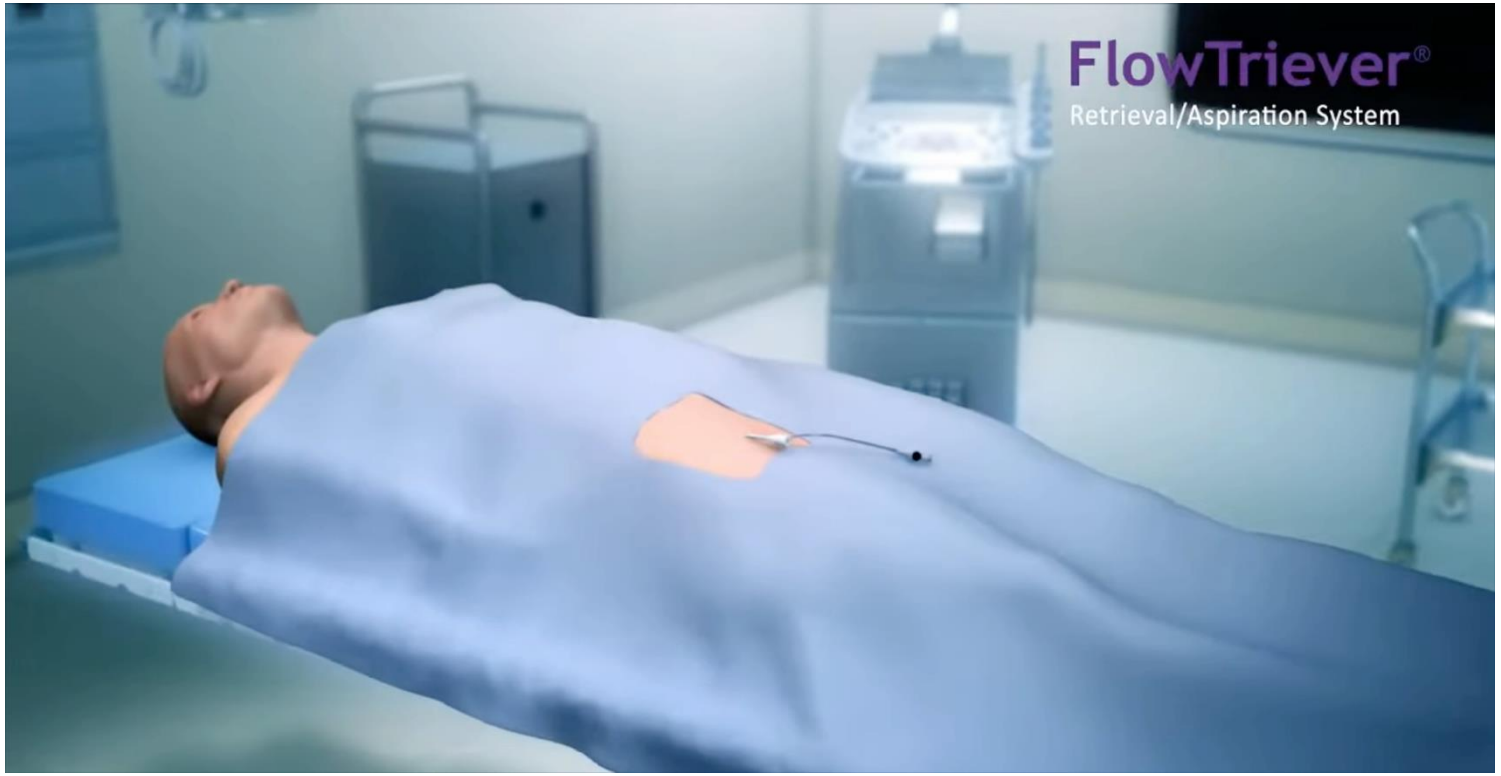
Treatment – Surgical embolectomy

- Rarely performed
- Direct removal of clots from the pulmonary arteries or right ventricle



Treatment – Catheter-directed therapies

- Currently considered controversial
- Catheter inserted into the femoral vein
- Specialized devices are employed to mechanically disrupt, fragment, or aspirate the thrombus – some systems additionally administer a local infusion of thrombolytic agents to accelerate clot removal
- Immediate reduction in thrombus burden
- Initial results promising
  - Only demonstrated in case series and small non-randomized trials



Case #3

<u>John</u>
Started on therapeutic Enoxaparin. PERT (pulmonary embolism response team) meeting determined to place patient on ECMO and pursue catheter-directed thrombectomy.

Tolerated cannulation without issue markers of tissue perfusion improved. Went to IR for thrombectomy which successfully lower pulmonary artery pressures 30 mmHg.

Was able to be decannulated from ECMO 2 days later and has since followed up in clinic and is doing well, with plan for indefinite anticoagulation.

Treatment

The treatment of choice for VTE is immediate initiation of therapeutic anticoagulation

Treatment

Duration of therapy

Balance the risk of recurrent thrombosis against the risk of bleeding from continued therapy

Provoked VTE	Unprovoked VTE
When a clot is associated with a transient risk factor (e.g., surgery, trauma, prolonged immobilization, or hormonal therapy), a shorter duration of anticoagulation (typically 3–6 months) may be sufficient.	Clots without an identifiable transient cause often have a higher risk of recurrence, which typically warrants extended or even indefinite anticoagulation.

Treatment

Duration of therapy

Balance the risk of recurrent thrombosis against the risk of bleeding from continued therapy

History of prior VTE

A previous episode increases the likelihood of another event and thus warrants indefinite anticoagulation.

Underlying thrombophilia

Inherited or acquired clotting disorders can elevate recurrence risk and consideration should be given to extended duration of treatment.

Persistent risk factors

Ongoing conditions (e.g., cancer, autoimmune disorders) may require longer treatment.

Treatment

Patient factors, including co-morbidities, lifestyle, and preferences, are incredibly important to incorporate into the above considerations, as individual patient circumstances often require personalized decision-making

Two reasonable physicians may have different recommendations for duration of anticoagulation given the same clinical scenario

Long-term complications

Recurrence

Recurrence is common after a first episode of VTE.

Practice has shifted towards continuing anticoagulation longer in patients with low bleeding risk and either unprovoked VTE or a non-transient risk factors.

Post-thrombotic syndrome

Due to valvular damage, leading to chronic venous insufficiency.

Symptoms include chronic leg pain, swelling, skin changes, and in severe cases, venous ulcers.

Medication-related complications

Long-term anticoagulation, while preventing recurrence, carries its own risks such as bleeding and requires ongoing monitoring and management.

CTEPH

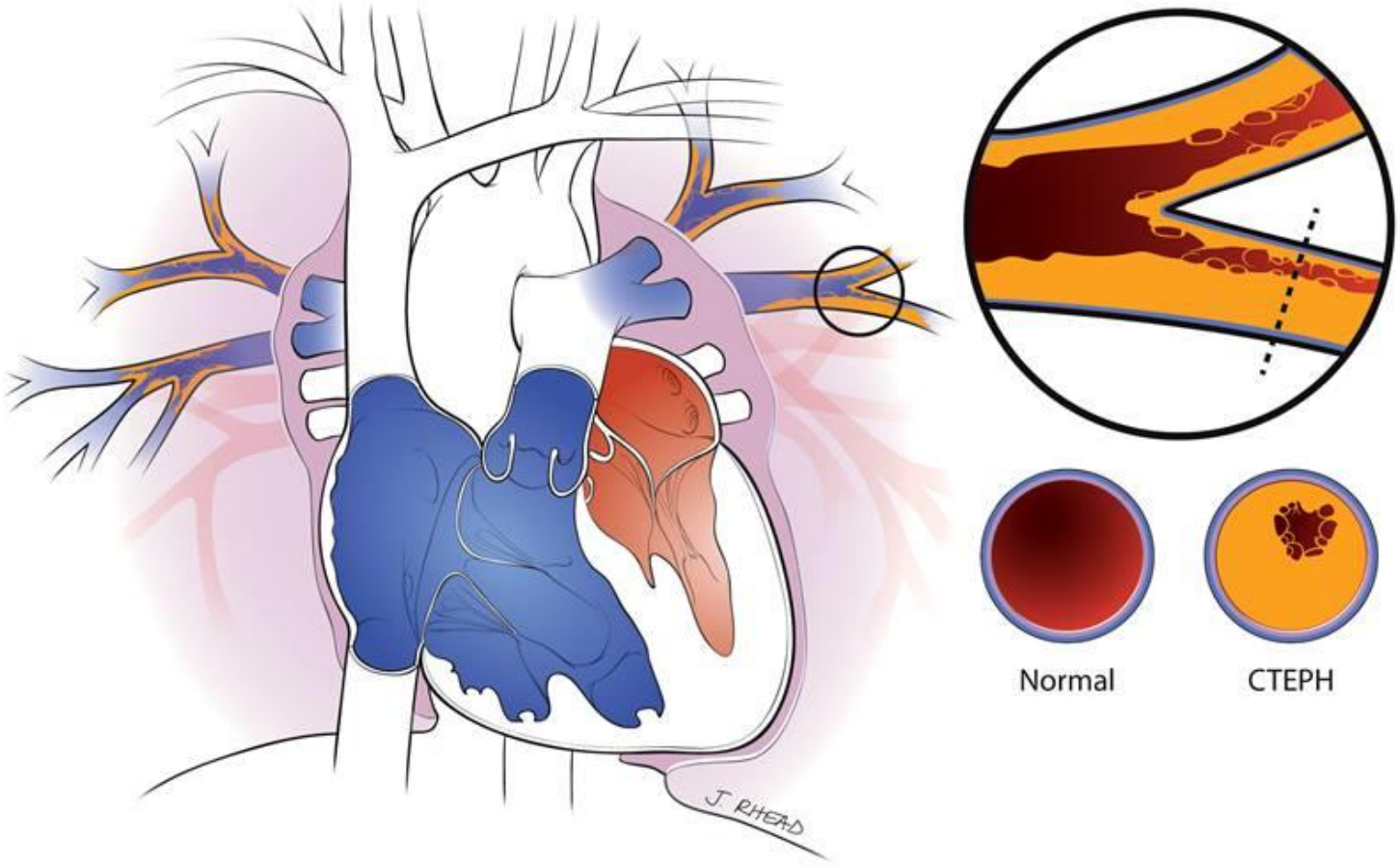
~1-2% of patients with acute pulmonary embolism develop chronic thromboembolic pulmonary hypertension (CTEPH).

Leads to pulmonary hypertension and right heart failure.

It is surgically treatable with pulmonary thromboendarterectomy surgery and indefinite therapeutic anticoagulation.

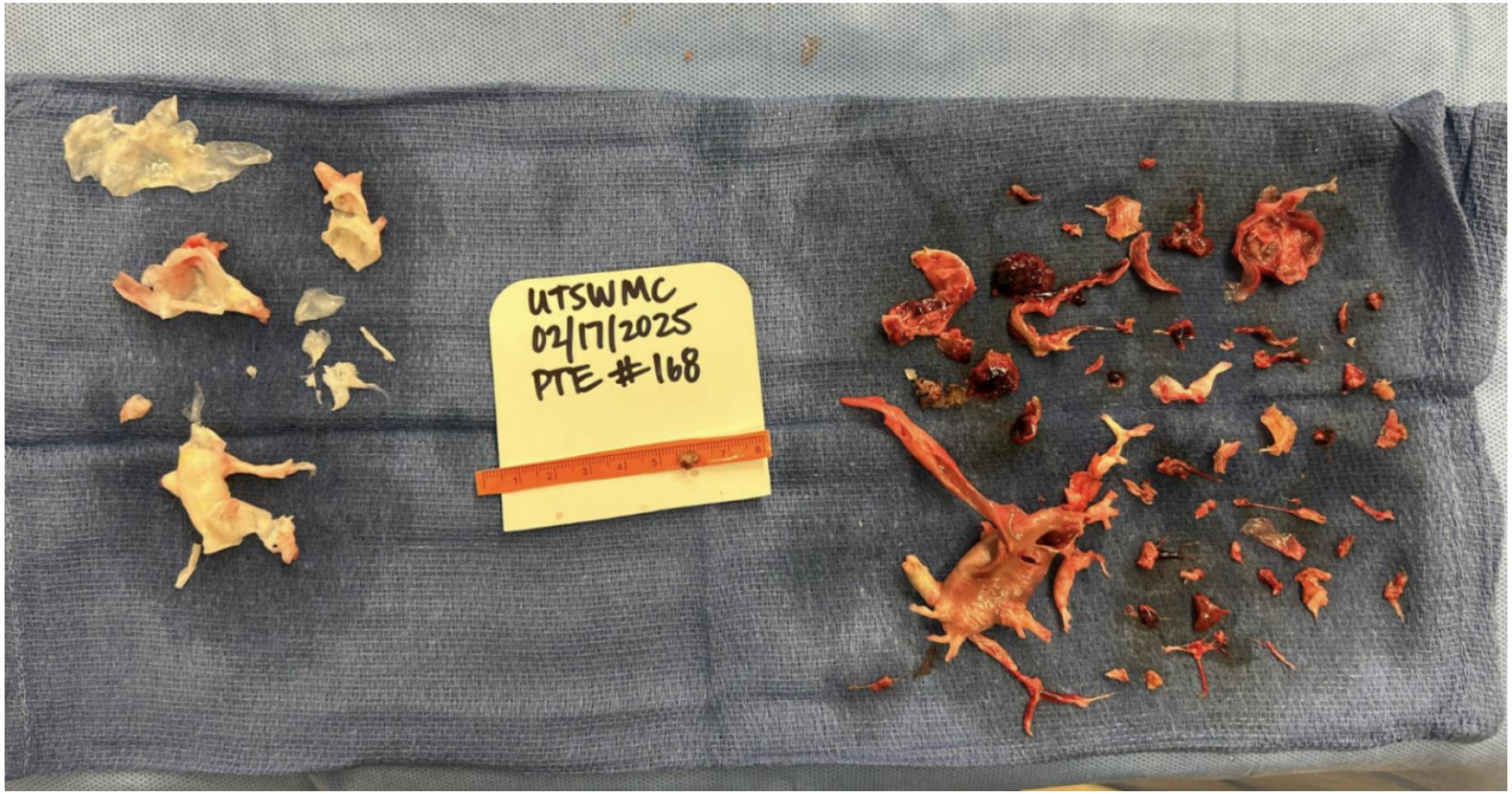
CTEPH

- Chronic clot endothelializes and becomes part of the vessel
- Leads to narrowing of pulmonary arterial branches and increased pressure as well as turbulent flow
- Turbulent flow causes microvascular damage
- Half of those with CTEPH do not have an apparent history of thromboembolism



CTEPH

Pulmonary thromboendarterectomy (PTE)



Summary

- Maintain a high clinical suspicion for DVT/PE, given the wide variance of clinical presentations and potential for high morbidity and mortality
- Primary risk factors for VTE include:
  - Stasis of blood flow
  - Endothelial injury
  - Hypercoagulability
- Use Wells' criteria to determine pre-test probability of PE
- Numerous diagnostic tests exists for VTE, each with pros and cons as well as varying amounts of sensitivity/specificity
- The treatment of choice for VTE is immediate initiation of therapeutic anticoagulation
- Other treatment options include IVC filter placement, thrombolytic therapy, ECMO, embolectomy, catheter-directed therapies
- Duration of therapy is at minimum 3-6mos, but should be extended for patients with continued risk factors for VTE or those without provoking risk factors
- Long-term complications include recurrence, post-thrombotic syndrome, medication-related complications such as bleeding, and CTEPH

Post-test Question 1

1. How do we evaluate a patient's pretest probability for pulmonary embolism?

    1. Virchow's score
    2. Well's criteria
    3. Count the number of risk factors for a PE
    4. All of the above

Post-test Question 1

1. How do we evaluate a patient's pretest probability for pulmonary embolism?

    1. Virchow's score
    2. **Well's criteria**
    3. Count the number of risk factors for a PE
    4. All of the above

Pre-test Question 2

1. What is a long-term complication of VTE?

    1. Post-thrombotic syndrome
    2. Recurrence of VTE
    3. Bleeding events on anticoagulation
    4. CTEPH (chronic thromboembolic pulmonary hypertension)
    5. All of the above

Pre-test Question 2

1. What is a long-term complication of VTE?

    1. Post-thrombotic syndrome
    2. Recurrence of VTE
    3. Bleeding events on anticoagulation
    4. CTEPH (chronic thromboembolic pulmonary hypertension)
    5. **All of the above**

References

- American Society of Hematology 2020 Guidelines for Management of Venous Thromboembolism: Treatment of Deep Vein Thrombosis and Pulmonary Embolism. Blood Adv (2020): 4693-4738
- Executive Summary. Stevens, Scott, M. et al. CHEST, Volume 160, Issue 6, 2247-2259