Chapter 2

Basic Electrophysiology
Objectives

- Define the absolute, relative refractory, and supernormal periods and their location in the cardiac cycle.
- Describe the normal sequence of electrical conduction through the heart.
Objectives

- Describe the location, function, and (where appropriate), the intrinsic rate of the following structures: SA node, atrioventricular (AV) junction, bundle branches, and Purkinje fibers.
- Differentiate the primary mechanisms responsible for producing cardiac dysrhythmias.
- Describe reentry.
- Explain the purpose of electrocardiographic monitoring.
- Identify the limitations of the electrocardiogram (ECG).
- Differentiate between frontal plane and horizontal plane leads.
- Describe correct anatomic placement of the standard limb leads, augmented leads, and chest leads.
- Relate the cardiac surfaces or areas represented by the electrocardiogram leads.
Objectives

- Identify the numeric values assigned to the small and large boxes on ECG paper.
- Identify how heart rates, durations, and amplitudes may be determined from electrocardiographic recordings.
- Define and describe the significance of each of the following as they relate to cardiac electrical activity: P wave, QRS complex, T wave, U wave, PR segment, TP segment, ST segment, PR interval, QRS duration, and QT interval.
- Recognize the changes on the electrocardiogram that may reflect evidence of myocardial ischemia and injury.
- Define the term artifact and explain methods that may be used to minimize its occurrence.
- Describe a systematic approach to the analysis and interpretation of cardiac dysrhythmias.
Types of Cardiac Cells

- **Myocardial cells**
  - Working or mechanical cells
  - Responsible for contraction

- **Pacemaker cells**
  - Specialized cells of electrical conduction system
  - Spontaneously generate and conduct impulses
Properties of Cardiac Cells

- Automaticity
  - Ability of pacemaker cells to initiate an electrical impulse without being stimulated from another source
Properties of Cardiac Cells

● Excitability (irritability)
  ➢ Ability of cardiac muscle cells to respond to an outside stimulus
Properties of Cardiac Cells

- Conductivity
  - Ability of a cardiac cell to receive an electrical stimulus and conduct that impulse to an adjacent cardiac cell
Properties of Cardiac Cells

- **Contractility**
  - Ability of cardiac cells to shorten, causing cardiac muscle contraction in response to an electrical stimulus
Phase 0—Depolarization

- Begins when the cell receives an impulse
  - Sodium moves rapidly into cell
  - Potassium leaves cell
  - Calcium moves slowly into cell
- Cell depolarizes; contraction begins
- Responsible for QRS complex on the ECG
Phase 1—Early Repolarization

- Na+ channels partially close
- Brief outward movement of K+
- Results in fewer positive electrical charges within the cell
Phase 2—Plateau Phase

- Repolarization continues relatively slowly
  - Slow inward movement of Ca++
  - Slow outward movement of K+
- Responsible for ST segment on ECG
Phase 3—Final Rapid Repolarization

- K⁺ flows quickly out of the cell
- Entry of Ca++ and Na⁺ stops
  - Cell becomes progressively more electrically negative and more sensitive to external stimuli
- Corresponds with T wave on the ECG
Phase 4—Return to Resting State

- Heart is "polarized" during this phase
  - Ready for discharge
- Cell will remain in this state until reactivated by another stimulus
Antiarrhythmics

- **Arrhythmia**
- **Dysrhythmia**
- **Antiarrhythmics**
  - Medications used to correct irregular heartbeats and slow down hearts that beat too fast
  - Classified by their effects on the cardiac action potential
Refractory Periods

● Refractoriness
  ➢ The period of recovery that cells need after being discharged before they are able to respond to a stimulus
Refractory Periods

- **Absolute refractory period**
  - Cells cannot be stimulated to conduct an electrical impulse, no matter how strong the stimulus
  - Onset of QRS complex to approximate peak of T wave
Refractory Periods

- Relative refractory period
  - Cardiac cells can be stimulated to depolarize if the stimulus is strong enough
  - Corresponds with downslope of T wave
Refractory Periods

- **Supernormal period**
  - Weaker than normal stimulus can cause cardiac cells to depolarize
  - Corresponds with end of T wave

1 = Absolute refractory period
2 = Relative refractory period
3 = Supernormal period
The Conduction System

- Conduction system
  - Specialized electrical (pacemaker) cells
  - Arranged in a system of pathways

- Primary pacemaker
  - Sinoatrial (SA) node
The Conduction System

- **Atria**
  - Fibers of SA node connect directly with fibers of atria
  - Impulse leaves SA node
  - Spreads from cell to cell across atrial muscle
The Conduction System

- Internodal pathways
  - Impulse is spread to AV node via internodal pathways
    - Merge gradually with cells of AV node
The Conduction System

- **AV junction**
  - Area of specialized conduction tissue
  - Provides electrical links between atrium and ventricle
The Conduction System

• AV node
  ➢ Located in floor of right atrium
    • Supplied by right coronary artery in most people
  ➢ Delays conduction of impulse from atria to the ventricles
    • Allows time for atria to empty into ventricles
The Conduction System

- AV node
  - Divided into three functional regions according to their action potentials and responses to electrical and chemical stimulation
  - Atrionodal (AN)
  - Nodal (N) region
  - Nodal-His (NH)
The Conduction System

- **Bundle of His**
  - Connects AV node with bundle branches
  - Pacemaker cells have an intrinsic rate of 40 to 60 bpm
  - Conducts impulse to right and left bundle branches
The Conduction System

- Right bundle branch

- Left bundle branch
  - Divides into three fascicles
    - Anterior fascicle
    - Posterior fascicle
    - Septal fascicle
The Conduction System

- Purkinje fibers
  - Receive impulse from bundle branches
  - Relay it to ventricular myocardium
  - Pacemaker cells have an intrinsic rate of 20 to 40 bpm
Conduction System Review
Causes of Dysrhythmias
Enhanced Automaticity

- Cardiac cells not normally associated with a pacing function begin to depolarize spontaneously or

- Pacemaker sites other than the SA node increase their firing rate beyond that considered normal
Triggered Activity

- Abnormal electrical impulses occur during repolarization (afterdepolarizations), when cells are normally quiet
  - Requires a stimulus to initiate depolarization
Reentry (Reactivation)

- An impulse returns to stimulate tissue that was previously depolarized.
Escape Beats or Rhythms

- Lower pacemaker site produces electrical impulses
  - Assumes responsibility for pacing the heart

- “Protective” mechanisms
  - Maintain cardiac output
  - Originate in the AV junction or the ventricles
Conduction Disturbances

- May occur because of:
  - Trauma
  - Drug toxicity
  - Electrolyte disturbances
  - Myocardial ischemia or infarction

- Conduction may be too rapid or too slow
The Electrocardiogram (ECG)
The ECG

- The ECG is a voltmeter
  - Records electrical voltages (potentials) generated by depolarization of heart muscle
The ECG

- Can provide information about:
  - The orientation of the heart in the chest
  - Conduction disturbances
  - The electrical effects of medications and electrolytes
  - The mass of cardiac muscle
  - The presence of ischemic damage
The ECG

- Does not provide information about the mechanical (contractile) condition of the myocardium

- Evaluated by assessment of pulse and blood pressure
Electrodes

- Applied at specific locations on the patient's chest wall and extremities
- One end of a monitoring cable is attached to the electrode
- The other end is attached to an ECG machine
- The cable conducts current back to the cardiac monitor
ECG Monitoring
ECG Monitoring
ECG Monitoring
ECG Monitoring
ECG Monitoring

[Image of a medical device displaying an ECG monitor]
ECG Monitoring
Leads

- A record of electrical activity between two electrodes
- Allow viewing of the heart’s electrical activity in two different planes
  - Frontal (coronal)
  - Horizontal (transverse)
- Each lead records the average current flow at a specific time in a portion of the heart
Frontal Plane Leads

- Six leads view the heart in the frontal plane
  - 3 bipolar leads
  - 3 unipolar leads
Frontal Plane Leads

- **Bipolar lead**
  - A lead that consists of a positive and negative electrode
  - Leads I, II, and III
Frontal Plane Leads

- **Unipolar lead**
  - A lead that consists of a single positive electrode and a reference point
  - **Augmented limb leads**
    - Leads aVR, aVL, and aVF
Standard Limb Leads

- Leads I, II, and III
- Right arm electrode is always negative
- Left leg electrode is always positive
Lead I

- Records difference in electrical potential between left arm (+) and right arm (−) electrodes
- Views lateral wall of left ventricle
Lead II

- Records difference in electrical potential between left leg (+) and right arm (−) electrodes

- Views inferior surface of left ventricle
Lead III

- Records difference in electrical potential between left leg (+) and left arm (−) electrodes

- Views inferior surface of left ventricle
## Standard Limb Leads

<table>
<thead>
<tr>
<th>Lead</th>
<th>Positive Electrode</th>
<th>Negative Electrode</th>
<th>Heart Surface Viewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Left arm</td>
<td>Right arm</td>
<td>Lateral</td>
</tr>
<tr>
<td>II</td>
<td>Left leg</td>
<td>Right arm</td>
<td>Inferior</td>
</tr>
<tr>
<td>III</td>
<td>Left leg</td>
<td>Left arm</td>
<td>Inferior</td>
</tr>
</tbody>
</table>
Augmented Limb Leads

- Leads aVR, aVL, aVF
  - A = augmented
  - V = voltage
  - R = right arm
  - L = left arm
  - F = foot (usually left leg)
Augmented Limb Leads

- Lead aVR
  - Views the heart from the right shoulder
  - Does not view any wall of the heart
Augmented Limb Leads

- Lead aVL
  - Views the heart from the left shoulder
  - Oriented to the lateral wall of the left ventricle
Augmented Limb Leads

- Lead aVF
  - Views the heart from the left foot (leg)
  - Views the inferior surface of the left ventricle
# Augmented Leads

<table>
<thead>
<tr>
<th>Lead</th>
<th>Positive Electrode</th>
<th>Heart Surface Viewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>aVR</td>
<td>Right arm</td>
<td>None</td>
</tr>
<tr>
<td>aVL</td>
<td>Left arm</td>
<td>Lateral</td>
</tr>
<tr>
<td>aVF</td>
<td>Left leg</td>
<td>Inferior</td>
</tr>
</tbody>
</table>
Horizontal Plane Leads

- View the heart as if the body were sliced in half horizontally

- Directions
  - Anterior
  - Posterior
  - Right
  - Left
Horizontal Plane Leads

- Six chest (precardial or “V”) leads view the heart in the horizontal plane

- Chest leads
  - $V_1$
  - $V_2$
  - $V_3$
  - $V_4$
  - $V_5$
  - $V_6$
Chest Lead Placement
Chest Lead Placement
Chest Lead Placement
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Chest Lead Placement
## Chest Leads

<table>
<thead>
<tr>
<th>Lead</th>
<th>Positive Electrode Position</th>
<th>Heart Surface Viewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_1$</td>
<td>Right side of sternum, 4(^{th}) intercostal space</td>
<td>Septum</td>
</tr>
<tr>
<td>$V_2$</td>
<td>Left side of sternum, 4(^{th}) intercostal space</td>
<td>Septum</td>
</tr>
<tr>
<td>$V_3$</td>
<td>Midway between $V_2$ and $V_4$</td>
<td>Anterior</td>
</tr>
<tr>
<td>$V_4$</td>
<td>Left midclavicular line, 5(^{th}) intercostal space</td>
<td>Anterior</td>
</tr>
<tr>
<td>$V_5$</td>
<td>Left anterior axillary line; same level as $V_4$</td>
<td>Lateral</td>
</tr>
<tr>
<td>$V_6$</td>
<td>Left midaxillary line; same level as $V_4$</td>
<td>Lateral</td>
</tr>
</tbody>
</table>
Right Chest Leads

- Used to view the right ventricle
- Placement identical to standard chest leads except on right side of chest
Right Chest Lead Placement
Right Chest Lead Placement
Right Chest Lead Placement
Right Chest Lead Placement
Right Chest Lead Placement
Right Chest Lead Placement
Posterior Chest Leads

- Used to view posterior surface of heart

- Use same horizontal line as $V_4$ to $V_6$
  - $V_7$ - posterior axillary line
  - $V_8$ - posterior scapular line
  - $V_9$ - left border of spine
Posterior Chest Lead Placement

![Diagram of posterior chest lead placement showing V7, V8, V9, V9R, V8R, and V7R leads.]
Posterior Chest Lead Placement
Posterior Chest Lead Placement
Posterior Chest Lead Placement
Posterior Chest Lead Placement
Modified Chest Leads

- Modified chest leads (MCLs)
  - Bipolar chest leads that are variations of the unipolar chest leads
  - Each MCL consists of a positive and negative electrode applied to a specific location on the chest
MCL₁

- A variation of chest lead V₁
  - Negative electrode below left clavicle toward left shoulder
  - Positive electrode right of sternum in 4th intercostal space

- Views ventricular septum
MCL⁶

- A variation of chest lead V₆
  - Negative electrode below left clavicle toward left shoulder
  - Positive electrode 5th intercostal space, left midaxillary line

- Views low lateral wall of left ventricle
What Each Lead “Sees”
Leads II, III, and aVF

- Positive electrode on left leg.
- Each lead “sees” inferior wall of left ventricle.
Leads I and aVL

- Positive electrode on left arm.
- Each lead “sees” lateral wall of left ventricle.
Leads $V_5$ and $V_6$

- Positive electrode on axillary area of left chest.
- Each lead “sees” lateral wall of left ventricle.
Leads $V_3$ and $V_4$

- Positive electrode on anterior chest.
- Each lead “sees” anterior wall of left ventricle.
Leads $V_1$ and $V_2$

- Positive electrode next to sternum.
- Each lead “sees” septal wall of left ventricle.
What Each Lead “Sees” — Summary

<table>
<thead>
<tr>
<th>Leads</th>
<th>Heart Surface Viewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>II, III, aVF</td>
<td>Inferior</td>
</tr>
<tr>
<td>V₁, V₂</td>
<td>Septal</td>
</tr>
<tr>
<td>V₃, V₄</td>
<td>Anterior</td>
</tr>
<tr>
<td>I, aVL, V₅, V₆</td>
<td>Lateral</td>
</tr>
</tbody>
</table>
ECG Paper
ECG Paper

- ECG paper is graph paper made up of small and larger, heavy-lined squares
  - Smallest squares are 1 mm wide and 1 mm high
  - 5 small squares between the heavier black lines
  - 25 small squares within each large square
Horizontal Axis = Time

- Width of each small box = 0.04 second.
- Width of each large box (5 small boxes) = 0.20 second
Horizontal Axis = Time

- 5 large boxes (each consisting of 5 small boxes) = 1 second.
- 15 large boxes = 3 seconds.
- 30 large boxes = 6 seconds.
Vertical Axis = Voltage/Amplitude

- Size or amplitude of a waveform is measured in millivolts (voltage) or millimeters (amplitude).
Calibration

- $1 \text{ mV} = 10 \text{ mm}$
Waveforms
Terms

- Baseline (isoelectric line)
- Waveform
- Segment
- Interval
- Complex
Waveform Deflections

- If the wave of depolarization moves toward the positive electrode, the waveform recorded will be upright
Waveform Deflections

- If the wave of depolarization moves toward the negative electrode, the waveform recorded will be upside down (inverted)
Waveform Deflections

- A biphasic (partly positive, partly negative) waveform or a straight line is recorded when the wave of depolarization moves perpendicularly to the positive electrode.

![Diagram of ECG leads and deflections](image)
P Wave

- Represents atrial depolarization and spread of the impulse throughout right and left atria
P Wave

- **Beginning**
  - First abrupt or gradual deviation from the baseline

- **End**
  - Point at which it returns to the baseline
Normal P Wave

- Smooth and rounded
- No more than 2.5 mm in height
- No more than 0.11 sec in duration
- Upright in leads I, II, aVF, and V₂ through V₆
Abnormal P Waves

- Normal
- Notched
- Peaked
- Inverted
QRS Complex

- Normally follows each P wave
- Consists of Q wave, R wave, and S wave
- Represents spread of electrical impulse through the ventricles
  - Ventricular depolarization
Q Wave

- First negative, or downward, deflection following the P wave
  - Always a negative waveform

- Represents depolarization of interventricular septum
Q Wave

- **Normal (physiologic) Q waves**
  - Less than 0.04 sec
  - Less than 1/3 the height of R wave in that lead

- **Abnormal (pathologic) Q waves**
  - More than 0.04 sec
  - More than 1/3 the height of the following R wave in that lead
R Wave

- The first positive, or upward, deflection following the P wave
  - Always positive
S Wave

- A negative waveform following the R wave
  - Always negative
- R and S waves represent depolarization of the right and left ventricles
Limb Leads—Waveform Comparison
Normal QRS Complex

- Measure the QRS complex with the longest duration and clearest onset and end

- Normal QRS duration is 0.10 seconds or less
Abnormal QRS Complexes

- An abnormal QRS complex is greater than 0.10 sec in duration
QRS Variations

- If the complex consists entirely of a negative waveform, it is called a QS wave

- If the QRS complex consists entirely of a positive waveform, it is called an R wave
QRS Variations

- If there are two positive deflections in the same complex, the second is called R prime and is written as R'

- If there are two negative deflections following an R wave, the second is written as S'
T Wave

- Represents ventricular repolarization
The normal T wave is slightly asymmetric
Normal T Waves

- Slightly asymmetric
- Usually 5 mm or less in height in any limb lead
- Usually 10 mm or less in height in any chest lead
- Usually 0.5 mm or more in height in leads I and II
Abnormal T Waves

- The T wave following an abnormal QRS complex is usually opposite in direction of the QRS
- Negative (inverted) T waves suggest myocardial ischemia
Abnormal T Waves

- Tall, pointed (peaked) T waves are commonly seen in hyperkalemia
Abnormal T Waves

- Cerebral T waves
U Waves

- Significance is not definitely known
  - May represent repolarization of Purkinje fibers
- Not easily identified due to its low amplitude
Normal U Waves

- Rounded and symmetric
- Usually less than 1.5 mm in height and smaller than the preceding T wave
Abnormal U Waves

- In general, a U wave more than 1.5 mm in height in any lead is considered abnormal.
- Abnormally tall U waves may be the result of:
  - Electrolyte imbalance
  - Medication
  - Hyperthyroidism
  - Central nervous system disease
  - Long QT syndrome
Segments

● Segment
  ➢ A line between waveforms
  ➢ Named by waveform that precedes or follows it

● Important segments:
  ➢ PR segment
  ➢ ST segment
  ➢ TP segment
PR segment

• Part of the PR interval
  - Horizontal line between end of P wave and beginning of QRS complex
  - Normally isoelectric (flat)
TP Segment
**ST Segment**

- Portion of the ECG tracing between QRS complex and T wave
- Represents early part of repolarization of right and left ventricles
Normal ST Segment

- Begins with the end of the QRS complex and ends with the onset of the T wave
- Limb leads
  - Isoelectric (flat)
  - May normally be slightly elevated or depressed (usually by less than 1 mm)
- Chest leads
  - ST segment may vary from -0.5 to +2 mm
The point at which the QRS complex and the ST segment meet = “J point” or junction
ST Segment Deviation
ST Segment

- A horizontal ST segment suggests ischemia
- Digitalis causes ST segment depression (scoop)
  - “Dig dip”
Intervals

- Interval
  - A waveform and a segment

- Important intervals
  - PR interval
  - QT interval
PR Interval (PRI)

- P wave + PR segment = PR interval
- Normally measures 0.12–0.20 sec
PR Interval (PRI)

- Begins with the onset of the P wave and ends with the onset of the QRS complex
Abnormal PR Interval

- Long PR interval (greater than 0.20 sec)
  - Indicates the impulse was delayed as it passed through the atria or AV junction

- Short PR interval (less than 0.12 sec)
  - May be seen when the impulse originates in the atria close to the AV node or in the AV junction
QT Interval

- QT interval represents total ventricular activity—the time from ventricular depolarization (activation) to repolarization (recovery)

- Duration of the QT interval varies according to age, gender, and heart rate
QT Interval

- Measured from beginning of QRS complex to end of T wave
  - If no Q wave, measure from beginning of R wave to end of T wave
To rapidly determine the QT interval:

- Measure the interval between two consecutive R waves (R-R interval) and divide the number by two
- Measure the QT interval
- If the measured QT interval is less than half the R-R interval, it is probably normal
R-R Intervals

- Used to determine ventricular rate and regularity
P-P Intervals

- Used to determine atrial rate and regularity
Artifact

- Distortion of an ECG tracing by electrical activity that is noncardiac in origin

- Can mimic various cardiac dysrhythmias, including ventricular fibrillation

- Patient evaluation **essential** before initiating any medical intervention
Artifact—Causes

- Loose electrodes
- Broken ECG cables or broken wires
- Muscle tremor
- Patient movement
- External chest compressions
- 60-cycle interference
Artifact—Loose Electrodes
Artifact—Muscle Tremor
Artifact—60-Cycle Interference
Analyzing a Rhythm Strip

- Assess rhythm/regularity
- Ventricular rhythm
  - Measure the distance between two consecutive R-R intervals
  - Compare with other R-R intervals
- Atrial rhythm
  - Measure the distance between two consecutive P-P intervals
  - Compare with other P-P intervals
- Variation of plus or minus 10% is acceptable
Terminology

- Essentially regular rhythm
- Irregular rhythm
- Regularly irregular rhythm
- Irregularly irregular rhythm
Analyzing a Rhythm Strip

- What is the rate?

- A “tachycardia” exists if rate is more than 100 bpm

- A “bradycardia” exists if rate is less than 60 bpm
Six-Second Method

- Ventricular rate
  - Count the number of complete QRS complexes within a period of 6 sec
  - Multiply that number by 10 to determine the number of QRS complexes in 1 min
- May be used for regular and irregular rhythms
Large Box Method

- Count the number of large boxes between two consecutive waveforms (R-R interval or P-P interval) and divide into 300
- Best used if the rhythm is regular
## Large Box Method

<table>
<thead>
<tr>
<th>Number of Large Boxes</th>
<th>Heart Rate (bpm)</th>
<th>Number of Large Boxes</th>
<th>Heart Rate (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>300</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
<td>7</td>
<td>43</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>8</td>
<td>38</td>
</tr>
<tr>
<td>4</td>
<td>75</td>
<td>9</td>
<td>33</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>
Sequence Method

- Select an R wave that falls on a dark vertical line
  - Number the next 6 consecutive dark vertical lines as follows:
    - 300, 150, 100, 75, 60, and 50
  - Note where the next R wave falls in relation to the 6 dark vertical lines already marked—this is the heart rate
Small Box Method

- Count the number of small boxes between two consecutive waveforms (R-R interval or P-P interval) and divide into 1500
- Time consuming, but accurate
Analyzing a Rhythm Strip

- Identify and examine P waves
  - Look to the left of each QRS complex
  - Normally:
    - One P wave precedes each QRS complex
    - P waves occur regularly and appear similar in size, shape, and position
Analyzing a Rhythm Strip

- PR interval (PRI)
  - Normal PR interval is 0.12 to 0.20 sec
  - If PR intervals are the same, they are “constant”
  - If the PR intervals are different, is there a pattern?
    - Lengthening
    - Variable (no pattern)
Analyzing a Rhythm Strip

- QRS complexes
  - Identify the QRS complexes and measure their duration
    - Narrow (normal) if it measures 0.10 sec or less
    - Wide if it measures more than 0.10 sec
Analyzing a Rhythm Strip

- Measure the QT interval in the leads that show the largest amplitude T waves.

- If the measured QT interval is less than half the R-R interval, it probably is normal.
Analyzing a Rhythm Strip

- ST segment
  - Usually isoelectric in the limb leads
  - Determine presence of ST segment elevation or depression
Analyzing a Rhythm Strip

- T waves
  - Are the T waves upright and of normal height?
  - The T wave following an abnormal QRS complex is usually opposite in direction of the QRS
  - Negative T waves suggest myocardial ischemia
  - Tall, pointed (peaked) T waves are commonly seen in hyperkalemia
Analyzing a Rhythm Strip

- Interpret rhythm & evaluate clinical significance
  - Interpret the rhythm
    - Specify site of origin (pacemaker site) of the rhythm (sinus)
    - Specify mechanism (bradycardia) and ventricular rate
      - For example: Sinus bradycardia at 38 bpm
  - Evaluate patient’s clinical presentation to determine how he or she is tolerating the rate and rhythm
Questions?