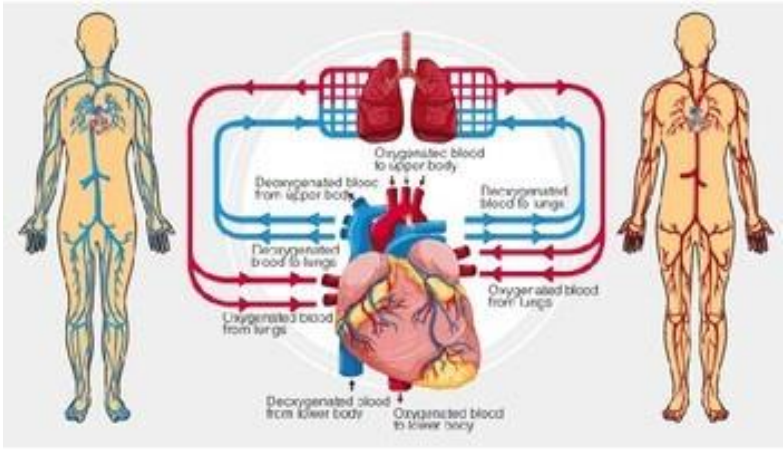
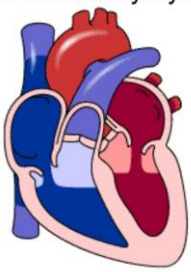
Cardiovascular System



1

- Right Side Heart Failure – blood moving backwards into _____
- Left Side Heart Failure – blood moving back into _____

The Circulatory System



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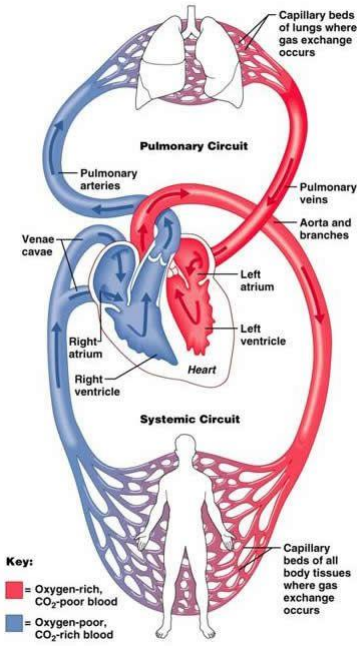

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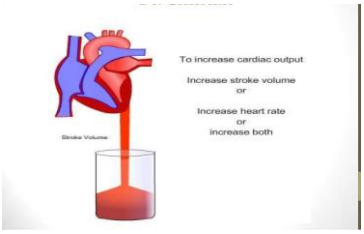
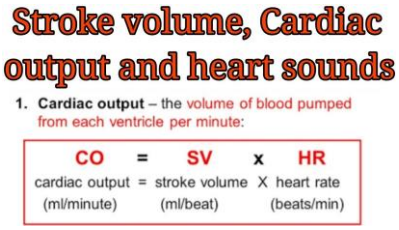
How to assess cardiac output



- **Cardiac output is the product of the heart rate**
- **Cardiac output =** volume of blood the heart pumps per minute.
  - is calculated by multiplying the stroke volume (SV) by the heart rate (HR).
    - Stroke volume is the volume of blood pumped from the ventricle per beat
    - Stroke volume is determined by preload, contractility, and afterload.

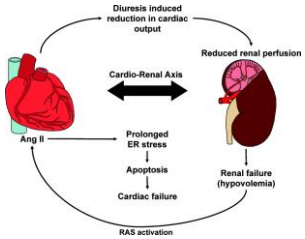


- How do you measure cardiac output?

3

Cardiac output

- If your heart is weak, your Cardiac Output (CO) will _____ (Increase? Decrease?)
- If your CO decreases, will you perfuse properly? (Yes? No?)
  - Your brain will be well perfused? (LOC ? ↓)
  - Your heart? (chest pain)
  - Your skin? (cold and clammy)
  - Lungs? (edema[wet lungs])
  - Peripheral Pulses? (decrease, or absent)
  - Kidneys? (↓ urine output)



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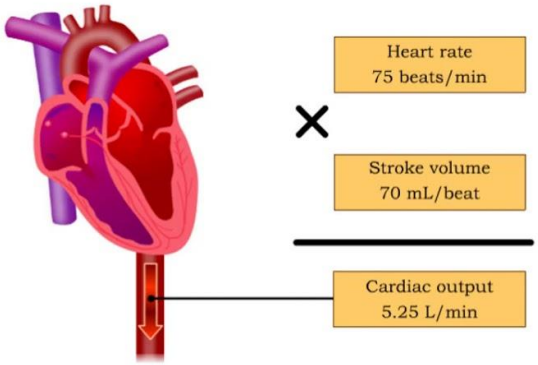

Introduction

- Cardiac output:
  - Maintains blood flow throughout the body.
  - Measure of blood volume ejected from the heart over a given time.
  - Determined by multiplying heart rate by stroke volume (CO = SV x HR).
- Heart rate: Number of beats/min.
- Stroke volume: Amount of blood ejected from the ventricles during one heartbeat.

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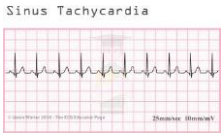
Cardiac output (CO)

- Cardiac output => think left ventricle (how much blood the left ventricle is pumping out to the body?)

- HR ↓ (ex: 30 bpm) leads to => less volume => less pressure (BP ↓) => compensatory mechanisms come (elevate to at least 90 to perfuse my body)
- HR ↑ excessively (ex: 250 bpm)=> extreme tachycardia => ventricles have no time to fill => cardiac output ↓



- ARRHYTMIAS are no big problem, <u>until it affects CO</u>
- Asystole and Ventricular Tachycardia => no cardiac output

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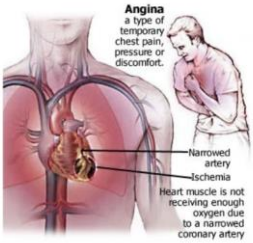
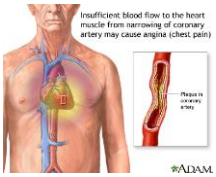
Chronic **stable** angina



- Decreased blood flow to the myocardia
  - Chest Pain caused by _____ (Ischemia? Necrosis?)
    - Caused by Coronary disease
    - What brings the pain? Low O_2
    - Usually due to exertion
    - What relieves?
      - Rest
      - sublingual Nitroglycerin
        - causes vasodilation → decrease in preload and afterload (↓workload)
        - Dilation of coronary arteries => increases blood flow to myocardia (more O_2)
        - Take 1 every 5 min → 3 doses sublingual (keep in glass bottle, cool, dry, and 👍 places)
        - To avoid headaches and dizziness → don't change position fast, sit, etc.
        - RENEW EVERY 6 MONTHS
        - After taking, BP drops → patient unstable (even though BP is expected to rise again)
          - → Do not leave the patient until BP rises to at least 90



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Chronic **stable** angina

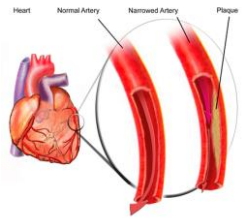
Medication:

-Nitroglycerin

-Beta blockers → decreases BP, Pulse, heart beat slowly and less strength

-Calcium channel blockers → ↓ bp, dilate coronary arteries enhancing blood flow to heart muscles

-Aspirin → anti platelets effect



Patient education: (#1 rule: do all to decrease the workload of the heart)

-Avoid isometrics (muscles squeeze)

-Avoid over eating

-Avoid drugs that increase heart rate

-Avoid extreme temperatures (dress properly)

-Rest frequently

-Rest 2 hours after meals before exercising

-Take nitroglycerin prophylactically (teach the patient to sit and take, avoid dizziness)

-Stop smoking

-Lose weight

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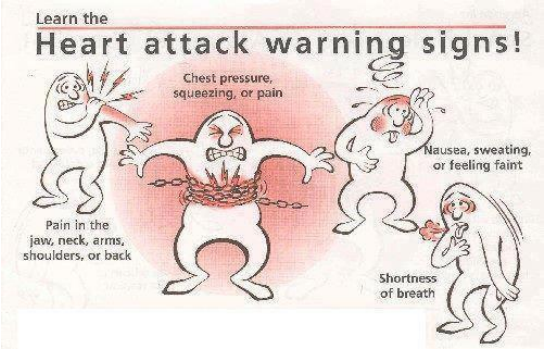
Acute Coronary Syndromes
- Unstable Angina
- MI



- As angina gets worse, the more unpredictable (unstable)
- Decreased blood flow to the heart, bringing _____
  - (ischemia? necrosis? Both?)
- Pain comes anytime (do not need to be doing anything)
  - Actually, many MI occur when coming out of REM sleep
- Rest or Nitroglycerin do **not** relieve pain

Signs and Symptoms *(most common, classic. – But can be different)*

- Pain, Pressure in the chest, radiation to the left side.
- Cold, clammy skin, BP Drop → cardiac output is going down.
- Temperature increases due to inflammation
- EKG changes (heart is irritated)
- Vomiting (lot of pain→ vagus nerve is stimulated, drops heart rate → less blood on GI tract → nausea

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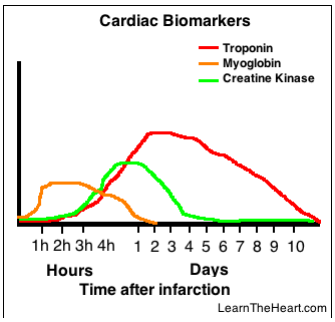
Acute Coronary Syndromes: - Unstable Angina - MI

Cardiac Enzymes / Cardiac Biomarkers

→Cardiac enzymes are released into the circulation when myocardial necrosis occurs.
→lactate dehydrogenase, or LDH, was also used but is non-specific



MYOGLOBIN

- released into circulation with **any** damage to skeletal muscle tissue.
- quite **nonspecific** for MIs.
- Benefit: detectable increase is seen only 30 minutes after injury occurs

TROPONIN (detectable increase can take between 3 and 4 hours)

- Troponin I and Troponin T → normal proteins that are important in the contractile apparatus of the cardiac myocyte.
- remain detectable for 10 days following →allows for the late diagnosis of MI but makes it difficult to detect re-infarction, as can occur in acute stent thrombosis after percutaneous coronary intervention, or PCI.
- There are a number causes for troponin elevation not related to myocardial infarction; however, troponin elevation is much more sensitive than myoglobin and even creatine kinase.

CREATINE KINASE (CK) (detectable increase can take between 3 and 4 hours)

- also known as creatine phosphokinase, or CPK — is a muscle enzyme that exists as isoenzymes.
- The MB type is specific to myocardial cells, whereas MM and BB are specific to skeletal muscle and brain tissue, respectively.
- The CK level increases approximately 3 to 4 hours after MI and remains elevated for 3 to 4 days.

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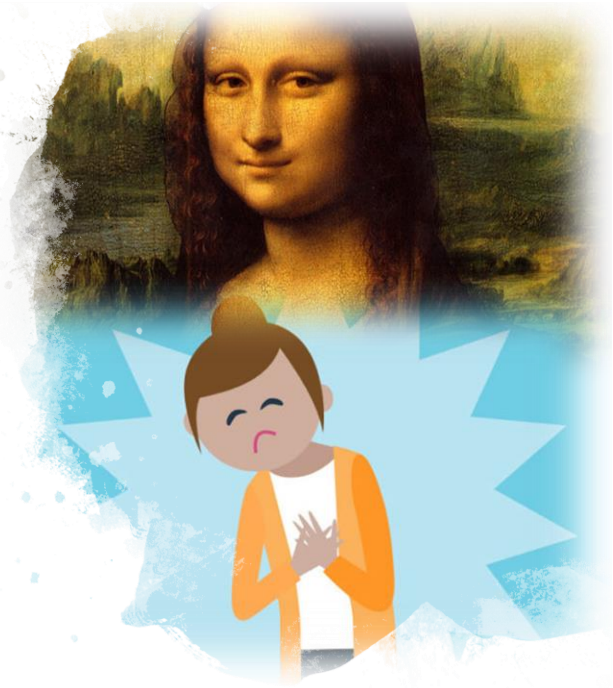
- If a client comes in complaining chest pain → give an aspirin
- Morphine for pain (IV) →releases pain and cause vasodilation (what decreases workload of the heart → helps saving the remaining muscles of the heart)



For chest pain (non-specific): MONA

- M → Morphine
- O → Oxygen
- N → Nitroglycerin
- A → Aspirin

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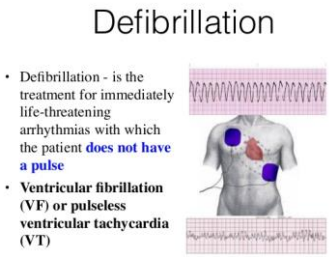
- What **untreated arrythmias** will put the patient on risk for **sudden cardiac death**?
  - Ventricular Fibrillation*
  - Pulseless Ventricular Tachycardia (you can have V tach with pulse)
  - Asystole

*Shock immediately – **early defibrillation**

- **Drugs**:
  - Lidocaine (side effects: check for neuro changes)
  - Amiodarone (side effects: hypotension and other arrythmias) (arrythmias can decrease Cardiac Output)
  - Position: Head up (to decrease workload of the heart and increase cardiac output)
  - Interventions: PCI (Percutaneous Coronary Intervention - that includes angioplasty and stents)
    - Can be for single or double vessel disease
    - Major complications: MI, bleeding
    - If any problem occur, patient go to surgery
    - If Chest Pain after procedure → call the dr.: Patient is reoccluding



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Rehabilitation

- Smoke cessation
- Diet (↓salt, ↓cholesterol – no processed food, no trans fat)
- A little bit of exercise: WALK (no isometrics [increases workload],
- No Valsalva [stimulates Vagus] (bradycardia can cause asystole) – no suppositories (give collates)
- If the client can walk around the block, stairs, with no discomfort, can resume sex (morning: well rested)
- Know that is risk for heart failure when: ankle edema, shortness of breath, confusion, weight gain

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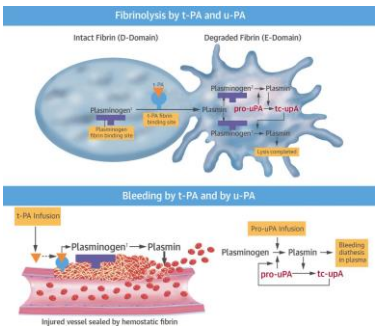
Fibrinolytics



- **Goal:** to dissolve the clot that is blocking blood flow muscle, to decrease the size of the infarction
- There are three major classes of **fibrinolytic drugs**:
  - Tissue plasminogen activator (tPA),
  - streptokinase* (SK), [*people can present allergy -> monitor for anaphylaxis]
  - and urokinase (UK).
- Administer 6 to 8 h (3 h for stroke)
- **Major complication:** bleeding (get a good history: recent surgeries, stroke, ulcer)
- **Contra-indications:**
  - intracranial neoplasm, intracranial bleed, any suspicion of internal bleeding
  - [Heparin, Coumadin, Lovenox]
  - Alcoholics/ Tylenol overdose/ hepatitis/ cirrhosis (the liver is very important to control bleeding)
  - Thrombocytopenia/ any kind of bleeding problem

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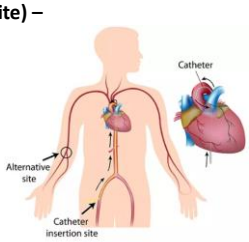
Fibrinolytics

- Look for arrythmias. Patient can have some because with Fibrinolytics the heart is being reperfused.
- Arrythmias can affect your Cardiac Output.
  - Decrease punctures and puncture sizes (arteries are hard pressure and will really bleed)
  - **For IV:** prefer ante cubital instead of Central line (**you must give a fibrinolytic in a compressible site) –** Hold pressure for 10 min after IV. Avoid IM



Cardiac Catheterization

- **Pre procedure: check for allergy** to shellfish or intravenous dye, or has diabetes or kidney disease. These **patients may not** tolerate the iodine-based dye
- **During the procedure:**
  - During the injection patient feel warm and flush (warn them ahead of time. It is scary→ decrease anxiety
  - Palpitation is normal
- **Pos procedure:**
  - Risk for bleeding, hematoma
  - Access puncture site for bleeding, hematoma
  - Access extremities distal on the puncture site (pain, pallor, pulselessness, paresthesia, paralyses)
  - Bed rest , leg straight for 6-8 h (can not ambulate . # 1 concern: bleeding)
  - Report pain as soon as possible

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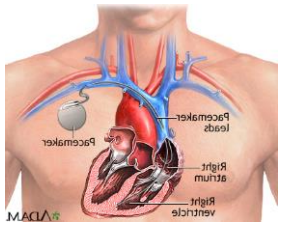
Pacemakers

- Depolarize the heart muscle (hopefully a contraction will occur) → that's why is important to watch the patient, not the monitor (pulseless electrical activity can occur → the electrical part of the heart is working but not the mechanical)
- **Repolarization** (Rest - Ventricles fill up with blood again)
- **3 types:** Temporary, Permanent, Transcutaneous.
  - Pacemaker works when my own rate slows and demands it.
  - Rate can not decrease from the set rate.
  - **Displacement risk:** immobilize the arm on that side (the wires need time to embed in the heart)
  - **Signs of malfunction:** Decreased cardiac output or <u>Decreased rate</u> (check pulse!!!)
  - (avoid microwave, MRIs, big magnets can take pacemaker off)
  - Avoid contact sports



CHF (Congestive Heart Failure)

- **Is a complication that can result from a problem such as Cardiomyopathy, Valve disease, endocarditis, acute MI.**
- **Congestive heart failure**: Inability of the heart to keep up with the demands on it, with failure of the heart to pump blood with normal efficiency. When this occurs, the heart is unable to provide adequate blood flow to other organs, such as the brain, liver, and kidneys. Abbreviated **CHF**.

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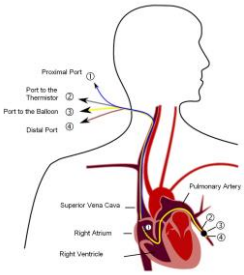
- When **left heart** fails, blood goes back into the lungs (pulmonary symptoms)
- Right side of heart failing (Cor pulmonale) – blood backs to venous system:
  - Enlarged organs
  - Edema
  - Distended neck veins
- One side failure can lead to the other side failure. But can be pure one side failure. Pure right side failure, the cause is pulmonary hypertension
- Systolic heart failure: heart cannot contract well
- Diastolic: heart cannot relax and fill
- Diagnosis: with swan catheter (type of central line that measure pressure inside the heart – more volume = more pressure)
  - Complication: air embolism or pulmonary infarction
    - Measure BP continuously on a monitor
  - Allen's Test (next slide) – to check for more circulation (if radial artery is occluded, your hand is still perfused)



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Allen's Test And its procedure

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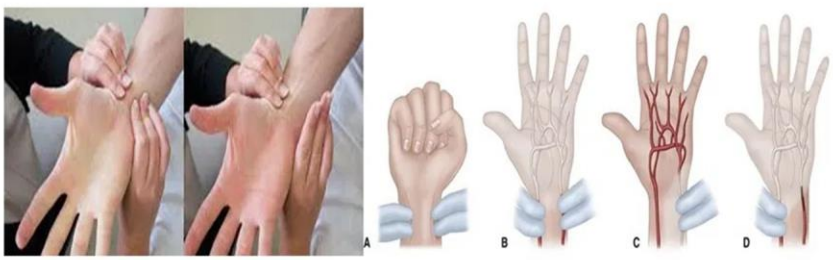

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CHF

- Ways to diagnose:
- BNP (Brain Natriuretic Peptide)
  - If patient using Nitrocor: stops 2 h prior drawing
- Chest X-Ray: large heart and pulmonary edema
- Echocardiogram: look at ejection fraction, pumping action (pic of the muscle)
- NY heart association- functional classification: I to IV(more severe)

Remember:

- When an artery is punctured, its pressure is high and blood returns
  - Need of **pressure cuff** to force the fluid in
  - Check distal circulation!
  - If patient pushes out the line → put pressure (arterial bleed)
  - Put arm on arm board to stabilize

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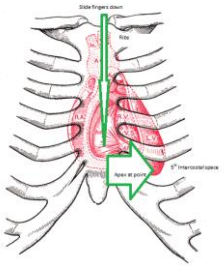
Heart Failure - Treatment

- Digitalis – controversial: can increase workload
  - Can control atrial arrythmia
  - Contraction stronger
  - Decreases heart rate (this gives the ventricle more time to fill with blood)
    - Squeezing down more blood volume with stronger contraction → cardiac output goes up
      - Kidney perfusion goes up (diuresis is good!! Patient cannot handle volume)
  - Loading dose: 1st few doses are bigger to build a therapeutic blood level
    - Normal Digitalis level: 0.5 to 2
  - Know it is working because cardiac output goes up → blood moving forward.
  - Intoxication: early signs: anorexia, nausea and vomiting
    - Arrythmias later, visual change
    - Before administering: check apical pulse (5th intercostal space
      - Midclavicular line (point of maximal impulse)
      - Not the same for everybody
    - Monitor electrolytes (Hypokalemia is the most problematic)
      - All electrolytes have to remain normal



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Heart Failure - Treatment

Other drugs:

- Diuretics (give morning time) – (Decrease preload)
- Aldactone (decrease hold on sodium and water)
- ACE inhibitors
- Beta blockers

Very important => Try to decrease Pre load

- Do not use salt substitutes - contain a lot of potassium
- Do not use canned and processed food (too much salt)

Elevate head of the bed:

increase cardiac output (gravity) – decrease workload

Weight gain

too much weight gain → water retention → can lead to pulmonary edema

in general during night time

if patient becomes restless, anxious – patient is hypoxic

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- **Lasix:** Decrease pre load through diuresis and vasodilation
  - 40 mg IV
  - Do not give too fast: BP decreases too much, or kill hearing nerve (8^{th}) ototoxic
  - Can be continuous
- **Nitroglycerin** IV to decrease afterload (diminish amount of pressure on the aorta – less pressure and cardiac output goes up)
  - With pulmonary edema, too much blood going back to the lungs. We want cardiac output to increase, more blood moving forward.
- **Morphine** IV push for vasodilation
- **Natrecor**: vasodilation and some diuresis

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Cardiogenic shock (Pump failure)

- What to do: decrease work load on the heart and allow heart muscle to rest.
- Pulmonary edema:
  - Sitting up, legs down
  - Check lung sounds
  - Avoid excess fluid volume

- Cardiac Tamponade (accumulation of fluid in the **pericardial** space)
  - Cardiac output decreases
  - Blood Pressure and CVP are different here, because BP decreases (hemorrhag pericardial space) and pressure inside the heart increases (heart compressed l membrane)
  - Heart sound distant (blood prevents to hear)
  - Neck vein distend
  - Can go into shock
  - Narrower BP (systolic near diastolic)

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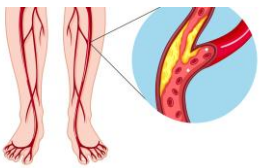
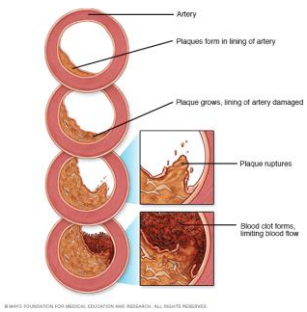
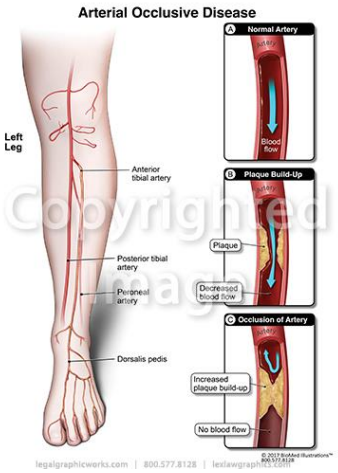
Arterial Disorders



- **Arteries:** carry Oxygenated blood
- **Veins:** carry Deoxygenated blood
- **Artherosclerosis:** hardening, calcification, plaques - can affect arteries anywhere in the body
- If there is **Acute arterial occlusion:** it is **Medical** emergency:





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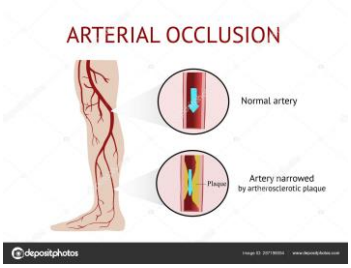
Arterial Disorders of lower extremities



- Medical emergency: Acute arterial occlusion
  - Patient can lose the extremity.
  - More syntomatic in lower extremities
- Symptoms:
  - pain, intermittent claudication: Without adequate arterial blood supply -> without adequate O_2 -> from aeorobic metabolism to anaerobic metabolism (end product is lactic acid, which causes buring pain)
  - numb, cold: no adequate perfusion/oxigenation
  - peripheral pulse: arteries are not being filled. (blowing, whooshing, or rasping sounds)
  - skin and nails changes (ulceration can occur)
  - rest pain: severe obstruction (pain without increased demand)

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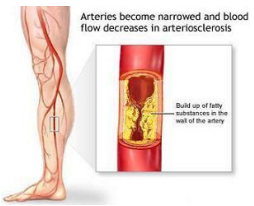
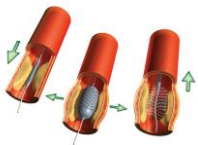
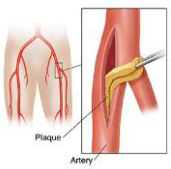
Arterial Disorders of lower extremities



- Medical emergency: Acute arterial occlusion
  - **Position:** Do not elevate the legs. Do not elevate artery problems
    - Legs down, to promote circulation (*elevate veins problems*)
  - Treatment:
    - Angioplasty balloon
    - Endarterectomy





When answering artery questions:

- If answering an artery question, think:
  - → not getting Oxygenation
  - → which artery? What that artery is feeding?

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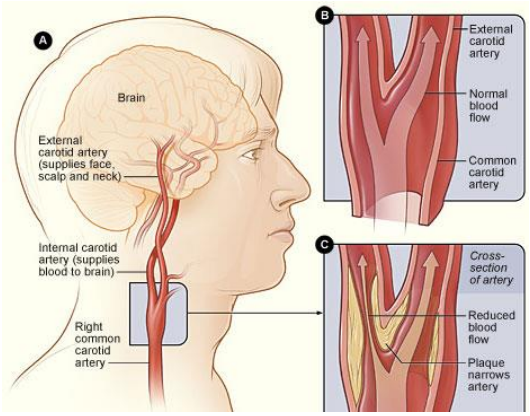
Arterial Disorders

A patient just had a carotid endarterectomy.

How can you tell if the procedure was a success?

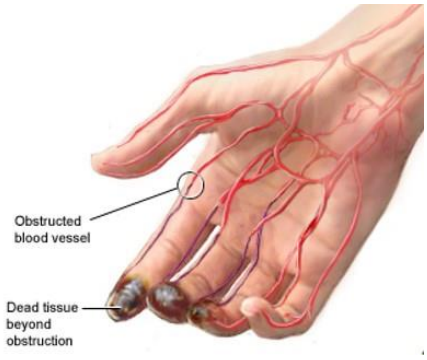
- ( ) Check temporal pulse?
- ( ) Check LOC?
- ( ) Check the patient's hair?



27

Arterial Disorders

- **Buerger's disease**
  - rare disease of the arteries and veins in the arms and legs.
  - also called thromboangiitis obliterans — your blood vessels become inflamed, swell and can become blocked with blood clots (thrombi).



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Arterial Disorders

- **Buerger's disease** causes: (vasoconstriction)
  - Smoke
  - Stress
  - Extreme cold
- Treatment:
  - Avoid the causes (stop smoking, wear gloves when dealing with too cold, etc.)
  - Hydration (blood thinner t
  - Avoid trauma (diabetes)
  - Surgery, amputation

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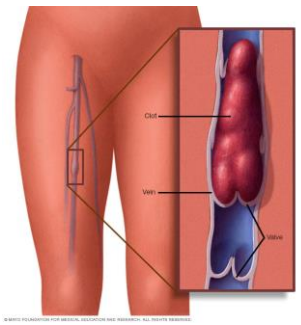
DVT

- **Deep vein thrombosis** (**DVT**) occurs when a blood clot (thrombus) forms in one or more of the deep veins in your body, usually in your legs. **Deep vein thrombosis** can cause leg pain or swelling, but also can occur with no symptoms.



- **Causes:** vasostasis, vessel injury, blood coagulation problems
- -> the blood can get to the tissue (no problem with oxygenation in that tissue)
- -> the blood cannot get away. It is trapped.

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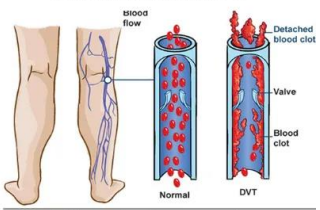

What is Deep vein thrombosis DVT

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DVT

Symptoms: Tenderness, Edema, Positive Homans (careful, you can dislodge a clot)

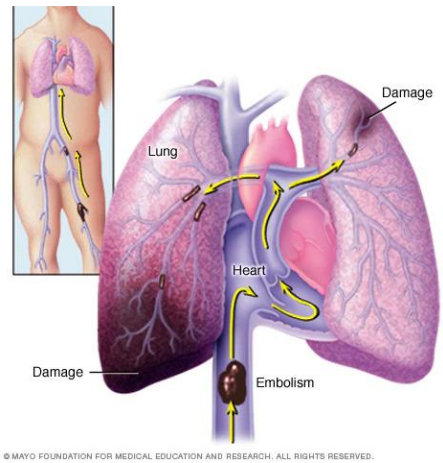
- Meds, Lab (memorize)

Treatment:

- bed rest, elevate, TED hose* → to increase blood return
  - *do not use if there is a known clot (do not compress a clot – can dislodge)
- Warm moist heat → to decrease inflammation - Warm-(not hot -> vasodilation)

Prevention:

- Ambulation
- Hydration
- Isometrics
- Sequential Compression Device (**SCD**)



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