Test Taking 101

Hx of unstable angina - Gastric bypass surgery
Pt. reports:
✓ Sudden S.O.B
✓ Chest pain with inspiration
✓ Anxious and apprehensive
Vital signs - 106/64; HR 124; RR 24; O₂ Sat 86%
Most likely cause???
Atherosclerosis
Plaque

- Fat, Cholesterol, Calcium
- Narrows the inside of the artery
- Restrict blood flow
- Types of plaque
  - Hard and stable
  - Soft, lipid filled, thin walled and unstable
Risk Factors for ASHD

- Age
- Gender
- Family history of early heart disease
- Factors that can be altered

Eliminate or Control Risk Factors
ASHD

- Asymptomatic until
  - Severely narrows an artery (80-85%)
  - Totally blocks an artery
- Coronary Arteries
- Brain
- Legs, pelvis or arms
- Kidneys

Cardiovascular Diseases

Unstable Angina | NSTEMI | STEMI | CVA | PAD

Common Underlying Atherothrombosis

Plaque rupture → Platelet activation
Platelet aggregation → Thrombus formation
Atherosclerosis Begins

Progression of Plaque

Platelet Attraction

Plaque Rupture
Platelet Activation

Platelets Activate

- Conformation shape change
- IIb-IIIa receptors expressed
- Release internal pools of signaling agents
  - More than 70 agonists released
  - ADP, thromboxane A2 - Activate platelets
  - Serotonin and epinephrine - Vasoconstrict
    - Further reduces blood flow to heart muscle
Platelet Aggregation

Microembolization
Clot Stabilization

Cardiac Muscle Structure

- Coronary Vein
- Coronary Artery
- Pericardium
- Epicardium
- Myocardium
- Endocardium

**Myocardial Infarction**
The Chambers

- Four hollow chambers
- Right & left atrium
  - Separated by interatrial septum
  - Receives blood
  - Pumps to ventricles
  - Left atria smaller but thicker walls

The Chambers

- Right & left ventricle
  - Separated by interventricular septum
  - Receive blood from the atria
  - Larger and have thicker walls than atria
  - Right ventricle pumps blood to lungs
  - Left ventricle larger than right
    - **Pumps blood through all other vessels**
The Valves

- Four Valves
- Allow forward flow only
- Prevent backward flow
- Open & close response to pressure changes
  - Ventricular contraction
  - Blood ejection

AV Valves

- Separate atria from ventricles
- Tricuspid and Mitral valves
- Prevent backflow
- Papillary Muscles - Chordae tendineae
Semilunar Valves

- Separate ventricles from major arteries
- Aortic Valve & Pulmonic Valve
- Prevent backflow
Auscultation

Aortic valve - 2\textsuperscript{nd} Right ICS @ SB
Pulmonic valve - 2\textsuperscript{nd} Left ICS @ SB
Erb’s point - 3\textsuperscript{rd} Left ICS @ SB
Mitral valve - 5\textsuperscript{th} Left ICS Medial to MCL
Triscupid valve - 5\textsuperscript{th} Left ICS @ SB

Auscultation

Base Right - 2\textsuperscript{nd} Right ICS @ SB
Base Left - 2\textsuperscript{nd} Left ICS @ SB
Apex - 5\textsuperscript{th} Left ICS Medial to MCL
Bruit - Carotid
Origins of Heart Sounds

- Vibrating vascular walls
- Flowing blood
- Contraction of heart muscle
- Opening & closing of heart valves

Valves and Heart Sounds

Mitral Triscupid Close

\[ S1 \]

Aortic Pulmonic Close

\[ S2 \]
\[ S3 \]

Mitral Triscupid Close

\[ S4 \]
\[ S1 \]

**Systole**  **Diastole**

S3 = Blood rushing against stiff non-compliant vent. wall

S4 = Non-Compliant Vent. during Atrial Cont.
Third Heart Sound - $S_3$
*Ventricular Gallop*

- Vibrations
  - Stiff non-compliant ventricular wall
  - Blood rushes during diastole
- Early diastole 0.14-0.16 sec after $S_2$
- Ventricular gallop-Diastolic

---

Third Heart Sound - $S_3$
*Ventricular Gallop*

- Early diagnostic sign of CHF- adult
- Brief diastolic impulse felt at apex
- Bell - low frequency
Fourth Heart Sound - $S_4$

Atrial Gallop

- Non-compliant ventricle
  - Atrial contraction
- Pre-systole after P wave
- Atrial gallop
- Bell - low frequency

Mechanisms of Heart Murmurs

- Regurgitation - backward flow
- Stenosis - flow across partial obstruction
- Defect - shunting of blood
- Others - Increased flow, flow into dilated chamber, flow across valvular irregularities
Valve Dysfunction - Murmur

- Valve open = Stenosis
- Valve closed = Regurgitation

Valves

- **Systole**
  - Aortic and Pulmonic open
  - Mitral and Triscupid closed
- **Diastole**
  - Mitral and Triscupid open
  - Aortic and Pulmonic closed
### Murmur Characteristics

| Location       | 2\(^{nd}\) RICS @ SB; 2\(^{nd}\) LICS @ SB  
|                | 3\(^{rd}\) LICS @ SB; 5\(^{th}\) LICS @ SB  
<table>
<thead>
<tr>
<th></th>
<th>5(^{th}) LICS @ MCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loudness</td>
<td>Grades 1-6</td>
</tr>
</tbody>
</table>
| Pitch          | Low (Bell)                             
|                | High (Diaphragm)                       
|                | Medium (Both)                          |
| Quality        | Blowing (Regurgitation)                
|                | Harsh or Rough (Stenosis)              |
| Timing         | Systolic or Diastolic                  |

### Holosystolic Murmur (Pansystolic)

- Mitral Regurgitation
- Tricuspid Regurgitation
- VSD

![Diagram of Holosystolic Murmur](image)
17. Pt. with dyspnea, tachypnea, pulmonary congestion, loud pansystolic murmur @ the apex with a thrill. The RN should suspect

1. Mitral regurgitation
2. Mitral stenosis
3. Aortic regurgitation
4. Aortic stenosis

Mid-Systolic Ejection Murmур

Aortic Stenosis
Pulmonic Stenosis

S1 S2 S1
Systole Diastole
**Mid-diastolic Murmurs**

- Mitral Stenosis
- Tricuspid Stenosis

**Early Diastolic Murmur**

- Aortic Regurgitation - *Erb’s Point*
- Pulmonic Regurgitation
Blood Vessels

- **Arteries** - Built for high speed
  - Thick muscular walls - ↑ B/P
  - Arterioles - constrict/dilate to move blood
- **Capillaries** - microscopic - single endothelial layer
- **Venules** - Low pressure
  - Gather blood from capillaries
- **Veins** - Low pressure
  - Thinner walls, larger diameters due to ↓ B/P
**Coronary Arteries**

**LCA**

- **LAD (Branches)**
  - Anterior & Lateral Walls - LV
  - Anterior 2/3 of Septum - LV

- **LCX (Branches)**

- **Posterior Lateral Wall - LV**

**RCA**

- Right Ventricle (Proximal RCA)
  - Inferior (90%) & True Posterior - LV
  - Posterior 1/3 of Septum

---

**Coronary Arteries**

<table>
<thead>
<tr>
<th>Area</th>
<th>Artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Wall Left Ventricle</td>
<td>LAD</td>
</tr>
<tr>
<td>Septal Wall Left Ventricle</td>
<td>Septal Perforating (LAD)</td>
</tr>
<tr>
<td></td>
<td>Posterior Descending (RCA)</td>
</tr>
<tr>
<td>Lateral Wall Left Ventricle</td>
<td>Circumflex and LAD</td>
</tr>
<tr>
<td>Inferior Wall Left Ventricle</td>
<td>RCA - 90%</td>
</tr>
<tr>
<td>Posterior Wall Left Ventricle</td>
<td>Posterior Descending (RCA -90%) or Circumflex</td>
</tr>
<tr>
<td>Right Ventricle</td>
<td>RCA (proximal)</td>
</tr>
</tbody>
</table>
Right Coronary Artery

- Supplies Left Ventricle
  - 25-30%
- SA Node – RCA 60%
  - LCX – 40%
- PDA – 85%
  - Inferior Wall, Ventricular Septum
  - Posteromedial Papillary Muscle

Papillary Muscle Rupture

- Posteromedial papillary muscle more susceptible to ischemia
- MI involving PDA → Mitral Regurgitation
9. Pt admitted with CP and 2\textsuperscript{nd} AV Block, Type II. Findings probably a result of occlusion of which artery?

1. Left anterior descending
2. Left circumflex
3. Left main
4. Right
Normal Conduction

Normal Sinus Rhythm
Cell to Cell Conduction

Ventricular or V-Paced

Bundle Branch Block
Normal Conduction System
Bundle Branch Block
Cell to Cell Conduction

Tachycardia
ECG Intervals

- PRI = 0.12 sec - 0.20 sec
- qRs = 0.04 sec - < 0.12 sec
- qT = rate and gender
- qTc = 0.31 - 0.44 sec

Prolonged or Shortened Intervals

- PRI
  - Prolonged = 1st Degree AV Block
  - Shortened = Junctional (↓ P) or WPW
- qRS
  - Prolonged = BBB, Ventricular or Paced
- qTc
  - Prolonged = Risk for Torsades (> 0.50 sec)
  - Shortened = Risk for V-Fibrillation
Abnormal qTc

- Prolonged qTc ≥ 0.44 sec.
  - ↑ Risk Torsades de pointes ≥ 0.50 sec
    - Polymorphic Ventricular Tachycardia
    - Treat with Magnesium

- Shortened qTc ≤ 0.32-0.30 sec.
  - Doesn’t change with rate
  - Tall peaked T waves
  - ↑ Risk SCD due to Ventricular Fibrillation

3. Which of the following is at the greatest risk for Torsades de Pointes

1. ↓ ST segment
2. Peaked T waves
3. Prolonged Q-T ▫
4. Development of U waves
Cardiac Rhythms

- Altered pacemaker site
  - Atrial Rhythms
  - Junctional Rhythms
  - Ventricular Rhythms
- Altered conduction
  - AV Conduction Blocks
  - Bundle Branch Blocks
- Artificially paced rhythms

*Be able to Recognize Rhythms

AV Heart Blocks

More Ps than qRs Complexes

1. PRI consistent?
2. Cyclic
   - PRI progressively prolongs
   - P w/o qRs occurs
3. P not r/t qRs?
2nd Degree AV Block, Type II

3rd Degree AV Block

3rd Degree AV Block

2nd Degree AV Block, Type I
8. This ECG Strip is Most Indicative of:

1. 2nd Degree AV Block, Type I
2. 2nd Degree AV Block, Type II
3. 1st Degree AV Block
4. 3rd Degree AV Block

Ventricular Tachycardia

Supraventricular Tachycardia
Symptomatic SVT Treatment Goals

- ↓ Heart rate
- ↑ Diastolic filling time

25. Pt admitted with R/O MI. Two hours after admission you see the following:

1. Ventricular Tachycardia
2. Orthodromic Tachycardia
3. RBBB
4. Torsades de pointes
Normal Myocardial O$_2$ Supply: Demand

- Myocardial O$_2$ Supply
  - Coronary Blood Flow
  - Oxygen Extraction

- Myocardial O$_2$ Demand
  - Afterload
  - Preload
  - Contractility
  - Heart Rate

Ischemic Cardiac Pain
Demand > Supply

Chest Pain

Myocardial O$_2$ Supply ≠

Myocardial O$_2$ Demand
Ischemic Cardiac Pain
Demand > Supply

- Anemia
- Hypoxia
- Cold Air
- $\uparrow$ B/P
- $\uparrow$ HR
- Artery Obstruction

Oxygen Supply Reduction

Ischemic Cardiac Pain
Demand > Supply

- Stress
- Emotional excitement
- Smoking
- Exercise
- Severe illness or injury
- $\uparrow$ B/P
- Fever
- Hyperthyroidism

Oxygen Demand Increase
Cardiac Output

Cardiac Output = HR \times \text{Stroke Volume}

- \uparrow \text{Stroke Volume} \rightarrow \downarrow \text{Heart Rate}
- \downarrow \text{Stroke Volume} \rightarrow \uparrow \text{Heart Rate}
Cardiac Output

Heart Rate \times \text{Stroke Volume}

- Preload
  - Venous Return
  - Ventricular Compliance

- Afterload
  - Aortic Impedance
  - Blood Volume
  - Blood Viscosity
  - Peripheral Vascular Resistance

Preload

- Blowing up the balloon

- Stretching of muscle fibers in the ventricles
  - Results from blood volume in the ventricles @ end diastole

- The more ventricles stretch during diastole
  - The more forcefully ventricles contract
Contractility
*Balloon’s Stretch*

- Inherent ability of myocardium to contract
- Influenced by preload
- The greater the stretch
  - The more forceful the contraction

Afterload
*Knot that ties the balloon*

- Resistance in the aorta
- Pressure that ventricular muscles must generate to overcome aortic resistance
  - Get the blood out of the heart.
Right Ventricle

- RV = LV in cardiac output
- RV $\frac{1}{6}$ muscle mass of LV
- RV performs $\frac{1}{4}$ of the energy of LV
  - Low pulmonary vascular resistance
  - PVR 10% of systemic resistance

See Cardiac Cycle in Notes
History

- Risk factors
- Past medical history
- Family history

Signs and Symptoms

- Pain
- Associated symptoms
Assessment Landmarks

- Aortic
- Pulmonic
- Erb's Point
- Mitral
- Triscupid

Assess Arterial Pulses Head-To-Toe
## Ischemic Cardiac Chest Pain

### History
- **Onset**
- **Location**
- **Radiation**
- **Quality**
- **Intensity**

### Duration
- **Relieving factors**
- **Precipitating factors**
- **Associated symptoms**
- **Emotional response**
- **Gestures**

## Physical Assessment
- **Vital signs**
- **Heart sounds**
- **Carotids**
- **PMI**
- **Jugular vein distension**
- **Respiratory assessment**
## Chest Pain

<table>
<thead>
<tr>
<th>CAD</th>
<th>Non CAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angina</td>
<td>Pericarditis</td>
</tr>
<tr>
<td>• Stable Angina</td>
<td>• Aortic Dissection</td>
</tr>
<tr>
<td>• Variant Angina</td>
<td></td>
</tr>
<tr>
<td>ACS</td>
<td>Pulmonary</td>
</tr>
<tr>
<td>• STEMI</td>
<td>• Pulmonary Embolism</td>
</tr>
<tr>
<td>• NSTEMI</td>
<td></td>
</tr>
<tr>
<td>• Unstable Angina</td>
<td></td>
</tr>
</tbody>
</table>

### Common Sites for Ischemic Chest Pain

1. **Angina**
   - Stable Angina
   - Variant Angina

2. **ACS**
   - STEMI
   - NSTEMI
   - Unstable Angina

3. **Pulmonary**
   - Pulmonary Embolism

---

*Image of human figures with shaded areas indicating common sites of ischemic chest pain.*
Stable Angina

Demand Related Ischemia

- Short of Breath
- Pain
- Nausea
- Vomiting
- Fatigue
- Dizzy
- Diaphoresis

Effort Symptoms

Predictable

Stop

Rest

NTG

Variant Angina

- Coronary artery spasm
- “Prinzental Angina”
- Often occurs at rest, at night
- ST elevation with pain
- MI if spasm causes damage
**Variant Angina**

- Wide Spread $\uparrow$ST - Leads I, II, III, aVf, V2-V6
- $\uparrow$STs resolved when CP relieved

**Unstable Angina**

- Recent onset (new)
- Less effort or at rest
- More frequent with same effort
- More protracted and less responsive
- Ischemic protracted pain w/o MI
Myocardial Infarction
STEMI or NSTEMI Pain

- Constricting, pressure, crushing
- Squeezing, heavy, tight, compressing
- Expanding, aching, full, deep
- Burning, choking, grabbing
Myocardial Infarction

Pain

❖ Crushing chest pain
  • Pressure like
  • Substernal, precordial
❖ Radiation of pain
  • Across chest to shoulders
  • Down arms - ulnar distribution (left)
  • Throat, neck, jaw - toothache

❖ Occurs suddenly
  • Not associated with exertion
  • Onset during sleep
  • After eating
❖ Steady, continuous, refractory
  • NTG, Oxygen and change in position
Myocardial Infarction

Signs and Symptoms

- Diaphoresis
- Nausea, indigestion & vomiting
- Dyspnea, sudden weakness, pallor
- Cool, clammy skin
- Fear, apprehension
  - Fear of impending doom

Myocardial Infarction

Assessment

- Poor quality pulse
- Cool, clammy head & neck
  - Extremities cold
- ↑ Respirations
- Rales
- Prefers semi-recumbent
- Looks ill, moves little
Myocardial Infarction

- **Women**
  - Pain down right arm, left axilla, mid-back
  - Pain epigastric
  - Pain into jaw - toothache
  - More likely to be atypical
- **Diabetics**
  - No Pain
  - Short of Breath
- **Elderly**
  - Perception of pain issues
Acute Pericarditis

- Severe, waxes & wanes
- Fever, chills, joint muscle aching
- Affected by position and movement
Acute Pericarditis

- ST elevation (all leads)
- ↓ PR segment Lead II
- Pericardial friction rub
- Felt more on the left

Pericarditis

Pain worsens
- Swallowing
- Lying Down
- Inspiration

Pain eases
- Leaning Forward
- Sitting Up
Pericarditis

Pain Location

- More on the upper left chest
- May radiate to trapezium
  - Ridge of shoulder

Pericarditis

- Concave ST elevations in Limb and V Leads
- PR segment depression in lead II
- Ø Reciprocal changes; Ø ST depressions
Acute Pulmonary Embolism

- More frequent on right and lower lobes
- Heavy, sharp
- Aggravated by respiration
- Tachypnea, SOB, dyspnea

Acute Pulmonary Embolism

- Cyanosis, syncope, shock
- Hemothysis, rales, weezes
- Pleural friction rub
- ECG Changes
  - S1 - Q3 - T3
  - Sudden right axis shift - 25%
Pulmonary Embolism ECG Changes

S1, Q3, T3
Large S wave Lead I,
Q wave in lead III, ↓ T wave in lead III

Sudden Right Axis Deviation - 25%

S1, Q3, T3
(-) I & (+) aVF = RAD
Aortic Dissection

Pain

- Sudden onset
- Severe tearing, stabbing, ripping, sharp
- Sternum, shoulder blades, back
- Pain moves
  - Shoulder, neck, arm, jaw, abdomen, hips
  - Arms/legs as dissection worsens
- Location associated with the dissection
  - Anterior = Ascending Aorta
  - Interscapular = Descending aortic

Aortic Dissection Symptoms

- Anxiety, impending doom
- Syncope, dizzy
- Shortness of breath or orthopnea
- Stroke symptoms, dysphagia
- Diaphoresis, clammy skin
- Nausea, vomiting, pallor
- Rapid, thready pulse
Aortic Dissection Findings

1. Abrupt onset thoracic or abdominal pain
   ◊ Tearing or sharp
2. Mediastinal widening on CXR
3. Pulse deficit or >20mmHg difference in B/P
   ◊ Between the right and left arms
   ◊ Between arms and legs
4. 83% High probability
   ◊ Combo of 1 & 2
   ◊ Pulse deficit or B/P difference

Aortic Dissection
Put it All Together

- Tearing sensation
- Hypertensive
- Blowing diastolic murmur
- B/P > 20mmHg right and left arm
- Pulse deficit
11. Your patient reports the following symptoms: Mid-sternal chest pain, radiates down his left arm into his two little fingers and his jaw, short of breath, skin cool and clammy. His symptoms indicate:

1. Variant Angina
2. Myocardial Infarction
3. Angina Pectoris
4. Pulmonary Embolism

4. Pt. reports sharp, constant chest pain, worse lying down and better sitting up and leaning forward. Most likely cause is:

1. Acute Coronary Syndrome
2. Pericarditis
3. Pulmonary embolism
4. Abdominal aortic aneurysm
31. Your patient reports that she is short of breath, fatigued and has the worse toothache of her life. You should:

1. Call the dentist on call.
2. Get a 12-Lead, start and IV, and call the M.D.
3. Give her a Tylenol for her toothache.
4. Let her rest and check with her in an hour.

18. Nitrate therapy is indicated for the treatment of unstable angina because it:

1. ↑ Preload ↑ myocardial demand
2. ↓ Preload ↑ myocardial demand
3. ↓ Preload ↓ myocardial demand
4. ↑ Preload ↓ myocardial demand

Vasodilator: Dilates veins > than arteries
↓ Demand and ↓ Arterial pressure;
↓ Preload and ↓ B/P
↑ Heart Rate
Causes of Myocardial Ischemia, Injury & Necrosis

Indirect Causes

- $\uparrow$ Myocardial workload
- $\downarrow$ Coronary arterial blood flow
- Hypoxemia
- Cocaine or Ethanol toxicity
**Cocaine Associated MI**

- Atherosclerotic plaque rupture
- Coronary vasospasm
- Coronary Thrombus formation
  - Stimulation of platelet activators
- Coronary artery dissection (rare)
  - Women 3:1 (pregnancy-25%) - LCA
  - Men - RCA

**Cocaine**

- Blocks the reuptake of Dopamine and presynaptic Norepinephrine
  - Powerful sympathetic response
  - ↑ Release of endothelin -
  - ↓ Production of nitric oxide -
  - Profound vasoconstriction
Most Common Cause

STEMI

Coronary Thrombosis

Coronary Artery Spasm

Microembolization
Myocardial Infarction

- Myocardial necrosis
- 500 heart cells die every second
- Release structural molecules
  - CK-MB
  - Troponin I or T

- Levels rise within 3-8 hours
- Peak 24-48 hours
- Fall to baseline 7-10 days
ECG Leads

- Which leads?
- What arteries?
- What ECG changes?
Contiguous Leads
Leads That Show Same Area

- II, III, aVf
- V1 - V2
- V3 - V4
- V5 - V6
- I, aVl
- V7, V8, V9
- RV4, RV5, RV6
- Inferior
- Septal
- Pure Anterior
- Low Lateral
- High Lateral
- Posterior
- Right Ventricle

Location of Infarction

<table>
<thead>
<tr>
<th>Infarction</th>
<th>Artery</th>
<th>Leads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septal</td>
<td>LAD</td>
<td>V₁-V₂</td>
</tr>
<tr>
<td>Pure Anterior</td>
<td>LAD</td>
<td>V₃-V₄</td>
</tr>
<tr>
<td>Lateral- Low</td>
<td>LCX or RCA</td>
<td>V₅-V₆</td>
</tr>
<tr>
<td>Lateral- High</td>
<td>LCX, LAD</td>
<td>I, aVL</td>
</tr>
<tr>
<td>Inferior</td>
<td>RCA</td>
<td>II, III, aVF</td>
</tr>
<tr>
<td>Posterior - LV</td>
<td>RCA or LCX</td>
<td>None*</td>
</tr>
<tr>
<td>Right Ventricle</td>
<td>RCA</td>
<td>V₄R-V₆R</td>
</tr>
</tbody>
</table>

*None*
5. Which of the following 12-Lead ECG Δ's should be expected with ACS involving the Inferior Wall

1. Q, ↑ST, ↓T in V4-V6, I, aVL
2. Q in I & aVL, ↑ST in II, III and V1-V6
3. Q, ↑ST, ↓T in II, III, aVF
4. Q, ↓ST, and ↑T in II, III, aVL

29. Pt admitted with chest pain and nausea. ECG shows new deep Q waves and ↑ST in I, aVL, V5-V6

1. Subendocardial infarction
2. Anterior wall MI
3. Inferior wall MI
4. Lateral wall MI
Preferred Leads

- **ACS**
  - Fingerprint not known - III, V3
  - Suspected ACS - III, V5
- **Non-cardiac surgical patients**
  - Surgery or ICU - V5 (demand ischemia)
- **Dysrhythmia detection**
  - V1 - Diagnose wide qRs
  - Lead II - Diagnose atrial activity and HR

Chest Pain

ECG

STEMI =

↑ ST in 2 Contiguous Leads

NSTEMI =

↓ ST in 2 Contiguous Leads

or

∅ ST ∆s and (+) Cardiac Markers

Unstable Angina =

∅ ST ∆s

(-) Cardiac Markers
Assess 12 Lead ECG

STEMI

ST Infarction

↑ ST

Assess 12 Lead ECG

NSTEMI (↓ STs)

ST Depression

Injury

Acute
**ECG Changes**

1. ST elevation in 2 contiguous leads
   - 1 mm in frontal leads
   - 2 mm in precordial leads
   - New LBBB

2. ST depression in 2 contiguous leads
   - 1 mm in frontal leads
   - 2 mm in precordial leads

3. No significant changes or normal 12 lead

---

**Myocardial Infarction Detection**

1. ↑ ST
   - With or w/o Q
   - Yes
   - STEMI

2. What Leads show ECG changes

3. Determine Presence of MI and Location
See Page in Walden's Handout

STEMI

See Page in Walden's Handout

STEMI

See Page in Walden's Handout
ECG Changes?

Previous ECG Noted Changes

- **ST ↑ in Leads II, III, aVF**
  - Inferior Leads
  - RCA
- **ST ↑ in Leads V5 and V6**
  - Low Lateral Leads
  - LCX or RCA

What areas are effected?
What arteries are effected?
ECG Changes?

ST Segment Elevation
ST Segment Depressions

ST Segment Alarm Parameters

- High risk - 1 mm above and below baseline
- Stable - 2 mm above and below baseline
- Change in body position
  - Right or left-side lying - Mimic ischemia
  - Return to supine position
  - ST deviation persists = myocardial ischemia

ST_Segment_Monitoring_05-2009.pdf
Dysrhythmia_Monitoring_04-2008.pdf
Ischemic Chest Pain

Assessment

Signs & Symptoms; VS; O2 Sat; IV; Monitor; 12 Lead ECG; Target History; Cardiac Markers, Electrolyte & Coagulation studies

Myocardial Infarction Diagnosis
1. Signs and Symptoms
2. 12 Lead ECG
3. Cardiac Markers

#1. ACS Symptoms

- Typical Symptoms
- Atypical Symptoms
  - Women
  - Diabetics
  - Elderly
# 2. Assess 12 Lead ECG

1. ST Elevation
   *STEMI*

2. ST Depression
   *NSTEMI*

3. Normal or Non-Diagnostic
   *Unstable Angina*

---

# 3. Cardiac Markers

- Troponins - *Cardiac specific*
  - Troponin I
  - Troponin T
# 4. ACS Risk Assessment

- History
- Physical exam
- ECG
- Serum cardiac markers

## Risk Stratification to Determine the Likelihood of Acute Coronary Syndrome

<table>
<thead>
<tr>
<th>Assessment</th>
<th>HIGH</th>
<th>INTERMEDIATE</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>• Chest or left arm pain or discomfort as chief symptom</td>
<td>• Chest or left arm pain or discomfort as chief symptom</td>
<td>• Probable ischemic symptoms</td>
</tr>
<tr>
<td></td>
<td>• Reproduction of previous documented angina</td>
<td>• Age &gt; 50 years</td>
<td>• Recent cocaine use</td>
</tr>
<tr>
<td></td>
<td>• Known history of coronary artery disease, including myocardial infarction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical examination</td>
<td>• New transient mitral regurgitation, hypotension, diaphoresis, pulmonary edema or rales</td>
<td>• Extracardiac vascular disease</td>
<td>• Chest discomfort reproduced by palpation</td>
</tr>
<tr>
<td></td>
<td>• Fixed Q waves</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Abnormal ST segments or T waves not documented to be new</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECG</td>
<td>• New or presumably new transient ST-segment deviation (&gt; 0.05 mV) or T-wave inversion (&gt; 0.2 mV) with symptoms</td>
<td></td>
<td>• T-wave flattening or inversion of T waves in leads with dominant R waves</td>
</tr>
<tr>
<td>Serum cardiac markers</td>
<td>• Elevated cardiac troponin T or I, or elevated CK-MB</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Acute Coronary Syndromes

1. Symptoms suggestive of ischemia or infarction

2. EMS assessment and care and hospital preparation:
   - Monitor, support ABCs. Be prepared to provide CPR and defibrillation
   - Administer aspirin and consider oxygen, nitroglycerin, and morphine if needed
   - Obtain 12-lead ECG; if ST elevation:
     - Notify receiving hospital with transmission or interpretation; note time of onset and first medical contact
   - Notified hospital should mobilize hospital resources to respond to STEMI
   - If considering prehospital fibrinolysis, use fibrinolytic checklist
Acute Coronary Syndromes

Immediate ED general treatment
- If O₂ sat <94%, start oxygen at 4 L/min, titrate
- Aspirin 160 to 325 mg (if not given by EMS)
- Nitroglycerin sublingual or spray
- Morphine IV if discomfort not relieved by nitroglycerin

- Hold ASA if allergic
  - Give 4 ASA 81mg chewed
- Hold NTG if ↓ B/P
- Hold Morphine if ↓ B/P

Acute Coronary Syndromes

STEMI
- ST elevation or new or presumably new LBBB; strongly suspicious for injury ST-elevation MI (STEMI)
- Start adjunctive therapies as indicated (see text)
- Do not delay reperfusion
- Time from onset of symptoms ≤12 hours?

NSTEMI
- ST depression or dynamic T-wave inversion; strongly suspicious for ischemia
- High-risk unstable angina/non-ST-elevation MI (UA/NSTEMI)
- Troponin elevated or high-risk patient (Tables 3, 4 for risk stratification)
- Consider early invasive strategy if:
  - Refractory ischemic chest discomfort
  - Recurrent/persistent ST deviation
  - Ventricular tachycardia
  - Hemodynamic instability
  - Signs of heart failure

Unstable Angina
- Normal or nondiagnostic changes in ST segment or T-wave
- Low-/Intermediate-risk ACS
- Consider admission to ED chest pain unit or to appropriate bed and follow:
  - Serial cardiac markers (including troponin)
  - Repeat ECG/continuous ST-segment monitoring
  - Consider noninvasive diagnostic test

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Acute Coronary Syndromes

STEMI

NSTEMI

Unstable Angina

Cardiac Catherization

- STEMI
- NSTEMI
- Unstable Angina
Percutaneous Coronary Intervention PCI

Cardiac Cath LCA Blocked

PCI Stent Placed
Deaths from MI

- Prehospital Deaths
  - 1st hour
  - Arrhythmias (VF or V-Tach)
  - Temporary electrical instability
- In-Hospital Deaths
  - Cardiogenic shock
- Mortality directly r/t infarct size
  - Limit infarct → limit mortality

MI Major Complications

- Dysrhythmias
- Acute CHF - 60 %
- Cardiogenic shock
  - Mortality of 80%
- Thromboembolism
  - Left ventricle or leg vein
- Rupture of left ventricle (7-10 days)
Papillary Muscle Rupture

- Mitral Regurgitation
- Sudden onset holosystolic murmur
- Grade VI murmur @ Apex
  - Heard with Stethoscope off the chest
  - (+)Thrust and/or Thrill
- Abrupt ↓ BP; ↓ cardiac output
- Right Ventricular Infarction
- Emergent surgery
Cardiac Tamponade

- ↓ BP
- ↓ CO; ↓ CI
- Sinus Tachycardia
- Distant heart sounds
- Distended neck veins
- ↑ CVP, PEA

Ventricular Septal Rupture

- Rare - Lethal
- Abrupt ↓ BP & CO/CI
- Loud HSM, ↑ ST V1-V2
- 2-8 days after infarction
- Cardiogenic shock
- Emergent surgery
  - CABG
7. Pt with Q waves and ↑ ST in V₁-V₃ develops ↓ B/P and pansystolic murmur @ LLSB. Most likely this is:

1. Idiopathic hypertrophic cardiomyopathy
2. Ventricular aneurysm
3. Cardiac tamponade
4. Ruptured interventricular septum

❖ + Pulse - symptomatic
  • Sedate
  • Synchronize cardiovert @ 100 Joules
❖ + Pulse - no symptoms
  • Amiodarone 150 mg IV over 10 min
Ø Pulse
  • Same as Ventricular Fibrillation
  • BLS
  • Defibrillate @ 200 joules biphasic

Pulseless Arrest

Assess rhythm → VF or VT
CPR
Give One Shock (200 J with Biphasic)
Resume CPR (5 Cycles of CPR) - Check Rhythm
  ? Shockable Rhythm
Yes
Give One Shock (200 J) - Resume CPR
Epinephrine 1.0 mg or Vasopressin during CPR
Check Rhythm - Shockable ? - 200 Joules
Resume CPR - Consider Antiarrhythmics
**Pulseless Arrest**

1. Assess rhythm → Asystole
2. Resume CPR - 5 cycles
3. Give Vasopressor
   - Epinephrine 1 mg IV Push every 3-5 minutes or
   - Vasopressin 40 U
4. 5 Cycles of CPR - Check Rhythm
5. Shockable Rhythm?

**Tachycardia**

1. TACHYCARDIA With Pulse
   - Assess and support ABCs as needed
   - Give oxygen
   - Monitor ECG (identify rhythm, blood pressure, oximetry)
   - Identify and treat reversible causes
2. Symptoms Persist
   - Stable: Unstable signs include altered mental status, ongoing chest pain, hypotension or other signs of shock.
   - Wide (≥0.12 sec): Perform immediate synchronized cardioversion
     - Establish IV access and give sedation if patient is conscious; do not delay cardioversion
     - Consider expert consultation
     - If pulseless arrest develops, see Pulseless Arrest Algorithm
Figure 1. Bradycardia Algorithm.
Ischemic Chest Pain

Assess Initial ECG
ST Segment Displacement

<table>
<thead>
<tr>
<th>ST ↑</th>
<th>ST ↓</th>
<th>Non-diagnostic</th>
</tr>
</thead>
</table>
| • Beta Blockers  
  • Clopidogrel  
  • Heparin IV  
  • Reperfusion (≤ 12°)  
  • Fibrinolytics  
  • PCI  
  • ACE Inhibitors/ARB  
  • Statin Therapy |
| • NTG  
  • Beta Blockers  
  • Clopidogrel  
  • Heparin  
  • IIb/IIIa Inhibitors  
  • Reperfusion  
  • ACE Inhibitor/ARB  
  • Statin Therapy |
| • Risk Assess  
  • ST Monitoring  
  • Serial Cardiac Markers & ECGs  
  • Stress Test  
  • Non-Invasive Test |

Pacemakers

- Temporary
  - Transcutaneous pacer
  - Transvenous
  - Epicardial
- Permanent
  - Transvenous
  - Epicardial
Basic Pacemaker Components

- Output = mA
- Sensitivity = mV
- Rate = PPM

Output mA

- Amount of energy delivered to the myocardium
- Milliamperes or current
- ↑ mA = ↑ current
Pulse Generator Sensitivity

- Ability of the pacemaker to “see” intrinsic cardiac activity
- The $\uparrow$ mV the $\downarrow$ sensitivity
- The $\downarrow$ mV the $\uparrow$ sensing

Sensing

- Failure to fire
  - Oversense = mV set too low (sensing high)
  - Increase the mV = $\downarrow$ sensing
- Failure to sense
  - Undersense = mV set too high (sensing low)
  - Decrease mV = $\uparrow$ sensing
1. Determine Automatic Interval
   Paced Complex to the Next Successive Paced Complex

2. Determine Escape Interval.
   Patient Complex to the Next Paced Complex.

   Escape interval should not be < Automatic Interval.
Normal Pacer Function

Escape interval is = Automatic Interval

Pacer Fires, Senses and Inhibits

Pacer to Pacer = Automatic
Patient to Pacer = Escape
Automatic and Escape Intervals should be equal
Pacer Failure

Too Early   = Failure to Sense
Too Late   = Failure to Fire
Absent     = Failure to Fire
Spike w/o complex = Failure to Capture

Pacer Failure

<table>
<thead>
<tr>
<th>Pacer Failure</th>
<th>Reason</th>
</tr>
</thead>
</table>
| Failure to Pace       | • Pacemaker Failure
                       | • Oversensing (mV setting is ↓) |
| Failure to Capture    | • Free floating
                       | • Inbeded in infarcted tissue |
                       | • Ischemia or inflammation   |
| Failure to Sense      | • Sensitivity setting too low (mV setting is ↑) |
                       | • Sensing circuit off        |
Failure to Sense

Failure to Sense
Escape interval is less than Automatic Interval
Failure To Fire/Pace

Failure to Fire

Escape interval is longer than Automatic Interval.
Pacer doesn’t fire.

Failure to Fire/Pace

Pacer Fires and Captures

Pacer Fails to Fire

P Waves
Failure to Capture

Spikes without a resultant patient complex
- P wave
- Wide qRs

Permanent Pacemaker Modes

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber Paced</td>
<td>Chamber Sensed</td>
<td>Pacemaker Response to Sensing</td>
<td>Programmability Rate Modulation</td>
<td>Multisite Pacing</td>
</tr>
<tr>
<td>O=None</td>
<td>O=None</td>
<td>O=None</td>
<td>O= None</td>
<td>O= None</td>
</tr>
<tr>
<td>A= Atrium</td>
<td>A= Atrium</td>
<td>I=Inhibits</td>
<td>P = Basic Programs (rate and output)</td>
<td>P= Antitachycardia Pacing</td>
</tr>
<tr>
<td>V= Ventricle</td>
<td>V= Ventricle</td>
<td>T= Triggered</td>
<td>M =Multiple Programs</td>
<td>C = Communication</td>
</tr>
<tr>
<td>D= Dual (A+V)</td>
<td>D= Dual (A+V)</td>
<td>D=Dual (T+I)</td>
<td>R= Rate Response</td>
<td>D = Dual (P+S)</td>
</tr>
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</tbody>
</table>
Pacemaker Indications

- TCP
  - Emergent unstable bradycardia
- AAI (Impaired Impulse Formation)
  - Sick Sinus Syndrome
  - Symptomatic Sinus Bradycardia
  - Tachy-brady Syndrome

Pacemaker Indications

- VVI or DDD (Impaired Conduction)
  - AV Blocks - 2\textsuperscript{nd}, Type II or 3\textsuperscript{rd} Degree
  - Bi or Trifascicular Blocks
- Biventricular Pacer (Resynchronization)
  - CHF with LVEF < 35%