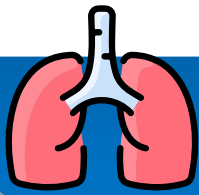




Round : Internal medicine

Group no : A4

Done By : Batool ALzubaidi



VENOUS THROMBOEMBOLISM

I. PATHOPHYSIOLOGY

- A. DEEP VEIN THROMBOSIS
- B. PULMONARY EMBOLISM

II. CLASSIC FINDINGS OF VTE

- A. DEEP VEIN THROMBOSIS
- B. PULMONARY EMBOLISM

III. COMPLICATIONS OF VTE

- A. DEEP VEIN THROMBOSIS
- B. PULMONARY EMBOLISM

IV. DIAGNOSTIC APPROACH TO VTE

- A. DEEP VEIN THROMBOSIS
- B. PULMONARY EMBOLISM

V. TREATMENT OF VTE

- A. DEEP VEIN THROMBOSIS
- B. PULMONARY EMBOLISM

00:14

I. PATHOPHYSIOLOGY

A. DEEP VEIN THROMBOSIS (DVT)

1. Pathophysiology:

a) Virchow's Triad:

i) Hypercoagulability

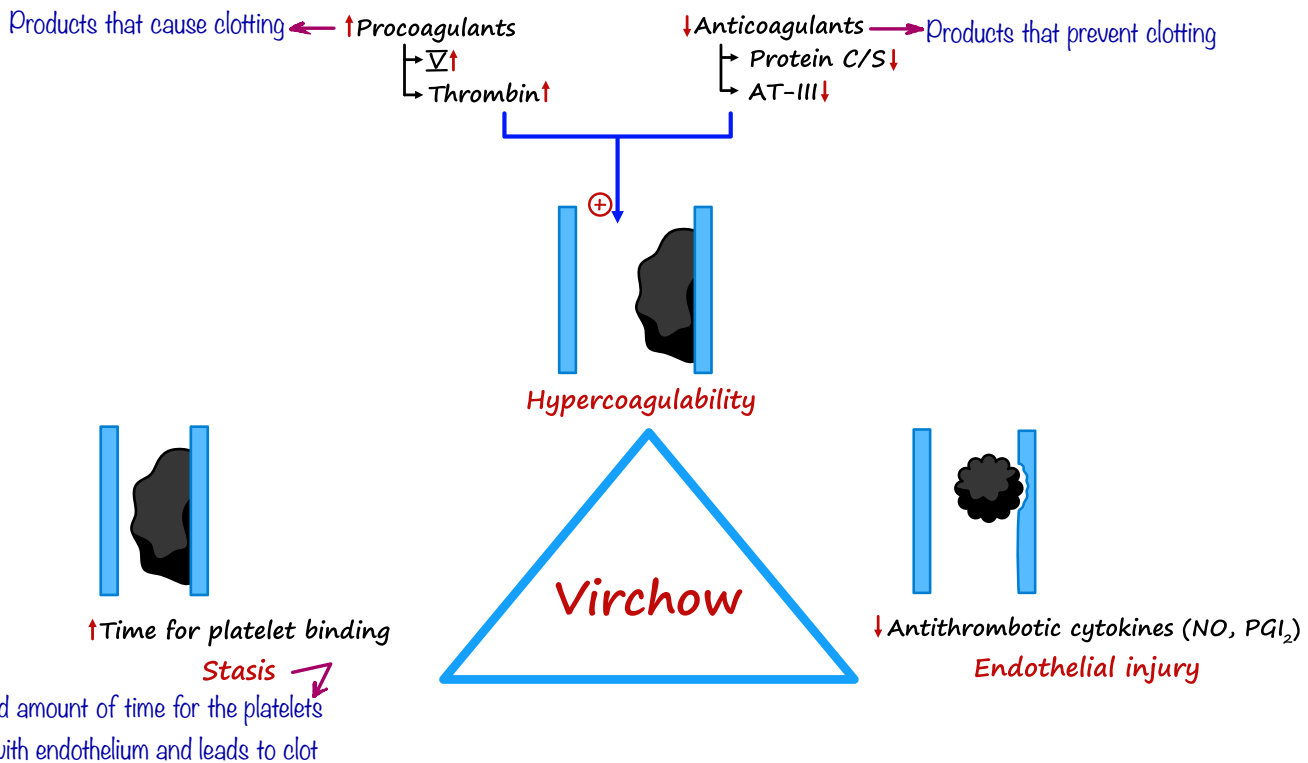
- ↑Procoagulants or ↓anticoagulants in the bloodstream → ↑Risk of thrombosis in the deep veins of the leg

ii) Stasis of Blood Flow

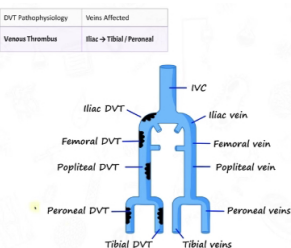
- Slow or no movement of blood flow through the deep veins → ↑Time for platelet to bind with the vessel lining → ↑Risk of thrombosis in the deep veins of the leg

iii) Endothelial Injury

- PGI₂ and Nitric Oxide production by damaged endothelial cells → ↑Platelet activation → Platelet binding with the vessel lining → ↑Risk of thrombosis in the deep veins of the leg



DVT Pathophysiology	Veins Affected	Causes of Thrombus	Classic Presentation
Venous Thrombus	Iliac → Tibial / Peroneal	Virchow's Triad	Leg pain / swelling Homan's sign (+)



2. Causes of DVT

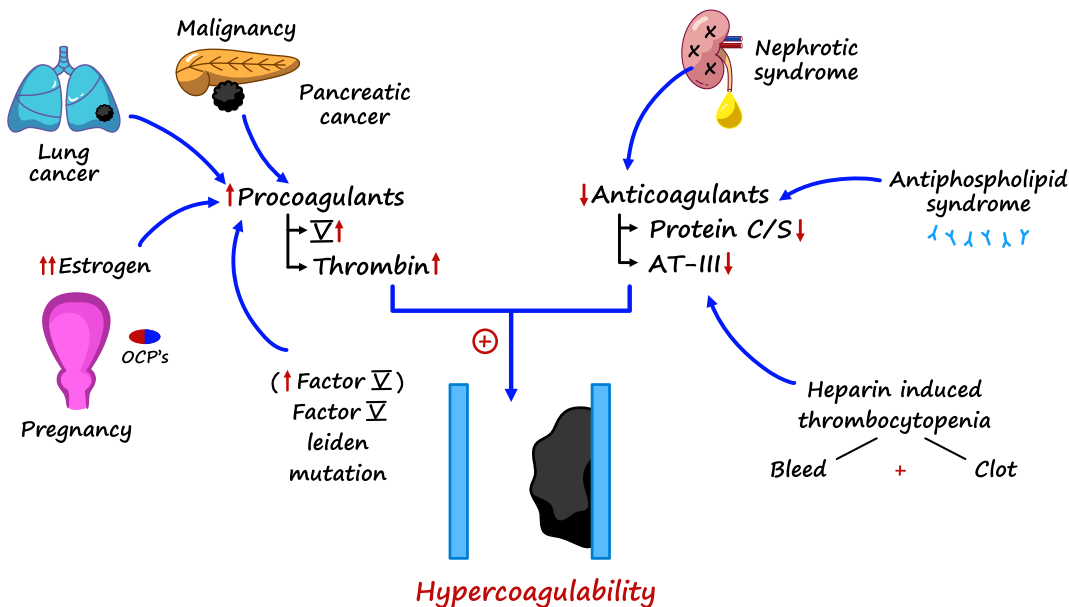
a) Hypercoagulability

i) Acquired

- **Antiphospholipid Syndrome**
 - Lupus anticoagulant, Anti-cardiolipin, Anti-B2 Glycoprotein antibodies → Activate platelets and procoagulants → ↑Clotting
- **Heparin-Induced Thrombocytopenia**
 - Exposure to heparin → IgG antibodies bind to heparin and PF4 on platelets → activates platelets → ↑Clotting
- **Nephrotic Syndrome**
 - Antithrombin III loss in urine → ↑Thrombin formation → ↑Clotting
- **Malignancy**
 - Lung cancer or Pancreatic cancer → ↑Thrombin formation → ↑Clotting
- **Pregnancy or Oral Contraceptives**
 - ↑Estrogen → ↑Thrombin formation → ↑Clotting

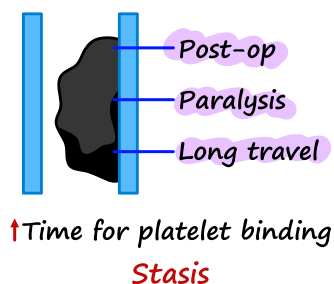
ii) Inherited

- **Factor V Leiden Mutation:**
 - ↑Factor V (procoagulants) → ↑Thrombin formation → ↑Clotting
- **Prothrombin Gene mutation**
 - ↑Prothrombin (procoagulants) → ↑Thrombin formation → ↑Clotting
- **Protein C and S deficiency**
 - ↓Protein C and S (anticoagulants) → ↑Thrombin formation → ↑Clotting
- **Antithrombin III deficiency**
 - ↓AT-III (anticoagulants) → ↑Thrombin formation → ↑Clotting



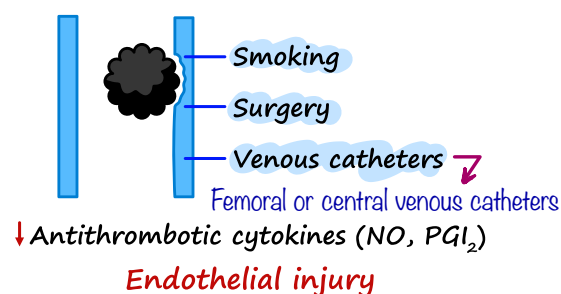
b) Stasis of Blood Flow

- **Postoperative State**
 - Prolonged immobilization → Slow or no movement of blood flow through deep veins
- **Prolonged Travel** (e.g. airplane or driving > 8 hrs)
 - Prolonged immobilization → Slow or no movement of blood flow through a deep vein



c) Endothelial Injury

- **Surgical Procedures** (e.g. orthopedic surgeries)
 - Direct injury to endothelium and the postoperative period increases the risk of thrombosis
- **Central Venous Catheters**
 - Femoral, Internal jugular vein catheters → Direct endothelial injury



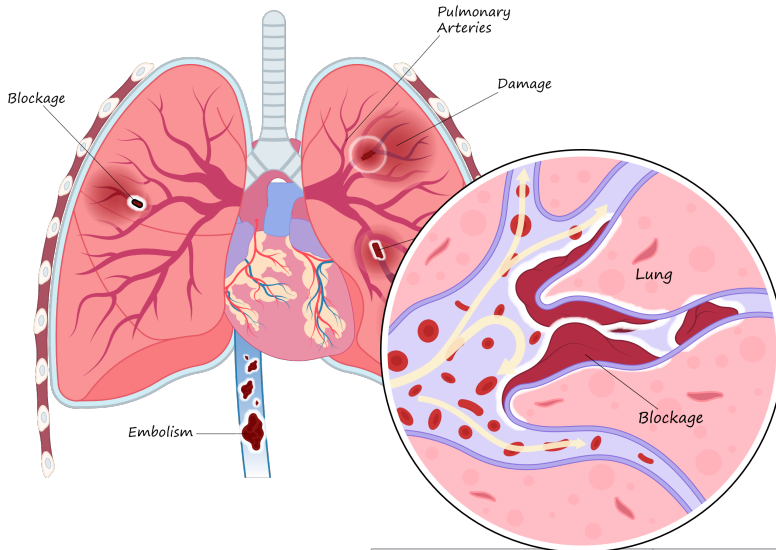
B. PULMONARY EMBOLISM (PE)

10:34

1. Pathophysiology:

- Most commonly occurs secondary to a thrombus in lower extremity veins → Emboli breaks from the thrombus → Travels up the IVC into right heart → Emboli become lodged in the pulmonary artery → Impaired perfusion to alveoli → Impaired gas exchange

Pulmonary Embolism (PE)



2. Causes of PE

a) Fat Emboli

- Long bone fracture → release of fat globules from medullary cavity into bloodstream → fat globules clump into the pulmonary artery

b) Amniotic Emboli

- During birth → amniotic fluid proteins clump up in the blood and occlude the pulmonary artery

c) Thrombus (DVT)

- Most common cause of PE

d) Air Embolism

- During central line placement → Air enters SVC or IVC and air bubble blocks pulmonary artery

e) Septic Emboli

- Infective endocarditis of tricuspid valve → Infective vegetation on tricuspid valve → Septic emboli occludes pulmonary artery

PE Pathophysiology	Causes of Embolism	Classic Presentation
Pulmonary Artery Embolus	- Fat embolus - Air embolus - Thrombus (DVT) - Amniotic embolus - Less common (septic emboli)	- Pleuritic chest pain - Dyspnea - Hemoptysis

II. CLASSIC FINDINGS OF VTE

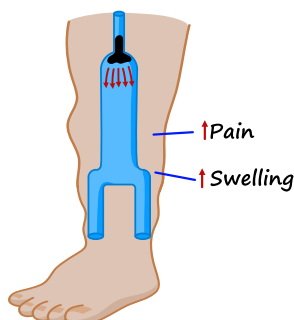
A. DEEP VEIN THROMBOSIS (DVT)

04:36

1. Leg Pain and Edema

- This is due to occlusion of deep veins of the legs (e.g. iliac, femoral, popliteal) → Leading to backflow of blood and interstitial edema from ↑hydrostatic pressure
 - Pain is worse with dorsiflexion → (+) Homan's sign

DVT presentation



B. PULMONARY EMBOLISM (PE)

10:55

1. Pleuritic Chest Pain

- Pulmonary artery occlusion near pleura → Pleural inflammation → Pain during inspiration

2. Dyspnea

- This is due to occlusion of pulmonary arteries → Impaired perfusion to alveoli → Impaired gas exchange → Hypoxia



III. COMPLICATIONS OF VTE

A. DEEP VEIN THROMBOSIS (DVT)

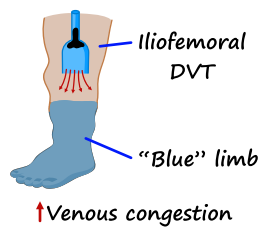
05:01

Complication	Presentation
Phlegmasia Cerulea Dolens	Iliofemoral DVT → Venous congestion (blue limb)
Phlegmasia Alba Dolens	Iliofemoral DVT → Venous congestion → Arterial compression (white limb)
Post-Thrombotic Syndrome	Post-DVT → Chronic Venous Insufficiency
Pulmonary Embolism	DVT → Pulmonary Artery → Cardiopulmonary failure

1. Phlegmasia Cerulea Dolens

- **Pathophysiology:**
 - Iliofemoral DVT → Severe venous congestion and backflow
- **Presentation:**
 - Severe lower extremity edema and bluish discoloration of limb

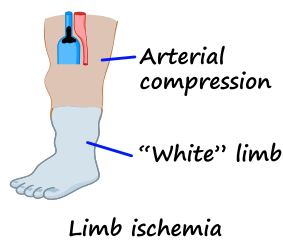
Phlegmasia Cerulea Dolens



2. Phlegmasia Alba Dolens

- **Pathophysiology:**
 - Iliofemoral DVT → Severe venous congestion, backflow, and compression of nearby arteries
- **Presentation:**
 - Severe lower extremity edema and white discoloration of limb

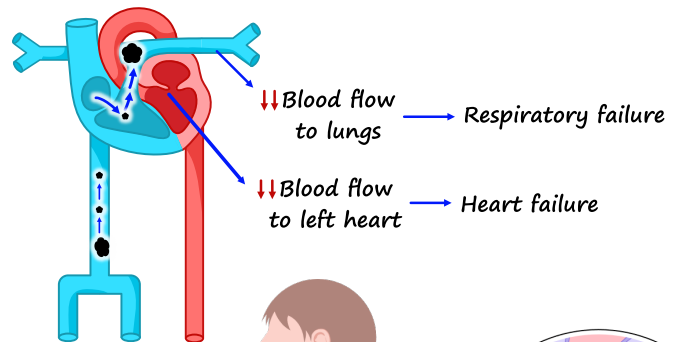
Phlegmasia Alba Dolens



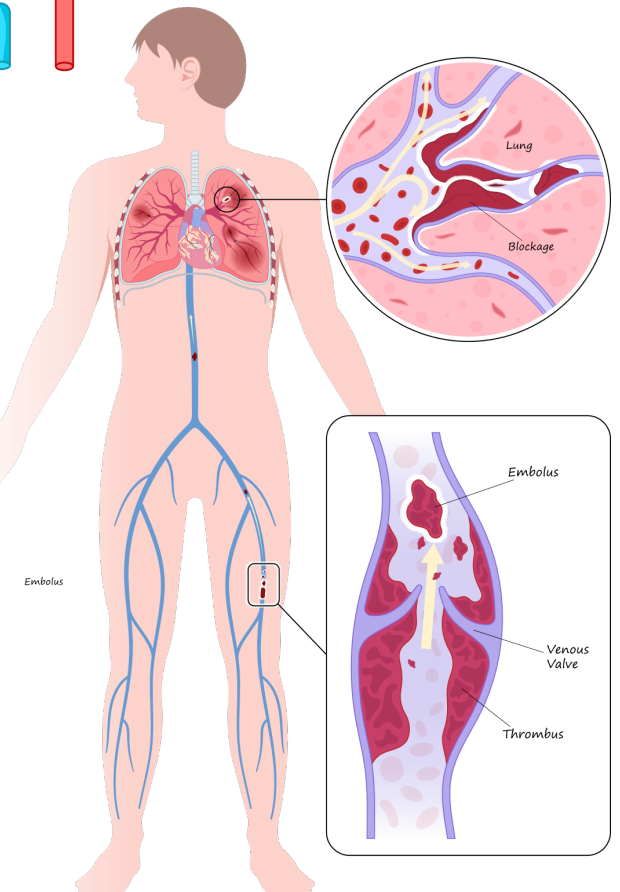
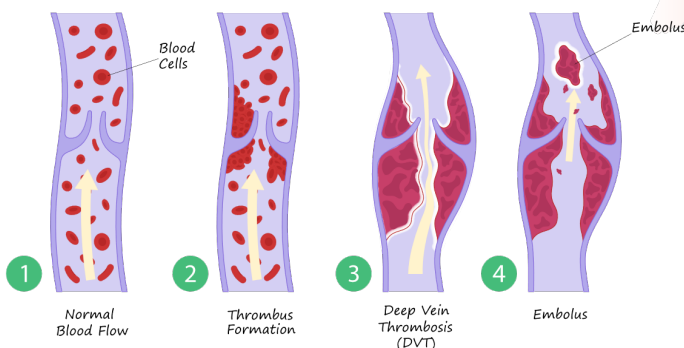
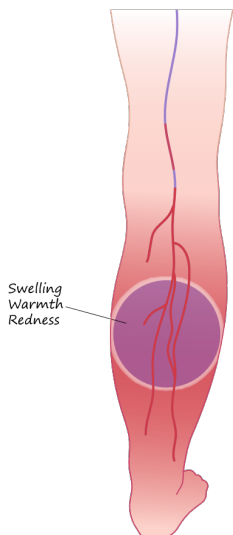
3. Post Thrombotic Syndrome

- **Pathophysiology:**
 - Long-term complication of DVT → Chronic high venous pressure in lower extremities
- **Presentation:**
 - Persistent pain and edema of lower extremities
 - Hyperpigmentation of skin
 - Venous ulcers

Pulmonary embolism



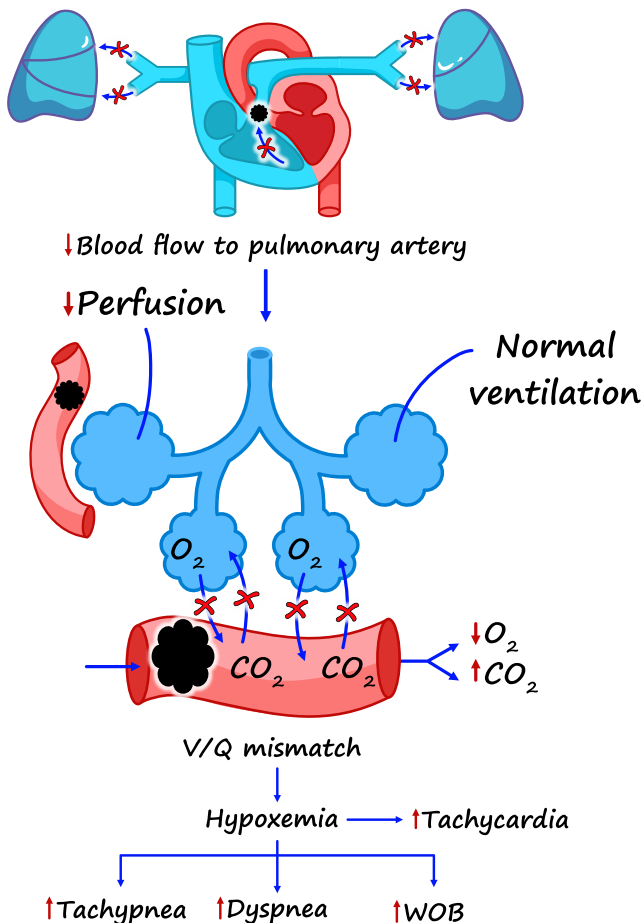
Deep Vein Thrombosis (DVT)



1. Respiratory failure

- **Pathophysiology:**
 - Pulmonary artery occlusion → Impaired perfusion to alveoli → Impaired gas exchange → Hypoxia
- **Presentation:**
 - Dyspnea, ↑RR, and ↑WOB secondary to hypoxia ($sPO_2 < 90\%$)
 - Tachycardia secondary to hypoxia ($sPO_2 < 90\%$)
 - ABG with Type I respiratory failure
 - ↓PaO₂ (hypoxemia)
 - Normal or ↓PaCO₂

Respiratory failure



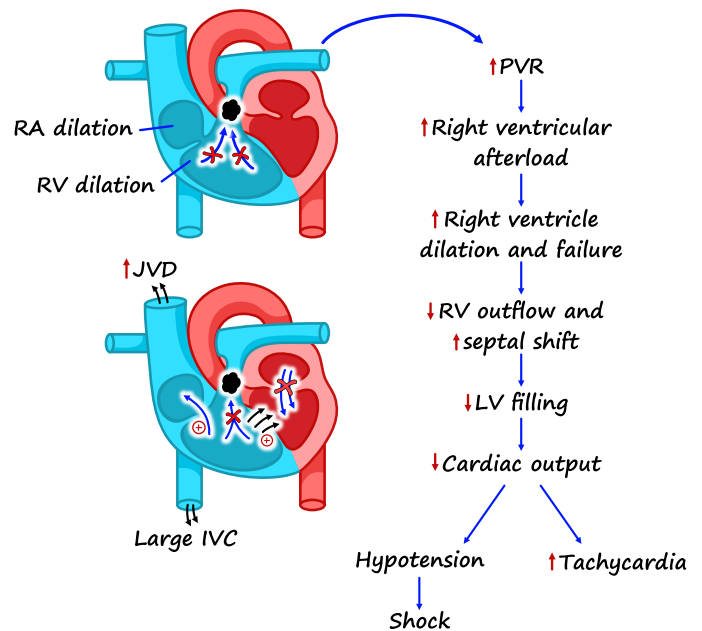
2. Pulmonary Hypertension IV

- **Pathophysiology:**
 - Chronic emboli → ↑ Pulmonary vascular resistance → ↑ Pulmonary artery pressures
- **Presentation:**
 - Dyspnea on exertion
 - ↑ Risk of Right heart failure

3. Obstructive Shock

- **Pathophysiology:**
 - Pulmonary artery occlusion → ↑ Pulmonary artery afterload → ↑ Pulmonary artery pressures → ↑ RV dilation and failure → ↓ RV cardiac output and ↓ LV filling from R to L septal shift → ↓ LV cardiac output
- **Presentation:**
 - Right Heart Failure
 - JVD (related to SVC backflow)
 - Hepatomegaly (related to IVC backflow)
 - Ascites (related to IVC backflow)
 - Lower extremity edema (related to IVC backflow)
 - Shock
 - Hypotension
 - Tachycardia
 - ↑ Lactate

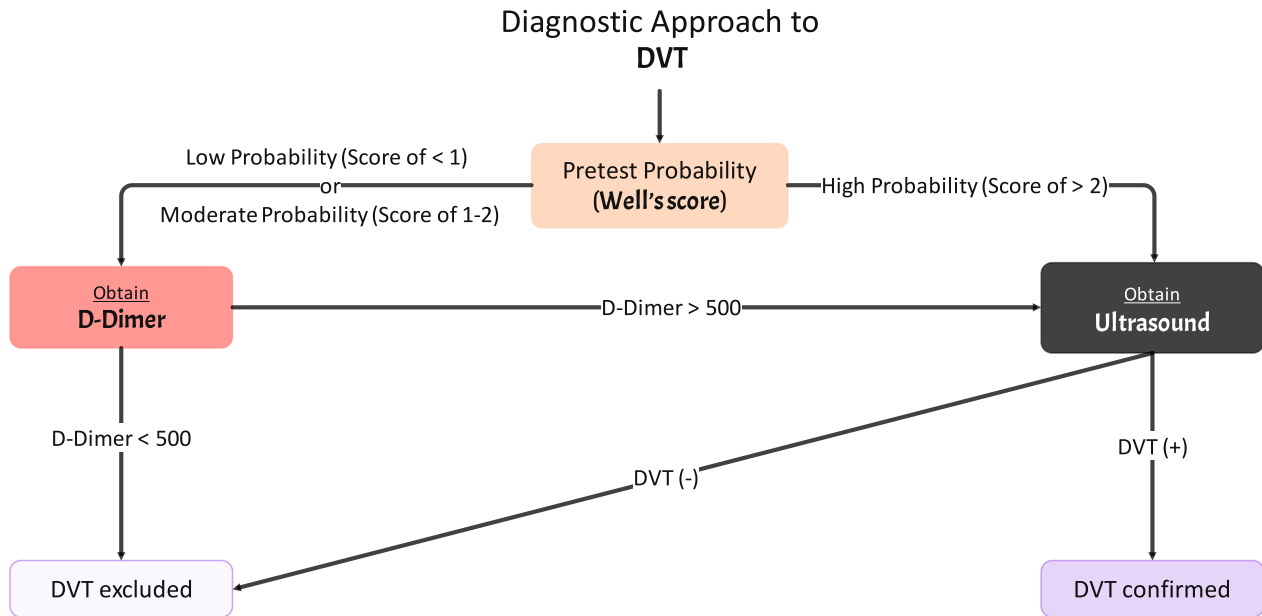
Obstructive shock



IV. DIAGNOSTIC APPROACH TO VTE

A. DEEP VEIN THROMBOSIS (DVT)

06:03



1. Assess for Presence of DVT

a) Obtain a D-Dimer

- **Indications:**
 - Wells criteria < 3
- **Purpose:**
 - If clots are present D-Dimer levels will be significantly elevated
 - This is **not specific for DVT**
- **Abnormal findings**
 - D-Dimer < 500 → Excludes DVT
 - D-Dimer > 500 → Unable to rule out DVT

WELLS SCORE

Clinical characteristics	Score
Active cancer	+1
Paralysis or plaster immobilisation	+1
Bed rest >3 days or major surgery <4 weeks	+1
Localised tenderness along the distribution of the deep venous system	+1
Entire leg swollen	+1
Calf swelling >3 cm when compared with asymptomatic leg	+1
Pitting o edema	+1
Collateral superficial veins (nonvaricose)	+1
Previously documented deep vein thrombosis	+1
Alternative diagnosis at least as likely as deep vein thrombosis-2	-2

Clinical probability	
Unlikely	<2
Likely	>2

b) Obtain a Venous Ultrasound

- **Indications:**
 - Wells criteria > 3
 - D-Dimer > 500
- **Purpose:**
 - Assess for radiographic evidence of DVT
- **Abnormal Findings:**
 - Venous thrombus and vein does not compress → (+) DVT
 - Absence of thrombus and veins compress → (-) DVT

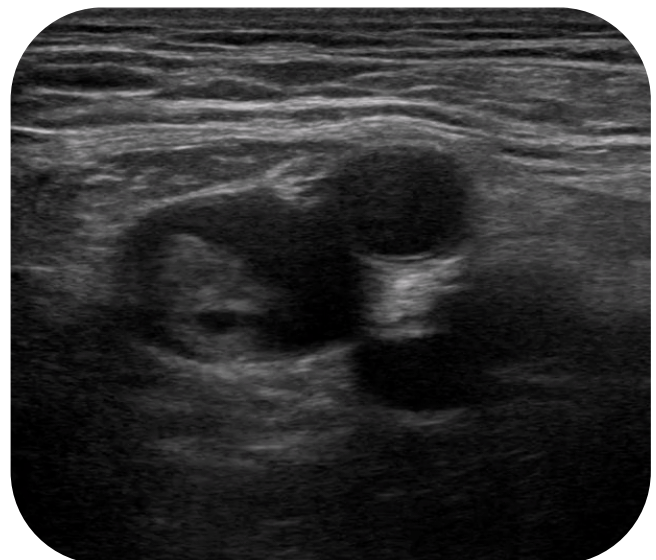


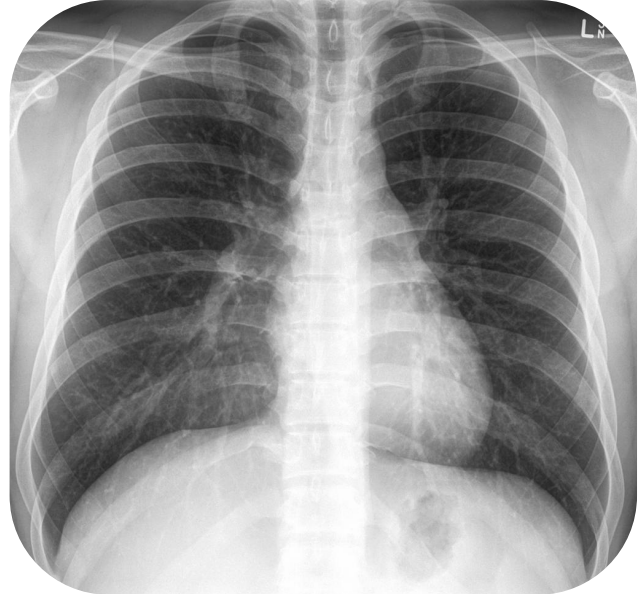
FIGURE 1. VENOUS ULTRASOUND SHOWING THE PRESENCE OF A DVT



1. Assess for Presence of Pulmonary Embolism

a) Obtain CXR

- **Purpose:**
 - Determine if the patient has an alternative cause for hypoxia (e.g. PNA, Pneumothorax, Pleural Effusions)
- **Findings Supportive of PE:**
 - Usually normal in PE



b) Obtain a 12 Lead ECG

- **Indications:**
 - Determine if the patient has an alternative cause for dyspnea and chest pain (e.g. Myocardial infarction)
 - Assess for evidence of acute right heart strain
- **Abnormal Findings:**
 - **Sinus Tachycardia**
 - Compensatory tachycardia in response to hypoxia and/or hypotension
 - **Most common finding**
 - **S₁Q₃T₃**
 - Pulmonary artery occlusion → ↑PVR → ↑Right heart strain
 - S wave in lead I
 - Q waves in lead III
 - Inverted T waves in lead III

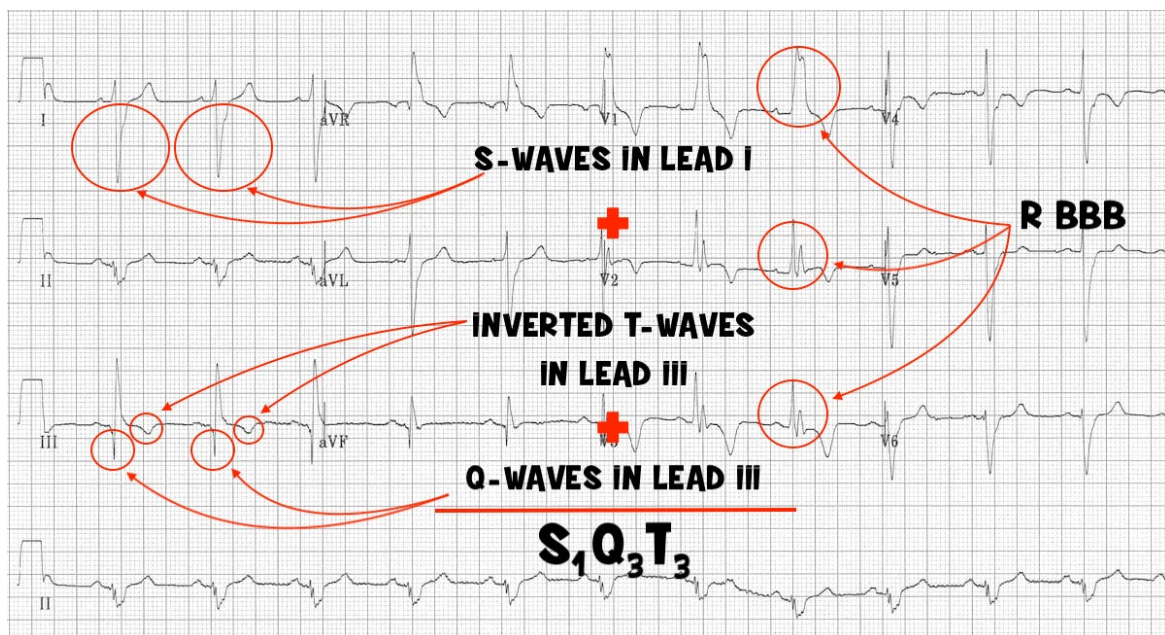


FIGURE 2. ECG SHOWING SINUS TACHYCARDIA (S₁Q₃T₃)



c) Obtain D-Dimer

- **Indications:**
 - Wells Criteria of 2-6
 - Wells criteria < 2 and PERC ≥ 1
- **Purpose:**
 - If clots are present D-Dimer levels will be significantly elevated
 - This is not specific for DVT or PE
- **Abnormal Findings:**
 - D-Dimer < 500 → Excludes PE
 - D-Dimer > 500 → Unable to rule out PE

Well's Criteria (Pretest Probability of PE)

Clinical symptoms of DVT	3 points
Other diagnoses less likely	3 points
HR >100 bpm	1.5 points
Immobilization or recent surgery	1.5 points
History of DVT / PE	1.5 points
Hemoptysis	1 point
Malignancy	1 point

PERC Criteria

Age ≥ 50	Prior PE / DVT
HR ≥ 100	Leg swelling
O ₂ Sat < 95%	Recent surgery / trauma
Hemoptysis	Estrogen use

d) Obtain CTPA vs V/Q scan

- **Indications:**
 - Wells Criteria > 6
 - D-Dimer > 500
- **Purpose:**
 - **CT Pulmonary Angiogram (CTPA):**
 - Best test
 - **V/Q Scan**
 - Preferred in contrast allergy, risk of Contrast-induced nephropathy, severe CKD, and in pregnancy (CTPA radiation)
- **Abnormal Findings:**
 - **CTPA**
 - Identifies lack of contrast filling in pulmonary arteries
 - **V/Q Scan**
 - Identifies areas of perfusion defects

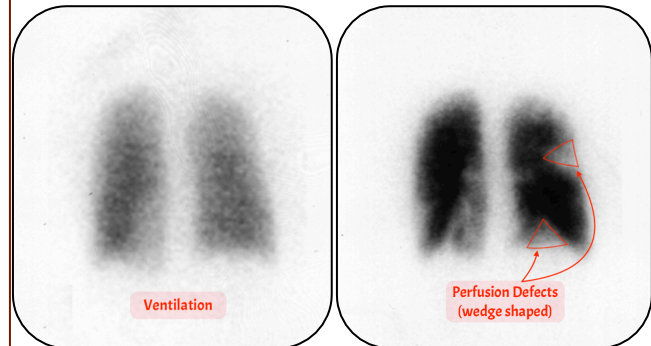


FIGURE 3. V/Q

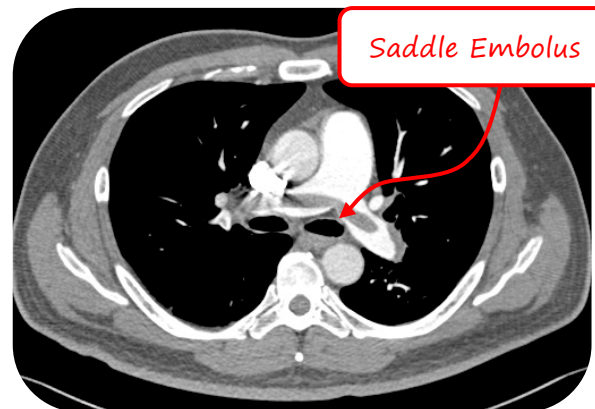


FIGURE 4. CTPA

2. Assess for the Presence of Right Heart Strain

Obtain Echocardiogram

- **Indications:**
 - Presence of pulmonary embolism found on imaging and looking to assess for RV dysfunction
- **Abnormal Findings:**
 - Low risk PE
 - No RV dysfunction
 - Submassive/Massive PE
 - RV dysfunction
 - **Monitor BP**
 - Submassive PE → Normal BP
 - Massive PE → ↓BP

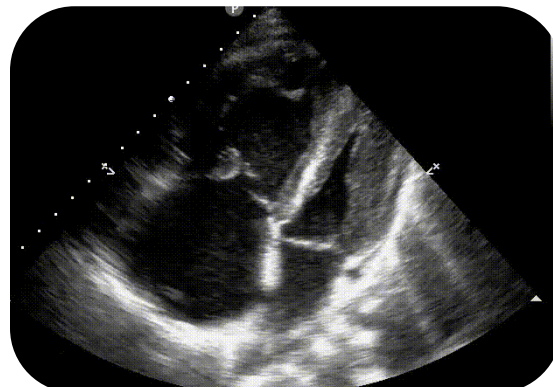


FIGURE 5. ECHOCARDIOGRAM SHOWING RV DYSFUNCTION

V. TREATMENT OF VTE

A. DEEP VEIN THROMBOSIS (DVT)

09:09

1. Remove Thrombus

- **Treatment:**
 - Thrombectomy
 - Catheter-directed thrombolysis
- **Indications:**
 - Thrombectomy
 - Massive Proximal DVT (e.g. Iliofemoral DVT) or Phlegmasia Cerulea Dolens **contraindicated in thrombolysis**
 - Catheter-directed thrombolysis
 - Massive Proximal DVT (e.g. Iliofemoral DVT) or Phlegmasia Cerulea Dolens with a **low risk of bleeding**
- **Purpose:**
 - Thrombectomy
 - Surgical removal of thrombus
 - Catheter-directed thrombolysis
 - Dissolving of thrombus via the use of tPA
- **Monitoring:**
 - Improvement in leg pain and swelling

Type of Prevention	Indications	Prevention Measures
Pharmacological	Hospitalized Patients (Immobility / Bedrest)	LMWH, Subcutaneous Heparin
Mechanical		Pneumatic Compression

2. Prevent Thrombus Propagation

- **Treatment:**
 - Anticoagulation (heparin, DOACs, warfarin)
 - IVC filter
- **Indications:**
 - Anticoagulation x 3-6 months
 - Proximal DVT
 - Persistent or worsening Distal DVT
 - IVC Filter
 - Proximal DVT **contraindicated in anticoagulation**
- **Purpose:**
 - Anticoagulation
 - Prevention of Proximal DVT clot propagation to prevent PE
 - IVC Filter
 - Prevention of clot propagation to prevent PE
- **Monitoring:**
 - Improvement in leg pain and swelling
 - Monitor PTT → Heparin infusion
 - Monitor INR → Warfarin
 - Monitor CBC and Platelets → Heparin

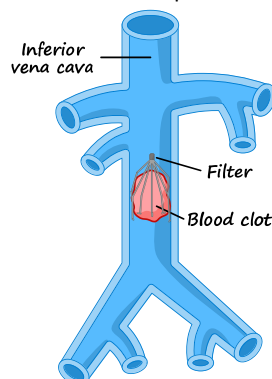


FIGURE 6. IVC FILTER

3. Prevention of DVT

- **Treatment:**
 - Pneumatic compression
 - Subcutaneous heparin
- **Indications:**
 - Pneumatic Compression
 - Contraindication to subcutaneous heparin
 - Subcutaneous Heparin
 - Prolonged immobilization
 - Postoperative state
 - Bedrest
 - Paralysis
 - Critically ill patients
- **Purpose:**
 - Pneumatic Compression
 - Intermittent compression of legs → Movement of blood through lower extremities
 - Subcutaneous Heparin
 - Binds AT-III → ↓Thrombin → ↓Clot formation
- **Monitoring:**
 - Monitor for any edema and leg pain in extremities
 - Monitor PTT → Heparin
 - Monitor CBC and Platelets → Heparin

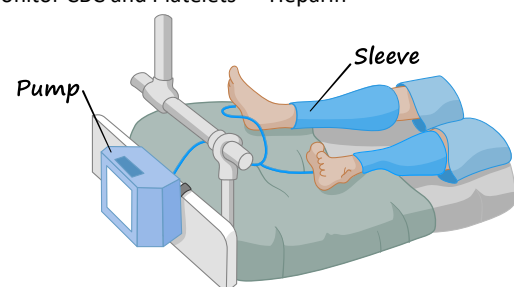
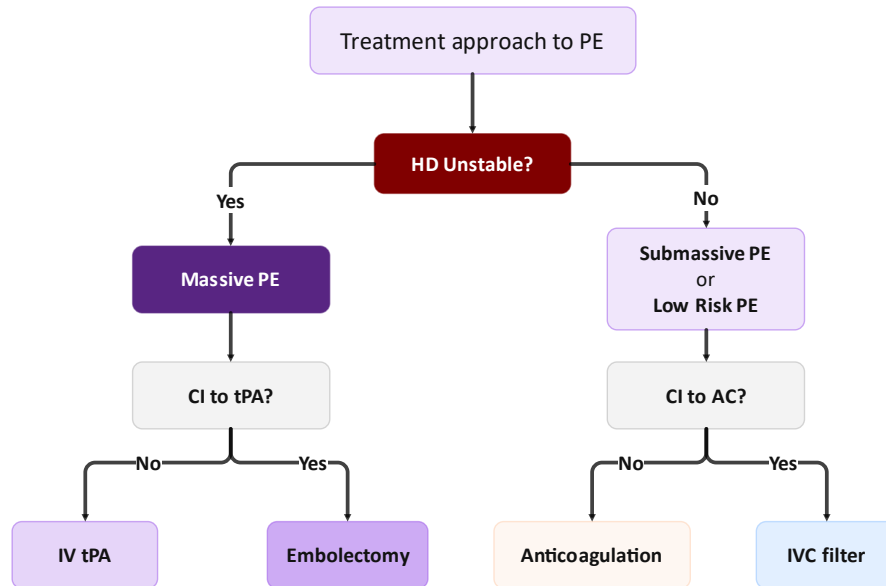


FIGURE 7. PNEUMATIC COMPRESSION





Type of PE	Contraindications to Anticoagulants or tPA?	Treatment
Submassive / Low Risk PE	No	Anticoagulation x 3 months
	Yes	IVC filter
Massive PE	No	tPA
	Yes	Embolectomy

1. Treatment of Massive PE

• Treatment:

- Embolectomy
- IV tPA

• Indications:

- Embolectomy
 - Massive PE with **contraindication to tPA**
- IV tPA
 - Massive PE

• Purpose:

- Embolectomy
 - Catheter-directed removal of thrombus
- IV tPA
 - Dissolving of embolus via the use of tPA

• Monitoring:

- Improvement in BP and HR
- Improvement in hypoxia
- Improvement in RV function

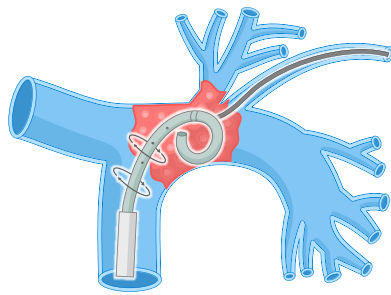


FIGURE 8. EMBOLECTOMY

2. Treatment of Submassive and Low Risk PE

• Treatment:

- Anticoagulation
- IVC Filter

• Indications:

- Anticoagulation x 3-6 months
 - Submassive PE or Low risk PE
- IVC Filter
 - Submassive PE or Low risk PE with **contraindications to anticoagulation**

• Purpose:

- Anticoagulation
 - Prevention of PE clot propagation
- IVC Filter
 - Prevention of clot propagation to prevent PE

• Monitoring:

- Improvement in hypoxia
- Improvement in RV function if submassive PE
- Monitor PTT → Heparin infusion
- Monitor INR → Warfarin
- Monitor CBC and Platelets → Heparin

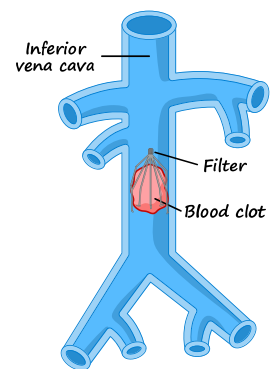


FIGURE 9. IVC FILTER

