Ischemic Heart Disease
2018-19

Heart Disease Lectures
- Ischemic Heart Disease
- Hypertensive Heart Disease
- Valvular Heart Disease Pathology
- Nonischemic (primary) Myocardial Disease
- Congenital Heart Disease (Dr. Bharati)
- Clinical Valvular Heart Disease (Dr. McKiernan)
- Pathophysiology of CHF (Dr. Liebo)
- Cardiac Infections (Dr. Pacheco)
- Hypertension (Dr. Evans)

Heart Disease
- Cardiovascular Disease leading cause of mortality world-wide

- 25% of USA deaths
  - Greater than all forms of cancer combined

- Significant morbidity impacting quality of life
**Heart Failure**

- “Congestive Heart Failure”
- Heart unable to pump blood sufficiently to meet needs of tissue
  - Ventricle unable to fill with or eject blood
- Typically progressive condition
- Poor prognosis
  - After dx 50% 5 year mortality

**Heart Failure Terms**

- Systolic (reduced Ejection Fraction)
- Diastolic (preserved Ejection Fraction)
- Left
- Right
- Biventricular

**Heart Failure**

- Systolic
  - Inadequate myocardial contractile function
Heart Failure

- Diastolic
  - Inability of heart chamber to relax, expand, and adequately fill during diastole
  - “Heart failure with preserved ejection fraction”

Heart Failure

- Right sided
  - Engorgement of systemic and portal venous circulation

- Consequence of left sided heart failure
  - Cor pulmonale

- Left sided
  - Dunning of blood in pulmonary circulation
  - Diminished peripheral blood flow

- Ischemia
- HTN
- Aortic/mitral valve disease
- Nonischemic myocardial diseases

Biventricular
• What are the symptoms/signs of right sided heart failure?

• What are the symptoms/signs of left sided heart failure?

Ischemic Heart Disease

• 700,000 myocardial infarctions annually
  ~50% morality

• Decrease in mortality over past 50 years
  – Advances in prevention
    • Risk factors = atherosclerosis risk factors
  – Advances in treatment

Ischemic Heart Disease

• Decreased perfusion (coronary blood flow)
• Increased myocardial demand
  ➢ Angina Pectoris
  ➢ Acute Myocardial Infarction
  ➢ Chronic Ischemic Heart Disease/ Heart Failure
  ➢ Sudden Cardiac Death
**Stable (Typical) Angina Pectoris**

- Chronic stenosing coronary atherosclerosis (>75% reduction of lumen area)
  - Increased cardiac demand and workload needs unmet
  - Substernal chest pressure
    - Physical activity, emotional excitement
    - Relieved with rest
      - Vasodilator, nitroglycerin

**Unstable Angina Pectoris**

(aka Crescendo angina, preinfarction angina)

- Anginal symptoms
  - frequent, less effort, at rest, longer duration

- Atherosclerotic plaque disruption
  - Thrombogenic plaque components, subendothelial basement membrane exposed
  - Platelets activation, aggregation
  - Vasospasm
  - **Partially occluding** thrombus

**Unstable Angina Pectoris**

- Vulnerable plaques
  - Lipid rich atheromas
  - Thin fibrous caps
  - **Inflammation**
  - Moderately stenotic - 50-75%
**Prinzmetal Variant Angina**

- Coronary artery **spasm**
- Unrelated to physical activity, heart rate, blood pressure
- Responds to vasodilators

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**Myocardial Infarction**

“Heart attack”
- Frequency increases with increasing age
- Risk: Men > Women
  - Risk in women increases post-menopause

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**Pathogenesis**

- Plaque disruption
  - Hemorrhage, ulceration, rupture, fissuring
- Platelet adhesion, aggregation, activation
- Vasospasm
- Coagulation
  - **OCCLUSIVE THROMBUS FORMATION**
    - Other Mechanisms?
Myocardial Infarction

- <30 minutes - reversible ischemia
- >30 minutes - irreversible, coagulative necrosis
Transmural vs Nontransmural Infarcts

Myocardial Infarction Morphology

- 1/2 - 4 hours
  - No gross or light microscopic changes
Myocardial Infarction Morphology

- **4 - 12 hours**
  - Beginning coagulation necrosis, hemorrhage
  
  (Remember the features of coagulation necrosis...)

Myocardial Infarction Morphology

- **12 - 24 hours**
  - Gross - Dark mottling
  - Ongoing coagulation necrosis
  - Pyknosis of nuclei

Myocardial Infarction Morphology

- **1 - 3 days**
  - Gross: Mottled myocardium
  - Microscopic: Loss of nuclei and myocytes
    - Neutrophil infiltrate
**Myocardial Infarction Morphology**

- **3 - 7 days**
  - Myocyte disintegration, dying neutrophils, phagocytosis of dead cells

**Myocardial Infarction Morphology**

- **7 - 10 days**
  - Well-developed phagocytosis and early granulation tissue
  - Remember “granulation tissue”...

**Myocardial Infarction Morphology**

- **10 - 14 days**
  - Granulation tissue

*Trichrome stain*
Myocardial Infarction Morphology

- 2 - 8 weeks
  - Scar formation

Myocardial Infarction
Clinico-pathologic correlation

- Crushing substernal chest pain, dyspnea, diaphoresis
- Tachycardia, pulmonary congestion, edema
- 10-15% of patients – “silent”

Laboratory Evaluation
Triphenyltetrazolium chloride stain (LDH substrate)
Infarcted myocardium does not stain due to enzyme depletion (leakage)

Myocardial Infarction

• Treatment
  – Aspirin and other antiplatelet agents
  – Heparin
  – Thrombolytic therapy
    • Drug vs interventional
  – Beta blockers
  – ACE inhibitors
  – Nitrates
  – Oxygen

Reperfusion

• Goal = Myocardial salvage
• Reperfusion INJURY = Restoration of blood flow leads to local myocardial damage
  – Free radical production
  – Increased intracellular calcium, myocyte hypercontraction
  – Leukocyte aggregation → proteases, elastases
  – Mitochondrial dysfunction → apoptosis
Myocardial Infarction Complications

• Cardiogenic shock
  – Severe pump failure
  – 10-15% patients
  – Large infarcts (>40% ventricle)

Myocardial Infarction Complications

• Arrhythmia
  – Myocardial irritability
  – Conduction disturbances

Myocardial Infarction Complications

• Myocardial rupture
  – 3-7 days
  • Free wall
    • Hemopericardium
    • Cardiac tamponade
  • Ventricular septum
  • Papillary muscle
Hemopericardium: pericardial sac filled with blood

Papillary muscle rupture

Myocardial Infarction Complications

- Acute Pericarditis
  - 2-3 days
  - Transmural MI

Robbins, figure 11-14
Myocardial Infarction Complications

- Ventricular aneurysm
  - late complication
  - mural thrombus

Myocardial Infarction Complications

- Progressive heart failure

Ischemic Heart Disease

- Sudden Cardiac Death
  - Unexpected death
  - Mechanism = Lethal arrhythmia
  - Myocardial irritability from nonlethal ischemia, fibrosis from previous injury
    - Less often acute plaque rupture with thrombosis
**Cardiac Stem Cells**

- Can cardiac stem cells be used to replace damaged myocardium?
  - In-vivo studies
    - "tantalizing"
  - Ex-vivo studies
    - "less than exciting"

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**Summary**

![Summary Diagram](image)

**Question**

A 65-year old man with HTN and DM has had pain in the left shoulder and arm for the past 12 hours. Over the past 6 hours, he develops dyspnea which persists for 2 days. On day 3 he visits his physician. On exam his pulse is 88/min, BP 150/90, respirations 16/min. Laboratory studies: serum creatinine kinase is in the reference range; troponin I level is elevated. On hospital day 2 he has a cardiac arrest. Bedside echocardiogram shows a large fluid collection around the heart. What complication has he developed?
A. Aortic valve perforation  
B. Hemopericardium  
C. Left ventricular aneurysm  
D. Papillary muscle rupture  
E. Pericarditis  
F. Sudden cardiac death

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-7 days</td>
<td>Hypereosin border; central yellow-tan softening, beginning disintegration of dead myofibers, with dying neutrophils, early phagocytosis of dead cells by macrophages at infarct borders</td>
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<tr>
<td>7-10 days</td>
<td>Maximally yellow-tan and soft, with depressed red-tan margins, well-developed phagocytosis of dead cells, granulation tissue at margins</td>
</tr>
<tr>
<td>10-14 days</td>
<td>Red-gray depressed infarct borders, well-established granulation tissue with new blood vessels and collagen deposition</td>
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<tr>
<td>2-6 wk</td>
<td>Gray-white scar, progressive from border toward core of infarct, increased collagen deposition, with decreased cellularity</td>
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<tr>
<td>&gt;2 mo</td>
<td>Scarring complete, dense collagenous scar</td>
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Hypertensive Heart Disease
Left-sided Hypertensive Heart Disease

- Hypertension
  - Hypertrophy of left ventricle
  - Mild blood pressure elevation can induce LVH

Cardiac Hypertrophy

- Systemic hypertension
  - LV wall thickness ≥ 2cm
  - Weight > 500 gm

- Aortic stenosis
  - 800 gm

Normal heart 250 - 350 gm
Normal LV wall thickness ~1.5cm

Robbins, Figure 11-16 Braunwald’s Heart Disease. 2007
Left-Sided Hypertensive Heart Disease

- Asymptomatic
- CHF
- Arrhythmias
  - Atrial fibrillation

PULMONARY Hypertensive Heart Disease

- “Cor Pulmonale”
- Pulmonary HTN
  - Pathology of lung and/or lung vasculature
    - COPD, Pulmonary fibrosis, chronic pulmonary thromboembolism, primary pulmonary HTN
    - Increased pulmonary vascular resistance

PULMONARY Hypertensive Heart Disease

- Right ventricular hypertrophy
- Dilatation

Robbins, figure 11-16