

Cardiac Disorders

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Pericarditis – Inflammation of the Pericardium

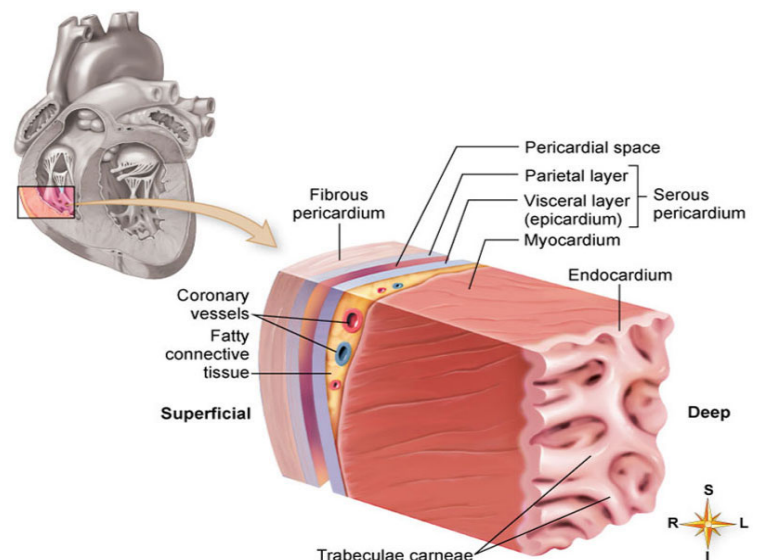
- The serous membrane is roughened up
- When the heart beats, it rubs against the pericardial sac, creating a “grating” sound
- Characterized by deep pain
- In severe cases a large amount of inflammatory fluid seeps into the pericardial cavity causing a compression when the heart beats
 - Cardiac Tamponade
- Pericarditis - Inflammation of the pericardium, often due to infection
 - **Radiation-induced pericarditis** – develops after prolonged radiotherapy for Hodgkin’s, lymphoma, or breast cancer
 - **Acute Pericarditis**- nonspecific inflammatory response to injury
 - Fibrin is often found in the pericardial fluid - often a sign of extent of disease (serous, serofibrinous, or fibrinous)
 - **Chronic Pericarditis** - arises as a complication of healing

Chronic constrictive pericarditis

- Excess fibrosis may produce diffusely and densely scarred pericardial sac
 - Characterized by shell encasing the heart.
 - 50% of cases result in calcified pericardium where heart is encased in a “mold.”
- Causes restriction of heart’s elasticity and diastolic filling, reduces cardiac output
 - Most common as a complication of tuberculosis pericarditis
 - Severe cases require surgical removal of pericardium layers

Wall of the Heart

- Structure of the heart
 - Wall of the heart: composed of three distinct layers
 - Epicardium: outer layer of heart wall
 - Myocardium: thick, contractile middle layer of heart wall; compresses the heart cavities, and the blood within them, with great force
 - Endocardium: delicate inner layer of endothelial tissue



Atria of the Heart Receiving Vessels

- Superior chambers
- Are the receiving chambers of the heart
- Atria alternately contract and relax to receive blood and then push it into ventricles
- Only a minimal contraction is needed to push the blood “downstairs” to the ventricles.
- Each atrium has a protruding auricle
- Blood enters right atria from superior and inferior venae cavae and coronary sinus
- Blood enters left atria from pulmonary veins

Ventricles of the Heart Discharging Chambers

- Inferior chambers
- Ventricles are the discharging chambers of the heart – The actual heart pumps
- The ventricles make up most of the volume of the heart
- Right ventricle pumps blood into the pulmonary trunk
- Left ventricle pumps blood into the aorta

Heart Valves

- Heart valves ensure unidirectional blood flow through the heart
- Atrioventricular (AV) valves lie between the atria and the ventricles
 - Tricuspid and bicuspid
- Semilunar valve lies between the ventricles and the great vessels
 - Aortic and pulmonary
 - Atrioventricular (AV) valves: prevent blood from flowing back into the atria from the ventricles when the ventricles contract
 - Tricuspid valve (right AV valve): guards the right atrioventricular orifice; free edges of three flaps of endocardium are attached to papillary muscles by chordae tendineae
 - Bicuspid, or mitral, valve (left AV valve): similar in structure to tricuspid valve except has only two flaps
- Semilunar valves: half-moon–shaped flaps growing out from the lining of the pulmonary artery and aorta; prevent blood from flowing back into the ventricles from the aorta and pulmonary artery
 - Pulmonary valve: valve at entrance of the pulmonary artery
 - Aortic valve: valve at entrance of the aorta
- Skeleton of the heart
 - Set of connected rings that serve as a semirigid support for the heart valves and the attachment of cardiac muscle of the myocardium
 - Serves as an electrical barrier between the myocardium of the atria and that of the ventricles

Cardiac Cycle

- Cardiac cycle: a complete heartbeat consisting of contraction (systole) and relaxation (diastole) of both atria and both ventricles
- When the heart muscle contracts (pushes in) it is called systole
- When the heart muscle relaxes (stops pushing in), this is called diastole
- Both atria do systole together
- Both ventricles do systole together
- But the atria do systole *before* the ventricles
- Even though the atrial systole comes before ventricular systole, all four chambers do diastole at the same time - This is called cardiac diastole
- The order is: atrial systole > ventricular systole > cardiac diastole
- When this happens one time, it is called a cardiac cycle

Cardiac Performance

$$CO = HR \times SV$$

- Maintenance of appropriate pressure throughout circulatory system

Heart Rate Control

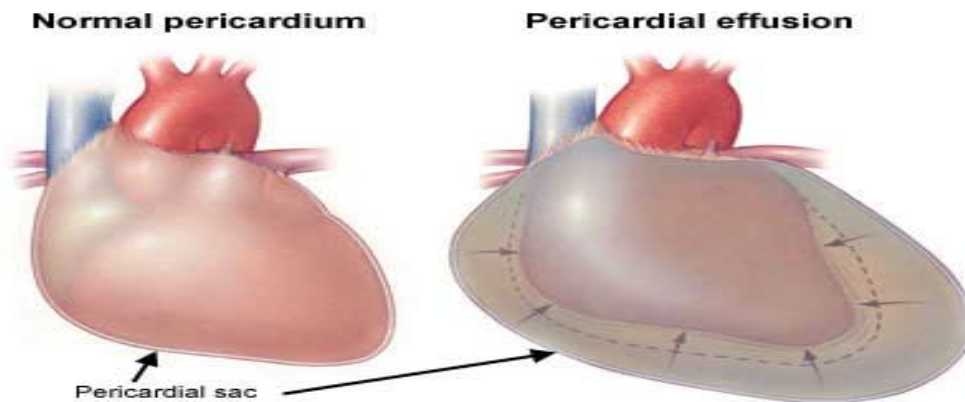
- **P wave**- Electrical signal for atria to depolarize and contract
- **QRS complex**- ventricles depolarize and contract
- **T wave**- ventricles repolarize
- **Absolute refractory period** - cardiomyocytes are unresponsive to any further stimulation

Heart Disease

- **Heart Failure** - ventricles failed to maintain blood circulation despite adequate venous filling
 - Typically the left ventricle (workload)
 - Has MANY different causes (diseases and defects)
 - Left of Right sided heart failure
 - Low or High output heart failure
- **Acute Heart Failure**
 - Characterized by quick development (seconds to days)
 - Patients often recover (~65%)
- **Chronic Heart Failure**
 - Characterized by slow development
 - More difficult for the body to “adapt”

Pericardial Diseases

- **Pericardial Effusion**- Too much fluid in the pericardial space
 - **Hydropericardium**- Too much serous fluid in space
 - **Hemopericardium**- Too much blood in the space
- **Purulent Effusion** - Pus infiltrates pericardium, often a result of bacterial or fungal infection
- **Therapy: Pericardiocentesis** - Puncture to remove pericardial fluid to relieve pressure on heart
 - May cure or relieve acute pericardial symptoms



Inflammatory Diseases

- **Myocarditis** - Inflammation of the myocardium
 - Often caused by many different viruses
 - Symptoms include:
 - **Acute** – Fever, malaise, eye swelling, constipation
 - **Chronic** – irregular heart beat, inflammation, heart failure, difficulty swallowing due to enlarged esophagus
- **Chagas' Disease**
 - Caused by *Trypanosoma cruzi* (a protozoan)
 - Afflicts 30% of population in South America and South Africa.
 - Spreads through: bloodsucking bugs, mother to fetus, blood transfusion, organ transplant
- **Infective Endocarditis (IE)**
 - Inflammation of the endocardium; also called bacterial endocarditis
 - Invariably fatal; often caused by bacterial infections and fungi
 - Characterized by a **vegetation** - can be several cm wide, easily fragmented infective mass that causes a basic lesion, thrombus
 - **Acute IE**- 5-10% mortality rate
 - **Subacute IE**- 60-80 % mortality rate
 - Develops over 3-6 months
 - Typical patient has preexisting heart condition

Valve Diseases

- **Valve Incompetence**
 - Inability for valve to fully close → some (40-50%) regurgitation of blood
 - Stroke volume increases causing cardiac output to be maintained
 - L ventricle hypertrophy as work load increases, walls thicken, lose elasticity and force as time goes on.
 - Heart will eventually be overloaded by excess volume that cannot be cleared, ventricle dilates
 - In severe cases there is 80-90% backflow of blood

Valve Diseases

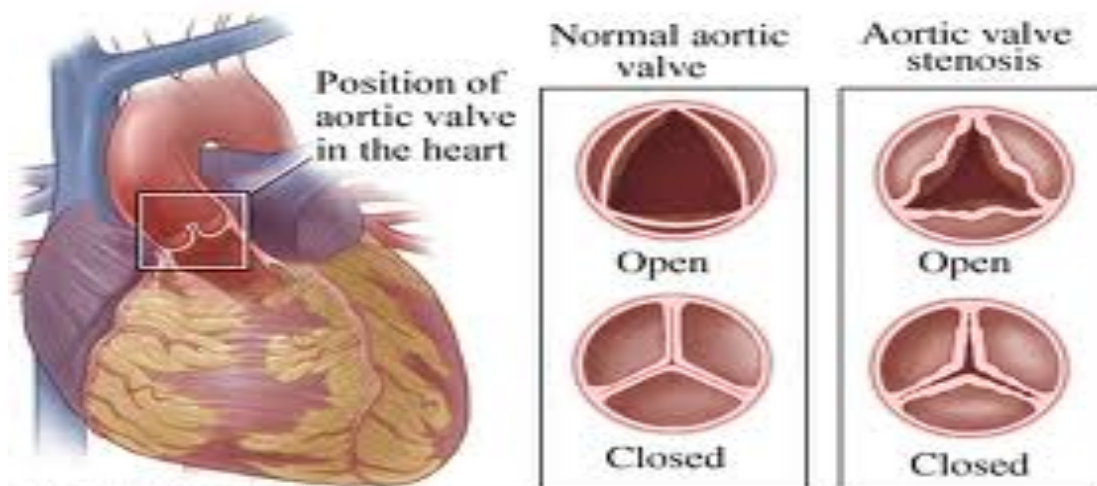
- **Valvular Stenosis** - Narrowing of valve diameter
 - **Congestion** - valve fails to open effectively or is obstructed when blood accumulates in upstream chambers of vessels (causes hypertension)
 - **Heart murmurs** - caused by turbulence
 - Either may happen in any of the four types of heart valves (some more often than others)
 - A valve can have stenosis and incompetency simultaneously

Rheumatic Heart Disease (RHD)

- Caused by the widespread inflammatory disease **rheumatic fever (RF)**
 - Often involves painful joints with much fluid infiltration
 - Started by *S. pyogenes* (Strep. Throat)
- May damage any part of the heart (usually valves)
- **Aschoff Bodies** (areas of swollen connective tissue proteins and macrophages in heart) **are indicators of RHD.**
 - Appear as lumps in the heart
- Symptoms- sudden and intense fever, sore, swollen joints, tachycardia (fast or irregular heart rate)

Heart Valves

- Mitral regurgitation (insufficiency)
 - In the past, was caused by rheumatic fever
- Mitral stenosis
 - Caused by rheumatic fever, congenital abnormalities, lupus, or tumor
- Aortic regurgitation (insufficiency)
 - The 3 cusps leak after contraction
 - Caused by rheumatic heart disease, congenital defects, endocarditis or degeneration
 - Causes ventricular enlargement
- Aortic stenosis
 - Most common valve problem in adults
 - Most caused by arteriosclerosis of flaps – normal aging



Endocarditis

- Infection of inner heart lining, usually bacterial
 - Can be acute or subacute
 - Usually occur on damaged valves in which the bacteria accumulates and forms blood clots on the valves
 - Bacteria in the bloodstream comes from mouth, dental work, gingivitis, skin infections, medical procedures (*Streptococcus*, *staphylococcus*, *enterococcus*)
 - Heart valve vegetations can and easily embolize throughout the body causing satellite abscesses
 - Diagnosis with ECHO and blood culture
 - Consider in any patient with fever heart murmur
 - Treatment – IV antibiotics and possible valve replacement

Ischemic Heart Diseases

- **Coronary Artery Disease (CAD) / Atherosclerotic Heart Disease (ASHD)**
 - Narrowing of the coronary arteries as a result of atherosclerosis (hardening of the arteries)
- **Ischemic Heart Disease (IHD)**
 - **Chronic Ischemia**- atherosclerosis and small, nonocclusive thrombi narrow artery lumen
 - **Acute Ischemia**- plaque with foam cells and lipid core; when ruptured it triggers coagulation and rapid occlusion as contents are released into lumen

Coronary Artery Disease

- **CAD Pathophysiology**
 - Atherosclerotic disease and coronary artery disease accounts for 45% of all USA deaths
 - 50% of female deaths are cardiovascular
 - Etiology includes the presence of plaques lining the coronary arteries with plaque rupture and coronary artery spasm
 - Result is ischemia, angina or MI, cell death and or electrical dysfunction

Coronary Artery Disease

- 3 Elements of atherogenesis is plaque formation, plaque rupture, vasoregulation creating atherosclerotic disease
 - CAD risk factors
 - Older age, family history, socioeconomic factors, overweight with trunk fat deposition, blood pressure, smoking
 - Personality and psychological factors, glycemic control
 - Increased LDL & triglycerides, poor dental hygiene, chronic infections
 - With several risk factors the risk could be up to 20X

Coronary Artery Occlusion with MI

- Incidence
 - 1,100,000 American had MI, with 650,000 being the first attack and 450,000 instant deaths
- S & S
 - Crushing chest pain with diaphoresis, dyspnea, weakness, palpitations, vomiting
- Diagnosis
 - Patient presentation with ECG and blood tests
- Treatment
 - Admission to CCU has best survival
 - Oxygen, beta blockers, heparin, tPa
 - Pacemaker insertion or CABG surgery

Areas of Pain in IHD

- **Angina Pectoris**
 - Sudden pain in chest or left arm, shoulder, and jaw caused by stenosis and ischemia
- **Sudden Cardiac Death**
 - Usually caused by sudden arrhythmia (irregularity in the force or rhythm of the heartbeat)
 - Tissue infarction not root cause
- **Myocardial Infarction (MI)**
 - Necrosis of the myocardium / "Heart Attack"
 - Often caused by thrombosis, atherosclerosis, etc.
 - Symptoms of Acute MI:
 - **Arrhythmias** - ventricular fibrillation (uncoordinated contraction of ventricles) most serious, usually fatal
 - **Cardiogenic Shock** - decreased cardiac output
 - **Thrombosis** - triggered by factors released from injured myocardial tissue
 - **Rupture** - dead muscle gradually softens and is susceptible to rupture (aneurysm)

4 Methods of Therapy for IHD

- Coronary by-pass – pieces of vein are sutured above and below area of stenosis
- Percutaneous transluminal coronary angioplasty – balloon inflated to stretch vessel media
- Stents – coils put in lumen to widen them
- Intra-aortic balloon pump – balloon inflates and deflates to increase cardiac output

Congestive Heart Failure

- CHF Incidence
 - In the USA, 3 million hospitalizations per year
 - 30-40% are readmitted with six months
 - 4-5 millions current cases
 - 500,000 – 600,000 new cases per year
 - 250,000 deaths per year
 - Half of all CHF diagnosis die within 5 years - 10% die in year one
 - Twice as common in African-Americans
 - USA yearly treatment cost - \$21 billion
- **Causes of CHF**
 - Coronary artery disease
 - Hypertension
 - Aortic stenosis and insufficiency
 - Mitral regurgitation
 - Atrial fibrillation, flutter or tachycardia
 - Viral myocarditis
 - Septicemia
 - Hyperthyroidism or hypothyroidism
 - Alcohol abuse
 - Chemotherapy
 - Congenital or rheumatic heart disease
 - Chagas' disease – parasitic heart infection
- Pathophysiology of CHF
 - The pumping action of the heart becomes less and less powerful
 - Despite its misleading name, in heart failure the heart doesn't suddenly stop working
 - Heart failure develops slowly as the heart muscle gradually weakens
 - The "failure" refers to the heart's inability to pump enough blood.
 - Blood and fluid do not move efficiently through the circulatory system, and starts to "back up"
 - Eventually, parts of your body (lungs, abdomen, and lower limbs) hold blood and fluid that your heart isn't circulating very well
 - This is called "becoming congested," and is why this condition is called "congestive heart failure"

Left sided vs. Right sided Heart Failure

- Can involve the heart's left side, right side or both sides, though CHF much more affects the left heart
- Left-sided heart failure
 - Fluid collects in the lungs - this extra fluid in the lungs ("congestion") makes it more difficult for the airways to expand as you inhale
 - Presents with dyspnea, pulmonary edema, and orthopnea
- Right-sided heart failure
 - Due to failure of the right ventricle
 - Fluid collects in other body tissues especially the lower extremities – pitting edema, liver enlargement
- CHF Symptoms
 - Three cardinal symptoms are dyspnea, fatigue and fluid retention
 - Sudden weight gain, despite loss of appetite
 - Swelling in legs, ankles, feet, or abdomen
 - Tired and short of breath when doing things that are normally easy, such as walking
 - Breathing difficulty when lying flat in bed or may wake up with a choking feeling
 - May need to sleep with your head raised up on several pillows
 - Persistent cough, more at night
- CHF Symptoms
 - Less frequent urination during the day
 - Irregular heartbeats, feeling of heart pounding
 - Chest pain, pressure or chest discomfort
 - Loss of appetite
 - Dizziness or lightheadedness, inability to concentrate

Four Stages of CHF - New York Heart Association Guidelines

- Class I (Mild) 35%
 - No limitation of physical activity
 - Ordinary physical activity does not cause symptoms fatigue
- Class II (Mild) 35%
 - Slight limitation of physical activity
 - Comfortable at rest, but ordinary physical activity results in fatigue, palpitation, or dyspnea
- Class III (Moderate) 25%
 - Marked limitation of physical activity
 - Comfortable at rest, but less than any activity causes fatigue, palpitation, or dyspnea
- Class IV (Severe) 5%
 - Unable to carry out any physical activity without discomfort
 - Symptoms of cardiac insufficiency at rest
 - If any physical activity is undertaken, discomfort is increased

3 Physiological Compensations for CHF

- **Myocardial Compensation**

- Increase EDV - occurs when heart fails to maintain adequate ejection fraction
 - Myocardial dilatation - Myocardium stretches and becomes thinner and less elastic
 - Cardiomegaly - heart enlargement, hypertrophy

- **Nervous System Compensation**

- Sympathetic Stimulation causes...
 - SA node elevates heart rate
 - Myocardium increases stroke volume
 - Vasoconstriction to arterioles

- **Renal Compensation**

- Renin-angiotensin system activation – activates retention of Na and H₂O.
- Gives little aid.

6 Types of Drug Therapy for Heart Failure

- Drugs that reduce susceptibility to thrombus formation
- Chronotropic drugs- alter heart rate contractility
- Inotropic drugs- alter heart contractility
- Diuretic drugs- indirectly affect heart by promoting urinary fluid loss
- Antiarrhythmic drugs- alter electrical properties of myocardial cells
- Vasodilation drugs- relax smooth muscle in arterioles

Cardiomyopathies

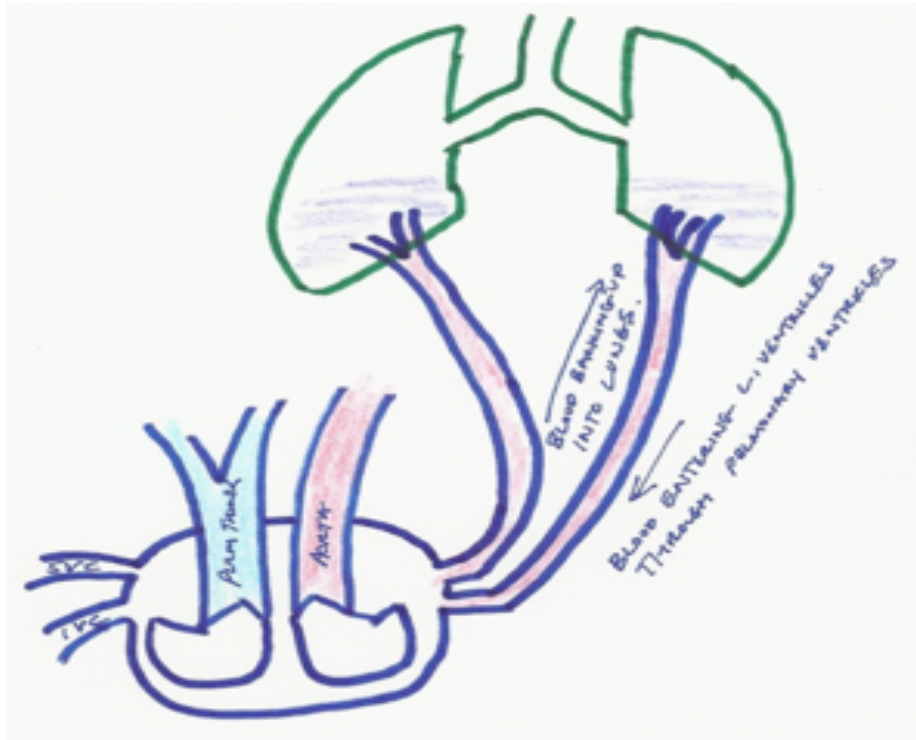
- Non-inflammatory heart diseases unrelated to the more common types of heart failure
- Impair myocardial function
- Often idiopathic
- 3 Functional Types:
 - Dilated Cardiomyopathy - Dilation and failure of the ventricles → reduced ejection
 - Hypertrophic Cardiomyopathy - ventricular hypertrophy → lowers outflow volume, reduces ventricular volume held
 - Restrictive Cardiomyopathy - Ventricle wall become stiff and less flexible

Congenital Heart Defects

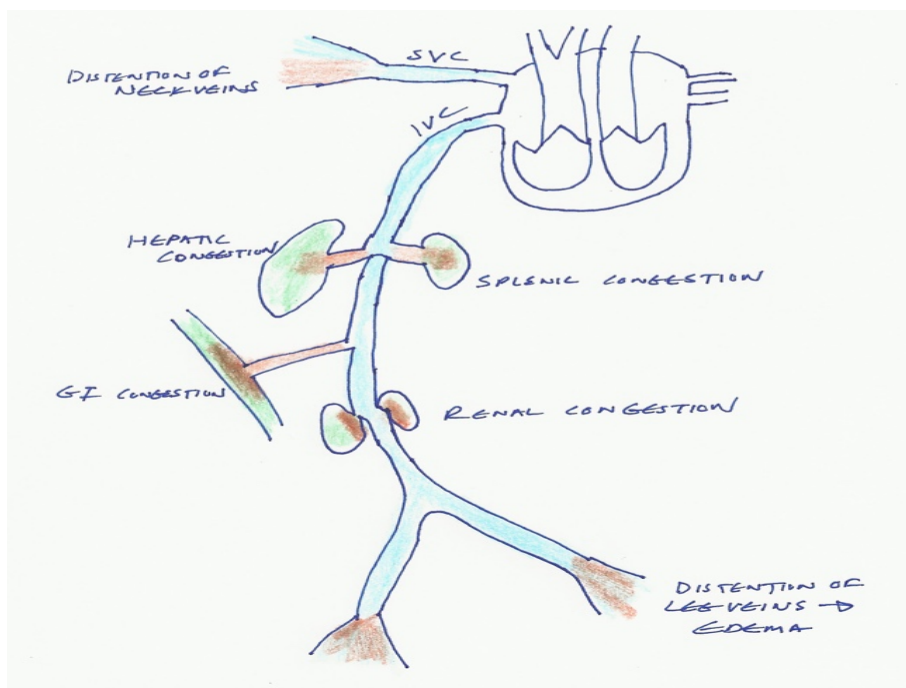
- CHD is a malformation of the heart during development
 - Over 90% of cases are idiopathic
- Ventricular Septal Defects (VSD) - Defect in the interventricular septum
 - Results in high infant mortality
- Atrial Septal Defects (ASD) - Defect in the interatrial septum (typically when foramen ovale fails to close)
 - Abnormal fusing of the interatrial septum
- Patent Ductus Arteriosus (PDA) - Blood from aorta is shunted into the PA
- Coarctation of the Aorta - Aorta narrows at some point in the patient's life

Congenital Heart Defects

- Tetralogy of Fallot- 4 structural abnormalities are present:
 - Ventricular septal defect
 - Pulmonary stenosis
 - Aorta shifted to the right
 - Right ventricle hypertrophy



Left Sided Failure



Right Sided Failure

the grinch's heart grew 3 sizes that day



and he promptly died of cardiomegaly

ROFLBOT