CARDIAC FAILURE

This is the end result of increasing workload of the heart. Ventricles first get big and beefy to improve the cardiac output (an adaptive process) that, if taken far enough, will cause the heart to become remodeled and weak. The natural progression is logical. There is an increase in resistance, so the heart beats stronger. Beating stronger makes it more muscular. Eventually, the muscle just cannot keep up and it craps out. Once “crapped out” irreversible remodeling has occurred. Thankfully, it is not all or nothing; early signs of failure can be reversed or halted before all tissue is completely remodeled. Note: most people refer to heart failure as “congestive heart failure” because blood backs up and affects either the lungs or visceral organs. A person can have failure without being “congested.”

Introduction

- Failure
  - Defined as the **inability to produce adequate cardiac output** or to do so only at an elevated filling pressure
  - Usually is preceded by **Hypertrophy** (chronic conditions)
  - Can be brought on acutely by **volume overload** (iatrogenic), **myocardial infarction** (sudden loss of myocardial contractility), or **acute valvular dysfunction**

- Types of Failure
  - **Systolic**
    - **Inability to contract** and get the blood out of the heart
    - Caused by Ischemic Injury, HTN, dilated cardiomyopathy, volume overload
    - 60% of Heart Failure cases
  - **Diastolic**
    - **Inability to relax** to allow sufficient preload
    - Caused by massive ventricular hypertrophy, fibrosis, or amyloidosis

- Initial adaptations (beneficial to maintain CO, but can be exceeded)
  - **Frank-Starling** – an increase in filling time allows an increase in end diastolic pressure resulting in a more forceful contraction
  - **Hypertrophy** – increase in muscle mass of the heart without division
  - **Neurohormonal** – increase in adrenergic response to +chronotrope +inotrope

- Terminal Adaptations
  - **Fibrosis** and Increased Surface Area without Increase in Capillary Density ultimately defeat hypertrophy, leading to ischemia, infarct, and arrhythmia
  - **Desensitization** and **remodeling** defeat neurohormonal increase, eventually resulting in the inability to respond to adrenergic stimulation
Pattern of Hypertrophy

- Pressure Overload = Afterload
  - Characterized by Hypertension (Pulmonary or systemic) or Aortic Stenosis; Pulmonary stenosis is rare, though theoretically possible.
  - Results in pressure-overload hypertrophy = concentric hypertrophy
    - Increased cross sectional area
    - No change in myocytes length
    - Sarcomeres parallel to existing axis of cells

- Volume Overload = Preload
  - Characterized by volume expansion
  - Results in volume-overload hypertrophy = dilated hypertrophy
    - Increased cross sectional area (hypertrophy)
    - Increased myocytes length (dilation)
    - Increase in ventricular diameter (dilation)

Other Changes

- Arteries
  - Increase in intercapillary distance with fibrous deposition between tissue
  - Decrease capillary density relative to myocytes size
  - Capillaries stay the same while myocytes surface area increases

- Cardiac Demand
  - Increase in cell size = Increase in tensile strength from Increase Mitochondria
  - To compensate Cardiac Output, HR and Contractility go up (stimulation by adrenergics)

- Cellular/Genetic
  - Synthesis of abnormal proteins
  - Reversion to fetal/embryonic states (c-fos, c-myc, c-jun)

Progression to failure
  - Adaptive change to retain cardiac output leaves myocytes poorly perfused despite an increase in workload. This is a tenuous balance between adaptive change and potentially harmful change.
  - Increased risk of ischemia makes the heart vulnerable to arrhythmia, infarct, and eventual failure
Left-Sided Failure

- **Causes**
  - **Ischemic Heart Disease** = infarction and loss of myocardium (acute)
  - **HTN, Aortic Stenosis** = increased afterload, hypertrophy, subsequent failure (chronic)
  - **Some Diastolic Dysfunction** can result from nonischemic myocardial disease
    - Restrictive or Hypertrophic Cardiomyopathy
    -
  - **Morphology**
    - Chamber is usually **hypertrophied** and **dilated** (according to Robbins its also dilated)
    - **Fibrosis** within myocardium
    - **Secondary Atrial Enlargement** with resultant **Atrial Fibrillation**
      - Fluid is not ejected, so backs up into atrium, which cannot hypertrophy, only dilate
      - Atrial enlargement = atrial failure = inability to contract
        - Compromise of cardiac output (loss of atrial kick)
        - Increased **risk of thrombus** from stagnant fluid

- **Effect on Lungs**
  - ↑Pressure in **pulmonary veins** is translated to arterioles and capillaries
    - Leads to **pulmonary edema** (the congestive part of congestive heart failure)
  - **Hemosiderin**
    - Iron or Heme containing compounds are phagocytized by macrophages, converting them to hemosiderin.
    - Presence of these **siderophages** in pulmonary tissue denotes previous edema
      - Nick-named “heart failure cells” or **hemosiderin-laden macrophages**
      - Pathognomonic for Pulmonary Edema (current or past)
  - **Symptoms**
    - **Dyspnea** = difficulty breathing, especially during activity
    - **Orthopnea** = difficulty breathing upon laying down, patients sleep with pillows
    - **Paroxysmal Nocturnal Dyspnea** = severe Dyspnea at night

**Effect on Kidneys**
- Decreased CO = Decrease RBF = **Increase in Renin/ANGII** in response. ANG II causes:
  - Constriction of efferent arteriole = **increased filtration** = **good**
  - Vasoconstriction = increased TPR = **increased afterload** = **bad**
  - Salt Retention = Fluid Retention = **increased preload** (venous return) = **bad**
    - “Bad” is bad because it ↑cardiac demand in an already failed heart
- Decreased filtration = decreased nitrogen excretion = **azotemia**

- **Effect on Brain**
  - Cerebral Hypoxia = **Hypoxic Encephalopathy**, only in severe cases
    - If you can’t breathe because there is fluid in your lungs where oxygen should be, you obviously won’t get enough oxygen to your brain
**Path Cardio Outline**

**Right Sided Failure**

- **Cause**
  - **Left failure** → pulmonary HTN → increased afterload for Right → Right Hypertrophy/Failure
    - The most common cause of Right Failure is Left Failure, but often they are tested as separate elements
  - **Cor Pulmonale** = Primary Pulmonary Hypertension
    - Chronic hypoxia (COPD, Bronchitis, Asthma) leads to pulmonary vasoconstriction
    - Pulmonary Vasculitis decreases luminal size, again increasing resistance
    - Vasoconstriction, Increased Resistance, HTN, all the same as saying “more to work against” making the right ventricle hypertrophy, then fail.

- **Portal Hypertension**
  - **Congestive Hepatomegaly**
    - Increased size and weight from engorgement of blood
    - Central Hypoxia with **centrilobar necrosis**
    - Prolonged ischemia = cardiac sclerosis/cirrhosis from increased fibrous tissue
    - Nicknamed a nutmeg liver
  - **Congestive Splenomegaly**
    - Engorged spleen with sinusoidal enlargement, stasis
  - **Ascites**
    - Edema into the peritoneum from GI/Portal Overload
  - **Distended Jugular Veins and pitting edema**
    - Backup of the vena cava superiorly (JVD)
    - Backup of the vena cava inferiorly (edema of the ankles)

- **Kidneys**
  - Backup of blood = increase pressure in portal vein = decreased blood flow through kidneys = decreased filtration = worsening azotemia

- **Lungs and Heart**
  - **Pulmonary Effusions** = accumulation of fluid in pleural space (not the alveoli)
  - **Pericardial Effusions** = accumulation of fluid in pericardial space

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<td><strong>Left</strong></td>
<td>Systemic Hypertension</td>
<td>Concentric Hypertrophy, dilated or not</td>
<td>Pulmonary Edema, fluid in alveolar spaces</td>
<td>Kidneys, Lungs, Brain</td>
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<td>Aortic Stenosis</td>
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<td>Nonischemic Injury (genetics)</td>
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<tr>
<td><strong>Right</strong></td>
<td>Cor Pulmonale</td>
<td>Concentric Hypertrophy, dilated or not</td>
<td>Pericardial effusions (fluid in pleural space)</td>
<td>Liver, Kidneys, Lungs, heart, brain</td>
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<td>Left Ventricular Failure</td>
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CONGENTIAL ABNORMALITIES

LEFT TO RIGHT SHUNT

Left to right shunts are characterized by insufficient cardiac output (since some of the left ventricle goes to the right side of the heart) that causes cyanosis months after birth. The blood is oxygenated, just not all of it gets out into the systemic vasculature. This high pressure entering the pulmonary vasculature murders the lungs, causing eventual pulmonary Vasculitis and eventual reversal of the shunt leading to cyanosis and death. All L→R Shunts have a D in their acronym.

**Atrial Septal Defect (ASD)**

- **Definition**
  - Abnormal opening permitting flow between the left and right atria that is not a patent foramen
  - If on its own, it is asymptomatic until adulthood

- **Morphology**
  - Usually isolated = occurring on their own
  - When with other abnormalities, the other malformation is more hemodynamically significant
  - Types are dependent on where they occur
    - Secundum = 90% of cases, defect or fenestration of the oval fossa
    - Primum = 5%, occurring at the AV valves, occur with cleft anterior mitral valve
    - Sinus Venosus = 5% occurring at entrance of vena cava.

- **Clinical Presentation**
  - L→R shunt because the left ventricle has a higher pressure and the right ventricle is more distensible (the push comes from the atria, remember)
  - Profound Pulmonary edema if the opening is severe
  - Murmur is present from excessive fluid, present in all cases
  - Right Ventricle Hypertrophy or Dilated Right Atrium is almost a certainty, regardless of level of symptoms

**Ventricular Septal Defect (VSD)**

- **Definition**
  - Incomplete closure of the ventricular septum allowing a ventricular L→R shunt
  - It is the most common congenital cardiac abnormality (Robbins says both VSD and ASD are, review books say VSD is)
  - Only 30% are isolated, many occurring with tetralogy of fallot.

- **Morphology**
  - There is a hole about the size of the aortic valve in the septum
    - Membranous VSD = 90%, involving the septum
    - Infundibular VSD = 10%, involving the are below the pulmonary artery
- **Clinical Presentation**
  - Small defects = close spontaneously (which is why surgery is delayed until 1 year of age)
  - Large Defects = permission of L\(\rightarrow\)R flow
    - **Right Ventricular Hypertrophy** and **Pulmonary Hypertension** as expected
    - **Pulmonary Vascular Disease** will lead to narrowing of pulmonary vessels leading to an essential stenosis, reversing the shunt to make a “blue baby syndrome” as in R\(\rightarrow\)L shunts, in the adult, which is fatal.
  - **Cardiac Failure** and **Murmur** are present at birth

**Patent Ductus Arteriosus** (PDA)

- **Definition**
  - Persistent ductus arteriosus, maintaining shunt between pulmonary artery and aorta distal to the major branches (carotid and subclavian).
  - Used to bypass pulmonary circulation in the fetus (R\(\rightarrow\)L shunt), now that there is a large left ventricle, it creates a patent L\(\rightarrow\)R shunt

- **Clinical**
  - Usually **no difficulties** at birth or with development
  - Detected as a **continuous harsh murmur**, “machine-like”
  - L\(\rightarrow\)R = no cyanosis, right ventricular hypertrophy, pulmonary hypertension and Vasculitis (as expected with all L\(\rightarrow\)R)
    - **Pulmonary Vasculitis** will cause a **reversal of shunt** = blue baby syndrome in adults, which is fatal
    - Closure of patent ductus is necessary as soon as possible when **isolated**
    - Patency is the only thing keeping the infant alive if there is pulmonary or systemic obstruction. Indomethicin to close, Misoprostol (PGE) to open.

**Atrioventricular Septal Defect** (AVSD)

- **When Complete.** Basically, you have one giant heart with two chambers, and two outflows. The one ventricle communicates with the pulmonary vasculature and the systemic vasculature, causing a mixture of oxygenated and deoxygenated blood to circulate. Causes **volume overload hypertension and failure**. Surgical repair is possible. This one is almost never asked in any review book.

RIGHT TO LEFT SHUNTS

Right to left shunts mix deoxygenated blood with the systemic vasculature. This causes “blue baby syndrome” caused by **cyanosis**. In these cases deoxygenated blood from the right side of the heart enters systemic circulation without passing through the lungs. In order for this to occur, there must either be extreme resistance in the pulmonary vasculature with a passage between left and right sides (otherwise the left ventricle would force a L\(\rightarrow\)R shunt), or there is a problem with the outflow pipes (switching of position, failure to separate, etc). All acronyms have a “T” in them.
**Tetralogy of Fallot – TOF**

- **Definition**
  - Tetralogy is:
    - **Ventricular Septal Defect** that give communication between left and right ventricles
    - Obstruction of Right Ventricular Outflow ([subpulmonary stenosis](#)) preventing the L→R shunt that would occur with a VSD
    - **Aorta** positioned on top of the VSD, allowing right ventricle to pump into aorta
    - **Right Ventricular Hypertrophy** as a result of increased pulmonary resistance and the right heart’s ability to pump to the left/systemic vasculature
  - Caused by an **anterior superior displacement of infundibulum**

- **Clinical Course**
  - Dependent on the severity of pulmonary stenosis
    - **Mild** = symptoms of an isolated VSD with a L→R shunt, so called “pink fallot”
    - **Severe** = classic R→L shunt, called “blue baby fallot”
  - Classic Case progression
    - Right Ventricle pushes blood through VSD and into systemic circulation because the stenosed pulmonary outflow causes increased resistance, resulting in RVH
    - Pulmonary Vasculature gets smaller and thin walled = [hypoplastic](#)
    - Aorta gets larger in diameter, while the pulmonary gets smaller
      - Makes the stenosis worse
      - Even pink fallot babies progress to blue babies
  - Fixable with surgery

- **Transposition of Great Arteries – TGA**

  - **Definition**
    - Normal vasculature is VC→RA→RV→PA→PV→LA→LV→Aorta
    - TGA vasculature is VC→RA→RV→Aorta and a separate PV→LA→LV→PA
      - The left ventricle and lungs form their own circuit
      - Blood circulating to system is purely deoxygenated
    - Aorta is normally posterior and to the left of the pulmonary artery, and now it anterior and to the right of the pulmonary artery.
  - **Morphology**
    - Without other defect this is incompatible with life
    - **Right Ventricular Hypertrophy** because the right ventricle is now systemic
    - **Left Ventricular Atrophy** because the left ventricle is now pulmonary
    - Some shunt must exist for survival
  - **Clinical Course**
    - There is an increased survival with increased mixing of blood(L→R)
      - A large ventral septal defect conveys survival
      - A patent foramen ovale is tenuous, as it is likely to close
      - Surgery is made to maintain VSD or Patent Foramen Ovale, while a reswitching of great vessels is made later in life
**Truncus Arteriosis - TA**

- **Cause**
  - A failure of the Aorta and the Pulmonary artery to separate from the truncus arteriosis.
    - Both come from the same embryonic tube, and they must separate to form two vessels.
    - Results in one giant great vessel connected to **both ventricles**
  - **Clinical**
    - Single great artery connecting everything resulting in normal and abnormal connections
    - **Abnormal**
      - The Left ventricle to the lungs causing **pulmonary hypertension** and **Vasculitis**
      - The right ventricle to the systemic vasculature causing **cyanosis** and **right ventricular hypertrophy**
    - **Normal**
      - Left ventricle to the systemic vasculature
      - Right ventricle to the pulmonary vasculature

**Tricuspid Atresia – TA-2**

- **Cause**
  - Unequal division of the AV canal results in a **larger-than-normal mitral valve** and a **tricuspid valve that doesn’t open**.
  - The Right Atrium and the right ventricle cannot communicate because there is just a wall, where there should be a valve

**Morphology**
- Atrophy/Hypoplastic **Right ventricle**
- If survival is to be achieved, there must be a means around the atresic valve
  - Patent Foramen Ovale or ASD allows R→L shunt atria to atria
  - VSD allows the left ventricle to push deoxygenated blood from RA into pulmonary vasculature

- **Clinical**
  - **Cyanosis** from birth with a **high mortality rate**

**Total Anomalous Pulmonary Venous Connection (TAPVC)**

- **Cause**
  - Common pulmonary vein does not form, and therefore there is no great vessel coming from the lungs to the right atrium. Longevity dependent on severity

- **Morphology and Clinical**
  - TAPVC are the veins that make the difference, coming from the lungs back to the right atrium, requiring an ASD or a patent foramen ovale to get oxygenated blood to the LV
  - RA is dilated, RV is dilated and hypertrophic, LA is hypoplastic, LV is normal, pulmonary vasculature is dilated
OBSTRUCTIVE CONGENITAL DEFECTS
These are defects whereby there is an inappropriate closure or failure to open of one of the larger vessels or valves. It creates an obstruction (a stenosis or other increase in resistance) that causes abnormal flow.

Coarctation of the Aorta

- Definition
  - Narrowing or encroachment on the lumen of the aorta, either descending or ascending (meaning proximal or distal) to the major branches
  - Increased resistance to left ventricular outflow and decreased perfusion to organs supplied distal to occlusion/stenosis
  - Coarctation with Patent Ductus = “Infantile”
    - Symptom onset is early in life, and is usually fatal
    - Coarctation is proximal to major branches, with patent ductus arteriosis
      - Oxygenated blood cannot get through the stenosis
      - Deoxygenated blood gets around the stenosis through PDA, supplying brain and body with deoxygenated blood
  - Coarctation without Patent Ductus = “Adult”
    - Symptom onset is dependent on severity of stenosis, in childhood or even adulthood, with coarctation distal to major branches
    - Significant hypertension in upper extremities because left ventricle supplies them well with oxygenated blood, but the lower half is “cut off”
    - Weak Pulses and hypotension in the lower extremities, revealed as intermittent pain (claudication) on excess movement of the legs
    - Collateral circulation through enlarged intercostals supplying organs distal to coarctation, revealed as “rib-notching” on chest X-ray.

- Commonalities
  - Systolic murmur that may be a thrill (more likely in infantile)
  - Left Ventricular Hypertrophy from increased resistance
  - Grafting, Ballooning, and surgery have good outcomes (remember Anatomy PBL)

Pulmonary Stenosis and Atresia

- Cause
  - Mild to severe obstruction of pulmonary valve
  - Can be isolated or occur with other abnormalities (Tetralogy of Fallot or TGA)

- Morphology
  - Right Ventricular Hypertrophy from increased resistance
  - Pulmonary Artery Dilation from forceful stream through stenosed valve
  - If entirely atretic = must be ASD with PDA to maintain blood blow, RV is hypoplastic
  - If with another disease, RV pressure is not translated to the valve, meaning right ventricular hypoplasia
Aortic Stenosis and Atresia

- **Cause** (3 kinds, all result in obstruction to left ventricular outflow)
  - Valvular – effects the cusps = dysplastic (thick) or abnormal number (fusion)
  - Subaortic – thickening of fibrous subendocardium prior to the cusps
  - Supravalvular – ascending wall is abnormally thick with luminal intrusion

- **Clinical and Morphology**
  - Severe Atresia = **Hypoplastic Left Heart Syndrome**
    - LV hypoplasia with Aortic Hypoplasia from decrease outflow tract
    - Requires a patent ductus arteriosis to get any blood through.
    - Fatal after the first week of life as the ductus closes
  - Moderate to mild
    - LVH from afterload increase
    - Requires prophylactic antibiotics
    - Strenuous activity can cause death
  - In all cases there is a prominent **systolic murmur** that is nondiagnostic for location

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<table>
<thead>
<tr>
<th>Disease</th>
<th>Type</th>
<th>Cause</th>
<th>Symptoms</th>
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</thead>
<tbody>
<tr>
<td>Atrial Septal Defect</td>
<td>L → R Shunt</td>
<td>Hole between the atria allowing oxygenated blood into right ventricle. Most common defect to occur alone, not the most common in general. More commonly occurs in the <strong>Primum</strong> (90%) and sometimes in <strong>Secundum</strong> (10%)</td>
<td>Pulmonary hypertension, Pulmonary Vasculitis, Late stage reversal of shunt = cyanosis and fatality, called <strong>Eisenmenger’s Syndrome</strong>. The RV will hypertrophy and/or pulmonary artery will stenose, reversing the flow to <strong>R → L</strong></td>
</tr>
<tr>
<td>Ventral Septal Defect</td>
<td>L → R Shunt</td>
<td>Hole between the ventricles allowing oxygenated blood into right ventricle. Most common defect in the heart. Associated with <strong>Down’s Syndrome</strong>.</td>
<td></td>
</tr>
<tr>
<td>Patent Ductus Arteriosis</td>
<td>L → R Shunt</td>
<td>Hole between the aorta and pulmonary artery allowing ox blood into lungs. Kept open with prostaglandin, closed with indomethacin</td>
<td></td>
</tr>
<tr>
<td>Transposition Great Arteries</td>
<td>R → L Shunt</td>
<td>Swapping of aorta to RV and pulmonary artery to LV, requiring communication (PDA) for life. Requires surgical correction. If no surgery, is fatal in 1st month of life</td>
<td></td>
</tr>
<tr>
<td>Truncus Arteriosus</td>
<td>R → L Shunt</td>
<td>Pulmonary artery and aorta do not separate, so are one big outflow vessel allowing mixing of blood in both directions.</td>
<td></td>
</tr>
<tr>
<td>Tricuspid Atresia</td>
<td>R → L Shunt</td>
<td>RA and RV do not communicate, requires ASD and VSD for life. The tricuspid valve never forms a hole</td>
<td></td>
</tr>
<tr>
<td>Coarctation of Aorta</td>
<td>Obstruction</td>
<td><strong>Infantile</strong> = Coarctation proximal major branches (fatal) <strong>Adult</strong> = Coarctation distal major branches (found as a kid) Occurs in <strong>Turner Syndrome</strong></td>
<td>Variable on PDA and extent of coarctation, usually distal cyanosis or weak pulse</td>
</tr>
<tr>
<td>Aortic Atresia</td>
<td>Obstruction</td>
<td>Stenosis or Atresia from something being in the way of left ventricular outflow</td>
<td>Atresia = Hypoplastic LV Stenosis = LVH</td>
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<tr>
<td>Pulmonary Atresia</td>
<td>Obstruction</td>
<td>Stenosis or Atresia from something being in the way of right ventricular outflow</td>
<td>Right ventricular hypertrophy and Pulmonary Dilation</td>
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</table>
ISCHEMIC HEART DISEASE

Ischemia is defined as a mismatch between myocardial oxygen supply and demand. Whether it happens over years or happens right now, if there is not enough supply, the myocardium will suffer.

Types of Ischemia

- **Chronic**
  - Caused by atherosclerosis, with the formation of plaques and a concentric stenosis of the coronary vessels leading to decreased blood flow. May be associated with vasospasm, thrombosis, or embolus.
    - At 75% occlusion, 25% flow, patients will experience **exercise induced ischemia**
    - At 90% occlusion, 10% flow, patients will experience **ischemia at rest**.
  - This represents the little old lady with years of smoking and fried chicken, with sufficient stenosing of her vessels
    - Multiple angina events will indicate ischemic disease, and can be managed

- **Acute**
  - Caused by vasospasm, embolus, or thrombosis without previous indication of ischemic disease. The first event is the Myocardial Infarction that kills them.
    - There is no significant stenosis, there is no induced angina/ischemia
    - May be histological indications, **eccentric non stenosing plaques**.
  - This is the 16 year old kid who does cocaine, suffering from an increased heart rate (increase myocardial demand) with vasospasm, reporting the ER with chest pain

Causes of Ischemia

- **Acute Plaque Change**
  - Changes in the condition of a stable plaque (either concentric/nonconcentric) lead to thrombosis and complete occlusion of a vessel
    - Rupture/Fissure = exposes highly thrombogenic plaque interna
    - Ulceration/Erosion = exposes highly thrombogenic basement membrane
    - Fragmentation/Embolus = plaque breaks off and occludes smaller vessel (rare)
  - Intrinsic plaque Influences
    - Increase in Foam Cells, Lipids, thin fibrous cap, Increase Inflammatory cells all increase the risk of plaque change
  - Extrinsic Plaque Influences
    - An increase in mechanical stress on a weak fibrous cap leads to damage
    - Adrenergic Stimulation, Emotional Stress, even the awakening from sleep all increase cardiac output and predispose for increased mechanical stress
Path Cardio Outline

- **Inflammation**
  - The stability of a plaque is dependent on **collagen** and the **fibrous content**.
  - Activation of **macrophages** (active inflammation) results in metalloproteinases that degrade the collagen, **weakening the fibrous cap**.
  - **C Reactive Protein** is an acute phase molecule of inflammation, used as a prognostic indicator for ischemic events

- **Vasoconstriction**
  - Vasospasm, for whatever reason, occludes blood vessel. In a healthy vessel, this does nothing. In an already stenosed vessel, this causes occlusion.
  - Responds well to nitrates

**Angina**

There is a spectrum of conditions that represent minor occlusion to complete occlusion. Thus, there are different types of angina. While categorized in the coming section, it must be noted that there is in fact a continuum of states and conditions that makes its way from **stable** to **unstable** to full blown **Myocardial Infarction**. Pritzmental is a special kind of angina. Angina itself is **ischemic chest pain**.

- **Stable Angina**
  - Significant stenosis = **75% occlusion** = decreased perfusion
  - Perfusion maintained while at rest
  - Exercise or emotional stress = **increase in demand** = ischemic chest pain
  - Alleviated with rest or nitrates

- **Unstable Angina**
  - Worsening stenosis = **90% occlusion** = critically decreased perfusion
  - Perfusion compromised while at rest or with little exertion.
  - Severe stenosis, thrombus, or vasospasm **not alleviated by nitrates**

- **Pritzmental Angina**
  - Uncommon, irregular attacks caused by **vasospasm**
  - Responds well to nitrates
  - Is unrelated to physical activity, BP, stress, etc

**Myocardial Infarction**

An infarct occurs in an area supplied by an occluded coronary vessel. For all intents and purposes, there is no collateral circulation in the heart, except in the case of long term, severely stenotic disease. The wall is thick, the arteries are on the **epicardial surface**. Therefore, the myocytes of the **endocardial surface** (called the **subendocardium**) are at particular risk, being farthest from the blood supply while the myocytes of the **epicardial surface** (called the **subepicardium**) are at least risk. Infarction results in **necrosis** and **loss of function**, unless **reperfusion** can be achieved in a relatively short amount of time.
- Types
  - Transmural
    - Complete thickness, literally “across the wall” from subendocardium to subepicardium representing a long standing, severe ischemia
    - Caused by an unalleviated completely occluding thrombosis or stenosis.
    - Occurs in a single geographical region supplied by the occluded vessel
  - Subendocardial
    - Involves less than the full thickness (1/3 – 1/2)
    - Subendocardium is the least well perfused and is most vulnerable
      - Coronary occlusion causes single area of risk
      - Systemic hypotension may result in global ischemia of vulnerable subendocardium throughout heart

- Clinical Features of MI
  - Patient - Presentation Suspects an MI
    - Cold, Clammy, Diaphoretic, Dyspnea, Substernal Chest Pain (visceral pain explained as a crushing) that radiates to the Jaw or down the arm
    - Feeling of Impending Doom – “I’m going to die!”
    - Diabetics, Elderly and Women may be asymptomatic (silent MI).
  - Electrocardiogram - Screen Suspected patients for MI
    - Hallmark of ischemia is the T wave inversion
    - Hall mark of Infarct = ST Segment Elevation (Transmural) ST Segment Depression (Subendocardial)
    - Hallmark of Old Infarct is Q wave Elongation
  - Labs – Troponins and CK-MB Confirm the Diagnosis
    - Cardiac Troponins are the new golden standard. Unique to myocytes, detectable throughout evolution of MI. Get Troponin I
    - CK-MB is former golden standard. Creatine Kinase is in brain (CK-BB), muscle (MM) and in heart (MB). When damaged, the heart should release CK-MB. Difficult to track, could be associated with another condition, and is only detectable later in evolution
    - Myoglobin, lactate Dehydrogenase (LDH), C reactive Protein, are useful markers when the clinical picture of infarct is present. These are nonspecific for myocardium and may be elevated if the patient worked out that day

<table>
<thead>
<tr>
<th></th>
<th>CK-MB Mol. Weight</th>
<th>Troponin Mol. Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase</td>
<td>3-6hrs</td>
<td>4-8hrs</td>
</tr>
<tr>
<td>Peak</td>
<td>12-24hrs</td>
<td>12-16hrs</td>
</tr>
<tr>
<td>Return</td>
<td>24-72hrs</td>
<td>5-9days</td>
</tr>
</tbody>
</table>

Pink area represents Subendocardial infarct
Pink area represents transmural infarct

Endocardium
Epicardium

Inverted T
ST Elevation
Q Wave
Path Cardio Outline

- **Coronary Artery Occlusion**
  - **Atherosclerosis** causes occlusion of the coronary vessel
  - **Rupture** of the atherosclerotic plaque causes **thrombosis** → ischemia
  - **Vasospasm** of the vessel around it causes vasoocclusion → ischemia

- **Reperfusion**
  - **Methods**
    - Thrombolytics = “clot busters” eliminate thrombus, not plaque
    - Percutaneous Coronary Intervention (Angioplasty/Stent) gets rid of the occlusion, the thrombus, and the plaque
    - Coronary Artery Bypass Graft (CABG) provides flow around obstruction
  - **Effects**
    - Early Reperfusion (<40min) = complete recovery of tissue
    - Delayed Reperfusion (2-4hrs) = necrosis of subendocardium, rescue of surrounding tissue
    - Late Reperfusion (>6hrs) no help = and may actually be hazardous, will not improve infarct size.

  - **Reperfusion Injury**
    - Caused by leukocyte produced O₂ Free Radicals distributed to healthy tissue upon reperfusion
    - Probably apoptosis mediated (future of anti-apoptotic meds)
  - **Terminology**
    - **Stunning** = post infarct dysfunction that may result in permanent remodeling or failure. Ischemic tissue becomes more damaged because of reperfusion.
    - **Preconditioning** = frequent angina attacks prior to major ischemic event trains the tissue to be hypoxic and the ischemic event is not as severe.

Here are some gross images of an MI and complications. Check out the next page for histology.

On the following page you will see the evolution of an MI in chart form. You must know what it looks like in gross, what it looks like in micro, and what the risks are for any given period. The paragraph format has a simplistic view that is similar to First Aid.

The questions you will have to answer is usually “if a patient dies at time X... what did he die of or what does his hear look like?”
### GROSS CHANGES FOLLOWING MI

<table>
<thead>
<tr>
<th>Survival Time</th>
<th>Predominant Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-18 hrs</td>
<td>No Change</td>
</tr>
<tr>
<td>18-24hrs</td>
<td>Vague pallor change, visible with special stain</td>
</tr>
<tr>
<td>1-3 Days</td>
<td>Yellow Pallor in the center</td>
</tr>
<tr>
<td>3 Days – 4 weeks</td>
<td>Yellow Pallor with surrounding Hyperemia</td>
</tr>
<tr>
<td>6 Weeks +</td>
<td>White/Grey Firm Scar</td>
</tr>
</tbody>
</table>

See page First Aid Page 262, Edition 2009 for a simplistic version of all this information

### HISTOLOGIC CHANGES FOLLOWING MI

<table>
<thead>
<tr>
<th>Survival Time</th>
<th>Predominant Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4 hrs</td>
<td>Wavy Myocytes and contraction bands</td>
</tr>
<tr>
<td>4-24hrs</td>
<td>Coagulative Necrosis with few Neutrophils</td>
</tr>
<tr>
<td>1-3 Days</td>
<td>Coagulative Necrosis with many Neutrophils</td>
</tr>
<tr>
<td>3-7 Days</td>
<td>Coagulative Necrosis with Macrophages</td>
</tr>
<tr>
<td>10+ Days</td>
<td>Collagen Deposition, Fibroblasts, Macrophages</td>
</tr>
</tbody>
</table>

### RISK FOLLOWING MI

<table>
<thead>
<tr>
<th>Survival Time</th>
<th>Predominant Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 hrs</td>
<td>Fatal Arrhythmia</td>
</tr>
<tr>
<td>1-7 days</td>
<td>Ventricular Rupture (Septal Wall or Ventricular Wall)</td>
</tr>
<tr>
<td>7+ Days</td>
<td>Ventricular Aneurysm (no rupture, just outpouching, leading to mural thrombus)</td>
</tr>
<tr>
<td>Any point</td>
<td>Chordae Rupture, Valve Prolapse, Hypotension</td>
</tr>
</tbody>
</table>

Granulation Tissue. Good Myocytes are to the bottom right. The rest is amorphous, mostly white fibrous tissue. The repair process if nearly complete. Note that myocytes do not regenerate, as they are permanent cells, permanently in G0.

Coagulative Necrosis (pink myocytes have no dark blue nuclei) with infiltrates in between. You can’t tell if they are neutrophils or macrophages, so you don’t know if you are at 1-3 or 3-7 days.

Trichrome stain showing the blue collagen laid down after everything is said and done. This is an old MI with scar tissue already formed. Normal myocytes are to the left, blue collagen all over, new arteries (granulation tissue) to the right.
HYPERTENSIVE HEART DISEASE

The topic here goes very closely with the section at the beginning of the discussion on heart. Why it is separated, I am uncertain. However, it is kept separate so as to go along with Robbins. This is what happens BEFORE the heart fails.

Left Ventricular Hypertensive Heart Disease

- Diagnosis
  - Left ventricular hypertrophy with a history of pathologic hypertension (140/90 or greater on either systolic or diastolic) without any other pathology to explain it

Signs and Symptoms
  - May be asymptomatic and the hypertrophic heart is found on routine echo or ECG. This type of heart disease would be considered compensated
  - May present with atrial fibrillation (atrial dilation), Congestive Heart Failure (pulmonary edema), or both. This is an example of uncompensated

Morphology
  - Concentric Left Ventricular Hypertrophy without Dilation on gross
  - Myocytes show an increased transverse diameter, irregular or large nuclei and cells, with evidence of interstitial fibrosis on histologic prep.

- Outcomes
  - Spectrum depending on how well hypertension is managed. There may be a complete reversion of remodeling back to a normal heart, or the patient may progress to full on failure and die of CHF. Anything in between is possible as well.

Right Ventricular Hypertensive Heart Disease

- Definition
  - Rare form of hypertensive heart disease, occurring only in cases of diseases of the pulmonary system or of the pulmonary vasculature that result in an increase in resistance of the right ventricle
    - COPD, Cystic Fibrosis, Sarcoidosis
    - Recurrent Embolism, Primary Pulmonary Hypertension, Drugs (Digoxin, Bleomycin, Isoiazid)
    - Obstruction of airway, metabolic acidosis
  - Left ventricular failure resulting in fluid backup and subsequent right ventricular failure does not count as RV Hypertensive Heart Disease, but is the most common cause of Right Ventricular Hypertrophy and Failure.

Morphology
  - Acute cor pulmonale = Dilation of the right ventricle
  - Chronic cor pulmonale = Hypertrophy of right ventricle (to the width of a normal LV)
  - Cor Pulmonale = primary pulmonary hypertension
VALVULAR HEART DISEASE

Valves control the flow of blood. Problems arise when the valves cannot close properly allowing backflow (regurgitation / insufficiency), when they cannot open correctly causing an increase in resistance to flow (stenosis), or a combination of both. Regurgitation can occur either as a pathological finding of the valve, or of a functional regurgitation whereby the dilation of the ventricle pulls the chordate tendinae apart, preventing the normal healthy valve from functioning correctly. The severity of the disease is variable, ranging from chronic long-onset (chronic rheumatic fever) with adaptation to rapid, fatal onset (bacterial endocarditis). The morphological changes to the heart will represent whatever is wrong (outflow blocked = hypertrophy, regurgitent jet = fibrosis) as will be shown. The four most relevant dysfunctions are mitral valve regurgitation and stenosis, and aortic valve regurgitation and stenosis.

Calcific Aortic Stenosis. (can also happen to the Mitral Valve, called “Mitral Annular Calcification”)

- **Cause**
  - Induced by the normal “wear-and-tear” of valve leaflets, experiencing 40 million contractions per day
  - Calcifications develop slowly over many decades

**Morphology**
- Heaped-up calcified masses within the aortic cusps that protrude through the outflow surfaces preventing opening of the valves. Basically, calcifications act as door stops, preventing the valve from opening all the way
- Calcification begins at the **valvular fibrosa**, the points of maximal tension
- There are no commissural fissures

**Clinical Features**
- Increased stenosis = increase resistance = effective systemic hypertension = Left Ventricular Hypertrophy which leads to left ventricular failure.
- Crescendo-Decrescendo Systolic Murmur

**Myxomatous Degeneration of the Mitral Valve (aka Mitral Valve Prolapse)**

- **Cause**
  - Unknown
  - Prospect says there is a defect in connective tissue that causes prolapsed after stress from ventricular pressure

**Morphology**
- **Gross**
  - Enlarged Ballooning of mitral leaflets
  - Tendinous Cords are long, thin, stretched, or even snapped off
  - Annular Dilation is common in mitral valve prolapsed, rare in other conditions
- **Histology**
  - Attenuation of the fibrous layer
  - Focally marked thickening of the spongiosa
- **Clinical features**
  - Generally **asymptomatic**, with approximately 1% of population having the condition, diagnoses on routine echo or physical exam
  - **Holosystolic Systolic Murmur** can be audible if sufficiently bad
  - While asymptomatic, there is an increased risk of developing
    - **Infective Endocarditis** – Bugs hide in the pocket formed by the bulging
    - **Thrombi** – Stagnation and clots can hide in that same pocket
    - **Mitrail Insufficiency** – if the prolapsed gets really bad, ejection fraction (to the periphery) is so low as to require surgery

**Rheumatic Fever and Rheumatic Heart Disease**
Both of these diseases affect the heart. Rheumatic Fever is technically the acute condition, upon which, with subsequent repeated episodes, results in Rheumatic Heart Disease, the chronic condition.

- **Cause**
  - **Sequella** of an untreated Strep A **pharyngitis** (S. Pyogenes)
    - **Antibodies** to Strep A **M** protein cross react with heart and joint tissue in host
    - Reinfection causes reactivation of antibodies and subsequent autoimmune
  - Chronic damage from repeated exposure causes **long term destruction** and **fibrosis** of the cardiac tissue (which cannot regenerate)

- **Morphology**
  - **Acute**
    - **Aschoff Bodies** = inflammatory lesions
      - Swollen Eosinophilic Collagen + Tc cells + Plump Macrophages called **Antishkow Cells**
      - Cause a **Pancarditis** infecting any layer of heart (epi, endo, myocardium)
  - **Chronic**
    - Organization of acute inflammation that leads to **fibrosis**
    - **Gross**
      - Leaflet Thickening, Commissural Fusion and Shortening, Thickening and Fusion of Chordae Tendinae
      - Is the leading and definitive cause of mitral stenosis (99% of cases)

- **Clinical Features**
  - **Acute**
    - 10days-6weeks after Strep A infection pharyngitis (must be pharyngitis)
    - **Arthritis** of large joints (adults>kids, resolve spontaneously)
    - **Carditis** (pleural friction rub, weak pulse, tachycardia)
    - **Rash, Fever, Spastic Movements**
  - **Chronic**
    - **No symptoms** for decades, results in a fibrotic stenosis eventually
    - Symptoms depend on **severity** and **valvular involvement**
      - 75% cases Mitral Stenosis Alone, 25% cases Mitral and Aortic
Infectious Endocarditis

- **Cause**
  - **Predisposing factors**
    - Rheumatic heart disease, mitral valve prolapsed, calcified aortic stenosis, prosthetic heart valves, or any condition that causes abnormal flow or creates a pocket for the organism to hide in
  - **Organisms**
    - *S. Pyogenes* = RHD, noninfective fibrosis is more of a predisposition than an infection
    - *S. Viridans* = 50-60% of all cases of normal heart valves, the dental organisms
    - *S. Aureus* = Highly virulent, seen commonly in IV drug users
    - *S. Epidermis* = commonly infect prosthetic valves
    - *Other* = Fungi or Gram negative Bacilli
  - **Routes**
    - The foremost predisposing factor is bacterial *seeding* (you have to let them in)
    - Obvious infection, dental work, IV drug use, penetrating trauma, occult gut

- **Morphology**
  - **Vegetations**
    - Effect *mitral* or *aortic valves* usually, though right sided is possible
    - Vegetations are *friable* (they break), bulky, potentially destructive containing fibrin, inflammatory cells, and the bacteria
    - They may *erode* into the myocardium forming a *ring abscess*
  - **Changes**
    - *Systemic Emboli* may break off and cause infarcts with abscesses because of the bacteria (called *septic infarcts*)
    - *Subacute Endocarditis* = less destruction of the valve, presence of granulation tissue, and, with time, calcification or fibrosis
    - *Acute Endocarditis* = giant holes and abscesses in valves without inflammation

- **Clinical**
  - **Fever** = Most consistent sign of Infectious Endocarditis, though may be falsely low in subacute (nonsevere) cases or in the elderly
  - **Murmurs** = occur in 90% of cases but may represent a predisposing condition, not a sign
  - **Autoimmune** = glomerular nephritis (Ag-Ab deposition) with hematuria and proteinuria
  - **Duke Criteria**
    - System of labs, clinical, echo, cultures that identify IE
    - Used to use outdated clinical appearance
      - Roth Spots = retinal hemorrhage
      - Osler Nodes = Subcutaneous Nodules in the Digits
      - Janeway Lesions = Erythmatous Nontender Nodules on Palms/Soles
      - Petechial Rashes

- **Treatment/Prevention**
  - Find the bug, find what it is vulnerable to, and give that antibiotic
  - Prophylaxis broad spectrum antibiotics or targeted therapy for area of surgery (dental, gut, etc)
Noninfectious Endocarditis

- Nonbacterial Thrombotic Endocarditis (NBTE)

**Causes**

- **Hypercoagulable State**
  - Frequently occurs with venous thrombosis or pulmonary embolism indicative of hypercoagulability
  - Causes by underlying condition (Cancer, Sepsis, Burns, elevate estrogen)
- **Endocardial trauma**, such as with a Swan-Ganz Pulmonary Catheter

**Morphology**

- Characterized by small deposits of **fibrin**, **platelets** and **blood components** on the leaflets of the valves which are **sterile** and contain **no organisms**
- **Nondestructive** lesions occurring in bands or single, which are small
- Histologically thy are bland thrombi without an immune reaction

- Libman Sacks Endocarditis

  **Cause**

  - **Antiphospholipid Syndrome** associated with **Lupus**
  - Thrombotic, Hypercoagulable lesions associated with venous and arterial thrombosis

  **Morphology**

  - Single or multiple **granular**, pink, small lesions on **either or both side of the valve**
  - Histology reveals NBTE with **hematoxilin bodies** (review Inflammation)
  - Fibrinoid Necrosis of the valve material occurs contiguous with the lesion
  - Repeated damage and fibrosis may require surgery

Red Bumps all lined up in a row on the edge of the valve, no penetration into myocardium or chordae

Normal valve with a fibrinous thrombus (no immune reaction)

Libman Sacks Endocarditis

- On Top
- On Bottom
  Difficult to see the yellow lesions on both sides of valve

RHD is marked by a row of small, warty vegetations along the lines of closure of the valve leaflets.
IE is characterized by large, irregular masses on the valve cusps that can extend onto the chordae
NBTE exhibits one or more small, bland vegetations, usually attached at the line of closure.
LSE has small or medium-sized vegetations on either or both sides of the valve leaflets.
PERICARDIAL DISEASES

Pericardial Effusion
- Normal pericardial fluid = 30-50mL of straw-colored, thin, serous fluid
- Extra fluid can accumulate of variable composition
  - **Pericardial Effusion** = Variable, usually serous
  - **Blood** = hemopericardium from trauma
  - **Pus** = purulent Pericarditis
- Response is dependent on **quantity** and **rate** of pericardial filling
  - Depends on how much the heart can stretch
  - **Rapid filling**, even with low fluid levels (200-300mL) = cardiac tamponade
  - **Slow filling** can accommodate more fluid (up to 500mL) and still be ok

PERICARDITIS

This is an inflammation of the pericardium. It is often caused secondary to something else (metastasis, surgery, thoracic/systemic disease, or infectious agents). Most causes result in an **acute pericarditis** with an acute inflammation reaction. Some cause **chronic Pericarditis**.

**Acute Pericarditis**
- **Serous Pericarditis**
  - Serous inflammatory exudate that is produced by **noninfectious inflammation** (RF, SLE, scleroderma) or an infection near the serosal layer (pleuritis)
  - The increased **vascular permeability** of inflammation results in an **exudative fluid** that normal has **scant inflammatory cells** in a fluid that accumulates slowly
- **Fibrinous and Serofibrinous Pericarditis**
  - Most Common type of Pericarditis
  - Composed of a **serous fluid** mixed with **fibrinous exudate**
  - Causes include MI, post infarction syndrome (Dressler’s Autoimmune), RF, SLE, trauma
  - Development of a **loud pericardial friction rub** is seen often with pain and systemic febrile reactions.
  - The fluid is either dry (fibrinous) or there can be thick yellow fluid owing to erythrocytes and inflammatory cells
- **Purulent or Suppurative Pericarditis**
  - Caused by the invasion of foreign organisms.
    - Direct extension of **neighboring inflammation** (pleuritis, infectious endocarditis)
    - Seeding from the **blood** or **lymphatic extension**
    - **Direct introduction** during cardiotomy
  - Clinical findings = those of fibrinous Pericarditis with increased systemic reactions (fever, chills, etc)
  - There is a **large amount of fluid** (500mL) with a variable consistency dependent on the concentration of organisms and strength of the immune response
Path Cardio Outline

- Histologically you see an **acute inflammatory reaction**
- This can spread to involve the mediastinum = **mediastinopericarditis**
- Organization is the usual outcome, resulting in a **constrictive pericarditis**, resolution is rare

  - **Hemorrhagic**
    - Fibrinous + Blood in the pericardium caused by metastasis, infection or trauma
    - Basically the same as everything above, just with a lot of blood
  
  - **Caseous**
    - Almost certainly caused by TB, though can be fungal
    - Caused by a direct spread from the tracheobronchial tree, resulting in **caseous necrosis**

**Chronic or Healed Pericarditis**

- **Normal**
  - Most of the pericarditis listed results in organization of fibrin
  - “Organization” usually means 1 of 3 things, all that **do not hamper cardiac function**
    - Fibrous plaques (“soldiers plaques”) on the serosal membrane
    - Thin, delicate adhesions of obscure origin
    - **Adhesive Pericarditis** = stringy fibrous connection between layers of pericardium, essentially obliterating the sac
  
- **Adhesive Mediastinopericarditis**
  - Follows caseous or suppurative pericarditis, sometimes irradiation
  - The pericardial sac is obliterated, forming adhesions between the external parietal layer and the rest of the mediastinum
  - With each contraction, the heart must pull against all organs in the mediastinum in order to squeeze blood, **significantly compromising cardiac function**
  - *Increased workload* results in hypertrophy and dilation mimicking DCM
  - Pulsus paradoxus, systolic retraction of rib cage, and other clinical findings

- **Constrictive Pericarditis**
  - If present, was usually a Sequella of suppurative pericarditis
  - The pericardial sac is obliterated, replaced with a **fibrous shell** which can be calcified or not.
  - **Limits Diastolic Relaxation** and therefore results in compromised cardiac function
  - Hypertrophy and Dilation cannot occur, because the heart has no room in which to expand into
  - **Surgery** to remove the shell is the only therapy available.
CARDIOMYOPATHY

Dilated Cardiomyopathy

- Definition
  - Progressive Cardiac Dilation and Contractile (systolic) dysfunction without hypertrophy
  - 25-30% genetic, 10% EtOH, low % Myocarditis, low% pregnancy, the rest is idiopathic
    - First Aid, Kaplan, and Goljan say “alcohol is the most common cause”

- Morphology
  - Large, Heavy, Flabby Heart with dilation of all 4 chambers
  - With dilation comes stretching of the myocardium so there is no visible thickening of the ventricular walls = “no hypertrophy”
  - With dilation comes stretching of the myocardium and with it the valves, so there may be a functional regurgitation of valves

- Causes
  - Myocarditis (see later)
  - Alcohol = caused by aldehydes or direct toxicity, is indistinguishable from other kinds
  - Pregnancy = poorly understood. There is probably a multi-factorial combination of HTN, volume expansion, and nutritional deficiency. Called peripartum cardiomyopathy
  - Genetic = Gene mutation of the cytoskeleton X-Linked, usually with Dystrophin.

Clinical

Ages 20-50 causing slow onset CHF that may precipitously lead to failure (EF<25%)

Hypertrophic Cardiomyopathy

- Definition
  - Hypertrophy, Abnormal Diastolic Filling, and intermittent ventricular outflow
  - Heart is hypercontracile, meaning it cannot relax (diastolic dysfunction)

- Morphology
  - Gross
    - Disproportionate septal thickening = “Banana Lumen”
    - Endocardial thickening of Left ventricular outflow tract and thickening of anterior leaflet of the mitral valve
  - Histo
    - Extensive Myocyte Enlargement (beyond any other disease)
    - Disarray of Bundles of Myocytes
    - Interstitial or Replacement Fibrosis
  - Cause
    - Genetic mutation, 403 Arg→Gln in the Beta-MHC gene, mutation of sarcomere
  - Clinical
    - Impaired diastolic filling along with a massive hypertrophied left ventricle
    - Harsh Ejection Murmur from near total obstruction of outflow
    - Focal Ischemia and Risk of thromboemboli cause angina and dyspnea
Restrictive Cardiomyopathy

- **Definition**
  - Primary Decrease in Ventricular Compliance (Systolic Dysfunction)
  - Associated with restrictive disease = amyloidosis, sarcoidosis, fibrosis

- **Morphology**
  - Normal sized ventricles, no dilation, but with firm chambers and enlarged atria
  - Patchy diffuse interstitial fibrosis

- **Other Causes**
  - **Endomyocardial Fibrosis**
    - Disease of children/young adults in Africa
    - Fibrosis begins at Apex and travels to the valves with regular mural thrombi
    - Unknown Etiology
  - **Loeffler Endomyocarditis**
    - Endomyocardial fibrosis caused by increased abnormal eosinophils releasing toxic granules that injures the ventricles. Repair leads to fibrosis.
    - Removal of fibrotic layer (endomyocardial stripping), surgically, will fix it.
  - **Endocardial Fibroelastosis**
    - Infantile/Childhood illness of unknown etiology
    - Causes fibrosis of mural left ventricular myocardium associated with some other stenotic valve disease responsible for the increased mortality.

Myocarditis

- **Cause**
  - Inflammation is the cause of, NOT a reaction to myocardial insufficiency
  - Infection
    - T. Cruzi = Chagas Disease = 80% of cases have Myocarditis
    - Trichinosis (helminthes), Lyme disease (B. Burgdorfi), parasite, etc
  - Noninfectious
    - Hypersensitivity Myocarditis = allergic reaction to drugs, diuretic, anti-HTN
    - Autoimmune Inflammation = RF, SLE, Polymyositis or transplant sensitivity

- **Morphology**
  - Patchy and diffuse inflammation
    - Interstitial Fibrosis with areas of necrosis adjacent to inflammatory cells
    - While mononuclear lymphocytes are most common, endocardial biopsy may show nothing because of the patchy nature of infiltrates
  - In gross, it can appear normal, hypertrophic, or dilated with patch lesions
  - Giant Cell Myocarditis has multinucleated giant cells and a poor prognosis
  - Chagas Disease = trypanosomes inside the myocytes

- **Clinical**
  - Acute illness can mimic MI (Dyspnea, chest pain, fatigue, fever)
  - Spectrum = asymptomatic/spontaneous resolution → death. Moderate cases progress to look like DCM
ANNUERYSMS

Aortic Aneurysm = Abdominal Aorta

- **Definition**
  - Out pouching of the aorta, most commonly in abdominal aorta, following atherosclerotic destruction of the aortic media, leading to vessel wall weakness

- **Morphology**
  - Big ass bulge out the side of the abdominal aorta of varying width and length
  - Often contains atheromatous ulcers with thrombi (source of atherothrombotic origin)
  - May be so large that it compresses nearby vessels or the thrombus causes occlusion syndromes
  - Special Variants
    - Inflammatory AAA = Macrophages, Giant Cells, Lymphocytes, Plasma cells, AAA
    - Mycotic AAA = Supuritic lesions with organisms hiding inside (salmonella)

- **Pathogenesis**
  - Atherosclerosis is number 1 cause
  - Cystic Medial Degeneration = Collagen. Aneurysms come from abnormal collagen (Marfan’s) or an abnormality of collagen remodeling (increased degradation decreased synthesis caused by an immune reaction) resulting in an inherently weakened aortic wall

- **Clinical Course**
  - Rupture is often fatal. Hemorrhage occurs into the peritoneum. ↑ size = ↑ risk
  - Obstruction of a vessel (mesenteric, renal, vertebral) leading to ischemic injury
  - Direct Compression of the ureter or of the vertebrae (casing vertebral erosion)
  - Embolism from the thrombus that’s sitting inside
  - Tumor = AAA is a palpable mass that may be mistaken as a tumor

**Syphilitic (Leutic) Aneurysms = Ascending Aorta**

- **Cause**
  - Syphilis (stage 3) has a vascular predilection for small vessels, especially of the aorta
  - Infection with subsequent inflammation of the vasa vasorum leads to obstruction, inducing ischemia and obliterator endarteritis of the aorta, causing death of muscle and elastic tissue, called syphilitic aortitis

- **Morphology**
  - Starts in the adventitia with vessels with inflammation reactions in adventitia (above)
  - Muscle that dies is replaced with fibrous scar tissue in the media, contraction of which causes the “tree-barking” appearance
  - Effects thoracic aorta with possible dilation of aortic valve leading to insufficiency

- **Presentation**
  - All causes by the encroachment on mediastinal tissues
  - Crush the lungs = Dyspnea
  - Pain from rib and vertebral erosions
  - Death from rupture
  - Crush the esophagus = Dysphagia
  - Cardiac Disease from valve involvement
  - Aortic Regurgitation
**Path Cardio Outline**

**Dissecting Hematoma = Thoracic Aorta (Ascending common, Descending less common)**

- **Definition**
  - Catastrophic illness characterized by dissection of blood between and along the laminar planes of the media with formation of a blood-filled channel within the aortic wall which can rupture outward

- **Morphology**
  - A single intimal tear cuts into but not through the media of the ascending aorta creating a blood filled pocket within the aorta, between layers
  - Dissection can continue in both direction (towards the heart and towards the femoral)
  - Usually rupture outwards, but can rupture back inwards
    - Outward = hemorrhage = fatal
    - Inward = second intimal tear back into the normal lumen, forming a new vascular channel ("double-barrel Aorta") which can, over time, endothelize and become a permanent vessel
  - No distinguishing histology except for warning signs = elastic tissue fragmentation and medial degeneration

- **Pathogenesis**
  - HTN is primary causative agent, if you see HTN pick Dissecting Hematoma
  - Medial weakening is not required for dissection, but cystic medial necrosis from Marfan’s or Ehler’s Danlos (weak elastic layer) predisposes dissection
    - If you have a dissection, pick HTN. If HTN isn’t there, pick Marfans
  - Once dissection has happened, arterial blood pressure favors hematoma

**Clinical Course**

- If the dissection is Proximal subclavian/carotid (type A = bad), if distal (type B = better)
- Pain in the chest radiating to the back is a tell tale sign
- Death usually results from rupture
- If dissection involves aortic root, you can get valve problems (regurgitation, murmur)

**VASCULITIDES**

This is more a rapid rundown of critical buzzwords, presentations, and treatments associated with the various diseases. We did not get a lecture on this content and should be part of your “tutorial.” Baby Robbins is sufficient for this section, and this is an outline of the content in that book. We begin with arterial vasculitides.

**Giant Cell Arteritis (Temporal Arteritis) = Board Favorite**

- Effects medium and small sized arteries
- Most common form of Vasculitis, especially in Elderly Women
- Characterized by giant cell granulomatous inflammation
- Head pain, vision disturbances (can lead to blindness), arthralgias
- Responds well to steroids

---

Classic presentation is an elderly female with unilateral temporal pain with firm nodules on palpation. She may or may not complain of blindness. When you take a biopsy you will see a giant cell granuloma. Don’t be surprised if her joints her too; don’t be fooled into an arthritis!
**Takayasu Arteritis**

- Effects **Japanese women** more than anyone else
- Effects medium + large sized arteries = the carotid and subclavian as they branch from aorta
- **Granulomatous inflammation** limits blood flow to the upper extremities
- Called **pulseless disease** since pulses are weak or absent in upper extremity periphery
- The vignette may sound like Giant Cell Arteritis, but these will be **young asian women**

**Polyarteritis Nodosum (PAN)**

- Effects medium and small sized arteries, disseminated randomly through periphery
- Causes a **necrotizing Vasculitis** which is **diffuse** and difficult to pinpoint
- Symptoms reflect organ supplied by necrotized artery, but the general fatigue, fever, and weight loss is generally always present.
- Critical Associations are with **Hep B Seropositivity** and with **p-ANCA (pANca for PAN)**
- Morphology dependent on stage, multiple stages present at one time
  - Acute = sharply inscribed fibrinoid necrosis
  - Healing = fibrinoid necrosis + fibroblasts
  - Healed = fibrous lesion into lumen with destruction of elastic lamina, possible aneurysm
- Responds well to **steroids**

**Kawasaki’s Disease**

- Effects medium and small sized arteries → effects the **Coronary Arteries**
- Manifests as fever, lymphadenopathy, with oral or conjunctival erythema, and a maculopapular rash on the skin
- Usually self-limiting but involvement of carotid can lead to **fatal aneurysm or thrombosis**
  - Aneurysm leads to tamponade, Thrombosis leads to infarction

**Wegener’s Granulomatosis**

- Effects small but can effect medium sized arteries with a **necrotizing granulomatous inflammation** which can lead to Rapidly Progressive Cresentic Glomerulonephritis (Renal)
- Effects middle-aged women (40-50)
- Targets focal lesions of the **lungs, kidneys, and upper respiratory system** (Nose, Sinus)
- No causative agent or pathology known, responds well to treatment with **immunosuppression** (cyclophosphamide) works well. Do well with treatment, poorly without
- **C-ANCA is usually elevated** (90%), p-ANCA is PAN, c-ANCA is the “other one”

**Buerger’s Syndrome (Thromboangiitis Obliterans)**

- Effects medium and small sized arteries of the extremities in **young (<35yo) chain smokers** often of Middle Eastern or Mediterranean Descent
- Vasoocclusive disease with segmental, thrombotic, granuloma formation with giant cells
- Causes **Raynaud-like phenomena**, progressive to vasoocclusive crisis with pain and gangrene from insufficient flow, usually effecting the hands

STOP SMOKING!
It’s the only treatment

27 | Owl Club Review Sheets
VEINS AND LYMPHATICS

Varicose Veins
- Superficial veins (usually of the legs) become distended, more cosmetic than anything else
- Obesity, jobs with legs dependent (barber, surgeon), and pregnancy are disposing factors
- Stasis of blood, rupture of valves, or thinning of walls allows distention
- May cause ulceration, but are generally asymptomatic (do not cause emboli)
- Can also be in the esophagus (esophageal varices) and in the anus (hemorrhoids).

Thrombophlebitis and Phlebothrombosis (aka Deep Vein Thrombosis, DVT)
- The distinction between thrombosis of the vein (phlebothrombosis) and inflammation of the vein with thrombosis (thrombophlebitis) is not relevant, they are all DVTs
- Presents with pain in the calf with red, tender lesions, with a positive Homan’s Sign (dorsiflexion induces pain)
- Risk increases with Estrogen, Birth Control, Smoking, Age, Hypercoagulability
- Can result in pulmonary embolism or edema

Superior and Inferior Vena Cava Syndromes
- Something blocks these large veins (invasive neoplasm, mural thrombosis) that causes a back up distally, without a failure of the heart
- Massive edema inferiorly for IVC (ankle, ascites, pelvis) or superiorly for SVC (face, neck, arms)

Lymphangitis and Lymphedema
- Infection gets into the lymph nodes
- Red streaks from site of penetration, follows along lymph tract, finished at lymph node
- Lymphadenopathy is present with PMNs and Lymphocytes infiltrating site of infection
- Caused by Cancer or Virulent Bacteria (Staph)

THE REST OF THE CONTENT OF THIS CHAPTER, “CANCERS”, WAS COVERED IN NEOPLASIA. Know that kids get rhabdomyosarcomas and adults get atrial myxomas. That was Kaplan’s entire review of that material.
### ISCHEMIC HEART DISEASE

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atherosclerosis</td>
<td>Development of <strong>atheromatous plaques</strong> from <strong>fibrous streaks</strong></td>
</tr>
<tr>
<td></td>
<td>Formed of <strong>lipid-laden macrophages</strong> surrounded by a <strong>fibrous cap</strong></td>
</tr>
<tr>
<td></td>
<td>Atheromas may <strong>rupture</strong> leading to bleed, thrombus or embolus</td>
</tr>
<tr>
<td></td>
<td><strong>Accelerated in Diabetes</strong>, causes Abdominal Aortic Aneurysm</td>
</tr>
<tr>
<td>Monckenberg’s Arteriosclerosis</td>
<td>Also termed <strong>Medial Calcific Arteriosclerosis</strong>; Benign condition of aging, Vessels become more rigid and the <strong>pulse pressure widens</strong></td>
</tr>
<tr>
<td>Essential Hypertension</td>
<td>Induced by atheromatous plaques and aging, i.e. the normal process of aging</td>
</tr>
<tr>
<td></td>
<td>Hypertension induces <strong>hyaline formation</strong> of the vasculature</td>
</tr>
<tr>
<td></td>
<td>Increases risk of myocardial infarction, kidney failure, stroke, and Dissecting Aneurysm/Hematoma</td>
</tr>
<tr>
<td>Malignant Hypertension</td>
<td><strong>Hyperplastic Arteriosclerosis</strong> = are the typical onion skinning vasculature and flea-bitten kidneys</td>
</tr>
<tr>
<td></td>
<td>Look for a BP of &gt;200/&gt;120 in the vignette, pick hyperplastic or malignant HTN</td>
</tr>
<tr>
<td>Stable Angina</td>
<td><strong>Chest pain</strong> induced by stress or exercise that <strong>subsides with rest or nitrates</strong></td>
</tr>
<tr>
<td></td>
<td>Produces no myocardial damage, beginning stages of heart disease, ST Segment Depression</td>
</tr>
<tr>
<td></td>
<td><strong>Atherosclerosis</strong> causes 75% occlusion</td>
</tr>
<tr>
<td>Unstable Angina</td>
<td><strong>Chest pain</strong> induced by stress or exercise that does not subside with rest or nitrates = 90% occlusion</td>
</tr>
<tr>
<td></td>
<td>No permanent damage, but serious intervention is required (Stent, CABG)</td>
</tr>
<tr>
<td></td>
<td>Seen as ST Segment Depression with chest pain, mimicking Subendocardial Infarct</td>
</tr>
<tr>
<td>Prinzmetal Angina</td>
<td><strong>Chest pain</strong> that has nothing to do with stress or exercise (vasospasm induced)</td>
</tr>
<tr>
<td>Myocardial Infarction</td>
<td><strong>Chest Pain radiating to the jaw/arm</strong> with sweating and hypotension</td>
</tr>
<tr>
<td></td>
<td>Indicated by ST Segment Depression (for Subendocardial infarct, usually hypotension) and ST Segment Elevation (for Transmural Infarct, usually thrombus)</td>
</tr>
<tr>
<td></td>
<td>Death in the first few hours occurs from <strong>arrhythmia</strong>, death in a few days Hempericardium</td>
</tr>
<tr>
<td></td>
<td>You must know what it looks like in gross and histo, and what are complications (see last page)</td>
</tr>
<tr>
<td></td>
<td>Risk factors include Hypertension, Diabetes, Increased Age, ↑TG, ↑Chol; Estrogen is PROTECTIVE</td>
</tr>
<tr>
<td></td>
<td>Elevations in Troponin I (best choice), CK-MB (sort of specific), LDH (not specific)</td>
</tr>
<tr>
<td>Right Sided Failure</td>
<td>Back up of blood before the lungs. Causes cardiac cirrhosis, pitting edema of lower extremities, and ↑JVP</td>
</tr>
<tr>
<td></td>
<td>Is generally the result of Left Failure, or may be Cor Pulmonale from COPD</td>
</tr>
<tr>
<td>Left Sided Failure</td>
<td>Back up of blood after the lungs. Causes pulmonary edema, paroxysmal nocturnal dyspnea (sleep with pillows)</td>
</tr>
<tr>
<td></td>
<td>Is generally the result of systemic hypertension or myocardial infarction</td>
</tr>
<tr>
<td></td>
<td>Called “Congestive Heart Failure” even though it does not require congestion to be failure</td>
</tr>
</tbody>
</table>

### AORTIC ANEURYSMS

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syphilitic Aneurysm</td>
<td>Caused by Tertiary <strong>Syphilis Infection</strong>, causes oblitative endarteritis (death of vaso vasorum)</td>
</tr>
<tr>
<td></td>
<td>Characterized as a tree-bark or tissue paper wrinkling of the aorta on gross</td>
</tr>
<tr>
<td></td>
<td>May involve aortic root, producing aortic regurgitation, affecting the ascending aorta</td>
</tr>
<tr>
<td></td>
<td>Rare because all antibiotics treat syphilis; look for a homeless sexually active male in vignette</td>
</tr>
<tr>
<td>Dissecting Aneurysm</td>
<td>Caused by Hypertension (first choice), or Cystic Medial Necrosis from Marfan’s (2nd choice)</td>
</tr>
<tr>
<td></td>
<td>Presents as a tearing pain radiating to the back, affecting the descending aorta</td>
</tr>
<tr>
<td></td>
<td>Death results from rupture, look for double-lumen or mediastinal widening on X-ray or CT</td>
</tr>
<tr>
<td>Abdominal Aortic Aneurysm</td>
<td>Caused by <strong>atherosclerosis</strong> generally occurring below the renal artery</td>
</tr>
<tr>
<td></td>
<td>Presents with intense flank pain, palpable abdominal mass, abdominal bruit</td>
</tr>
<tr>
<td></td>
<td>Can be fixed with a large stent but rupture = death</td>
</tr>
</tbody>
</table>
## Path Cardio Outline

### Valvular Diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious Endocarditis (IV Drug Abuser)</td>
<td><strong>Acute</strong> = Staph Aureus, 50% fatal even WITH treatment; <strong>Subacute</strong> = Strep Viridans/ Rheumatic heart Friable vegetations on the atrial side of the valve, can embolize and cause septic infarct. May effect the right side (Intravenous Drug Abuser), Mitral most common, can effect Aortic Valve. Produces Splinter Hemorrhages on the fingernails, Osler Nodes which are Painful, Janeway Lesions which are painless, and Roth Spots on the eyes (red with white in the center).</td>
</tr>
<tr>
<td>Noninfectious Endocarditis (Old Man or Woman)</td>
<td><strong>Marantic Endocarditis</strong> occurs in the elderly and is usually associated with metastasis/cancer. It is NOT a metasis, but Marantic Endocarditis occurs only in old dying, very sick patients. May break off and cause sterile emboli.</td>
</tr>
<tr>
<td>Libmann-Sacks Endocarditis (Young Woman 20-40)</td>
<td>Associated with Lupus (usually a women with positive ANA, positive dsDNA-Ab); SLE → LSE Sterile Vegetations on both sides of the valve, which may embolize causing sterile emboli. Usually a picture of a valve with vegetations on both sides, putting it in words is too easy.</td>
</tr>
<tr>
<td>Rheumatic Heart Disease (Kids Post-Strep)</td>
<td>Follows a <em>Streptococcal Infection</em> of pharynx, develops an increased ASO Titer (Anti-M protein). There is a cross-reactivity to the mitral valve, causing Aschoff bodies with Anitschkow Cells. Is not an infection but it predisposes the mitral valve to infection (Viridans Prophylaxis at dentist). Jones criteria: chorea, arthralgia, subcutaneous nodules, fever, and others (10+ criteria).</td>
</tr>
<tr>
<td>Aortic Stenosis</td>
<td>Caused by aging (benign calcification) or by rheumatic fever (fish-mouth fusion of leaflets). Characterized by a crescento-decrescendo systolic murmur located at the 2nd intercostal space. Causes left ventricle hypertrophy (from ↑afterload), heard at the Right sterna Border.</td>
</tr>
<tr>
<td>Mitral Stenosis</td>
<td>Most common valve affected by Rheumatic Fever, heard at the apex, 5th intercostal space. Causes a diastolic murmur as blood fills the ventricles through a stenosed valve.</td>
</tr>
<tr>
<td>Mitral Prolapse aka Insufficiency</td>
<td>Holosystolic Harsh Murmur occurring at S2, ending at S1. Causes a “backward failure” with blood rushing back into the atria, a result of Papillary Muscle Rupture (Ballooning), myocardial infarction, or Myxomatous degeneration (Dermatan Sulfate).</td>
</tr>
</tbody>
</table>

### Cardiomyopathies

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilated Cardiomyopathy</td>
<td>Most commonly caused by Alcohol, but can also be Chagas, Doxorubicin, or Coxsackie Virus. All four chambers are dilated and there is a left and right heart failure (systolic dysfunction).</td>
</tr>
<tr>
<td>Hypertrophic Cardiomyopathy</td>
<td><strong>Autosomal Dominant</strong> mutation of the B-MHC gene resulting in a fatty heart, Myocyte disarray. First presentation is usually an athlete who drops dead on the court (no warning signs). Shows a banana-lumen producing obstruction to outflow; septum is hypertrophied &gt; free wall.</td>
</tr>
<tr>
<td>Restrictive Cardiomyopathy</td>
<td>Iron overload from hemochromotosis (GI block), Amyloid, or Fibro-Elastosis are causes. There is a diastolic dysfunction as the muscle cannot relax.</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>Chronic or Acute Inflammation WITHIN the heart muscle. Most commonly caused by Chagas Disease.</td>
</tr>
</tbody>
</table>

### Cardiac Tumors

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhabdomyosarcoma</td>
<td>You find them in kids (if child in vignette and has a heart cancer, pick Rhabdo). Associated with autosomal dominant Tuberus Sclerosis (not mentioned in this block). Contains a “muscle background;” i.e. the tumor is of the muscle.</td>
</tr>
<tr>
<td>Atrial Myxoma</td>
<td>You find them in adults (if adult in vignette and has a heart cancer, pick Atrial Myxoma). Has a Myxomatous background within the Left Atrium. Can cause sudden cardiac death from ball-valve dropping into the mitral valve = 0 Cardiac Output.</td>
</tr>
</tbody>
</table>
### PERICARDITIS

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibrinous</td>
<td>Occurs <strong>two weeks after MI</strong> looking like “bread-and-butter,” called <strong>Dressler’s Syndrome</strong> Represents an exudate on the pericardial surface</td>
</tr>
<tr>
<td>Serous</td>
<td>Caused by <strong>Lupus</strong> or other autoimmune disorder</td>
</tr>
<tr>
<td>Purulent</td>
<td>Caused by <strong>infection</strong>, it is, obviously, purulent. Commonly a thick white or yellow fluid</td>
</tr>
<tr>
<td>Hemorrhagic</td>
<td><strong>Inflammation and blood</strong> enters the pericardium, but is NOT from a ventricular rupture (hemopericardium) Associated with post-surgical conditions</td>
</tr>
<tr>
<td>Adhesive</td>
<td><strong>Sequellae</strong> of infectious pericarditis where the pericardium is obliterated and the muscle adheres to all tissues Heart must contract against lungs and diaphragm (which is not easy) resulting in hypertrophy</td>
</tr>
<tr>
<td>Constrictive</td>
<td><strong>Squella</strong> of infectious pericarditis where the pericardium gets stiff, resulting in failure-to-relax (diastolic)</td>
</tr>
<tr>
<td>Pericardial Effusions</td>
<td><strong>Beck’s Triad</strong> = Kussumal Sign, <strong>Pulsus Paradoxus</strong>, Neck Vein Distention <strong>Look for muffled heart sounds</strong>, from fluid around the heart, preventing diastolic relaxation</td>
</tr>
</tbody>
</table>

### DISEASES OF THE BLOOD VESSELS

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giant Cell Arteritis</td>
<td><strong>Granulomatous</strong> inflammation effecting the <strong>temporal artery</strong> of the elderly Presents with <strong>head pain</strong> (especially with palpation) and maybe <strong>blurry vision</strong> May lead to blindness. Do a <strong>ESR (↑ in disease)</strong> to differentiate from stroke</td>
</tr>
<tr>
<td>Kawasaki’s</td>
<td><strong>Necrotizing Granulomatous</strong> inflammation in a <strong>baby</strong> (in this block, baby will do it) Look for <strong>mucocutaneous involvement</strong>, <strong>lymphadenopathy</strong>, or a <strong>desquamating rash</strong> in a kid in the stem May involve the <strong>coronary artery</strong> leading to a fatal aneurysm (tamponade) or thrombosis (infarction)</td>
</tr>
<tr>
<td>Takayasu</td>
<td><strong>Pulseless Disease</strong> effecting middle aged <strong>Japanese women</strong> Look for <strong>absent pulses</strong> in the upper torso, caused by <strong>inflammation of aorta</strong> or <strong>carotid</strong> as it branches May produce neurologic or visual symptoms that may lead you to think its Giant Cell</td>
</tr>
<tr>
<td>Wegner’s Granulomatosis</td>
<td><strong>Necrotizing Granulomatous</strong> inflammation of the <strong>lungs</strong>, <strong>kidney</strong>, and <strong>nose/sinus</strong> (all 3 = pathognomonic) Associated with <strong>C-ANCA</strong> and treated with <strong>Cyclophosphamide</strong> and <strong>Corticosteroids</strong></td>
</tr>
<tr>
<td>Polyarteritis Nodosa (PAN)</td>
<td>Symptoms that affect multiple organs but do not fit together causing a <strong>Fibrinoid Necrosis</strong> in each one Associated with <strong>P-ANCA</strong> (P-ANCA for PAN). Treat with <strong>steroids</strong> or cyclophosphamide (90% remission) Strong association with <strong>Hepatitis B infection</strong> (far more sensitive than p-ANCA)</td>
</tr>
<tr>
<td>Henoch-Schonlein Purpura</td>
<td><strong>Common childhood systemic Vasculitis</strong> characterized by <strong>palpable Purpura</strong> on the <strong>legs and buttocks</strong> Commonly follows an Upper Respiratory infection, it is an <strong>IgA Immune Disease</strong> Look for other IgA diseases such as Pernicious Anemia or Dermatitis Herpataiforms</td>
</tr>
<tr>
<td>Buerger’s Syndrome</td>
<td><strong>Disease of young males</strong> who <strong>chain smoke</strong> and are usually <strong>middle eastern</strong> Causes <strong>Raynaud’s Phenomenon</strong> in the distal extremities which may lead to amputation Smoking Cessation is the only treatment</td>
</tr>
<tr>
<td>Varicose Veins</td>
<td><strong>Benign</strong> lesions that may thrombose but cannot embolize Present problems of <strong>cosmetics</strong> though they may <strong>ulcerate</strong> and can be <strong>painful</strong> if neglected</td>
</tr>
<tr>
<td>DVTs Veins</td>
<td><strong>Deep Vein Thrombosis</strong> develops in the <strong>popliteal and femoral veins</strong> = swollen, tender, red calves May embolize causing a <strong>pulmonary embolism</strong>. Look for postsurgical or post flight dyspnea <strong>↑ Risk with Oral Contraceptives, Smoking, Factor V Leiden, and Stasis (immobility)</strong></td>
</tr>
<tr>
<td>Superior Vena Cava Syndrome</td>
<td><strong>Pulmonary tumor compresses the superior vena cava</strong>, causing a backup above it May produce <strong>blurry vision</strong> or may induce sufficient stasis for <strong>cerebral infarction</strong> Look for <strong>vein engorgement</strong> superior to the neck, especially if the engorgement is unilateral face</td>
</tr>
</tbody>
</table>
### CONGENITAL DEFECTS

<table>
<thead>
<tr>
<th>Disease</th>
<th>Type</th>
<th>Cause/Character</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial Septal Defect</td>
<td>L→R Shunt</td>
<td>Hole between the atria allowing oxygenated blood into right ventricle. <strong>Most common defect to occur alone</strong>, not the most common in general. More commonly occurs in the Septum Secundum (90%) and sometimes in Septum Primum (10%)</td>
<td></td>
</tr>
<tr>
<td>Ventral Septal Defect</td>
<td>L→R Shunt</td>
<td>Hole between the ventricles allowing oxygenated blood into right ventricle. <strong>Most common defect</strong> in the heart. Associated with Down’s Syndrome. Presents with a systolic murmur</td>
<td></td>
</tr>
<tr>
<td>Patent Ductus Arteriosis</td>
<td>L→R Shunt</td>
<td>Hole between the aorta and pulmonary artery allowing ↑O₂ blood into lungs. Kept open with prostaglandin, closed with indomethacin. <strong>Causes a continuous machine-like murmur</strong></td>
<td></td>
</tr>
<tr>
<td>Tetralogy of Fallot</td>
<td>R→L Shunt</td>
<td>RVH, Subpulmonary Stenosis, VSD, Aorta on top of VSD. Caused by an <strong>anterosuperior movement of infundibulum</strong>. Must be surgically corrected. Look for “<strong>boot-shaped heart</strong>” in the vignette, or cyanosis <strong>relieved by squatting</strong> (↑TPR)</td>
<td></td>
</tr>
<tr>
<td>Transposition Great Arteries</td>
<td>R→L Shunt</td>
<td>Swapping of aorta to RV and pulmonary artery to LV, requiring communication (PDA) for life. Requires surgical correction. If no surgery, is fatal in 1&lt;sup&gt;st&lt;/sup&gt; month of life. Occurs in diabetic mothers (but NOT in diabetes of pregnancy)</td>
<td></td>
</tr>
<tr>
<td>Truncus Arteriosis</td>
<td>R→L Shunt</td>
<td>Pulmonary artery and aorta do not separate, so are one big outflow vessel allowing mixing of blood in both directions.</td>
<td></td>
</tr>
<tr>
<td>Tricuspid Atresia</td>
<td>R→L Shunt</td>
<td>RA and RV do not communicate, requires ASD and VSD for life. The tricuspid valve never forms a hole</td>
<td></td>
</tr>
<tr>
<td>Coarctation of Aorta</td>
<td>Obstruct</td>
<td><strong>Infantile</strong> = Coarctation proximal major branches (fatal)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Adult</strong> = Coarctation distal major branches (found as a kid)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Occurs in Turner Syndrome. Look for rib notchting.</td>
<td></td>
</tr>
<tr>
<td>Aortic Atresia</td>
<td>Obstruct</td>
<td>Stenosis or Atresia from something being in the way of left ventricular outflow</td>
<td></td>
</tr>
<tr>
<td>Pulmonary Atresia</td>
<td>Obstruct</td>
<td>Stenosis or Atresia from something being in the way of right ventricular outflow</td>
<td></td>
</tr>
</tbody>
</table>

### GROSS CHANGES FOLLOWING MI

<table>
<thead>
<tr>
<th>Survival Time</th>
<th>Predominant Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-24 hrs</td>
<td>No Change</td>
</tr>
<tr>
<td>1-3 Days</td>
<td>Yellow Pallor in the center</td>
</tr>
<tr>
<td>3 Days – 4 weeks</td>
<td>Yellow Pallor with surrounding Hyperemia</td>
</tr>
<tr>
<td>6 Weeks +</td>
<td>White/Grey Firm Scar</td>
</tr>
</tbody>
</table>

### HISTOLOGIC CHANGES FOLLOWING MI

<table>
<thead>
<tr>
<th>Survival Time</th>
<th>Predominant Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4 hrs</td>
<td>Wavy Myocytes and contraction bands</td>
</tr>
<tr>
<td>4-24hrs</td>
<td>Coagulative Necrosis with few Neutrophils, No Myocyte Nuclei, All Pink</td>
</tr>
<tr>
<td>1-3 Days</td>
<td>Coagulative Necrosis with many Neutrophils increasing in number</td>
</tr>
<tr>
<td>3-7 Days</td>
<td>Coagulative Necrosis with Macrophages</td>
</tr>
<tr>
<td>10+ Days</td>
<td>Collagen Deposition, Fibroblasts, Macrophages, Granulation Tissue</td>
</tr>
</tbody>
</table>

### RISK FOLLOWING MI

<table>
<thead>
<tr>
<th>Survival Time</th>
<th>Predominant Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 hrs</td>
<td>Fatal Arrhythmia, usually Ventricular Fibrillation or Ventricular Tachycardia</td>
</tr>
<tr>
<td>1-7 days</td>
<td>Ventricular Rupture (Septal Wall or Ventricular Wall) → Hemopericardium → Death</td>
</tr>
<tr>
<td>7+ Days</td>
<td>Ventricular Aneurysm (no rupture, just outpouching, leading to mural thrombus)</td>
</tr>
</tbody>
</table>