CVS and CIRCULATORY PATHOLOGY

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Edema

- Definition: presence of excess fluid in the intercellular (interstitial) space of the ECF compartment
- Causes:
- 1. Increased vascular hydrostatic pressure
  - a. Congestive heart failure (generalized edema)
  - b. Portal hypertension in cirrhosis
  - c. Renal retention of salt and water
  - d. Venous thrombosis (local edema)
  - e. Pulmonary edema in left sided heart failure
- 2. Hypo albuminemia and decreased colloid osmotic pressure
  - a. Liver disease
  - b. Nephrotic syndrome
  - c. Protein deficiency (e.g., Kwashiorkor)
  - d. Malabsorption

- 3. Lymphatic obstruction (lymphedema)
  - a. Tumor
  - b. Surgical removal of lymph node drainage (eg: following modified radical mastectomy)
  - c. Parasitic infestation(filariasis~ elephantiasis)
  - d. Scrotal and vulvar lymphedema due to Lymphogranuloma venerum.
- 4. Increased endothelial permeability
  - a. Inflammation
  - b. Type I hypersensitivity reactions
  - c. Drugs (e.g.,bleomycin, heroin, etc.)
- Anasarca: severe generalized edema
- Effusion: fluid within the body cavities

- Transudate versus exudate
  - a. Transudate
    - i. Edema fluid with low protein content (< 3g/dL)
    - ii. Less number of cells
    - iii. Specificgravity <1.020
  - b. Exudate
    - i. Edema fluid with high protein content and cells
    - ii. Specificgravity> 1.020
    - iii. Types of exudates
      - Purulent (pus)
      - Fibrinous
      - Eosinophilic
      - Hemorrhagic

Disorders of Platelets

- Thrombocytopenia
- Qualitative defect

- Thrombocytopenia
  - Decreased production:
    - Aplastic anemia
    - Tumor infiltration of the marrow
  - Increased destruction
    - ITP
    - TTP
    - DIC
    - Hypersplenism

Qualitative Defect

- Von Willebrand disease
- Bernard-Soulier syndrome
- Glanzmann thrombasthenia
- Uremia

Immune thrombocytopenia purpura (ITP)

- Etiology
  - i. *Antiplatelet antibodies against platelet antigens such as Gp IIb-IIIa and Gp Ib-IX*
  - ii. Antibodies are made in the spleen
  - iii. Platelets are destroyed peripherally in the spleen by macrophages, which have Fc receptors that bind IgG-coated platelets

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- Forms of ITP
  - i. Acute ITP
    - Seen in children following a viral infection
    - Self-limited disorder
  - ii. Chronic ITP
    - Usually seen in women in their childbearing years
    - May be the first manifestation of systemic lupus erythematosus (SLE)
    - Petechiae, ecchymoses, menorrhagia, and nosebleeds

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- c. Lab
  - i. Decreased platelet count and prolonged bleeding time
  - ii. Normal prothrombin time (PT) and partial thromboplastin time (PTT)
  - iii. Peripheral blood smear shows thrombocytopenia with enlarged immature platelets (**megathrombocytes**)
  - iv. Bone marrow biopsy shows increased numbers of megakaryocytes with immature forms

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- d. Treatment
  - Corticosteroids, which decrease antibody production
  - Immunoglobulin therapy, which floods Fc receptors on splenic macrophages
  - Splenectomy, which removes the site of platelet destruction and antibody production

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Thrombotic thrombocytopenic purpura (TTP)

- a. Pathology
  - i. Widespread formation of platelet thrombi with scant fibrin (hyaline thrombi)
  - ii. No activation of the coagulation system
- b. Clinical findings
  - i. Most often affects adult women
  - ii. *Pentad of characteristic signs*
    - Fever
    - Thrombocytopenia
    - Microangiopathic hemolytic anemia
    - Neurologic symptoms
    - Renal failure

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- c. Lab
  - i. Decreased platelet count and prolonged bleeding time
  - ii. Normal PT and PTT
  - iii. Peripheral blood smear shows thrombocytopenia and schistocytes, and reticulocytosis

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Hemolytic uremic syndrome (HUS)

- i. Occurs most commonly in children
- ii. Follows a gastroenteritis with bloody diarrhea
- iii. Organism: verotoxin-producing *E. coli O157:H7*
- iv. Similar clinical pentad

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Coagulation

- a. Coagulation factors
  - i. The majority of the clotting factors are produced by the liver
  - ii. Are proenzymes that must be converted to the active form
  - iii. Some conversions occur on a phospholipid surface
  - iv. Some conversions require calcium
- b. Intrinsic coagulation pathway is activated by the contact factors
  - i. Contact with subendothelial collagen
  - ii. High molecular weight kininogen (HMWK)
  - iii. Kallikrein

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- c. Extrinsic coagulation pathway is activated by the release *of tissue factor*
- d. Laboratory tests for coagulation
  - i. *Prothrombin time (PT)*
    - *Tests the extrinsic and common coagulation pathways*
    - Tests factors VII, *X, V, prothrombin, fibrinogen*
    - *International normalised ratio standardizes the PT*
  - ii. *Partial thromboplastin time (PTT)*
    - *Tests the intrinsic and common coagulation pathways*
    - XII, XI, IX,VIII, *X, V, prothrombin, fibrinogen*
  - iii. *Thrombin time (TT) tests for adequate fibrinogen levels*
  - iv. *Fibrin degradation products (FDP) tests the fibrinolytic system (increased with* DIC)

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Hemophilia A (classic hemophilia)

- a. Deficiency *of factor VIII*
- b. X-linked recessive
- c. Clinical features
  - i. Predominately affects males
  - ii. Symptoms are variable dependent *on the degree of deficiency*
  - iii. Spontaneous hemorrhages into joints (hemarthrosis)
  - iv. Easy bruising and hematoma formation after minor trauma
  - v. Severe prolonged bleeding after surgery or lacerations
  - vi. No petechiae *or ecchymoses*

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- d. Lab
  - 1. Normal platelet count and bleeding time
  - ii. Normal PT and *prolonged PTT*
- e. Treatment: factor VIII concentrate

- Hemophilia B (Christmas disease)
  - a. Deficiency *of factor IX*
  - b. X-linked recessive
  - c. Clinically identical to hemophilia A

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Acquired Coagulopathies

- a. Vitamin K deficiency: decreased synthesis *of factors II,VII, IX,X, and protein C & S*
- b. Liver disease: decreased synthesis *of virtually all clotting factors*

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Von Willebrand disease

- Definition: inherited bleeding disorder characterized by either a deficiency *or* qualitative defect in von Willebrand factor
- vWF is normally produced by endothelial cells and megakaryocytes
- Clinical features
  - i. Spontaneous bleeding from mucous membranes
  - ii. Prolonged bleeding from wounds
  - iii. Menorrhagia in young females
  - iv. Bleeding into joints is uncommon

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- d. Lab
  - i. Normal platelet count and a prolonged bleeding time
  - ii. Normal PT with often a prolonged PTT
  - iii. Abnormal platelet response to ristocetin (adhesion defect) is an important diagnostic test
- e. Treatment: treat mild cases (type I) with desmopressin (an antidiuretic hormone [ADH] analog), which releases vWF from Weibel Palade bodies of endothelial cells

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Disseminated intravascular coagulation (DIC)

- a. DIC is always secondary to another disorder
- b. Causes
  - i. Obstetric complications (placental tissue factor activates clotting)
  - ii. AML-M3 (cytoplasmic granules in neoplastic promyelocytes activate clotting)
  - iii. Adenocarcinomas (mucin activates clotting)
  - iv. Gram-negative sepsis (tumor necrosis factor [TNF] activates clotting)
  - v. Micro-organisms (especially meningococcus and rickettsia)

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- c. Pathology
  - i. Results in widespread micro-thrombi
  - ii. Consumption of platelets and clotting factors causes hemorrhages
- d. Lab
  - i. Platelet count is decreased
  - ii. Prolonged PT/PTT
  - iii. Decreased fibrinogen
  - iv. Elevated fibrin split products (D-dimers)
- e. Treatment:
  - treat the underlying disorder
  - Symptomatic disorder

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Thrombosis

- a. Definition: pathologic formation of an intravascular fibrin-platelet thrombus
- b. Factors involved in thrombus formation (Virchow's Triad)
  - i. *Endothelial injury*
    - *Atherosclerosis*
    - Vasculitis
    - Many others
  - ii. *Alterations in laminar blood flow*
    - Stasis of blood (e.g., immobilization)
    - Turbulence (e.g., aneurysms)
    - Hyperviscosity of blood (e.g., polycythemia vera)
  - iii. *Hypercoaguability of blood*

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- Clotting disorders (factor Sleiden, deficiency of antithrombin III, protein C, or protein S)
- Tissue injury (postoperative and trauma)
- Neoplasia
- Nephrotic syndrome
- Advanced age
- Pregnancy
- Oral contraceptives

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- c. Common locations of thrombus formation
  - i. Coronary and cerebral arteries
  - ii. Heart chambers atrial fibrillation or post-MI (mural thrombi)
  - iii. Aortic aneurysms
  - iv. Heart valves (vegetations)
  - v. Deep leg veins (DVTs)
- d. Outcomes of thrombosis
  - i. Vascular occlusion and infarction
  - ii. Embolism
  - iii. Thrombolysis
  - iv. Organization and recanilization

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Embolism

- 1. Definition: any *intravascular mass that has been carried down the bloodstream from* its site of origin
- 2. Composition of emboli
  - a. *Thromboemboli-most common (98%)*
  - b. Atheromatous emboli-severe atherosclerosis
  - c. Fat emboli-bone fractures and soft-tissue trauma
  - d. Bone marrow emboli-bone fractures and cardiopulmonary resuscitation (CPR)
  - e. Gas emboli-decompression sickness ("the bends" and Caisson disease)
  - f. Amniotic fluid emboli-complication of labor
  - g. Tumor emboli-metastasis
  - h. Talc emboli-intravenous drug abuse (IVDA)
  - i. Bacterial/septic emboli-infectious endocarditis

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Pulmonary emboli (PE)

- a. Epidemiology
  - i. Often clinically silent
  - ii. Most commonly missed diagnosis in hospitalized patients
  - iii. Found in almost half of all hospital autopsies
- b. Pathology
  - i. Most (95%) arise in *deep leg veins (DVT)*
  - ii. Pelvic venous plexuses of the prostate and uterus
  - iii. Right side of the heart
- c. Diagnosis
  - i. V/Q scan mismatch
  - ii. Doppler ultrasound of the leg veins to detect a DVT

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- d. Potential outcomes of PEs
  - i. No sequela (75%) .
    - Asymptomatic or transient dyspnea/tachypnea
    - No infarction (dual blood supply)
    - Complete resolution
  - ii. Infarction (15%)
    - More common in patients with cardiopulmonary compromise
    - Shortness of breath (SOB),hemoptysis, pleuritic chest pain, pleural effusion
    - Gross: hemorrhagic wedge-shaped infarct
    - Regeneration or scar formation

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- iii. Sudden death (5%)
  - Large emboli may lodge in the bifurcation (saddle embolus) or large pulmonary artery branches and cause sudden death
  - Obstruction of >50% of the pulmonary circulation
- iv. Chronic pulmonary hypertension (3%)
  - Caused by recurrent PEs
  - Increased pulmonary resistance
  - Pulmonary hypertension
  - May lead to cor pulmonale

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Systemic arterial emboli

- a. Most arise in the heart
- b. Most cause infarction
- c. Common sites of infarction
  - i. Lower extremities
  - ii. Brain
  - iii. Intestine
  - iv. Kidney
  - v. Spleen

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Paradoxical emboli

- Definition: any venous embolus that gains access to the systemic circulation by crossing over from the right to the left side of the heart through a septal defect.

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Infarction

- a. Definition: localized area of necrosis secondary to ischemia
- b. Pathogenesis
  - i. Most infarcts (99%) result from *thrombotic or embolic occlusion of an artery or Vein*
  - ii. Vasospasm
  - iii. Torsion of arteries and veins (e.g., volvulus, ovarian torsion)
- c. Factors that predict the development of an infarct include
  - i. Vulnerability of the tissue to hypoxia
  - ii. Degree of occlusion
  - iii. Rate of occlusion
  - iv. Presence of a dual blood supply or collateral circulation
  - v. Oxygen-carrying capacity of the blood

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- d. Common sites of infarction
  - i. Heart
  - ii. Brain
  - iii. Lungs
  - iv. Intestines
- *e.* Gross pathology of infarction:
  - Wedge shaped infarction (mostly)
  - Apex point to the site of occlusion

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Shock

- a. Definition: shock is characterized by *vascular collapse and wide spread hypoperfusion of cells and tissue due to reduced blood volume, cardiac output, or vascular tone*
- b. Cellular injury is initially reversible
- c. If the hypoxia persists, the cellular injury becomes irreversible, leading to the death of cells and the patient
- 2. Major causes of shock
- a. Cardiogenic shock (pump failure)
  - i. Myocardial infarction
  - ii. Cardiac arrhythmias
  - iii. Pulmonary embolism
  - iv. Cardiac tamponade

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- b. Hypovolemic shock (reduced blood volume)
  - i. Hemorrhage
  - ii. Fluid loss secondary to severe burns
  - iii. Severe dehydration
- c. Septic shock (bacterial infection)
  - i. Gram-negative septicemia
  - ii. Release of *endotoxins (bacterial wall lipopolysaccharides) into the circulation*
  - iii. High levels of endotoxin results in
    - Production of cytokines TNF, IL-l, IL-6, and IL-8
    - Vasodilatation and hypotension
    - Acute respiratory distress syndrome (ARDS)
    - DIC
    - Multiple organ dysfunction syndrome
  - iv. Mortality rate: 50%

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- d. Neurogenic shock (generalized vasodilatation)
  - i. Anesthesia
  - ii. Brain or spinal cord injury
- e. Anaphylactic shock (generalized vasodilatation)-type I hypersensitivity reaction
- Stages of shock:
- Stage 1: compensation
- Stage 2: decompensation
- Stage 3: irreversible

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Ischemic Heart Disease

- a. Definition: Imbalance between myocardial O_2 demand and supply from the coronary arteries.
- b. Most common cause of death in the United States
- c. Most common in middle-age men (60 yrs) and postmenopausal women (>70 yrs)

- notes:
  - Coronary arteries fill during diastole
  - Tachycardia(180) decreases filling time → ischemia

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Angina pectoris

- a. Definition: transient cardiac ischemia ***without cell death*** resulting in substernal chest pain
- TYPES OF ANGINA :
- 1. Stable angina
  - i. Most common type of angina
  - ii. Caused by:
    - coronary artery atherosclerosis with luminal narrowing greater than 75%
    - Aortic stenosis with concentric LVH
    - Hypertrophic cardiomyopathy
  - iii. Chest pain is brought on by increased cardiac demand (exertional or emotional)
  - iv. EKG:ST segment depression (subendocardial ischemia)
  - v. Relieved by rest or nitroglycerin (vasodilitation)

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- 2. Prinzmetal variant angina
  - i. Caused by coronary artery vasospasm
  - ii. Episodic chest pain often occurring at rest
  - iii. EKG:transient ST segment elevation (transmural ischemia)
  - iv. Relieved by nitroglycerin (vasodilatation)
- 3. Unstable or crescendo angina
  - i. Caused by formation of a nonocclusive thrombus in an area of coronary atherosclerosis
  - ii. Increasing frequency, intensity, and duration of episodes
  - iii. Occurs at rest
  - iv. High risk for myocardial infarction

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Myocardial infarction (MI)

- a. Definition: localized area of cardiac muscle necrosis due to ischemia
- b. Most common cause of death in the United States
- c. Mechanism
  - i. Coronary artery atherosclerosis with plaque rupture and superimposed thrombus formation
  - ii. Coronary artery spasm
  - iii. Vasculitis
  - iv. Embolisation of plaque material
  - v. Thrombosis syndromes (eg: antithrombin III deficiency, polycythemia)

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- d. Distribution of coronary artery thrombosis
  - i. Left anterior descending (LAD)=45%
  - ii. Right coronary artery (RCA) = 35%
  - iii. Left circumflex coronary artery (LCA) = 15%
- e. Types:
  - 1. Transmural infarction
    - i. Most common
    - ii. Ischemic necrosis of >50% of myocardial wall
  - 2. Subendocardial infarction ischemic necrosis of <50% of myocardial wall
- f. Clinical presentation
  - i. Sudden onset of severe "crushing" substernal chest pain
  - ii. Often radiates to the left arm, jaw, and neck
  - iii. Chest heaviness, tightness, and shortness of breath
  - iv. Diaphoresis, nausea, and vomiting
  - v. Jugular venous distension (ND)
  - vi. Anxiety and often have a "feeling of impending doom

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Serum markers to Diagnose MI:

	Elevated by	Peak	Returns to Normal by
CK-MB	4–8 h	18 h	2–3 d
Troponin I & T	3–6 h	16 h	7–10 d
LDH	24 h	3–6 d	8–14 d

- g. EKG
  - i. ST segment elevation
  - ii. Q waves representing myocardial necrosis develop in 24 to 48 hrs
- h. Gross and microscopic sequence of changes
  - i. The microscopic and gross changes represent a spectrum
  - ii. The time intervals are variable and depend on the size of the infarct, as well as other factors

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- i. Complications
  - i. Sudden cardiac death
  - ii. Cardiac arrhythmias
  - iii. Congestive heart failure
  - iv. Cardiogenic shock
  - v. Mural thrombus and thromboembolism
  - vi. Fibrinous pericarditis
  - vii. Cardiac rupture (most common 4-7 days post-MI)
    - Ventricular free wall -7 cardiac tamponade
    - Interventricular septum -7 left to right shunt
    - Papillary muscle -7 mitral insufficiency
  - viii. Ventricular aneurysm

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Sudden cardiac death

- a. Definition: death within 1 hour of the onset of symptoms
- b. Mechanism: fatal cardiac arrhythmia; usually ventricular fibrillation
- c. Etiology
  - i. Coronary artery disease (80%)
  - ii. Hypertrophic cardiomyopathy
  - iii. Mitral valve prolapse
  - iv. Aortic valve stenosis
  - v. Congenital heart abnormalities
  - vi. Myocarditis

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Congestive heart failure (CHF)

- a. Definition: insufficient cardiac output to meet the metabolic demand of the body's tissues and organs
- b. Final common pathway for many cardiac diseases
- c. Increasing incidence (in the United States)
- d. Complications
  - i. Forward failure =decreased organ perfusion
  - ii. Backward failure =passive congestion of organs
- e. Right- and left-sided heart failure often occur together

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Left heart failure

- a. Etiology
  - i. Ischemic heart disease
  - ii. Hypertension
  - iii. Myocardial diseases
  - iv. Aortic or mitral valve disease
- b. Gross
  - i. Increased heart weight
  - ii. Left ventricular hypertrophy and dilatation
  - iii. Heavy, edematous lungs
- c. Presentation:
  - Dyspnea
  - Orthopnea
  - paroxysmal nocturnal dyspnea
  - rales, and
  - S3 gallop

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- d. Micro
  - i. Cardiac myocyte hypertrophy with "boxcar" nuclei
  - ii. Pulmonary capillary congestion and alveolar edema
  - iii. Intra-alveolar hemosiderin-laden macrophages ("heart failure cells")
- e. Complications
  - i. Passive pulmonary congestion and edema
  - ii. Activation of renin-angiotensin-aldosterone system leading to 2° hyperaldosteronism
  - iii. Cardiogenic shock

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Right heart failure

- a. Etiology
  - i. Most commonly caused by left-sided heart failure
  - ii. Pulmonary or tricuspid valve disease
  - iii. Cor pulmonale
- b. Presentation:
  - jugular venous distention *(ND)*
  - *Hepatospleenomegaly*
  - *Dependent* edema
  - Ascites
  - weight gain and
  - pleural and pericardial effusions
- c. Gross: RVH and dilatation
- d. Complications
  - i. Chronic passive congestion of the liver
  - ii. Cardiac cirrhosis (only with long-standing congestion)

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Valvular Heart Disease

Degenerative calcific aortic valve stenosis

- a. Most common valvular abnormality
- b. Definition: age-related dystrophic calcification, degeneration, and stenosis of the aortic valve
- c. Common in congenital *bicuspid aortic valves*
- d. Results in concentric left ventricular hypertrophy (LVH)and CHF
- e. Increased risk of sudden death
- f. Treatment: valve replacement

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Mitral valve prolapse

- a. Epidemiology
  - i. Young women
  - ii. Affects 5-10% *of the US population*
  - iii. Associated with Marfan syndrome
- b. Asymptomatic with a mid-systolic click on auscultation
- c. Gross: enlarged, floppy mitral valve leaflets that prolapse into the atrium
- d. Micro: myxomatous degeneration
- e. Complications
  - i. Infectious endocarditis and septic emboli
  - ii. Rupture *of chordae tendineae and mitral insufficiency*
  - iii. Sudden death (rare)

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Rheumatic valvular heart disease/ acute rheumatic fever

- a. Definition: rheumatic fever is a systemic inflammatory disease, triggered by a pharyngeal infection with Group A beta-*hemolytic streptococci*
- b. Mechanism: in genetically susceptible individuals, the infection results in production of antibodies that cross-react with cardiac antigens
- c. Epidemiology
  - i. Children (ages 5-15 years)
  - ii. Decreasing incidence in the United States
- d. Clinical findings
  - i. Symptoms occur 2-3 weeks after a pharyngeal infection
  - ii. Lab: elevated antistreptolysin o (ASO) titers
  - iii. Jones criteria

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Jones Criteria for diagnosis of Rheumatic Fever

Major criteria	Minor criteria
Migratory polyarthritis	Fever
Pancarditis	Arthralgias
Subcutaneous nodules	Elevated acute phase reactants
Skin rash (erythema marginatum)	1st degree heart block – Prolonged PR interval
Sydenham chorea	

Diagnosis : 2 major or 1 major + 2 minor

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Acute rheumatic heart disease

- PANCARDITIS
- i. Myocarditis- Aschoff *body: fibrinoid necrosis surrounded by macrophages (Anitschkowcells), lymphocytes, and plasma cells*
- ii. Fibrinous pericarditis
- iii. Endocarditis
  - Involves mitral and aortic valves
  - Fibrin vegetations along the lines of closure
  - MacCallum plaques: left atrial endocardial thickening

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Chronic rheumatic heart disease

- i. Mitral and aortic valvular fibrosis
  - Valve thickening and calcification
  - *Fusion of the valve commissures*
  - *Chordae tendineae are short, thickened, and fused*
- ii. Complications
  - *Mitral stenosis and CHF*
  - *Infectious endocarditis*

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Infectious bacterial endocarditis

- a. Definition: An infection of the endocardium that usually involves the valves and adjacent structures, is caused by a wide variety of bacteria and fungi, characterized by *vegetations on* the valve leaflets
- b. Risk factors:
  - rheumatic heart disease
  - mitral valve prolapse
  - bicuspid aortic valve
  - degenerative calcific aortic stenosis
  - congenital heart disease
  - artificial valves
  - indwelling catheters
  - dental procedures
  - immunosuppression, and
  - IVDA

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- c. Acute endocarditis
  - i. High virulence organism: *Staphylococcus aureus*
  - ii. Can colonize a normal valve
  - iii. Produces large destructive vegetations
  - iv. Prognosis: poor; mortality =50%
- d. Subacute endocarditis
  - i. Low virulence organism: *Streptococcus group viridans*
  - ii. Usually colonize a previously damaged valve

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- e. Clinical presentation
  - i. Fever, chills, weight loss, and cardiac murmur
  - ii. Systemic emboli
  - iii. Roth spots: retinal emboli
  - iv. Osler nodes: painful, red subcutaneous nodules on the fingers and toes
  - v. Janeway lesions: painless, red lesions on the palms and soles
  - vi. Splinter hemorrhages
- f. Diagnosis: serial blood cultures
- g. Complications
  - i. Septic emboli
  - ii. Valve damage resulting in insufficiency and CHF
  - iii. Myocardial abscess
  - iv. Dehiscence of an artificial heart valve

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Marantic endocarditis

- a. AKA nonbacterial thrombotic endocarditis (NBTE)
- b. Definition: small, *sterile vegetations along the valve leaflet line of closure in patients* with a *debilitating disease*
- c. Complication: embolism

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Congenital Heart Disease

- a. Most common cause of childhood heart disease in the United States
- b. Etiology
  - i. Idiopathic (90%)
  - ii. Genetic association-trisomies, Cri du Chat, Turner syndrome, etc.
  - iii. Viral infection (especially congenital rubella)
  - iv. Drugs and alcohol

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Coarctation of the aorta

- a. Definition: segmental narrowing of the aorta
- b. Types:
  - Preductal coarctation (infantile-type)
    - i. Associated with Turner syndrome
    - ii. Severe narrowing of aorta *proximal to the ductus arteriosis*
    - iii. Usually associated with a patent ductus arteriosis (PDA),which supplies blood to aorta distal to the narrowing
    - iv. Right ventricular hypertrophy
    - v. Presentation: infant with CHF and weak pulses and cyanosis in the lower extremities
    - vi. Poor prognosis without surgical correction

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- Postductal coarctation (adult-type)
  - i. Narrowing of the aorta *distal to the ductus arteriosis*
  - ii. Presentation: child or adult with *hypertension in the upper extremities and hypotension and weak pulses in the lower extremities*
  - iii. Collateral circulation via the internal mammary and intercostal arteries
  - iv. Chest x-ray: notching of the ribs
- c. Complications
  - i. Congestive heart failure
  - ii. Intracerebral hemorrhage
  - ii. Dissecting aortic aneurysm

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Tetralogy of Fallot

- a. Most common cause of cyanotic heart disease
- b. Classic tetrad
  - i. *Pulmonary outflow obstruction/stenosis*
  - ii. *Right ventricular hypertrophy*
  - iii. VSD
  - iv. *Overriding aorta*
- c. Clinical features: cyanosis, shortness of breath *(SOB), digital clubbing, and polycythemia*
- d. Prognosis: progressive pulmonary outflow stenosis and cyanosis over time
- e. Treatment: surgical correction

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Transposition of the great arteries

- a. Definition: abnormal development of the truncoconal septum results in *inversion of the aorta and pulmonary arteries with respect to the ventricles*
- b. Risk increased in infants of *diabetic mothers*
- c. Develop early cyanosis and right ventricular hypertrophy
- d. To *survive, infants must have mixing of blood by a VSD, ASD, or PDA*
- e. Poor prognosis without surgery

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Truncus arteriosis

- a. Definition: failure to develop a dividing septum between the aorta and pulmonary artery, resulting in a common trunk
- b. Massive blood flow to the lungs causes pulmonary hypertension
- c. Clinical: early cyanosis and CHF
- d. Poor prognosis without surgery

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Tricuspid atresia

- a. Definition:' absence *of a communication between the right atrium and ventricle* due to developmental failure to form the tricuspid valve
- b. Associated defects: right ventricular hypoplasia and an ASD
- c. Poor prognosis without surgery

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Ventricular septal defect (VSD)

- a. Most 'common congenital heart defect
- b. Definition: direct communication between the ventricular chambers
- c. Small VSD
  - i. May be asymptomatic and close spontaneously
  - ii. May produce a jet stream that damages the endocardium and increases the risk *of infectious endocarditis*
- d. Large VSD may lead to pulmonary hypertension, RVH, reversal *of the shunt, and* late cyanosis *(Eisenmenger complex)*
- e. Auscultation: systolic murmur
- f. VSDs are commonly associated with other heart defects
- g. Treatment: surgical correction *of large defects*

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Atrial septal defect (ASD)

- a. Definition: direct communication between the atrial chambers
- b. Most common type: ostium secundum
- c. Complications
  - i. Eisenmenger syndrome
  - ii. Paradoxical emboli

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Patent ductus arteriosus (PDA)

- a. Definition: direct communication between the aorta and pulmonary artery due to the continued patency *of the ductus arteriosis after birth*
- b. Associated with prematurity and congenital rubella infections
- c. Clinical: *machinery murmur, late cyanosis, and CHF*

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The Cardiomyopathies

Dilated cardiomyopathy

- a. Most common form *of cardiomyopthy*
- b. Definition: cardiac enlargement with *dilatation of all four chambers resulting in* progressive congestive heart failure
- c. Etiology
  - i. Idiopathic (majority *of cases)*
  - ii. Alcohol
  - iii. Drug related-adriamycin (doxorubicin) and cocaine
  - iv. Viral myocarditis-Coxsackievirus Band enteroviruses
  - v. Parasitic infections-Chagas disease
  - vi. Pregnancy related

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- d. Echocardiogram: decreased ejection fraction
- e. Presentation: progressive CHF
- f. Complications: mural thrombi and cardiac arrhythmias
- g. Prognosis: poor; 5 year survival = 25%
- h. Treatment: heart transplantation

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Hypertrophic cardiomyopathy

- a. Synonyms: asymmetrical septal hypertrophy, idiopathic hypertrophic subaortic stenosis (IHSS)
- b. Etiology
  - i. Hereditary: autosomal dominant disorder (>50% of cases)
  - ii. Idiopathic
- c. Common cause of *sudden cardiac death in young athletes*
- d. Gross
  - i. Asymmetrical cardiac hypertrophy, which is *most prominent in the ventricular septum*
  - ii. The ventricular outflow tract is often obstructed by the septal hypertrophy.
- e. Micro: cardiac myofiber hypertrophy and disarray

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Restrictive cardiomyopathy

- a. Definition: uncommon form of cardiomyopathy caused by diseases that produce restriction of cardiac filling during diastole
- b. Etiology
  - i. Amyloidosis
  - ii. Sarcoidosis
  - iii. Endomyocardial fibroelastosis
  - iv. Loeffler endomyocarditis

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Carcinoid Heart Disease

- a. Definition: *right-sided endocardial and valvular fibrosis secondary to exposure to* serotonin in patients with carcinoid tumors which have metastasized to the liver
- b. Plaque-like thickening of the endocardium and valves of the right side of the heart
- c. Carcinoid syndrome
  - i. Skin flushing
  - ii. Diarrhea
  - iii. Cramping
  - iv. Bronchospasm and wheezing
  - v. Telangiectasias
- d. Diagnosis: urinary 5-hydroxyindoleacetic acid (5-HIAA)

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Cardiac Tumors

Cardiac myxoma

- a. Benign tumor usually arising within the left atrium near the fossa ovalis
- b. Micro: stellate-shaped cells within a myxoid background
- c. Complications
  - i. Tumor emboli
  - ii. "Ball-valve"obstruction of the valves

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Cardiac rhabdomyoma

- a. Benign tumor usually arising within the myocardium
- b. Associated with *tuberous sclerosis*

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Mitral Stenosis

- Etiology
  - Rheumatic fever (most common)
- Pathophysiology:
  - A. narrowing of mitral valve orifice
  - B. back pressure to left atrium, then lungs and right heart
- C/F:
  - Opening snap followed by mid diastolic rumble
  - Dyspnea
  - Hemoptysis , with rust colored sputum
  - Atrial fibrillation
    - Due to left atrial dilation and hypertrophy
    - Intra-atrial thrombus develops due to stasis → embolization

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- Pulmonary venous hypertension
  - RVH eventually develops
- Left atrial hypertrophy
  - Dilation of left atrium compresses the esophagus
  - Dysphagia to solid

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Mitral Regurgitation

- Etiology
  - Mitral valve prolapse (most common cause)
  - Left-sided heart failure
  - Infective endocarditis, rupture or dysfunction of the papillary muscle
- Pathophysiology
  - Retrograde blood flow into the left atrium during systole
    - Due to incompetent valve or dilated valve ring
  - Volume overload in the left ventricle and left atrium leads to LHF
- C/F:
  - Pansystolic murmur radiating to axilla
  - Dyspnea and cough from LHF

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Aortic Regurgitation

- Isolated aortic valve regurgitation
- Infective endocarditis
- Long standing essential hypertension
- Chronic rheumatic fever
- Aortic dissection
- Coarctation of aorta
- Austin flint murmur

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Aortic stenosis

- Dystrophic calcification : normal/ bicuspic aortic valve
- Age related sclerosis
- Chronic rheumatic fever
- Angina with exercise
- Syncope with exercise
- Hemolytic anemia with schistocytes

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