Cardiovascular System

- Presented by: Julie Ross, BSN, RN

Cardiovascular System

Anatomy & Physiology (Review)

- Composition
  - Heart
  - Blood vessels
    - Arteries
    - Capillaries
    - Veins
- Function
  - Pump & distribute blood thru body

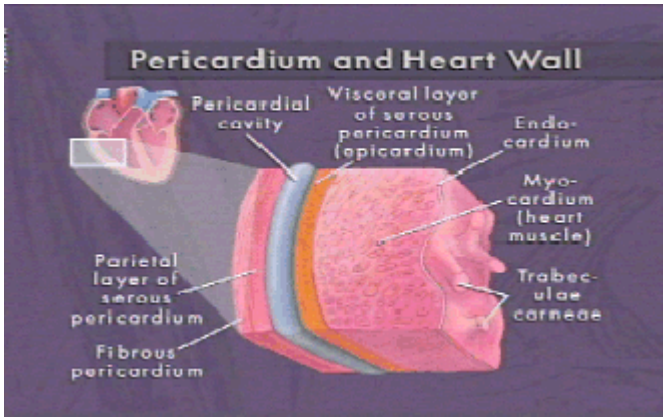
The Heart

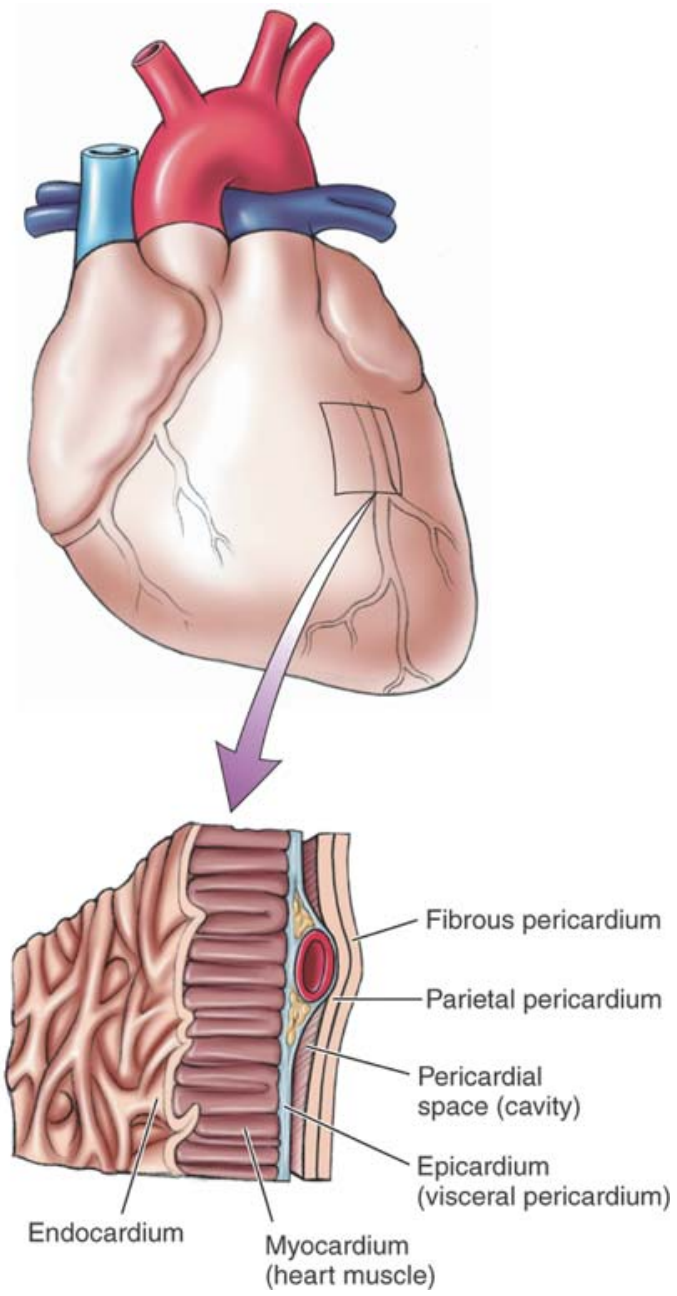
Location & Membranes

- In mediastinum (between lungs)
- Three pericardial membranes
  - Fibrous pericardium
  - Parietal pericardium
  - Visceral pericardium (epicardium)
- Serous fluid
  - Between parietal & visceral layers
  - Prevents friction w/heartbeat

The Heart

Location & Membranes

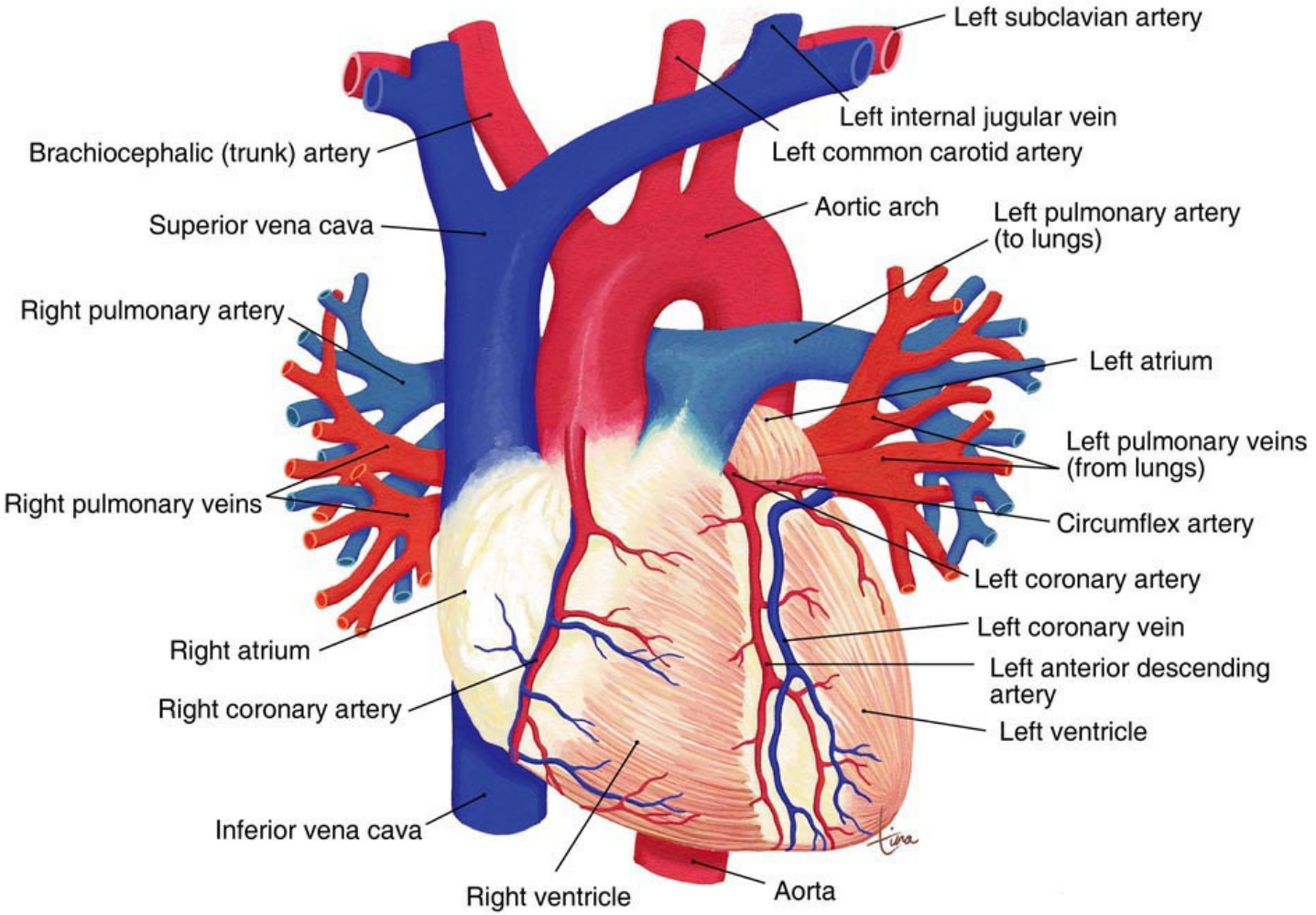



Fibrous pericardium
Parietal pericardium
Pericardial space (cavity)
Epicardium (visceral pericardium)
Endocardium
Myocardium (heart muscle)

The Heart Structure and Vessels

- 4 Chambers- composed of myocardium or cardiac muscle
- Endocardium- lines 4 chambers, covers valves, and extends and lines vessels
- Coronary Vessels- (arteries,veins,capillaries) circulate blood throughout heart
- 2 Main coronary arteries- first branches of ascending aorta

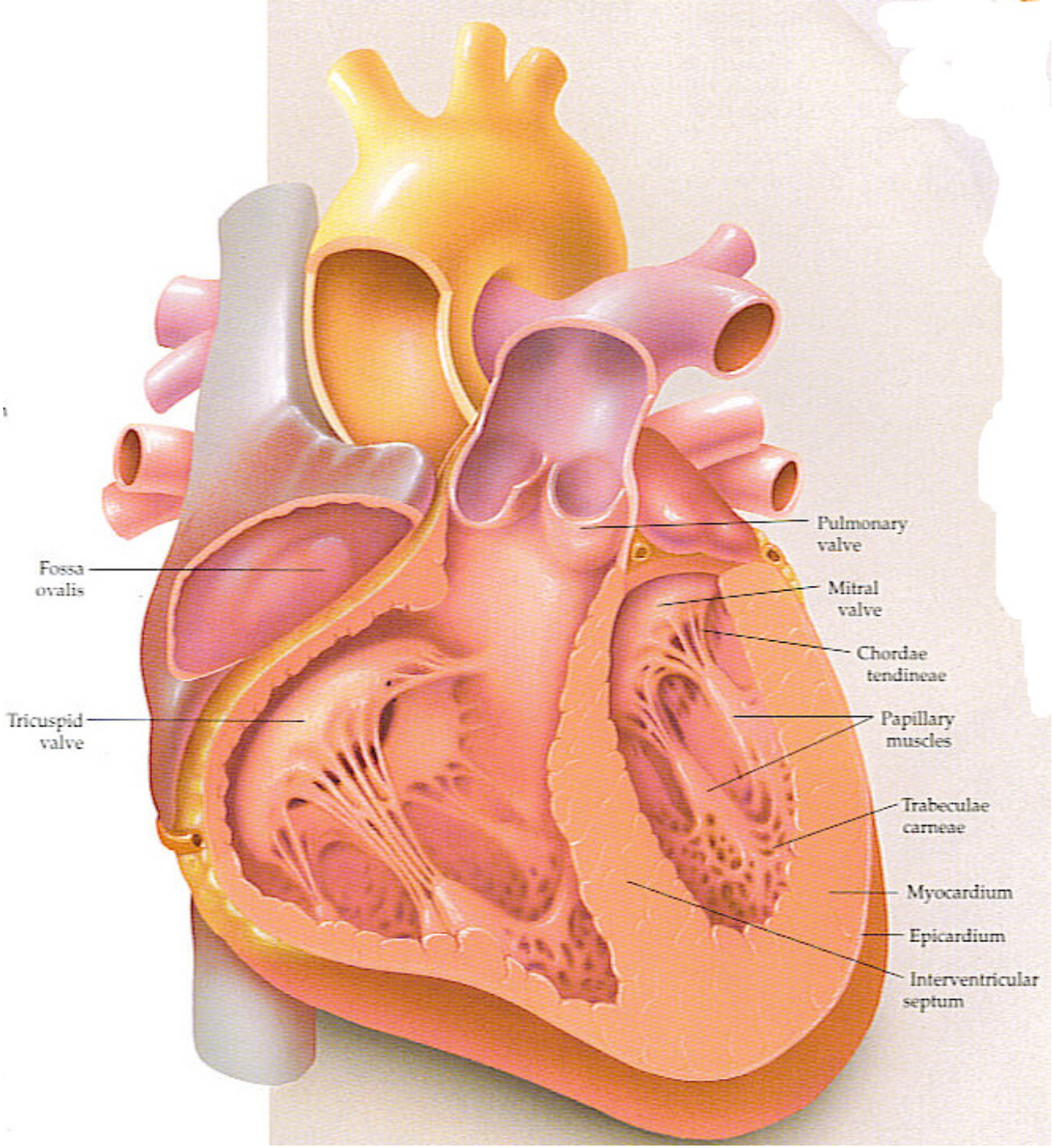
The Heart Location and Membranes



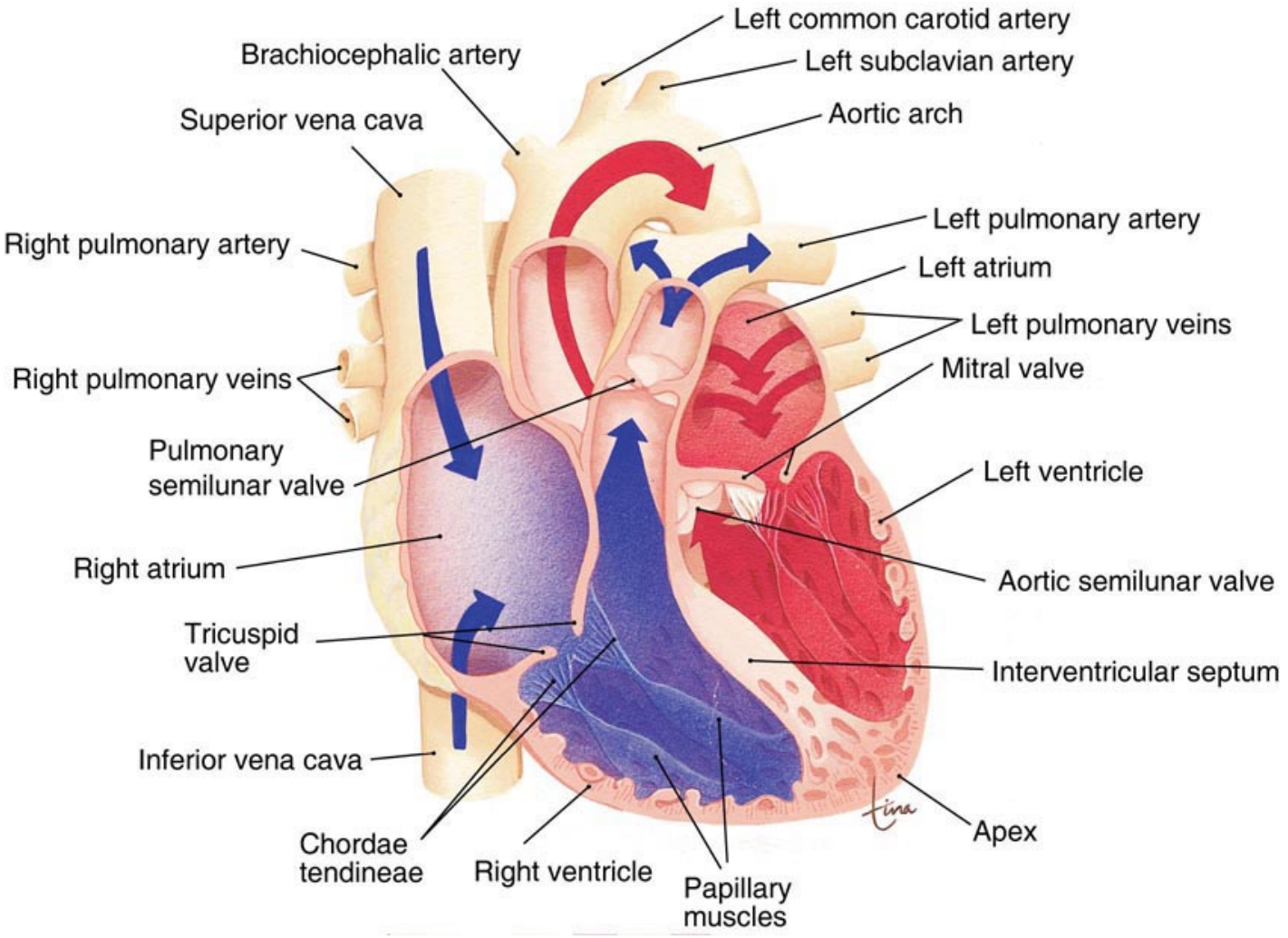
The Heart

Structure & Vessels

- Atrium
  - Thin walled
  - Two upper chambers
  - Separated by interatrial septum
- Ventricles
  - Two lower chambers
  - Separated by interventicular septum


Pulmonary valve
Fossa ovalis
Mitral valve
Chordae tendineae
Tricuspid valve
Papillary muscles
Trabeculae carneae
Myocardium
Epicardium
Interventricular septum

The Heart- Structure & Vessels

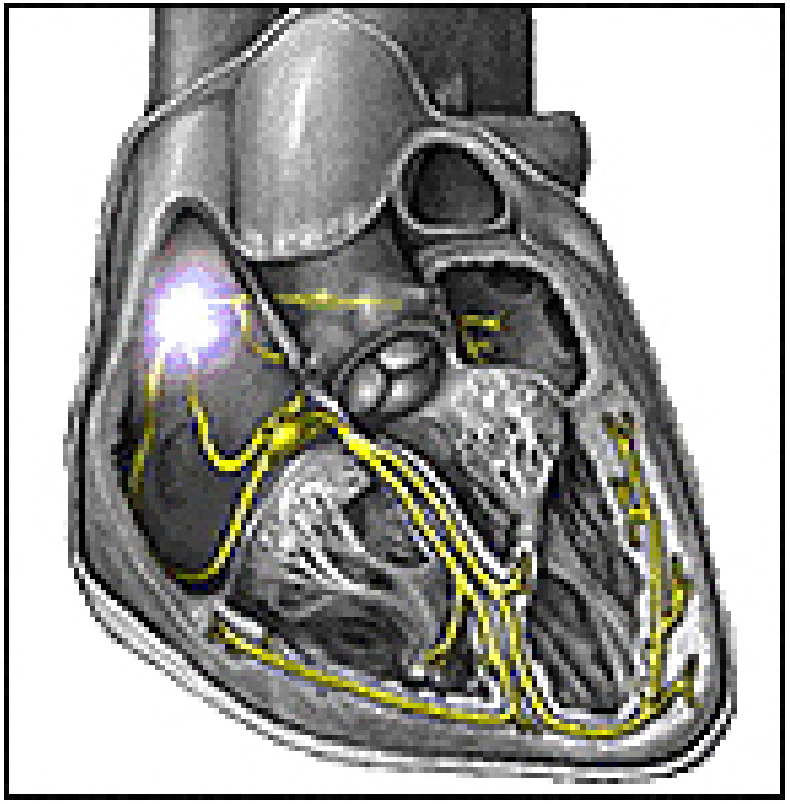


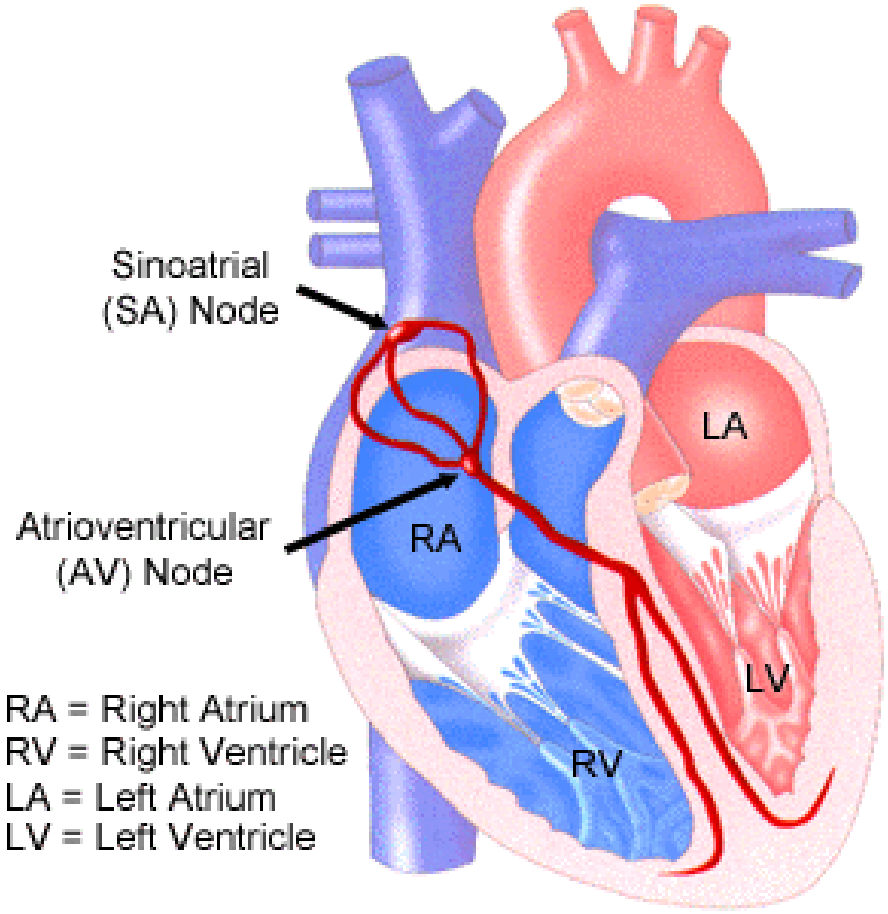
Cardiac Conduction Pathway

- Generates the heartbeat
- Sinoatrial node (SA)
  - Located in wall of right atrium
  - Depolarizes approx. 100 times/min
  - aka: Pacemaker
  - Initiates each heartbeat
- Normal heartbeat called normal sinus rhythm

Cardiac Conduction Pathway (cont.)

- SA node
  - Impulse starts
- AV node
  - Located in lower interatrial septum
  - Intrinsic rate at 40 -60 beats/min
- To Bundle of His
  - Located in upper interventricular septum
  - Intrinsic rate 20 – 35 beats/min
- To right and left bundle branches
  - Located in the septum
- To Purkinje fibers
  - Located in ventricles





A.D.A.M.
adam.com

Cardiac Conduction Pathway
Ode to a Node

- Have a heart, and have no fear,
- The SA node is over here,
- Beating at a constant rate,
- 60 – 100 is really great,
- The AV node can make a show
- If SA node has gone to slow
- 40 – 60 is not too bad
- If it's all you've got, you will be glad
- Should the whole thing drop its speed,
- His and bundle branches will take the lead.
- And that, my friend is the whole and part,
- Of the conduction system of your heart.

Cardiac Cycle

- Sequence of mechanical events in one heartbeat
- 2 atria contract simultaneously followed by simultaneous contraction of ventricles
- Contraction = systole
- Relaxation = diastole

Cardiac Cycle (cont.)

- Atria during diastole:
  - Continually receive blood from venous circulation
  - ↑ amount blood causes atrial pressure to ↑
  - AV valves are forced open
    - Most blood passively passes in ventricles
- Atria during systole (atrial kick)
  - Pumps remaining blood in ventricles
  - Atria then relax

Cardiac Cycle (cont.)

- Ventricle systole follows
  - Pressure in ventricles cause AV valves to close
    - Forces semilunar valves to open
  - Blood is pumped into aorta and pulmonary artery
  - No passive blood flow (like w/atria)
  - End of ventricle systole
    - Blood backflows
      - Causes closure of semilunar valves

Cardiac Cycle (cont.)
Normal heart sound

- Two major sounds - lubbdupp
- First
  - Closure of AV valves = lubb = ventricular systole
  - Closure of aortic and pulmonary semilunar valves = dupp = diastole
- To review
  - http://www.nhlbi.nih.gov/health/dci/Diseases/hhw/hhw_pumping.html
  - http://en.wikipedia.org/wiki/Image:ECG_Principle_fast.gif#file

Cardiac Output

- Amount of blood pumped (ejected) by the left ventricle in 1 minute
- CO = SV x P (pulse)
  - **Stroke volume** (SV)
    - Amount of blood pumped (ejected) by ventricle in one beat
    - Averages 60-80 mL
- **Starling's law of the heart**
  - The more the heart muscle is stretched, the greater the force of the blood ejected

Cardiac Output (cont.)

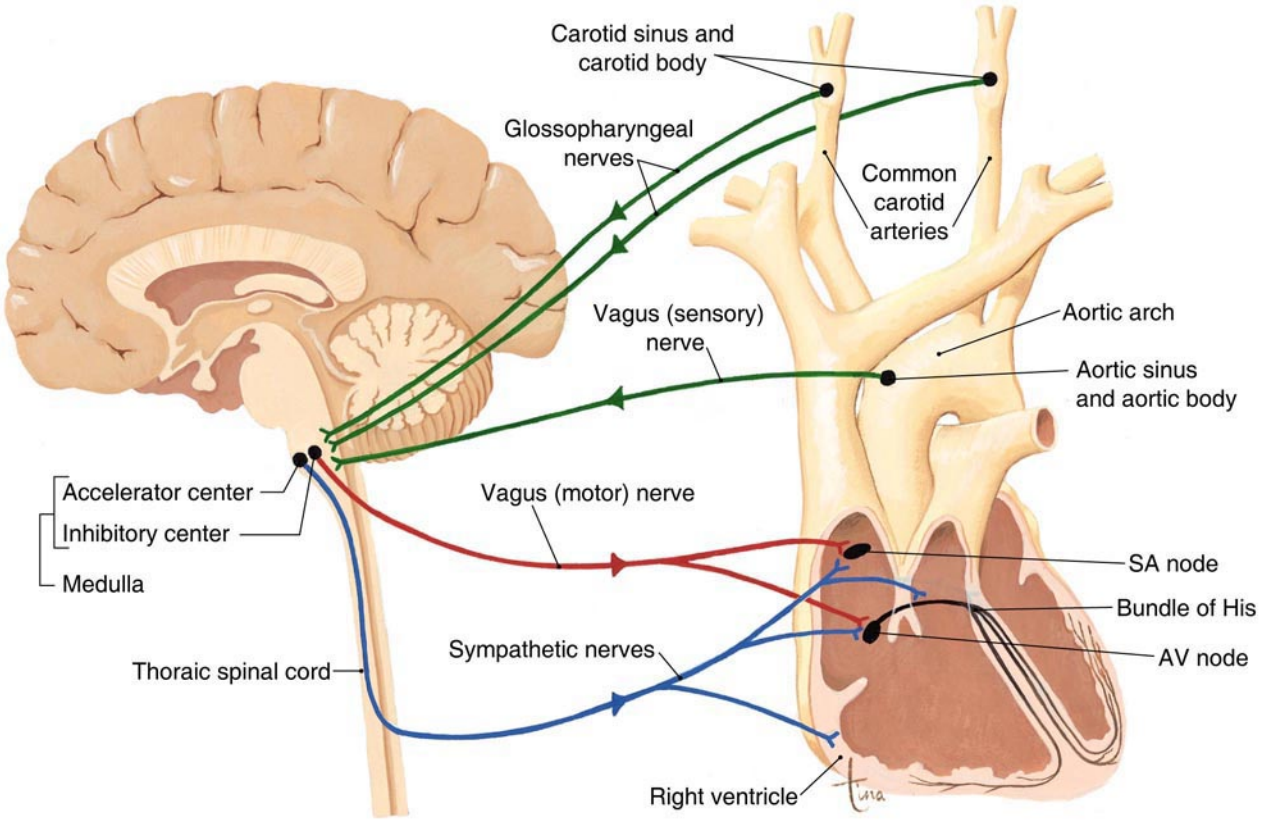
- **Ejection fraction** (EF)
  - Measure of ventricular efficiency
    - Normal ~ 60%
  - EF = SV / total volume of blood in ventricle
    - Total volume of blood in ventricle at end of diastole
      - aka; end-diastolic volume
      - ~ 120 -130 mL EF

Regulation of the heart

Electrical impulse

- Generated by the heart itself (begins SA node)
- Nervous system – can change rate
  - Cardiac centers in medulla
    - Accelerator center
    - Inhibitory center
  - Sympathetic nerve impulses
    - Branches off thoracic spine to SA node, AV node & most of the myocardium – increase rate & force of contraction
  - Parasympathetic impulses
    - From vagus nerve to SA & AV node
    - Decreases heart rate

Regulation of the heart (cont.)



Hormones & The Heart

- Epinephrine
  - Increases HR, contraction force, dilates coronary vessels
- Aldosterone
  - Helps regulate Na+ and K+
- Atrial natriuretic peptide (ANP)
  - aka; Atrial natriuretic hormone (ANH)
  - Decreases blood volume & BP

Blood Vessels
Arteries & Arterioles

- Carry blood away from heart to capillaries
  - Under high pressure

- Walls are relatively thick
  - To prevent rupture

Blood Vessels

Arteries & Arterioles -*3 Layers*

- Outer
  - Composed of fibrous connective tissue
  - Prevents rupture
- Middle
  - Layer of smooth muscle/elastic connective tissue
  - Changes the diameter of artery
    - Contributes to maintenance of BP (esp. diastolic)
    - Regulated by sympathetic nervous system
    - Can also alter where greatest amount of blood is directed
- Inner
  - Composed of simple squamous epithelium
    - Called endothelium
    - Very smooth to **prevent abnormal clotting**

Blood Vessels

Veins & Venules

- Carry blood from capillaries to heart
- Thinner walls
  - Less smooth muscle
  - Less role in BP maintenance
- Under sympathetic NS control
  - can have extensive constriction of veins
- Lined with endothelium (like arteries)
  - Prevents abnormal clotting
- Contain valves
  - Prevents backflow of blood

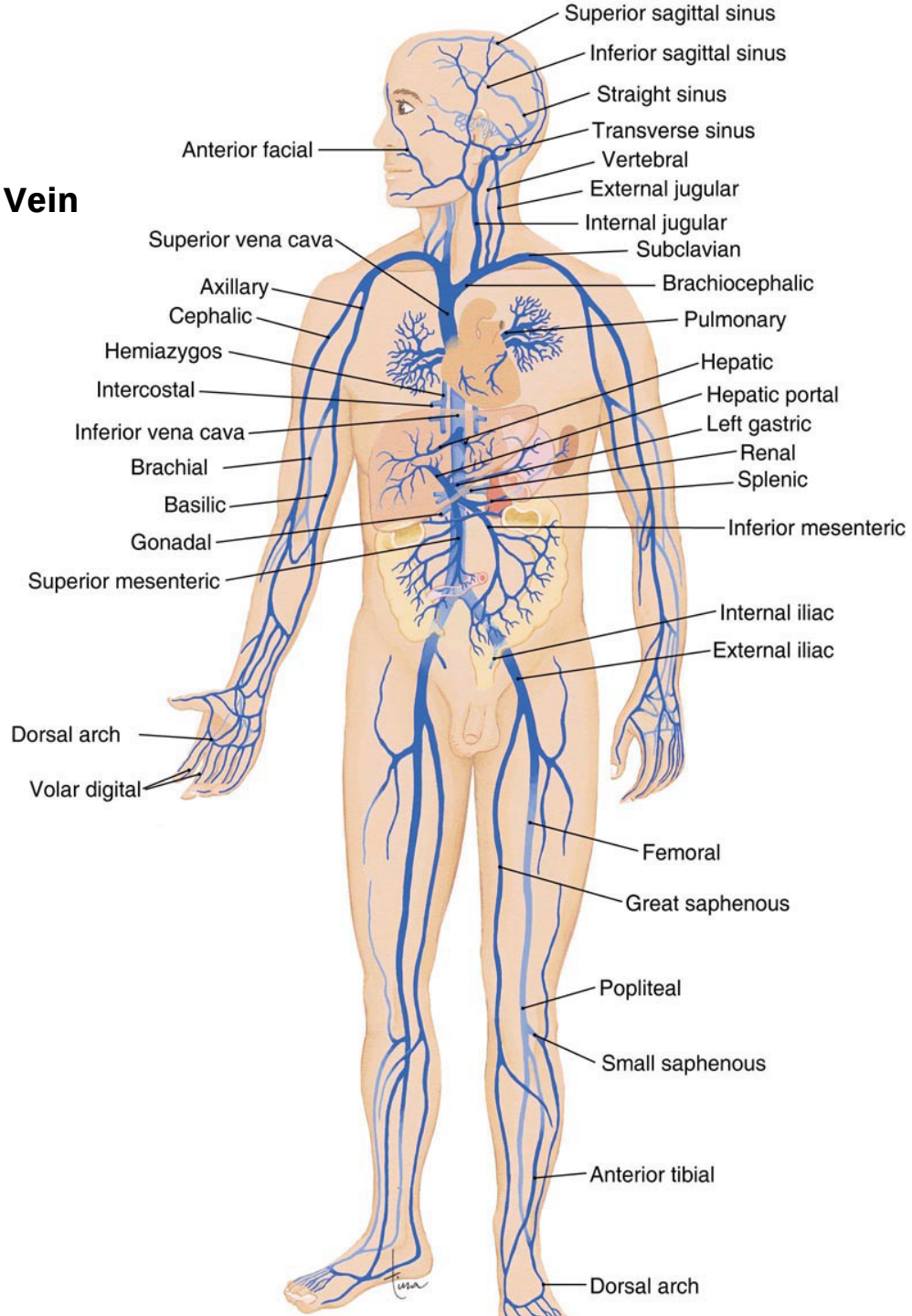
Capillaries

- Arteries → arterioles → **capillaries** → venules → veins
- Form extensive networks of vessels
  - Found in most tissues, except
    - Epidermis, cartilage, lens & cornea of eye
- One cell thick
  - Permits exchange of gases, nutrients and waste products between blood and tissues

Capillaries (cont.)

- Blood pressure
  - Arterial
    - 30-35 mm Hg
  - Venous
    - 15 mm Hg
- Edema
  - With an ↑ BP in capillaries
  - More fluid forced into fluid surrounding cells
  - Lymph system unable to collect all fluid

Artery → Arteriole →
Capillary network → Venule → Vein



Blood Pressure

- The force of blood against the walls of blood vessels
- Measured in mm Hg
- Systolic over diastolic
- Highest in arteries
  - Decreases in arterioles and capillaries
  - Become one pressure
    - Systolic and diastolic pressures merge
  - Pressure decreases more as enters veins
    - Approaches zero in caval veins

Blood Pressure (cont.)

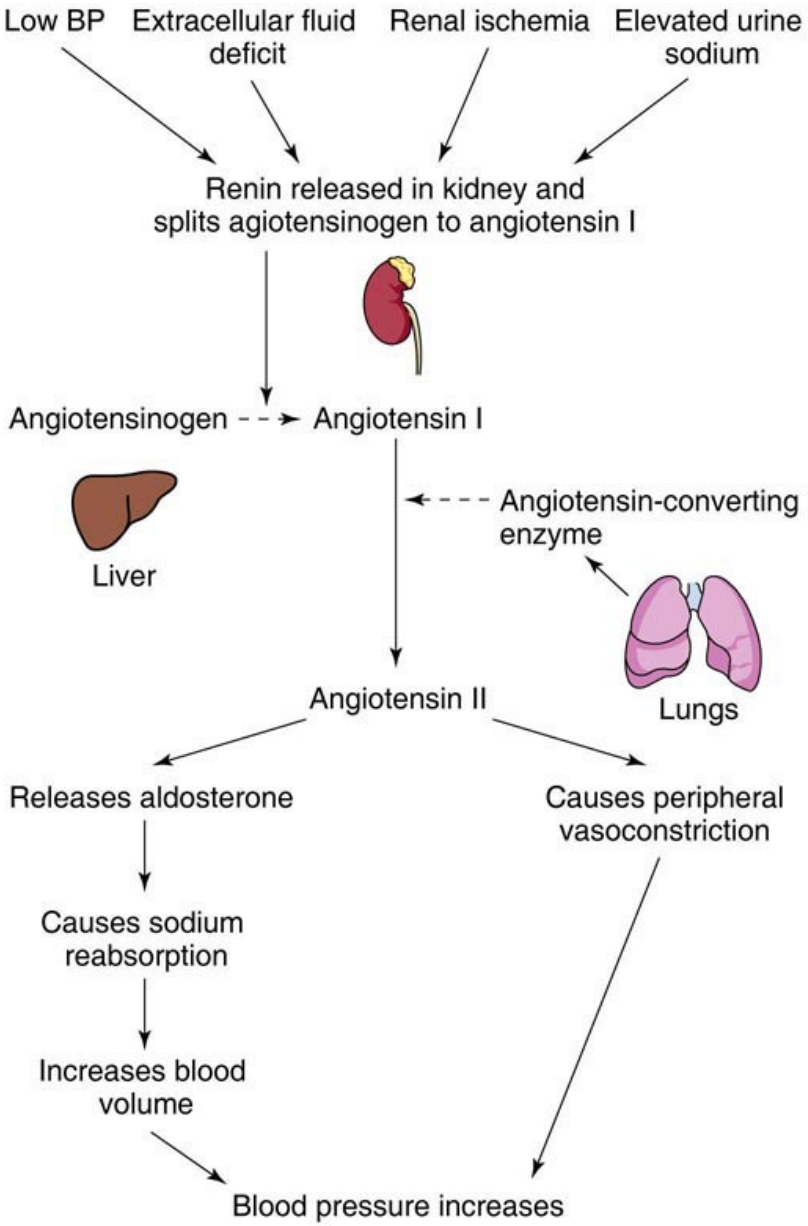
- Arteries & veins
  - Slight state of continued constriction
    - Helps maintain BP(esp. diastolic)
  - Called peripheral vascular resistance (PVR)
    - Regulated by the vasomotor center
      - Medulla oblongata
        - » Sends impulses along sympathetic nerves
        - » More impulses = ↑ constriction & ↑ BP
        - » Less impulses = vasodilatation & ↓ BP

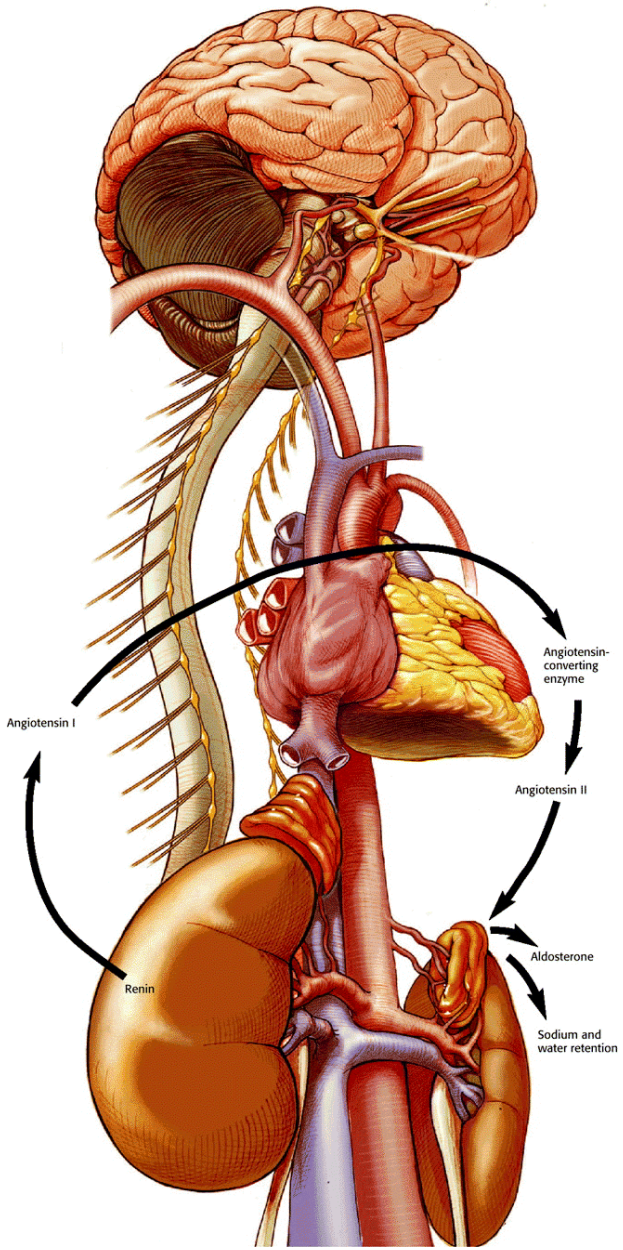
Blood Pressure (cont.)

- Other factors that affect BP
  1. Heart rate and force of heart contraction
  2. Adequate venous return
     1. Depends on constriction of veins (no pooling)
     2. Skeletal muscles pumping to squeeze deep veins of legs
     3. Muscles of respiration compressing veins in chest
  3. Elasticity of large arteries

Renin-Angiotensin-Aldosterone Mechanism (RAAM)

- Kidneys
  - Major role in BP regulation
  - ↓ kidney blood flow
    - ↓ renal filtration
    - ↓ urinary output
      - Preserves blood volume
  - Renin
    - Secreted in response to ↓ BP
    - Initiates the RAAM





Two Pathways of Circulation
Pulmonary

- Unoxygenated blood begins Rt ventricle
- Pulmonary artery
- To lung(two arteries- one to ea lung)
  - Gas exchange(in pulmonary capillaries around the alveoli)
- Pulmonary veins- oxygenated blood
- Returns to left atrium

Two Pathways of Circulation

Systemic

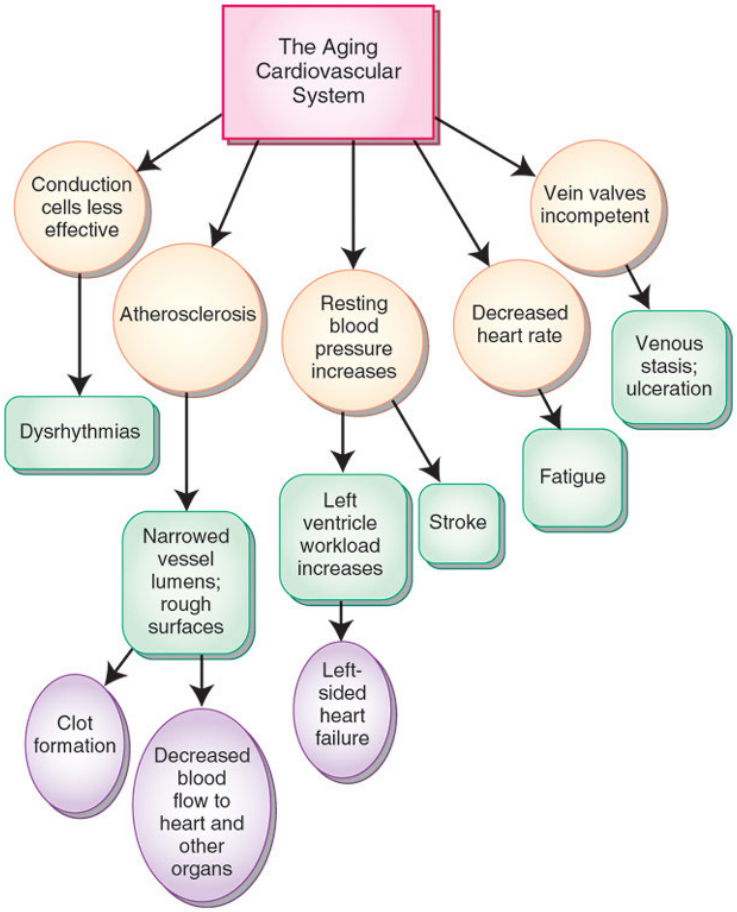
- Oxygenated blood begins in left ventricle
- Aorta-arteries-capillaries
- Tissues
- Superior & inferior vena cava and coronary sinus (dirty blood-deoxygenated)
- Right atrium

Two Pathways of Circulation
Systemic

- Hepatic portal circulation
  - Blood from capillaries of the digestive organs/spleen
  - Enter portal vein
  - Into liver capillaries (sinusoids)
    - Regulates blood levels of nutrients
      - Glucose
      - Amino acids
      - Iron
      - Removes toxins(alcohol/meds)
  - Blood returns to heart

Aging and the Cardiovascular System

- Atherosclerosis
  - Deposition of lipids on or in walls of arteries
- Arteriosclerosis
  - Gradual deterioration of the walls of the arteries
- Average resting B/P increases with age
- Valves of veins incompetent
- Heart muscle less efficient, decrease in CO and HR
- Dysrhythmias
  - Left ventricular hypertrophy



Cardiovascular Disease

- Coronary heart disease (CHD)
  - Leading cause of death (AHA, 2002)
    - » 1 in 2.6 deaths
  - 335,000 sudden deaths
    - Myocardial Infarction or Ventricular fibrillation
  - Greatest cause of death in women
  - Higher among certain ethnicities
    - Mexican-American, African-American
  - Hypertension (silent killer)
    - Occurs in 1 in 4 adults
  - Lifestyles considerations

Subjective Nursing Assessment

"What's Up?"

- **W**here is pain?
- **H**ow does it feel?
- **A**ggravating/alleviating factors?
- **T**iming of pain: onset, duration, frequency?
- **S**everity of pain?
- **U**seful data for associated symptoms?
- **P**erception of client about problem?

Nursing Assessment

- Health history for acute problem
  - Subjective data
    - Allergies
    - Smoking
    - Medications – prescription & OTC
    - Pain
    - Dyspnea
    - Fatigue
    - Palpitations
    - Dizziness
    - Weight gain

Nursing Assessment
Pain

- P- provocation
  - What brings pain on? What relieves it?
- Q- quality
  - What does the pain feel like?
- R- region, radiate
  - Location? Does the pain radiate?
- S- severity
  - Rate on 1-10 scale
- T- timing
  - When does the pain occur?

Nursing Assessment

Objective Data

- Note general appearance
- Level of consciousness
  - Indicator of oxygenation to the brain
- Height & weight
- Vital signs

Nursing Assessment
Objective Data

- Assessing Blood Pressure
  - Correct size cuff
  - Both arms (use higher reading)
    - Difference is reported to MD
  - Leg normally 10 mm Hg higher than arm
  - Lying, sitting, standing
    - Assessing postural differences
    - Normally change with sitting or standing
      - Drop of 15 mm systolic
      - Slight decrease or increase of diastolic 3-10 mm

Nursing Assessment

Objective Data

- Pulses
  - Auscultate 1 full minute
  - Normal 60-100
  - Apical
  - Rate and rhythm
  - Pulse deficits

Nursing Assessment

Pulses (con't)

- **Quality of pulses**:
  - 0 - absent
  - 1+ - weak, thready
  - 2+ - normal
  - 3+ - bounding
- **Thready**: disappears with slight pressure
- **Normal**: easily palpated
- **Bounding**: strong and present with pressure applied

Nursing Assessment
Pulses (con't)

- **Thrill**
  - Abnormal vessel
    - Bulging or narrowed
    - Vibration *felt*
- **Bruit**
  - Abnormal vessel
    - Turbulent blood flow
    - Humming *heard* upon auscultation

Nursing Assessment

Objective Data

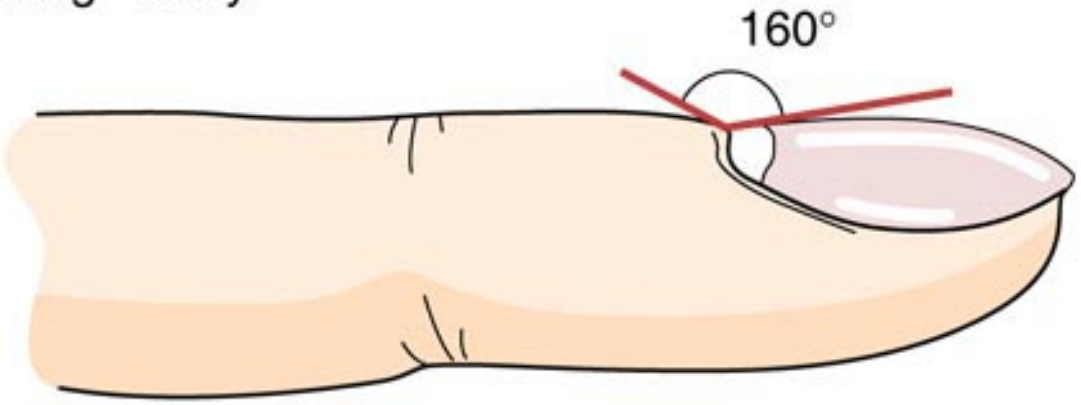
- Respirations
  - Rate and ease
  - Breath sounds
    - auscultation
  - Sputum characteristics
  - Cough

Nursing Assessment

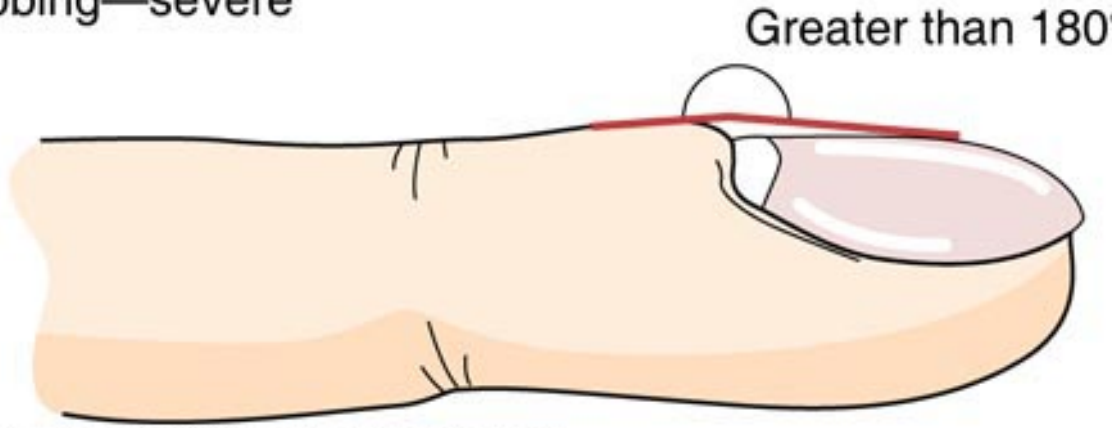
Inspection

- Skin Color:
  - Pallor-anemia
  - Cyanosis- oxygen distribution disturbance
  - Rubor (reddish-brown) in lower extremities
    - Indicates decreased arterial blood flow
- Note hair distribution & nails
- Distended neck veins
- Capillary refill: normal less than 3 seconds
- Clubbing: oxygen deficiency
- Presence of varicose veins, stasis ulcers, s/s of thrombophlebitis

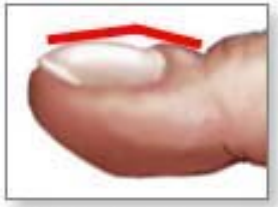
Clubbing—early



Clubbing—severe

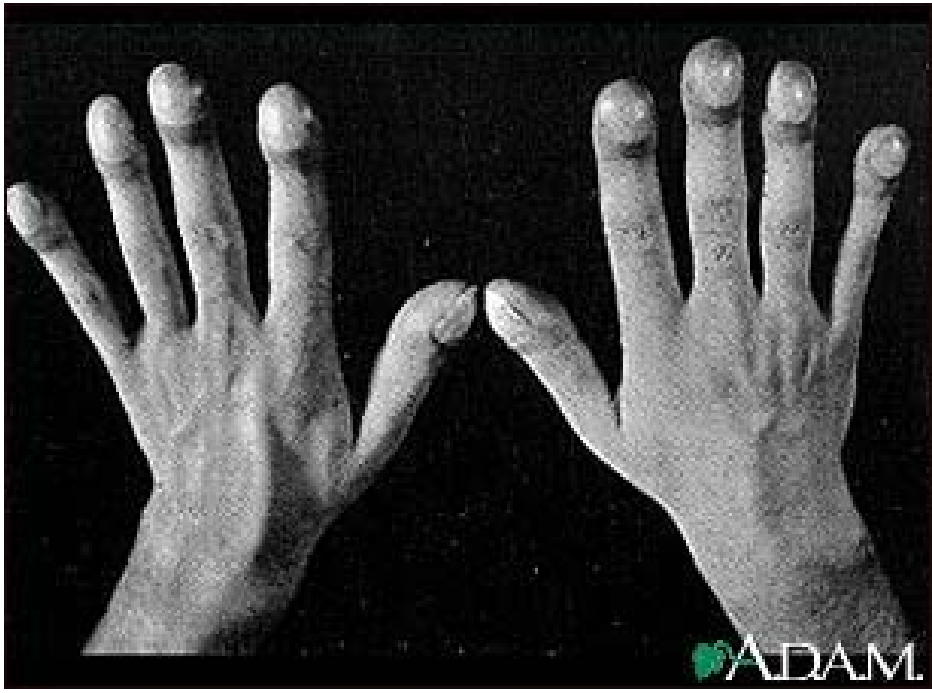


Normal angle of nail bed



Distorted angle of nail bed

Clubbed fingers



Nursing Assessment

Palpation

- Point of maximal impulse (PMI)
- Temperature of extremity
- Absence of blood flow, extremity becomes temperature of environment: poikilothermia
- Edema
- Homan's sign

- Six P's of peripheral vascular disease:
  - Pain
  - Pulselessness
  - Pallor
  - Poikilothermia
  - Paralysis
  - parathesia

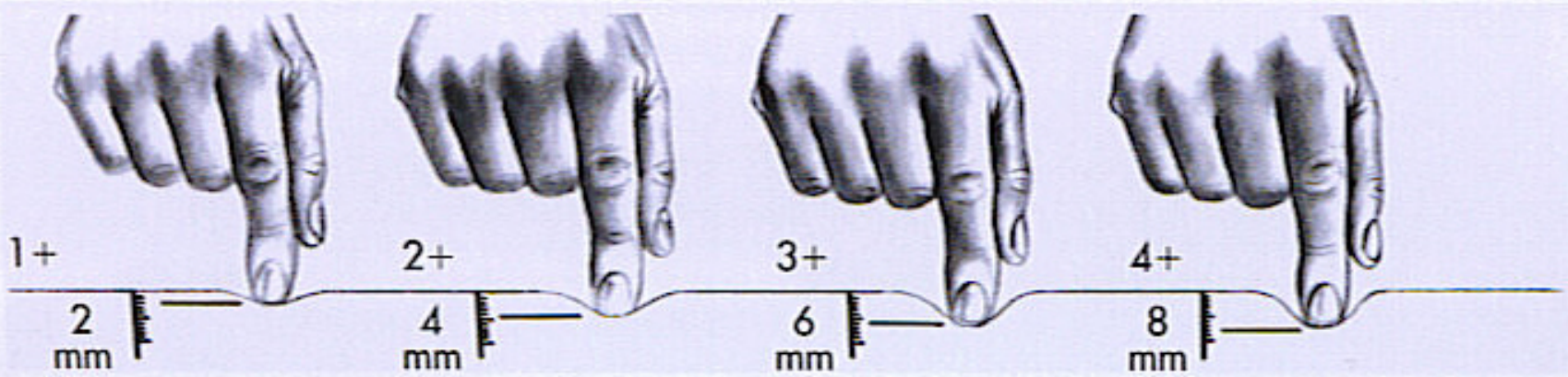
Assessment Scale for Pitting Edema

1+ Slight pitting, no visible distortion, disappears rapidly

2+ Somewhat deeper pit than in 1+, no readily detectable distortion, disappears in 10-15 sec

3+ Pit noticeably deep, may last more than a minute; the dependent extremity looks fuller and swollen

4+ Pit very deep, lasts 2-5 min; dependent extremity is grossly distorted

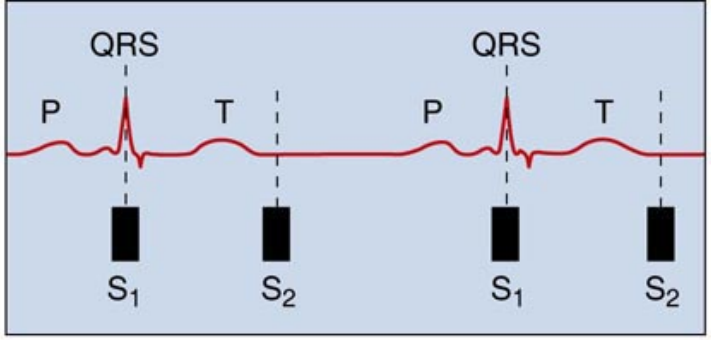


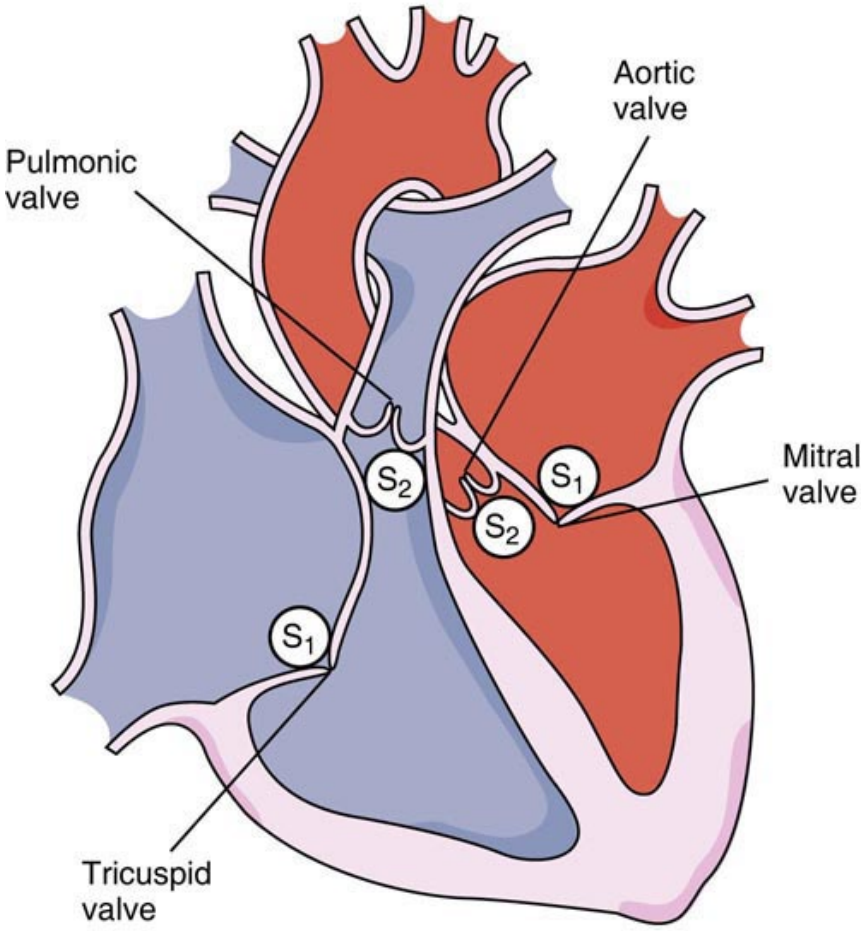
Nursing Assessment

Auscultation

- S1
  - Beginning of systole
  - Tricuspid and mitral valve closes
- S2
  - Beginning of diastole
  - Aortic and pulmonic semilunar valves close
- Heard best w/diaphragm of stethoscope

Heart Sounds





Nursing Assessment

Auscultation

- S3 & S4
  - Bell at apex
  - Lean forward or on left side
- Murmur
  - Prolonged sound caused by narrowed valve opening or not closed properly
- Pericardial Friction Rub
  - Inflammation of pericardium

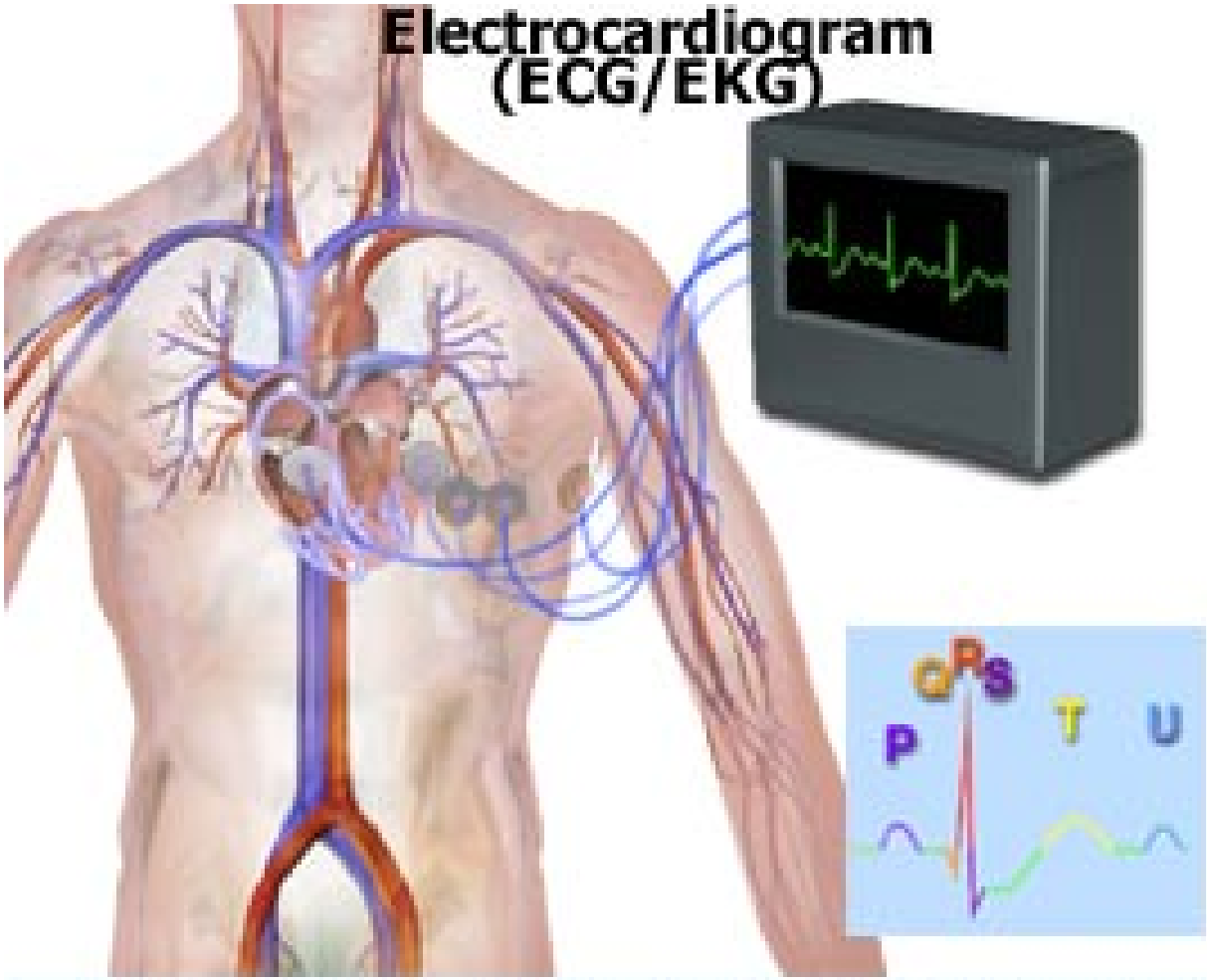
Diagnostic Studies

- Chest Xray
- Cardiac Calcium Scan
- Signal -Averaged EKG
- Holter Monitor
- Transesophageal Echocardiogram
- Doppler Ultrasound
- PET Scan

1

2

Electrocardiogram (ECG/EKG)



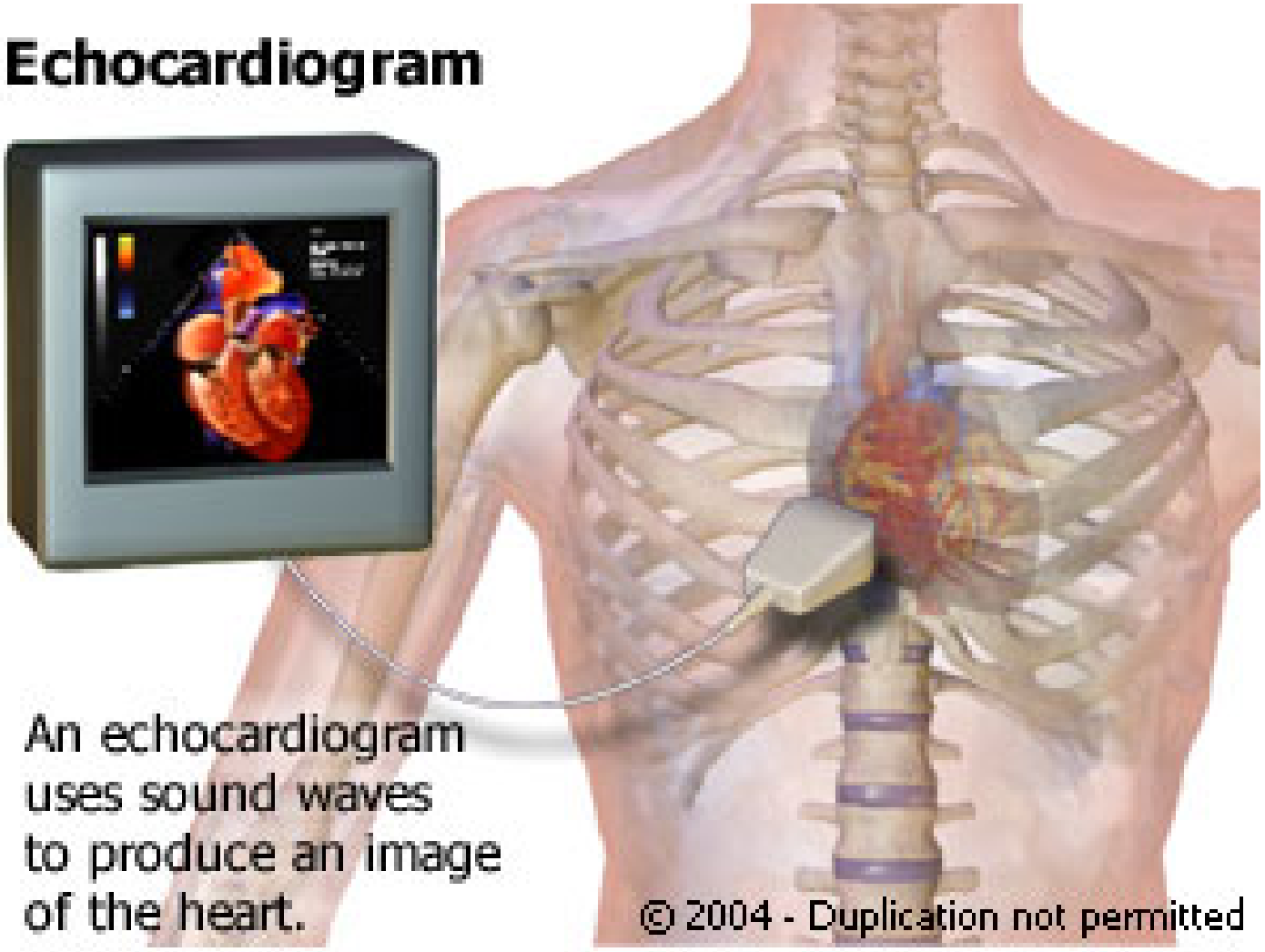
The EKG (also called ECG) displays each heartbeat as a series of electrical waves. Contractions, which pump blood, are represented by the P wave, the QRS complex and the T wave. The P wave represents activity in the heart's upper chambers. The QRS complex and T wave represent activity in the lower chambers.

Diagnostic Tests (cont'd)

- Ambulatory Electrocardiogram Monitoring
- Transtelephonic Event Recorders
- Pressure Measurement
- Tilt Table Test
- Peripheral Vascular Stress Test
- Plethysmography
- Arterial Stiffness Test (ASI)

- Radioisotope Imaging
- Thallium Imaging
- Technetium Pyrophosphate Scan
- Technetium 99m Sestamibi
- Blood Pool Imaging

Echocardiogram

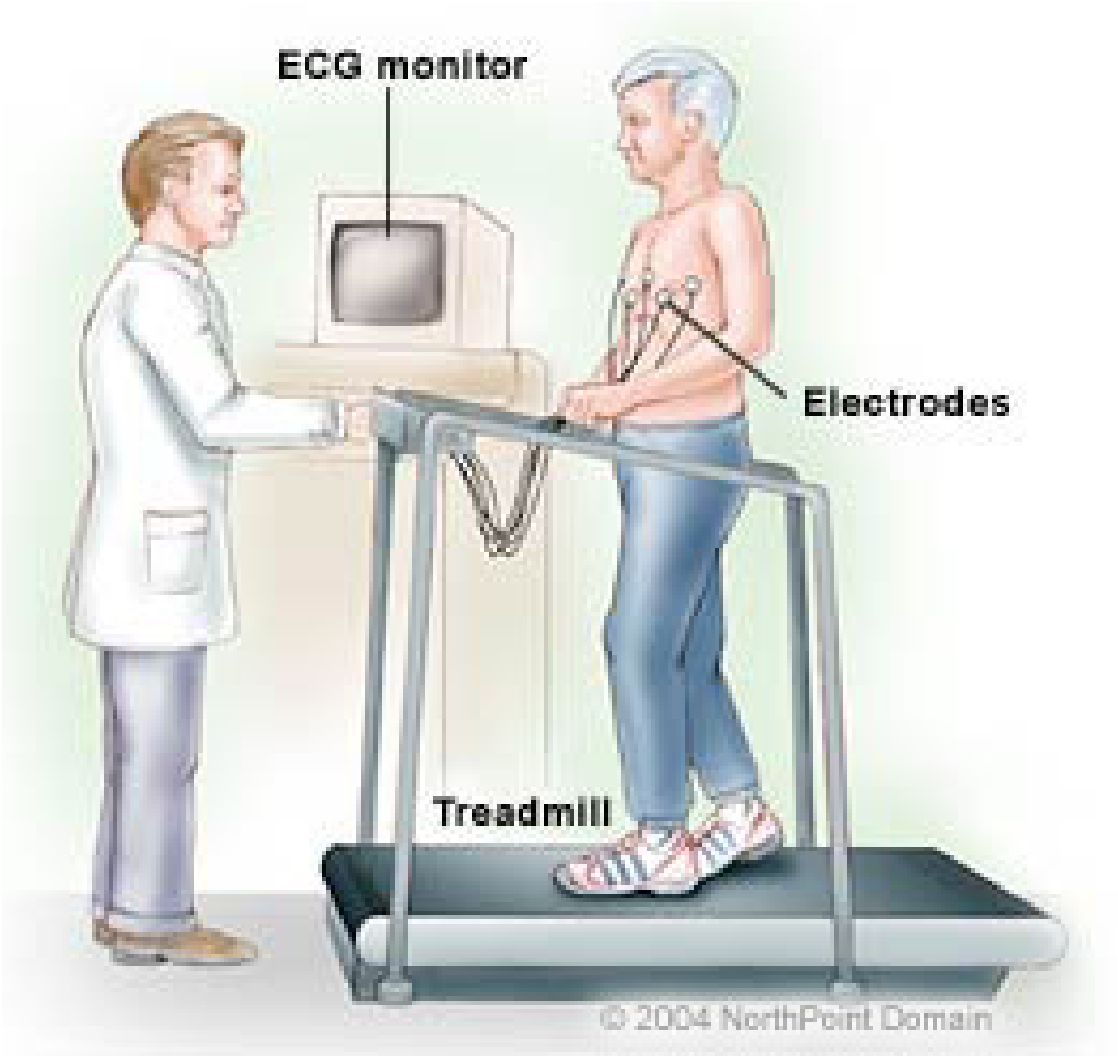


An echocardiogram uses sound waves to produce an image of the heart.

Diagnostic Studies

Exercise Tolerance /Cardiac StressTest

- Measures cardiac function or peripheral vascular disease
- No smoking, eating or drinking 2 hours pre-test
  - No caffeine/stimulants
- Comfortable walking shoes, loose top and supportive bra
- Shows hearts response to increased oxygen needs
- Completed when at peak heart rate (220 – patients age, chest pain, unable to go further or ECG changes


ECG monitor
Electrodes
Treadmill
© 2004 NorthPoint Domain

Diagnostic Tests
Laboratory Blood Tests

- Homocysteine
- CRP (C-Reactive Protein)
- MPO (myeloperoxidase antigen)
- Cardiac Troponin

Diagnostic Studies

Laboratory Blood Tests

- Cardiac Enzymes
  - CK, CPK, LDH
- Myoglobin
- Blood Lipids
  - Cholesterol, HDL, LDL, Triglycerides
  - Lipid Profile Guide

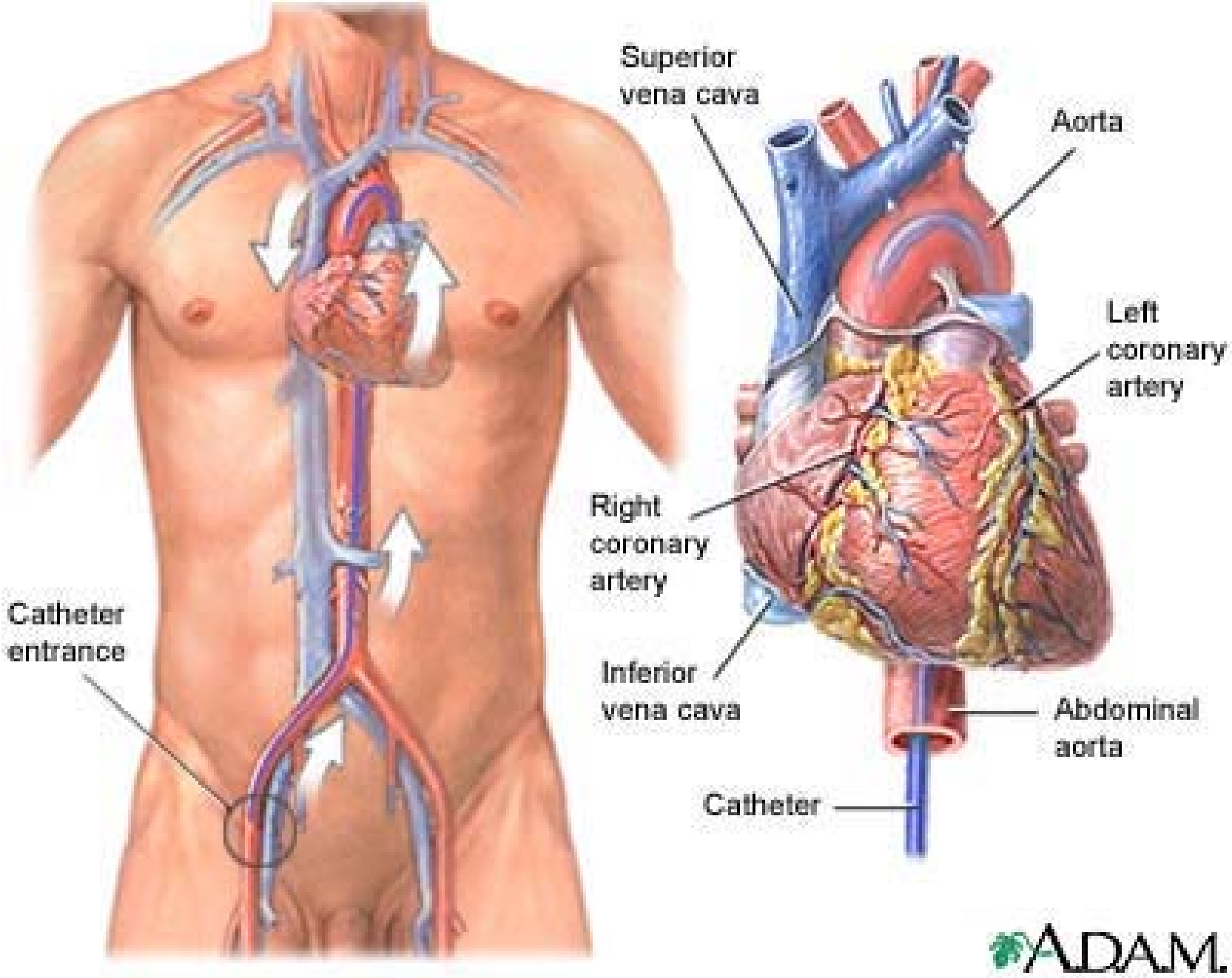
Diagnostic Studies
Angiography

- Arteriography: examines arteries
- Venography: examines veins
- Dye injected to visualize vessels
- Assess blood clot formation, peripheral vascular disease, grafting use.
- NPO 4 hours before
- Burning sensation

Diagnostic Studies

Cardiac Catheterization

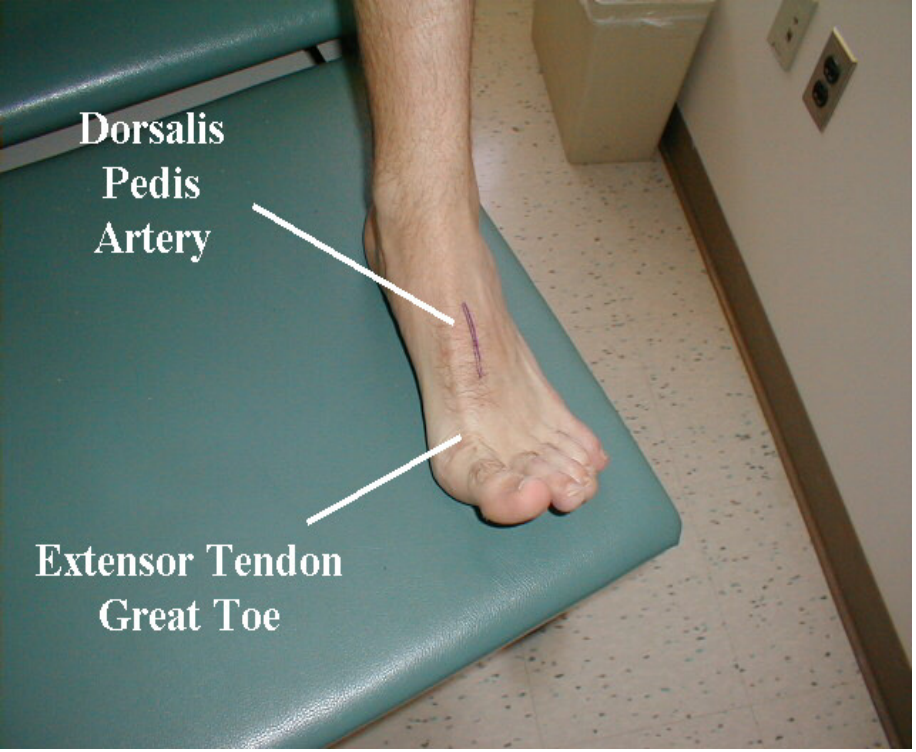
- Study of heart's anatomy and physiology
- Invasive
- Measures pressures
- Fluoroscopy
- Complications: allergic reaction, breaking of catheter, hemorrhage, thrombus formation, emboli of air or blood, dysrhythmias, MI, CVA, puncture of heart chambers or


Superior vena cava
Aorta
Left coronary artery
Right coronary artery
Inferior vena cava
Abdominal aorta
Catheter
Catheter entrance
A.D.A.M.

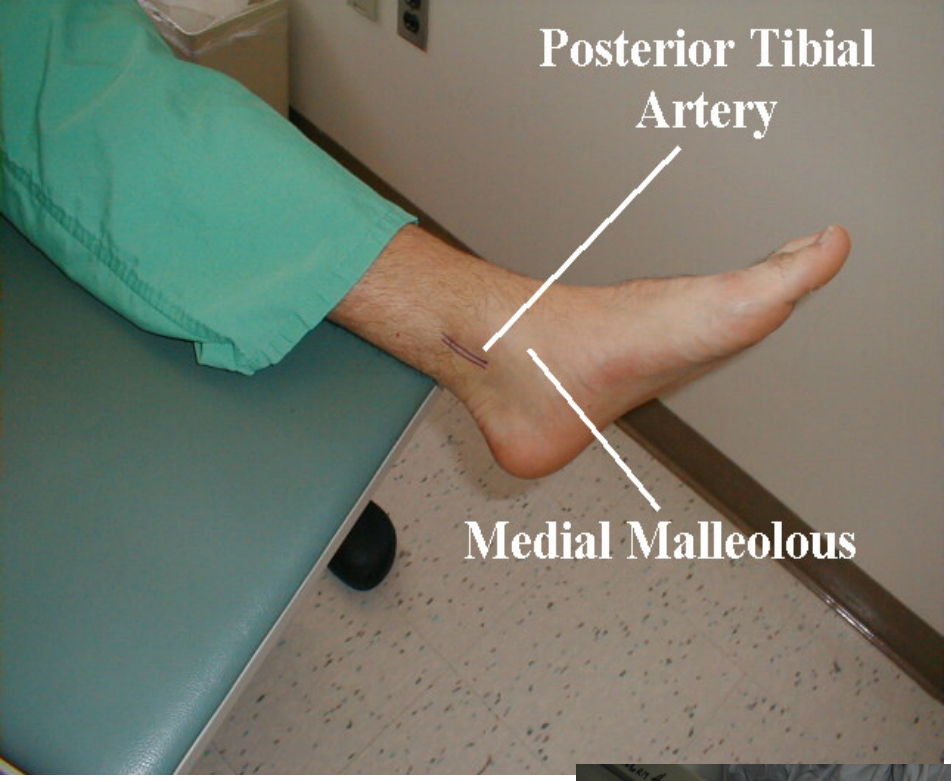
Diagnostic Studies

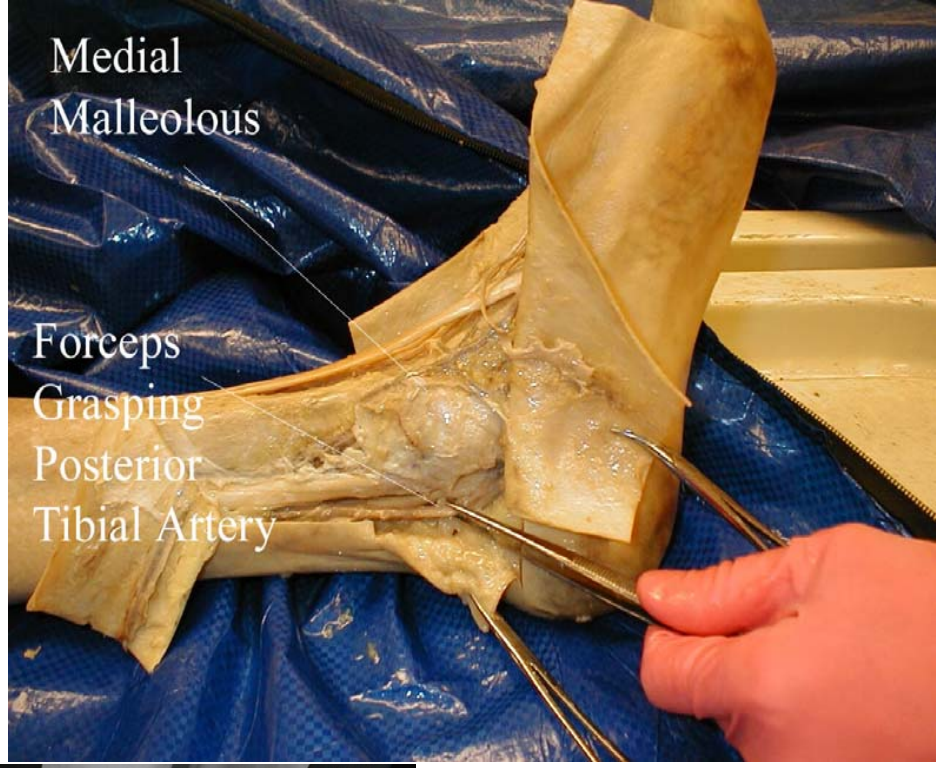
Post Catheterization Care

- Firm pressure at insertion site several minutes
- Pressure dressing or sandbag for several hours
- Vital signs
- Peripheral pulses
- Keep extremity still
- May eat, encourage fluids


Dorsalis
Pedis
Artery
Extensor Tendon
Great Toe


Forceps
Grasping
Dorsalis
Pedis Artery
Extensor
Tendon
Great Toe


Posterior Tibial
Artery
Medial Malleolous

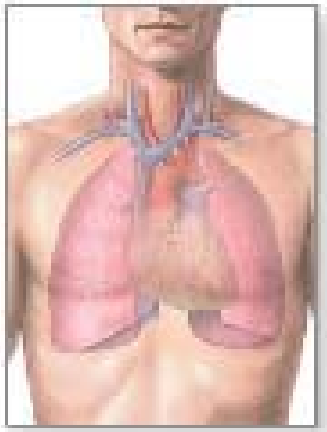

Medial
Malleolous
Forceps
Grasping
Posterior
Tibial Artery

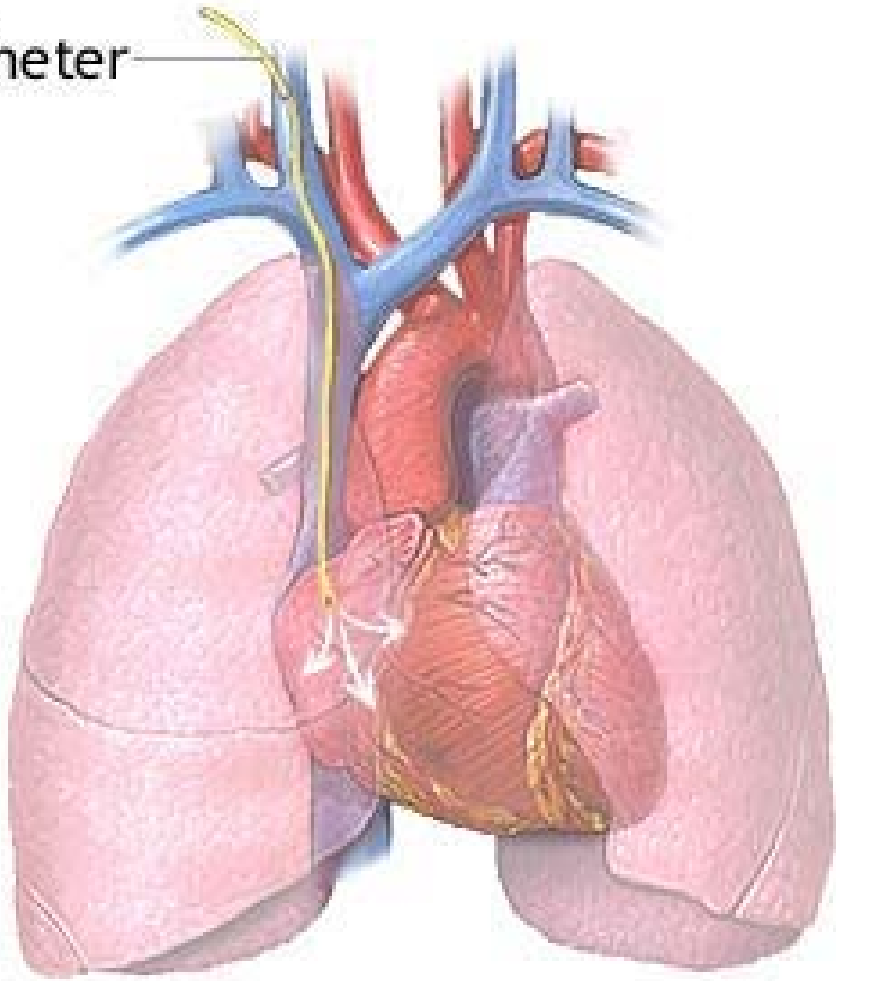

ULTRASONIC DOPPLER
FLOW DETECTOR
Model 811-B
CHARGER
EARPHONES

Diagnostic Studies

Hemodynamic Monitoring

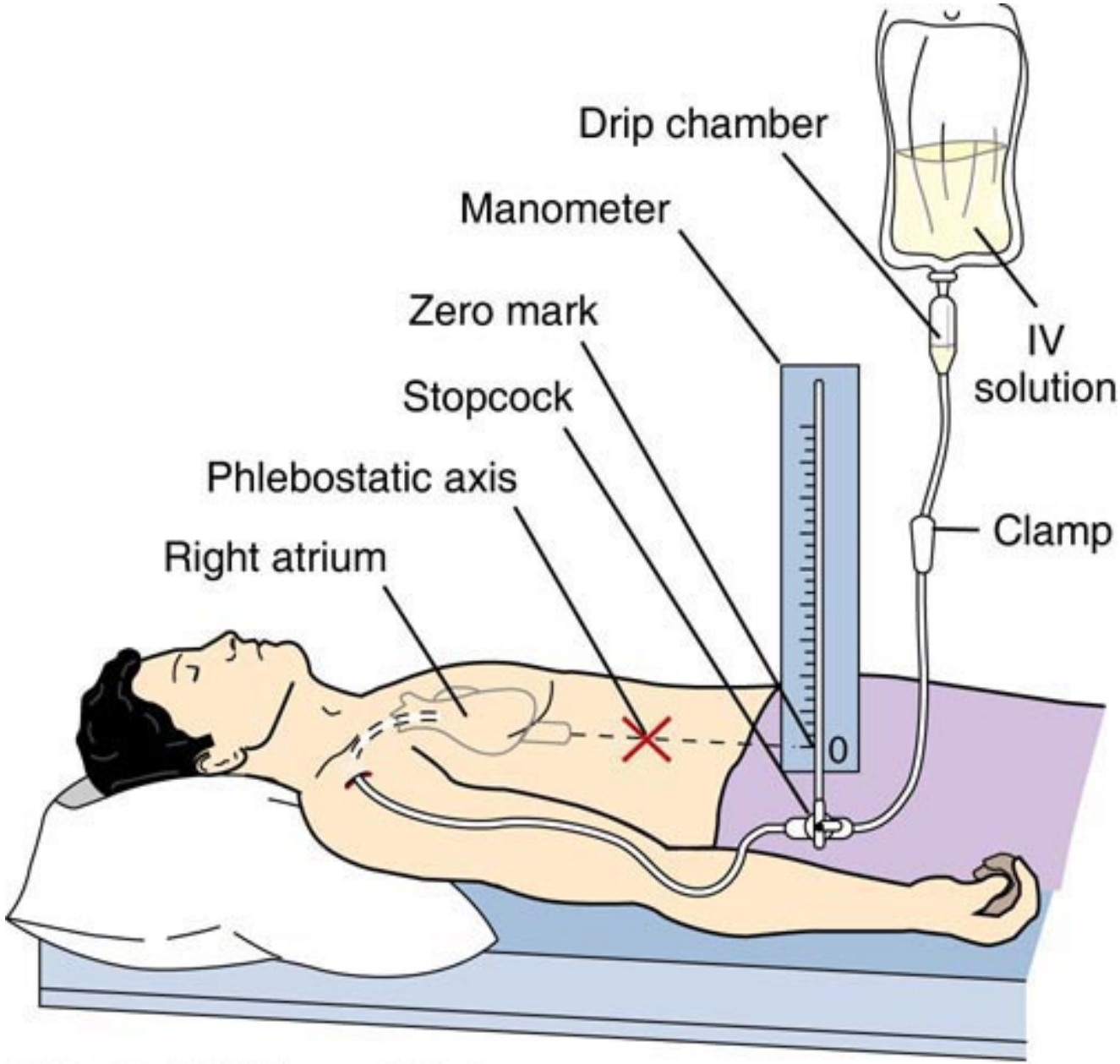
- Monitoring pressures in blood vessels or heart.
- Arterial line measures arterial pressures
- CVP central catheter into vena cava measures preload or fluid volume status

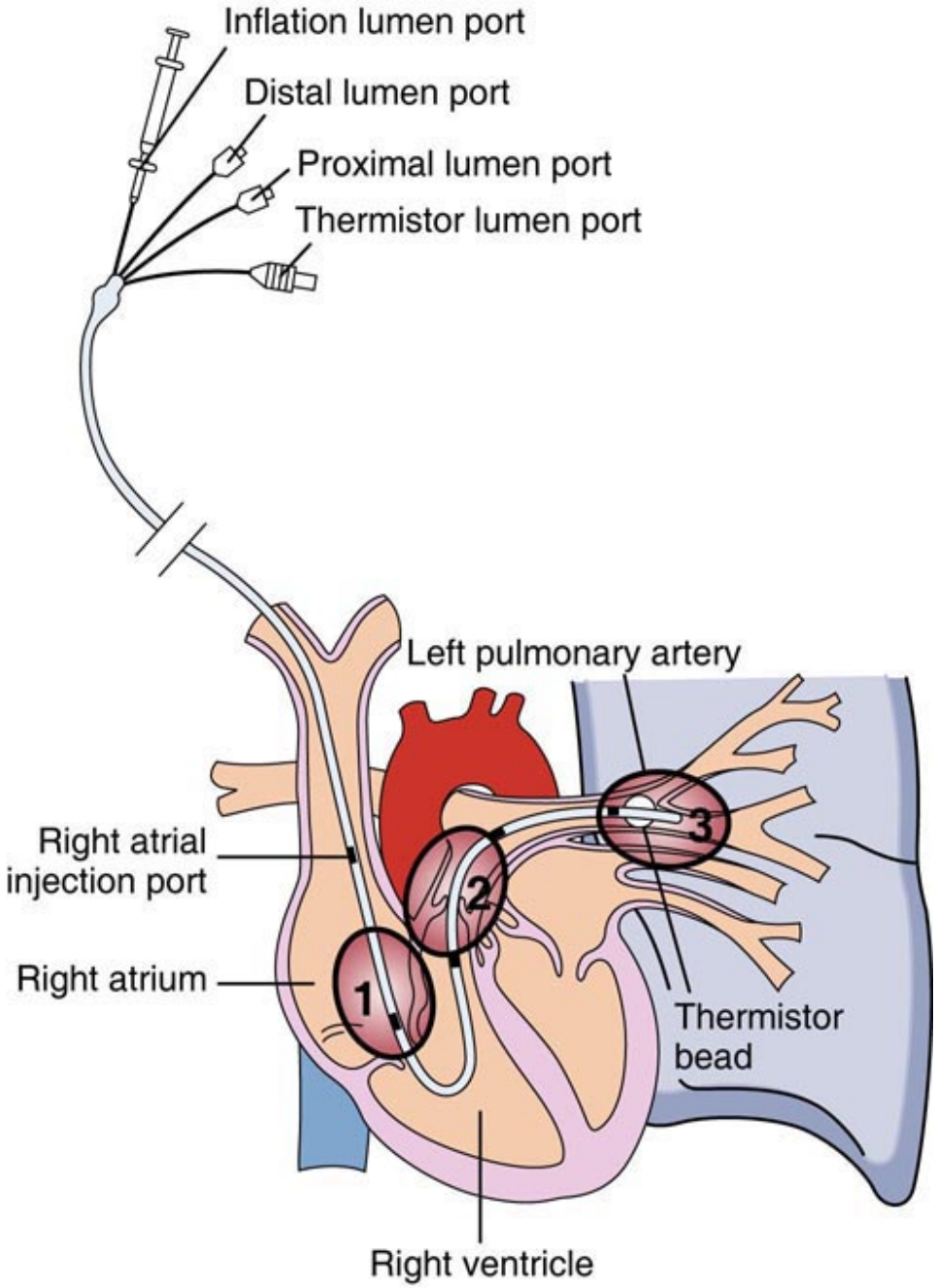




After catheter is threaded to heart dye is injected

A.D.A.M.





Electrophysiology Study

- Studies hearts electrical system
- One or more electrodes (2-3 usual)
- Inserted via femoral vein to right side of heart
- Electrical impulses recorded
- Pacing can be done
- Dysrhythmias can be triggered to aid in diagnosis

Therapeutic Measures

- Exercise
- Smoking Cessation
- Diet
- Oxygen
- Medications
- Antiembolism devices
- Lifestyle changes

Cardiac Surgery

- Baseline tests performed(PFT, ABG)
- NPO 8-12 hours before
- Good preop teaching necesssary
- Cardiopulmonary Bypass
  - temporarily diverts blood away from heart and lungs to special pump where it is oxygenated
- Sternotomy- closed with wires, chest tubes to promote drainage
- CTICU for few days