CCRN Review 2013
Cardiovascular System Assessment and Pathology

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Cardiovascular Disease

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
  ✓ Hypertension
  ✓ Weight, activity
  ✓ Diabetes
  ✓ Smoking

ASHD - Signs and Symptoms - Site Dependent
❖ Asymptomatic until
• Severely narrows an artery (80-85%)
• Totally blocks an artery
❖ Coronary Arteries
❖ Brain
❖ Legs, pelvis or arms
❖ Kidneys
Platelet Cascade

Plaque Rupture
- Exposes endothelium - Platelets stick to subendothelium - Bind with von Willebrand factor
- Form monolayer over injury
- Collagen causes bound platelets to activate

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
- Able to bind with fibrinogen (Occurs naturally in plasma)
- Fibrinogen binds with two IIb-IIIa receptors
- Allows platelets to clump together
- Platelets bind together repeatedly - Results in beginning of thrombus

Microembolization
- Platelet aggregation → Thrombus forms (Platelet aggregates washed downstream)
- Occlude tiny arterioles and capillaries
- Resultant ischemia → Myocardial necrosis
- Death of small sections of heart muscle at multiple sites

Clot Stabilization
- Platelets continue to aggregate → Thrombin is produced → Unbound fibrinogen convert to fibrin → Forms a mesh-like network around clot
- Fibrin strands cross-link which Stabilizes the thrombus
- Network thickens → Mesh traps RBCs, macrophages
- Solid red clot - Large quantities of trapped RBCs
Cardiac Structure

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

Auscultation

- Aortic valve - 2nd Right ICS @ SB
- Pulmonic valve - 2nd Left ICS @ SB
- Erb's point - 3rd Left ICS @ SB
- Mitral valve - 5th Left ICS Medial to MCL
- Tricuspid valve - 5th Left ICS @ SB

Valves and Heart Sounds

Auscultation

- Base Right - 2nd Right ICS @ SB
- Base Left - 2nd Left ICS @ SB
- Apex - 5th Left ICS Medial to MCL
- Bruits - Carotid
**S₃ – Third Heart Sound – Ventricular Gallop**
- Early diastole 0.14-0.16 sec after S₂
- Ventricular gallop-Diastolic
- Early diagnostic sign of CHF- adult
- Brief diastolic impulse felt at apex
- Bell - low frequency

**S₄ – Fourth Heart Sound - 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**

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

Systolic Murmurs
- Mitral or Tricuspid Regurgitation – Holosystolic
- Aortic or Pulmonic Stenosis – Mid-Systolic Ejection

Diastolic Murmurs
- Mitral or Tricuspid Stenosis – Mid-diastolic
- Aortic or Pulmonic Regurgitation – Early-diastolic
  - Aortic best heard at Erb’s point

Right Coronary Artery
- Supplies Left Ventricle
  - 25-30%
- SA Node – RCA 60%
  - LCX – 40%
- PDA – 85%
  - Inferior Wall, Ventricular Septum
  - Posteromedial Papillary Muscle
  - Posteromedial papillary muscle more susceptible to ischemia
- MI involving PDA may lead to Mitral Regurgitation

<table>
<thead>
<tr>
<th>Coronary Arteries</th>
<th></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) 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>
Cardiac Function
Cardiac Function – Electrical and Mechanical

Electrical
- Impulse formed
- Conduction system is the normal conduction pathway
- Conduction can occur myocardial fiber to myocardial fiber
Potential Pacemaker Sites

Cardiac Pacemaker Function

Normal Conduction Pathway
SA Node → Atrial Tracts → AV Node → Common Bundle → Right and Left Bundle Branches → Purkinje Fibers

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

Compare Tachycardias
ECG Interval Measurements

- 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

Identify Cardiac Rhythms

- Altered pacemaker site
  - Atrial Rhythms *
  - Junctional Rhythms *
  - Ventricular Rhythms *

- Altered conduction
  - AV Conduction Blocks *
  - Bundle Branch Blocks

- Artificially paced rhythms

AV Heart Blocks - Review

More Ps than qRs Complexes

- PRI consistent?
- Cyclic
  - PRI progressively prolongs
  - P w/o qRs occurs
- P not r/t qRs?
Cardiac Mechanical Function

Normal Myocardial Oxygen Supply and Demand

- Supply = Demand
- Demand > Supply = Chest Pain

Oxygen Supply Reduction Causes
- Anemia
- Hypoxia
- Cold Air
- ↑ B/P
- ↑ HR
- Artery Obstruction

Oxygen Demand Increase Causes
- Stress
- Emotional excitement
- Smoking
- Exercise
- Severe illness or injury
- ↑ B/P
- Fever
- Hyperthyroidism
Cardiac Output = Stroke Volume $\times$ Heart Rate

**Cardiac Output**
- With Increased Stroke Volume then Heart Rate Increases
- With Decreased Stroke Volume then Heart Rate Decreases

**Cardiac Output**

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

- **Afterload**
  - 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 1/6 muscle mass of LV
- RV performs 1/4 of the work of LV
  - Low pulmonary vascular resistance
  - PVR 10% of systemic resistance
1. Atrial Systole
- Late Ventricular Diastole
- SA Node Fires
- Atrial Depolarization
- Atrial Contraction
- Atrial Kick (30%)
- PRI

2. Ventricular Contraction
- Bundles, Purkinje fibers
- Ventricular depolarization
- qRs
- Rise in pressure in ventricles
- AV Valves close
- S1 Occurs
- Ventricular Contraction
- Semi-Lunar valves stay closed

3. Ventricular Systole
- Ventricular Pressure > PAP, Aortic pressure
- Semi-Lunar valves open
- Ventricles eject blood
- AV Valves stay closed

4. Atrial Diastole
- Ventracles empty and relax
- PAP, Aorta pressure > Ventricular pressure
- Semi-lunar valves close
- S2 Occurs
- AV Valves stay closed
- Blood fills the atria

5. Ventricular Diastole
- Atrial pressure > Ventricular pressure
- AV valves open
- Semi-lunar valves stay closed
- Blood flows into Ventricles (70%)

S. Walden 2/07
Cardiovascular Assessment

History, Pain and Associated Symptoms
- Risk factors
- Past medical history
- Family history

Assessment Landmarks

Arterial Pulses
- Carotid
  - Just medial trachea, below angle of jaw
- Brachial
  - Medial to biceps tendon
- Radial
  - Ventral side of wrist, below base of thumb
- Femoral
  - Hard pressure inferior to inguinal ligament
  - Obese - crease of groin, ½ pubic - hip bone
- Popliteal
  - Firm in popliteal fossa @ back of knee
- Posterior tibial
  - Behind and slightly below malleous of ankle
- Dorsalis pedis
  - Medial dorsum of foot - point toes
Chest Pain Analysis
Sandy Walden, MS, RN, © 2/1/05 Revised 3/1/07, 7/11/08

Onset
Gradual or Sudden

Location and Radiation
Specific site
Does it radiate
Note body language

Quality
Describe in own words
What is pain like
Describe how it feels

Intensity (Severity)
How bad is it (1-10)
How does it affect to activity

Duration
How long does it last

Precipitating & Relieving Factors
What brought on the pain - what was the patient doing
What makes it better
What makes it worse

Emotional Response
How does it make you feel

Associated Symptoms
Other symptoms with chest pain

Gestures
Note any gestures patient uses to describe pain

Chest Pain-Physical Assessment
- Vital signs
- Heart sounds
- Carotids
- Jugular vein distension
- Respiratory assessment
Cardiac Chest Pain

Ischemic

Angina
  • Stable Angina
  • Variant Angina

ACS
  • STEMI
  • NSTEMI
  • Unstable Angina

Non-Ischemic

Pericarditis

Oxygen Supply Reduction

❖ Anemia
❖ Hypoxia
❖ Cold Air
❖ ↑ B/P
❖ ↑ HR
❖ Artery Obstruction

Oxygen Demand Increase

❖ Stress
❖ Emotional excitement
❖ Smoking
❖ Exercise
❖ Severe illness or injury
❖ ↑ B/P
❖ Fever
❖ Hyperthyroidism

Angina – Demand related ischemia
Stable Angina – Angina Pectoris
Unstable Angina – Acute Coronary Syndrome
Variant Angina – Prinzmental Angina – Unstable Angina at Rest
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Stable Angina</th>
<th>Unstable Angina</th>
<th>Variant Angina</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onset</strong></td>
<td>Crescendo</td>
<td>Occurs with less exertion than stable or at rest or with exertion</td>
<td>Occurs at night, rest and in clusters.</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Mid retrosternal</td>
<td>Mid retrosternal</td>
<td>Retrosternal radiates to neck, jaw, shoulder, arm (left &gt; right), back, may be epigastric</td>
</tr>
<tr>
<td><strong>Radiation</strong></td>
<td>Radiation inside of left arm, both arms</td>
<td>Radiation inside of left arm, both arms</td>
<td></td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>Pressing, Squeezing, Tightness, Heaviness</td>
<td>Heaviness (more severe)</td>
<td>Heaviness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Severe Pressure</td>
<td>Pressure, squeezing, tight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard pain</td>
<td>Symptoms may be similar to Myocardial Infarction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Choking, Short of Breath</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nausea &amp; Vomiting</td>
<td></td>
</tr>
<tr>
<td><strong>Intensity</strong> (Severity)</td>
<td>Mild to Moderate Discomfort</td>
<td>Severe, Distressing</td>
<td>Severe</td>
</tr>
<tr>
<td></td>
<td>Gradual worsening with stress removed</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>2-5 minutes after precipitating factor removed</td>
<td>Up to 30 minutes</td>
<td>Protracted – Chest pain may stop suddenly – ST segments will return to baseline when pain is no longer present.</td>
</tr>
<tr>
<td><strong>Relieving Factors</strong></td>
<td>Rest, NTG</td>
<td>(SL) NTG {May require IV}</td>
<td>Intracoronary or IV NTG, Calcium Channel Blockers used to treat</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rest, Beta Blockers, ASA, Heparin</td>
<td></td>
</tr>
<tr>
<td><strong>Precipitating Factors</strong></td>
<td>Effort, Stress, Cold environment</td>
<td>Occurs at rest or minimal exertion less than if stable before</td>
<td>Usually has a trigger: Emotional stress, stimulants, hyperventilation, cold. I.D and eliminate trigger.</td>
</tr>
<tr>
<td><strong>Emotional Response</strong></td>
<td>Vague anxiety</td>
<td>Anxious</td>
<td>Anxiety – may have had the pain before if diagnosed as Variant Angina</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Myocardial Infarction</th>
<th>Acute Pericarditis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>Sudden Onset</td>
<td>Sudden Onset</td>
</tr>
<tr>
<td></td>
<td>Builds to maximum severity, Protracted</td>
<td></td>
</tr>
<tr>
<td>Location Radiation</td>
<td>Retrosternal radiates to neck, jaw, shoulder, arm (left &gt; right), back, may be epigastric</td>
<td>Retrosternal Usually felt more on the left, may radiate over trapezium ridge of shoulder</td>
</tr>
<tr>
<td>Quality</td>
<td>Constricting, Pressure (Pressing), Squeezing, Heaviness, Tightness, Expanding, Aching, Fullness, Burning (Searing), Choking, Grabbing, Crushing, Compressing, Deep, &quot;Like a band around the chest&quot;, &quot;Like an elephant on my chest&quot;, &quot;Like a ton of bricks on my chest&quot;</td>
<td>Aching, deep, vague heaviness Uncomfortable, Affected by position &amp; movement Aggravated by inspiration</td>
</tr>
<tr>
<td>Intensity (Severity)</td>
<td>Severe; may become agonizing</td>
<td>Severe but rarely excruciating</td>
</tr>
<tr>
<td>Duration</td>
<td>Protracted, With medications can last for hours</td>
<td>Comes and goes, waxes and wanes Present for hours but may come and go for days</td>
</tr>
<tr>
<td>Relieving Factors Precipitating Factors</td>
<td>Rest Alleviates (only temporarily)</td>
<td>Swallowing, lying down and inspiration worsens: Leaning forward eases</td>
</tr>
<tr>
<td>Associated Symptoms</td>
<td>Nausea, Vomiting, Short of Breath, Weakness, Faintness, Pallor and Profuse Perspiration, Looks Ill</td>
<td>Fever, chills, joint and muscle aching</td>
</tr>
<tr>
<td>Emotional Response</td>
<td>Anxiety, Fear of impending doom</td>
<td>Anxiety fear</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Pulmonary Embolism</td>
<td>Pneumothorax</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Onset</td>
<td>Sudden onset</td>
<td>Sudden onset at rest</td>
</tr>
<tr>
<td>Location</td>
<td>More frequent on right and lower lobes</td>
<td>Over the pneumothorax; Sometimes referred to top of shoulder on the affected side</td>
</tr>
<tr>
<td>Radiation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td>Heavy, sharp</td>
<td>Pleuritic</td>
</tr>
<tr>
<td>Intensity (Severity)</td>
<td>Severe</td>
<td>Severe</td>
</tr>
<tr>
<td>Duration</td>
<td>Varies</td>
<td>Several hours, may wax &amp; wane for several days</td>
</tr>
<tr>
<td>Relieving Factors</td>
<td>Aggravated by respiration</td>
<td>Aggravated by inspiration &amp; coughing</td>
</tr>
<tr>
<td>Precipitating Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associated Symptoms</td>
<td>Tachypnea, short of breath, dyspnea, cyanosis, syncope, shock, hemoptysis, rales, wheezes, friction rub, pleural effusion</td>
<td>Breath sounds decreased on affected side, hyperventilation, tachycardia</td>
</tr>
<tr>
<td>Emotional Response</td>
<td>Severe anxiety</td>
<td>Anxious - Severe anxiety</td>
</tr>
</tbody>
</table>

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**Angina Pectoris - Chest Pain**
- Crescendo then fades
- Midretrosternal
- Pressing, squeezing
- Tightness, heaviness
- Uncomfortable
- Lasts 2 - 5 minutes
- Rest and NTG relieves pain
- Effort, stress, cold worsens pain
- Vague anxiety

**Variant Angina**
- Caused by Coronary artery spasm
- Other name is “Prinzmetal Angina”
- Often occurs at rest, at night
- Will see ST elevation with pain, STs back to baseline when pain subsides
- MI if spasm causes damage

**Unstable Angina**
- One of the Acute Coronary Syndromes
- Recent onset
- Less effort or at rest
- More frequent with same effort
- More protracted and less responsive
- Ischemic protracted pain w/o MI

**Myocardial Infarction - Pain**
- STEMI or NSTEMI (ACS)
- Constricting, pressure, crushing
- Squeezing, heavy, tight, compressing
- Expanding, aching, full, deep
- Burning, choking, grabbing
- Crushing chest pain
  - Pressure like
  - Substernal, precordial

**Atypical Chest Pain**
- Women
  - Likely to be atypical
  - Radiation to Right Arm, left axilla, mid-back, jaw (toothache)
  - Pain epigastric
- Diabetics
  - No Pain
- Shortness of Breath
- Elderly
  - Perception of pain issues
Myocardial Infarction - Pain

- 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 do not relieve

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
### Acute Pericarditis - Symptons
- Sudden onset, builds in intensity
- Retrosternal (left)
- Aching, deep, vague heaviness
- Affected by position & movement
- Severe, waxes & wanes
- Fever, chills, joint muscle aching
- ST elevation (all leads)
- Pericardial friction rub

### Acute Pericarditis

**Position and Movement**
- Pain Increased by:
  - Swallowing
  - Lying Down
  - Inspiration
- Pain relieved by:
  - Leaning Forward

### Acute Coronary Syndrome

**Causes of Ischemia, Injury and Infarction**

#### Indirect Causes
- ↑ Myocardial workload
- ↓ Coronary arterial blood flow
- Hypoxemia
- Cocaine or Ethanol toxicity

#### Direct Causes
- STEMI (Most Common)
- NSTEMI
- Variant Angina

### Cocaine Associated MI
- Atherosclerotic plaque rupture
- Coronary vasospasm
- Coronary Thrombus formation - Stimulation of platelet activators
- Coronary artery dissection (rare)
- Blocks the reuptake of Dopamine and presynaptic Norepinephrine
- Powerful sympathetic response
- ↑ Release of endothelin - vasoconstrictor
- ↓ Production of nitric oxide - vasodilator
- Profound vasoconstriction
Troponin I or T
- Levels rise within 3-8 hours
- Peak 24-48 hours
- Fall to baseline 7-10 days

ECG Leads - Assessment
- Which leads?
- What arteries?
- What ECG changes?
### 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>

### Contiguous Leads

<table>
<thead>
<tr>
<th>Location</th>
<th>Leads</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, aVf</td>
<td>II, III, aVF</td>
</tr>
<tr>
<td>V1 – V2</td>
<td>V1 – V2</td>
</tr>
<tr>
<td>V3 – V4</td>
<td>V3 – V4</td>
</tr>
<tr>
<td>V5 – V6</td>
<td>V5 – V6</td>
</tr>
<tr>
<td>I, aVl</td>
<td>I, aVl</td>
</tr>
<tr>
<td>V7, V8, V9</td>
<td></td>
</tr>
<tr>
<td>RV4, RV5, RV6</td>
<td></td>
</tr>
<tr>
<td>Inferior</td>
<td>Inferior</td>
</tr>
<tr>
<td>Septal</td>
<td>Septal</td>
</tr>
<tr>
<td>Pure Anterior</td>
<td>Pure Anterior</td>
</tr>
<tr>
<td>Low Lateral</td>
<td>Low Lateral</td>
</tr>
<tr>
<td>High Lateral</td>
<td>High Lateral</td>
</tr>
<tr>
<td>Posterior</td>
<td>Posterior</td>
</tr>
<tr>
<td>Right Ventricle</td>
<td>Right Ventricle</td>
</tr>
</tbody>
</table>

### 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

### See Handouts - AACN Practice Alerts on AACN.org


**ECG Changes**

- **ST elevation in 2 contiguous leads**
  - 1 mm in frontal leads
  - 2 mm in precordial leads
  - New LBBB
- **ST depression in 2 contiguous leads**
  - 1 mm in frontal leads
  - 2 mm in precordial leads
- **No significant changes or normal 12 lead**
- **ST elevation in 2 contiguous leads = STEMI (q wave MI)**
- **ST depression in 2 contiguous leads = NSTEMI (Non q wave MI)**
- **No ECG changes and No cardiac Marker elevation = Angina**

**Myocardial Infarction Detection Method**

1. **ST elevation with or without q waves - Yes = STEMI**
2. **What leads show the changes**
3. **Determine presence of MI and location**
12 Lead ECGs
Preferred Leads - See Handouts AACN Practice Alerts (http://www.AACN.org)

- 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
- 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

Refer to AACN Practice Alerts: ST Segment Monitoring and Dysrhythmia Monitoring on www.AACN.org.

Ischemic Chest Pain
Assessment
Signs & Symptoms: Vital Signs, O2 Sat; IV; Monitor; 12 Lead ECG; Target History; Cardiac Markers, Electrolyte & Coagulation studies.

Steps to Diagnose Myocardial Infarction
1. Signs and Symptoms
   a. Typical vs Atypical
2. ECG Changes
   a. STEMI
   b. NSTEMI
   c. Unstable Angina
3. 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>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>• Fixed Q waves</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 ECG</td>
</tr>
</tbody>
</table>
## Complications

### 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

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Cardiac Tamponade</th>
<th>Ventricular Septal Rupture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral Regurgitation</td>
<td>↓ BP</td>
<td>Rare - Lethal</td>
</tr>
<tr>
<td>Sudden onset holosystolic</td>
<td>↓ CO; ↓ CI</td>
<td>Abrupt ↓ BP &amp; CO/CI</td>
</tr>
<tr>
<td>murmur</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade VI murmur @ Apex</td>
<td>Sinus Tachycardia</td>
<td>Loud HSM, ↑ ST V1-V2</td>
</tr>
<tr>
<td></td>
<td>Heard with Stethoscope off the chest</td>
<td></td>
</tr>
<tr>
<td>(+)Thrust and/or Thrill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abrupt ↓ BP;</td>
<td>Distant heart sounds</td>
<td>2-8 days after infarction</td>
</tr>
<tr>
<td>↓ cardiac output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Ventricular Infarction</td>
<td>Distended neck veins</td>
<td>Cardiogenic shock</td>
</tr>
<tr>
<td>Emergent surgery</td>
<td>↑ CVP, PEA</td>
<td>Emergent surgery - CABG</td>
</tr>
</tbody>
</table>
Adult Cardiac Arrest
Stable
Bradycardia Treatment

Ischemic Chest Pain

Assess Initial ECG
ST Segment Displacement

ST ↑
- Beta Blockers
- Clopidogrel
- Heparin IV
- Reperfusion (≤ 12h)
  - Fibrinolytics
  - PCI
- ACE Inhibitors/ARB
- Statin Therapy

ST ↓
- NTG
- Beta Blockers
- Clopidogrel
- Heparin
- IIB/IIIA Inhibitors
- Reperfusion
- ACE Inhibitor/ARB
- Statin Therapy

Non-diagnostic
- Risk Assess
- ST Monitoring
- Serial Cardiac Markers & ECGs
- Stress Test
- Non-Invasive Test
Basic Pacemaker Function and Malfunction

- 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 ↑ mV the ↓ sensitivity
- The ↓ mV the ↑ sensing

ECG Paper Measurement Rate Pulse Per Minute (PPM)
- Type of pacer dependent
- Single chamber - 50-80 per minute
- Dual chamber - Absolute lower/higher limit

Sensing
- Failure to fire
  - Most often due to oversense = mV set too low (sensing high)
  - Increase the mV = ↓ sensing
- Failure to sense
  - Most often due to undersense = mV set too high (sensing low)
  - Decrease mV = ↑ sensing
Pacer Strip Basic Steps to Interpret

1. Measure Automatic Interval = Consecutive paced to paced complex
2. Measure Escape Interval = Patient/intrinsic/native complex to paced complex that immediately follows.
3. Compare Automatic Interval and Escape Interval. They should be equal.
4. Escape Interval shorter than Automatic Interval = Failure to Sense
5. Escape Interval longer than Automatic Interval = Failure to Fire

Automatic Interval = Paced to Paced complex

Escape Interval = Intrinsic to Paced complex

Intervals equal therefore the pacer sensed the intrinsic complex. Normal pacer function

Pacer Function or Malfunction?
### Pacer Failure

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

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

#### Failure to Sense -

- Escape interval is less than Automatic Interval

---

**Failure to Sense**

---
### Failure to Fire

- Escape interval is longer than Automatic Interval
- Pacer doesn't fire - Pacer spikes absent

---

### Failure to Capture

- Spikes without a resultant patient complex
  - Missing P wave after spike

<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>0=None</td>
<td>0=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>S= Shock</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>
</tbody>
</table>
Pacemaker Indications
  - TCP
    - Emergent unstable bradycardia
  - AAI (Impaired Impulse Formation)
    - Sick Sinus Syndrome
    - Symptomatic Sinus Bradycardia
    - Tachy-brady Syndrome
  - VVI or DDD (Impaired Conduction)
    - AV Blocks - 2nd, Type II or 3rd Degree
    - Bi or Trifascicular Blocks
  - Biventricular Pacer (Resynchronization)
    - CHF with LVEF < 35%

Atrial Fibrillation and Pacemaker Indications
  - Dual Chamber - DDD
    - Paroxysmal Atrial Fibrillation -
    - Tachy-Brady Syndrome
      - Fast with A-fib
      - Slow without A-fib
  - VVI or DDD
    - Catheter ablation of the AV Node

Implantable Cardioverter Defibrillator
ICD Indications
- Survivor cardiac arrest
- Spontaneous sustained VT-stable/unstable
- LVEF < 35%
- Hypertrophic cardiomyopathy
- LV dysfunction due to prior M.I. or syncope
- Long QT syndrome - syncope or VT
- Brugada syndrome - syncope or VT

Pacer ICD Interference
- Pacer unsafe
  - Generators, MRI
  - Ham radio, Arc welding
  - Airport metal wand
- ICD - external defibrillation
  - Do not place over ICD pulse generator

Cardiogenic Shock
**Cardiogenic Shock**

- Systemic arterial hypotension < 90 mmHg
- MAP > 30 mmHg below basal levels
- PAWP > 15 mmHg
- Reduced C.O.
  - Cardiac Index < 2.2 L/min/m²
    - Normal CI 2.6 - 4.2 L/min/m²
- Cool skin, altered mental status
- Diminished urine output
- Systolic ↓ 90 mmHg - 30 minutes
- ↓ C.O., ↑ Filling pressures
- ↑ Pulse, faint and irregular
- Tachypneic, pulmonary rales
- ↑ JVD, precordial heave
- Distant S1, S2; + S3 and/or +S4
- MR or VSD Murmur
- Ashen, cyanotic
- Cool skin, mottled extremities
- Clouded sensorium
- Restlessness, agitation
Cardiogenic Shock - Initial Treatment Steps

- O2 → Mechanical Ventilation
- Venous access, monitor, pain relief
- Hemodynamic support
  - Fluid challenge (_topic pulmonary edema)
  - Vasopressors for unresponsive ↓ B/P

Cardiogenic Shock - Tissues Perfusion Remains Inadequate

- Inotropic agents
  - Dobutamine (Systolic > 80 mmHG)
  - Dopamine (Systolic < 80 mmHG)
  - Milrinone (Chronic heart failure)
- IABP
  - ↓ Systolic afterload
  - Augments diastolic perfusion pressure
  - ↑ Cardiac output
- Reperfusion

Cardiogenic Shock - Adequate Perfusion with Pulmonary Edema

- Diuretics
- Vasodilators - Nitroprusside & NTG
  - Extreme caution
  - Possible ↓ B/P and ↓ Coronary blood flow
  - When stable can ↓ preload and afterload
- Reperfusion
Practice Questions

1. When externally shocking a pt with an ICD pacemaker, you should:
   1. If v-fib develops, you should not defibrillate with external paddles
   2. CPR is not indicated if ICD is firing correctly and pt is pulseless
   3. Avoid placing paddle directly over the ICD pulse generator
   4. Turn off all functions of the ICD by applying a magnet

2. After a STEMI, your pt. experiences ↓ LOC, weak & thready pulse, posterior crackles in ↓ half of lung fields bilaterally, B/P 76/43; HR 130; RR 24; UO 5 ml; O2 Sat 88% (↓ 97%). The most likely cause is:
   1. CVA
   2. Cardiogenic Shock
   3. Pulmonary Embolus
   4. ARDS

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

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

5. Which of the following 12-Lead ECG Δs 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
6. Which of the following is indicated for pulmonary edema and cardiogenic shock:
   1. Alpha-adrenergic drugs to ↑ coronary perfusion
   2. Nitrates to ↓ afterload
   3. Beta-receptor blockade drugs to ↑ cardiac contractility
   4. Mechanical circulatory assist devices to ↑ coronary perfusion

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

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

9. Pt admitted with CP and 2nd 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
10. Pt has the rhythm below, unresponsive, B/P 72/50; the most appropriate therapy is:
   1. Cardioversion
   2. Defibrillation
   3. Lidocaine, 1mg/kg IV
   4. Verapamil 5mg IV

![Heart rhythm image]

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

![Symptoms image]

12. The most appropriate initial intervention for an unstable patient with 2nd Degree, II is:
   1. TCP
   2. Transvenous Pacing
   3. Atropine
   4. Epinephrine

![Pacing image]

13. Your patient has the following rhythm and is pulseless and apneic, what should you do first?
   1. Defibrillate @ 200 j biphasic
   2. Synchronize cardiovert @ 200 j biphasic
   3. Wait for the Code Team to arrive
   4. Administer 300 mg Amiodarone IV

![Rhythm image]
14. Pain associated with M.I. typically presents as:
   1. Crushing, constricting, or pressure-like CP
   2. Radiating into left arm, ulnar distribution
   3. Radiating into jaw, neck or throat
   4. Associated with exertion
   5. 1, 2 & 3 are correct

15. What is the most appropriate permanent pacer mode to use when a Pt. goes into Atrial Fibrillation
   1. DVI
   2. DDD
   3. VAT
   4. VVI

16. In a patient receiving a beta blocker, identify a CV effect to be expected
   1. Wolfe-Parkinson-White Syndrome
   2. Prolonged PRI
   3. Shortened qTc
   4. Increased B/P

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

18. Nitrate therapy is indicated for the treatment of unstable angina due to:
   1. ↑ Preload ↑ myocardial demand
   2. ↓ Preload ↑ myocardial demand
   3. ↓ Preload ↓ myocardial demand
   4. ↑ Preload ↓ myocardial demand

19. The dysrhythmia most commonly associated with mitral stenosis
   1. 2nd Degree AV Block, Type II
   2. IVR
   3. Sinus Bradycardia
   4. Atrial Fibrillation
20. Temp pacer fails to capture; 3rd Degree AV Block rate of 46. B/P 84/52 & slightly dyspneic. Most appropriate initial intervention is:
   1. Reposition the patient
   2. Advance the pacing wire
   3. Increase the PPM
   4. Decrease the mA

21. The emergency drug of choice for polymorphic VT with a prolonged QT is:
   1. Atropine
   2. Amiodarone
   3. Adenosine
   4. Magnesium

22. Dobutamine is used at a rate of 10-12 mcg/kg/min for cardiogenic shock to:
   1. Myocardial ischemia
   2. Improve urinary output
   3. Improve myocardial contraction
   4. Oxygen consumption

23. In a temporary pacer, the most common cause of failure to fire is:
   1. The sensitivity is too high (mVs are ↓)
   2. The sensitivity is too low (mVs are ↑)
   3. Current is too low (ma is ↓)
   4. Current is too high (ma is ↑)

24. Who is more likely to experience atypical chest pain
   1. Diabetic female
   2. 60-year old male with known CAD
   3. 50-year old man shoveling snow
   4. Patient with PAD
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

![ECG strip showing ventricular tachycardia]

26. Pt has loss of consciousness with B/P 78/42, HR 48 and 3rd Degree AV block, you should:
1. Administer atropine 0.5 mg IV.
2. Administer fluids
3. Apply TCP
4. Administer Lidocaine

27. Pt presents in the E.D. with c/o lethargy. Lab reveals a K+ 7.2, & B/P 100/60. The ECG strip is below. The ICU RN should anticipate:
1. Cardioversion
2. 1 amp D50W & 20U of Reg Insulin
3. Defibrillation
4. Ca++ to stabilize cardiac membranes

![ECG strip showing potassium imbalance]

28. Ischemic chest pain is caused when:
1. Myocardial O2 supply exceeds demand
2. Myocardial O2 demand exceeds supply
3. Hypertension, anemia, cold air, or smoking
4. 2 & 3 are correct
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

30. The patient has the rhythm below, B/P 120/80, A & O x 4, lungs clear, no c/p; you should expect the following treatment:
   1. Atropine 0.5 mg IV
   2. Amiodarone 150 mg IV
   3. Amiodarone 300 mg IV
   4. Defibrillation 200 joules

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.
Answers to Practice Questions

1. 3
2. 2
3. 3
4. 2
5. 3
6. 1
7. 4
8. 4
9. 1
10. 1
11. 2
12. 1
13. 1
14. 5
15. 4
16. 2
17. 1
18. 3
19. 4
20. 1
21. 4
22. 3
23. 1
24. 1
25. 1
26. 3
27. 4
28. 4
29. 4
30. 2
31. 2