



# Chapter 19 Disorders of the Venous System



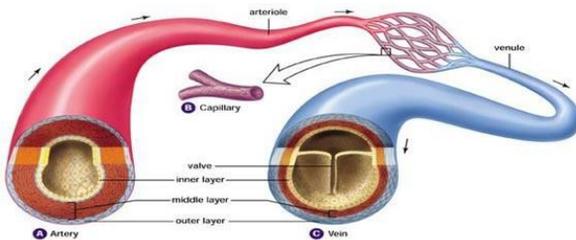
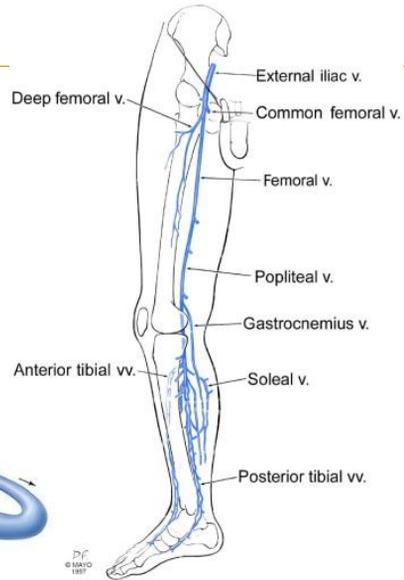
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## Veins

- Veins are large-capacity vessels that carry almost two-thirds of the body's blood volume
  - Susceptible to stasis of blood



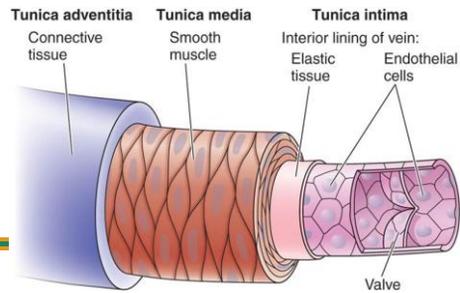
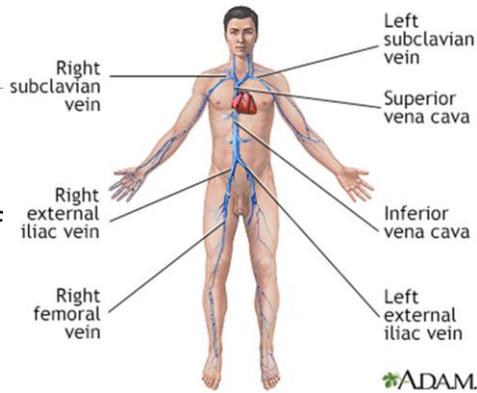
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## Anatomy of VEINS

- Thin-walled, flexible
- Vein walls are composed of three layers
  - Tunica intima
    - Endothelial cell lining
  - Tunica media
    - Thin layer of smooth muscle
  - Tunica adventitia
    - Exterior layer of connective tissue



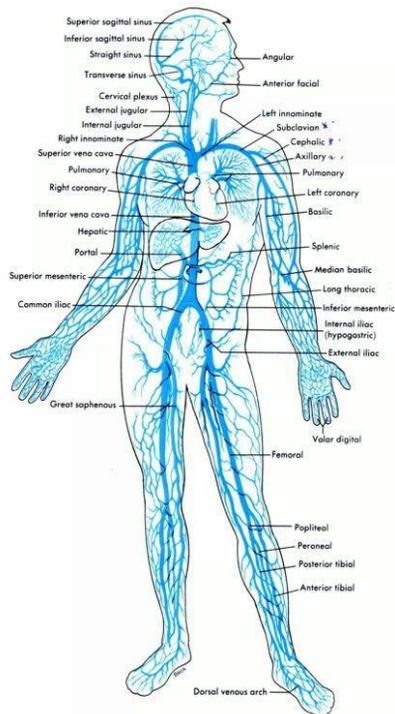
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## Anatomy of Veins

- Two systems of veins
  - Superficial, small diameter veins
    - Skin and subcutaneous tissues
    - Drain into deep veins
  - Deep, large diameter veins
    - Empty into inferior and superior vena cava

Perforating veins connect the two systems

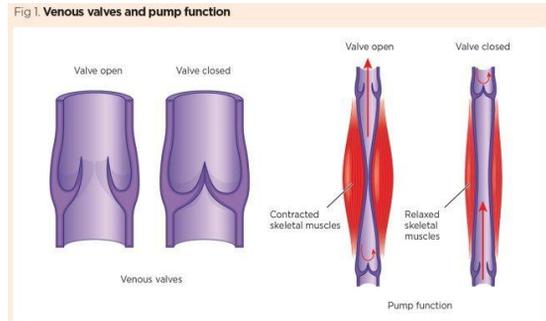


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## Physiology of Veins

- Return blood to heart
  - Low pressure system
  - Valves
- Do not pump blood
- Must work against downward pull of gravity
- Rely on skeletal muscle pump and valves



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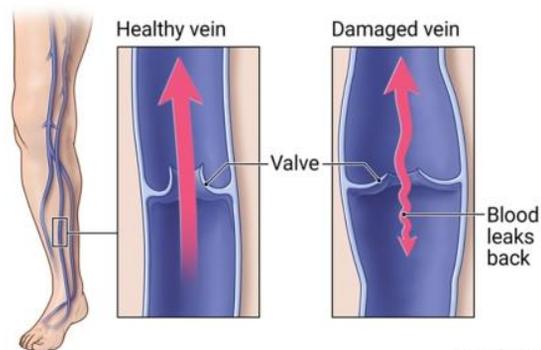
## Venous Disorders

**EPIDEMIOLOGY:** Venous disorders are common, mainly in women, adults older than age 50 years

**STAGES:** From MILD (varicose veins) to SERIOUS (DVT: deep vein thrombosis)

**TYPES:** (Major vein disorders)

- Varicose veins
- Venous insufficiency
- Venous ulcers
- DVT



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## Varicose Veins

- A varicose vein, also called a varicosity, is an abnormally dilated superficial vein



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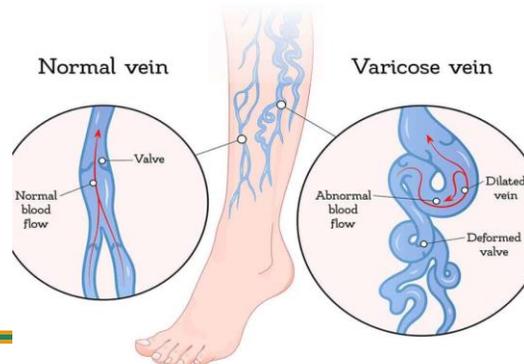
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## Varicose Veins (continued)

- Varicosities more likely in superficial veins
- **Epidemiology:** Prevalence increases with age, more common in women
- **Causes:** Due to high pressure within the superficial veins that weaken valves
  - Pressure increased by *prolonged standing or sitting, pregnancy, obesity*



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## Treatment / Prevention

- **Treatment:** Remove the superficial veins by:
  - Surgery
  - Endovenous ablation
  - Sclerotherapy ablation (inject sclerosing substance in vein)
- **Prevention:** Elastic, supportive stockings, moving/walking, elevating legs



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## Venous Insufficiency

- **Deep or superficial veins**
  - Superficial vein distension
    - Varicose veins
  - Deep veins
    - Susceptible to increased hydrostatic pressure, as with standing
    - Can lead to edema in tissues
    - Deep vein insufficiency can lead to DVT
- **Risk factors:**
  - Obesity and pregnancy can weaken valve leaflets in veins
  - Hardiness of veins is an inheritable quality - Familial predisposition for venous insufficiency



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## Diagnosis of Venous Insufficiency

- Doppler ultrasonography
- Photoplethysmography
  - Emits light to determine volume of blood in circulation
- Venography
  - Determine venous blood flow
  - Used to identify occlusions, collaterals

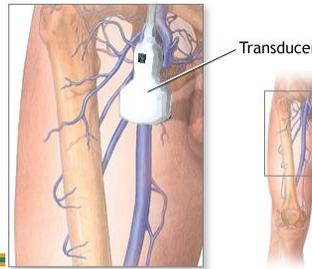
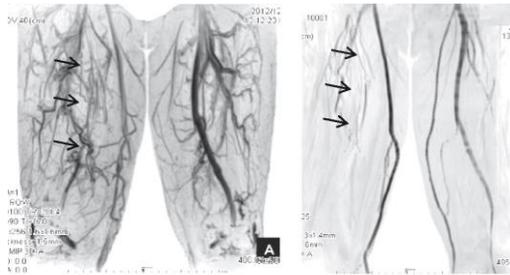
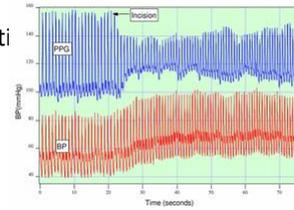
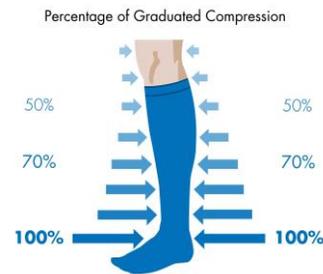
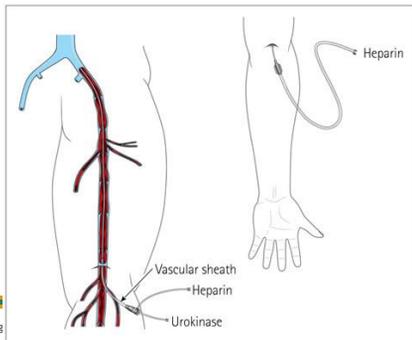


Fig. 2 MRV image with DVT in common femoral vein. MRV, magnetic resonance venography; DVT, deep vein thrombosis.  
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## Treatment of Venous Insufficiency

- Gradient compression *stockings*
- Pneumatic compression *devices*
- Anticoagulant or antiplatelet *medications* are used
- Catheter-delivered thrombolytic agents
- Venoablation to remove major reflux pathways
  - Sclerotherapy, radio frequency ablation (RFA), and endovenous laser therapy (EVLT)



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## Chronic Venous Insufficiency (CVI)

- Often result of damage to valves in the deep leg veins
  - Valves damage impairs venous return.
- Causes:
  - Trauma
  - Obesity
  - Pregnancy
  - Prolonged standing



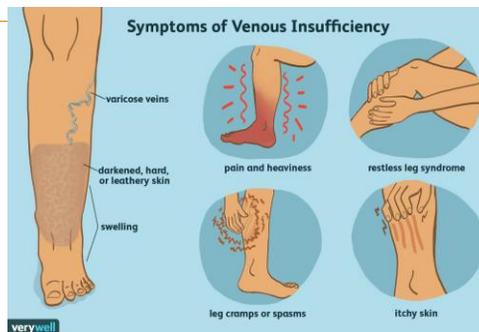
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## Clinical Presentation Chronic Venous Insufficiency

- Shiny skin
- Dusky discoloration
- Edema
- Poor healing
- Reduced/absent hair distribution
- *Stasis dermatitis*
  - Circumferential dusky discoloration noted on lower extremity
  - Due to build up of hemosiderin



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## Venous Ulcers (venous stasis ulcers)

- **Occur in** lower extremities affected by venous insufficiency → lack of circulation leads to Skin breakdown, tissue damage, and necrosis occur
- **Caused by** Trauma or pressure on the lower limbs
- **Pathophysiology:** Sluggish circulation → poor tissue oxygenation, poor cellular nutrition, poor waste product removal
- **Signs/Symptoms:** dark red in color, has an uneven margin, is usually painful, and is accompanied by a large amount of edema and drainage
  - Lateral malleolus common site for venous ulcer
- **Treatment**
  - Lifestyle modifications, measures to promote venous return



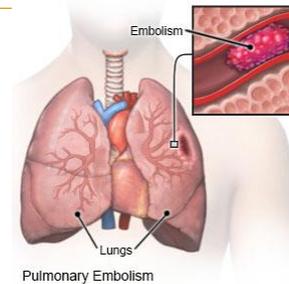
### Stages of development of varicose ulcers



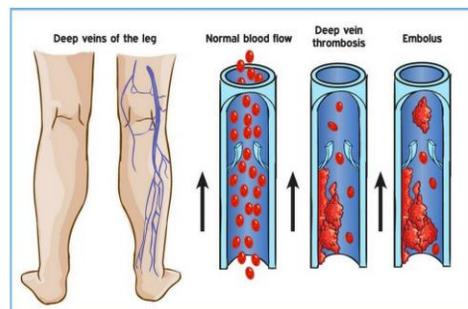
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## Deep Venous Thromboembolism (DVT)

- Encompasses both **DVT** and **pulmonary embolism (PE)**
  - Hospital admissions for DVT are increasing, likely due to greater sensitivity to detect



- **Virchow's triad**
  - Venous stasis
  - Vascular damage
  - Hypercoagulability

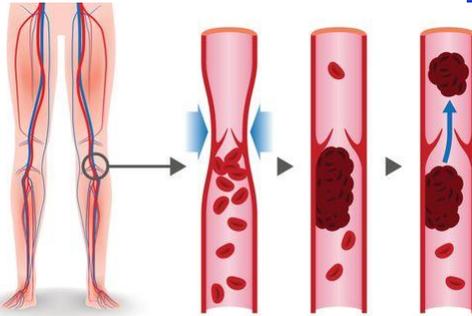
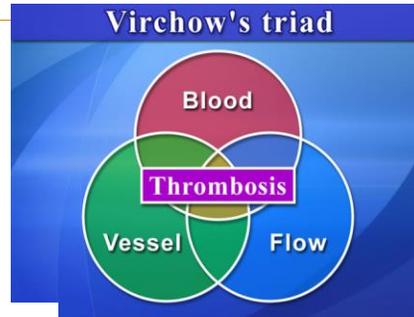


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## Deep Venous Thromboembolism (DVT)

- Virchow's triad
  - Venous stasis
  - Vascular damage
  - Hypercoagulability



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## Examples of Virchow's Triad Conditions

- Venous stasis
  - Sedentary behavior, immobility
- Venous injury
  - Trauma or surgery (especially orthopedic (may occur in 30% to 80%) of post-op patients)
- Hypercoagulability
  - Cancer, estrogen (oral contraceptive pill), smoking



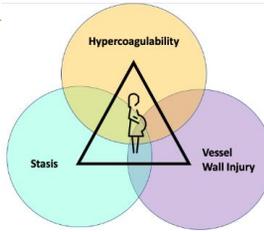
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## Clinical Presentation of DVT

- Look for characteristics of Virchow's triad
- DVT may present with:
  - Unilateral leg pain
  - Redness
  - Ropiness
  - Tenderness
  - Warmth over vein
  - Calf may be swollen



### Signs and Symptoms of a DVT

- Leg swelling
- Ache
- Pain
- Redness

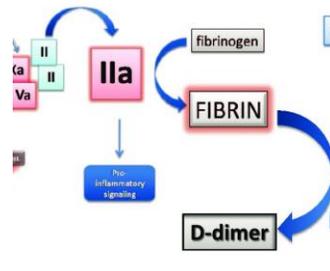
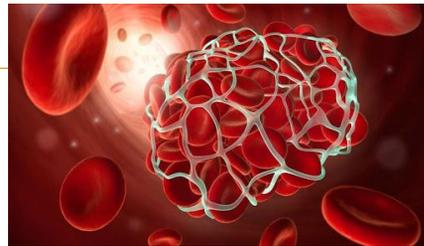


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## Diagnosis of DVT

- D-dimer (blood test that detects the presence of fibrin clot degradation products in the blood / Measures fibrin clot degradation)
  - Used to rule out if DVT has not occurred, not diagnose
  - Levels remain elevated in DVT and PE for about 7 days
- Well's criteria
  - Clinical signs of DVT, such as leg swelling
  - Scale of 0 to 3



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## Diagnosis of DVT (continued)

- **Negative D-dimer and Well's score less than 2** rules out DVT

- **Positive D-dimer and Well's score greater than 2** requires duplex ultrasonography to confirm

Wells Score Criteria Description	Points
Active Cancer (treatment within last 6 months or palliative)	+1 point
Calf swelling $\geq$ 3 cm compared to asymptomatic calf (measured 10 cm below tibial tuberosity)	+1 point
Swollen unilateral superficial veins (non-varicose, in symptomatic leg)	+1 point
Unilateral pitting edema (in symptomatic leg)	+1 point
Previous documented DVT	+1 point
Swelling of entire leg	+1 point
Localized tenderness along the deep venous system	+1 point
Paralysis, paresis, or recent cast immobilization of lower extremities	+1 point
Recently bedridden $\geq$ 3 days, or major surgery requiring regional or general anesthetic in the past 12 weeks	+1 point
Alternative diagnosis at least as likely	-2 points

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## Treatment of DVT: Anticoagulants

- **Prophylactic treatment** with drugs that interfere with clotting → Prolong clotting time
- **Possible medications**
  - Factor Xa inhibitors
  - Direct thrombin inhibitors
  - Low molecular weight heparin
  - Unfractionated heparin
  - Warfarin
- **IMPORTANT:** Monitor the therapeutic effects of heparin and warfarin, prothrombin time (PT) and activated partial thromboplastin time (aPTT)
  - measures the time it takes for the blood to clot

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## Anticoagulant Treatment Monitoring

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- **Clotting Time**
  - PT measures the extrinsic coagulation system,
  - aPTT measures the intrinsic coagulation system.
  - International normalized ratio (INR) also indicates clotting time
- **Goal of DVT therapy**
  - Increase clotting time to 1.5 to 2.5 times normal

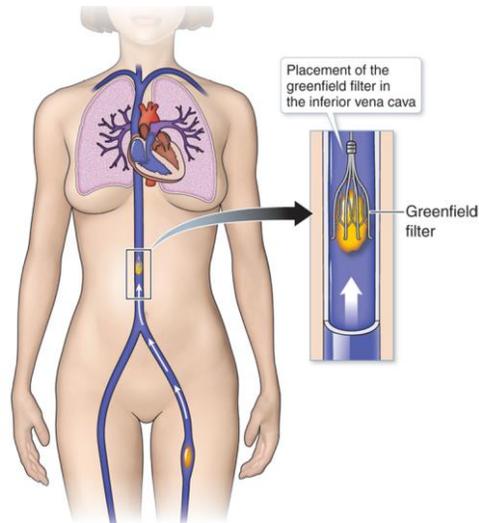
## Clot Busters

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- Thrombolytic agents, known as “clot busters”
- Dissolve existing clot
- Only patients with no risk of bleeding are eligible

## Inferior Vena Cava Filter (Greenfield filter)

- Blocks clots from lower extremity
- Prevent clot from entering pulmonary circulation
- Thrombectomy
  - May be used if other treatments fail



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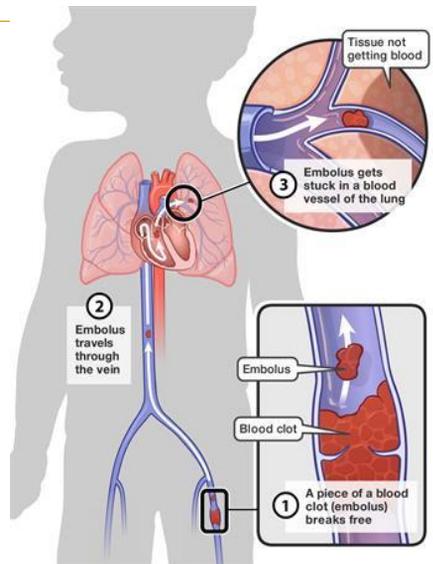
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## DVT Leading to Pulmonary Embolism (PE)

- Stasis of venous blood leads to thrombus
- Inflammation occurs and a thrombus forms in the vein
  - The thrombus becomes an embolus and travels into the inferior vena cava
  - From inferior vena cava thrombus travels into right atrium
  - From right atrium into pulmonary artery

**In pulmonary artery:** referred to as PE

**Clot may block blood supply to area of lungs**



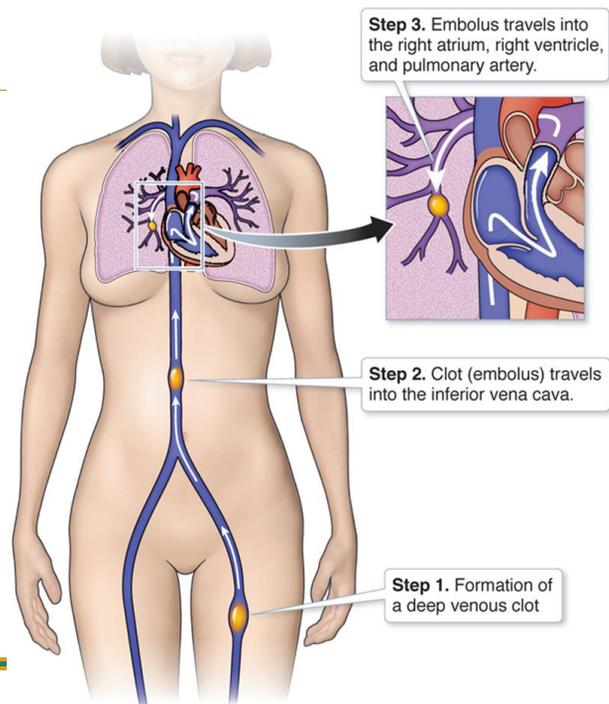
→ PE can be fatal

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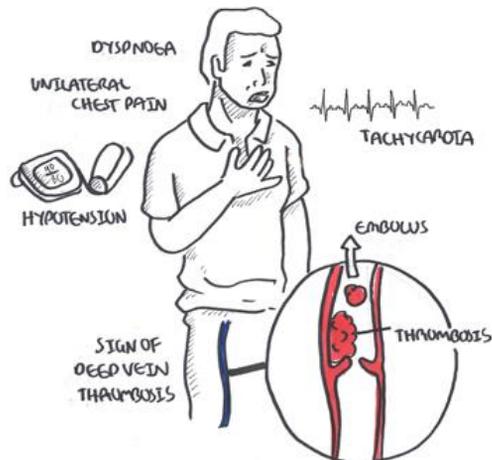
## DVT to PE



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## Clinical Presentation of PE

- Can be silent
- Dyspnea
- Chest pain
- Tachycardia
- Hypotension
- Hemoptysis



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## Diagnosis of DVT and PE



20.3 Resistance and Resistivity

### Impedance Plethysmography.



$$R = \rho \frac{L}{A} = \rho \frac{L}{V_{\text{cell}}/L} = \rho \frac{L^2}{V_{\text{cell}}}$$

Measuring small changes in resistance reflect changes in the volume of blood, which is a good conductor.  
→ Used as an indicator for *venous thrombosis*



- Can not be diagnosed based solely on symptoms, which may be absent
  - Not ideal to perform imaging studies in all patients suspected of DVT
- DVT
  - Duplex ultrasonography
    - Ultrasound plus Doppler blood flow
  - Impedance plethysmography (IPG)
    - Measures blood volume of extremity
  - CT venography and MRI (test of choice in some circumstances)