CARDIAC CONDUCTIVITY DISTURBANCES & THE ECG CHANGES

Presented by Omar AL-Rawajfah, RN, PhD
Lecture Outlines

- Describe the cardiac conductive system.
- Describe characteristics of cardiac muscle.
- Discuss 12-lead ECG
- Discuss the normal ECG
- Discuss conductive system disturbances and possible treatment
- Questions and answers
Cardiac Cells

- **The electrical cardiac cells:**
  - Automaticity: spontaneous generation of electrical impulse
  - Excitability: respond to an electrical impulse
  - Conductivity: transmit an electrical impulse

- **The mechanical cells:**
  - Contractility: shorten and lengthen its muscle fibers
  - Extensibility: ability to stretch
Conduction System of the Heart

- Sino-atrial node
- Atrio-ventricular node
- Right atrium
- Right Ventricle
- Left Ventricle
- Left atrium

[Diagram of the heart with labeled parts]
History of ECG

• 1872: Alexander Muirhead attached wires to a feverish patient's wrist to obtain a record of the patient's heartbeat while studying for his Doctor of Science (in electricity) in France.

• This activity was directly recorded and visualized using a Lippmann capillary electrometer by the British physiologist John Burdon Sanderson.

• The first to systematically approach the heart from an electrical point-of-view was Augustus Waller in London.

• Willem Einthoven, working in Leiden, The Netherlands, used the string galvanometer which he invented in 1901, which was much more sensitive than the capillary electrometer that Waller used.

• Einthoven assigned the letters P, Q, R, S and T to the various deflections, and described the electrocardiographic features of a number of cardiovascular disorders.

• In 1924, he was awarded the Nobel Prize in Medicine for his discovery.
A "Method" of ECG Interpretation

- Measurements
- Rhythm analysis
- Conduction analysis
- Waveform description
- ECG interpretation
- Comparison with previous ECG (if any)
- In the interpretation answer the following questions: What is the rate? Is it regular or irregular? Are P waves present? Are QRS complexes present? Is there a 1:1 ratio between P waves and QRS complexes? Is the PR interval constant?
- http://ecg.utah.edu/
- http://www.practicalclinicalskills.com/
Practical Clinical Skills provides free training and reference guides. Our simulation-based case studies cover heart sounds, lung sounds, carotid bruit, blood pressure measurement and EKG training. The quick reference guides are a timely information source for essential clinical skills at the point of care.

Electrocardiogram (EKG/ECG)

Extensive library of arrhythmia tracings. EKG training with lessons, tutorials and drills. Try our new graded quizzes and patient monitor simulation.

Heart Sounds

Quick reference guide to over 100 heart sounds, real and simulated. Interactive courses covering S1, S2, S3, S4, systolic and diastolic heart murmurs and carotid bruit.

Blood Pressure

Lung Sounds
12-Lead ECG - Standard limb Leads

- Bipolar limb leads
  - Lead I: Rt and Lt Arms (used to obtain a rhythm strip)
  - Lead II: Rt Arm and Lt Leg
  - Lead III: Lt Arm and Lt Leg
12-Lead ECG - Augmented Limb Leads
(unipolar leads)

1. $aV_R$: always QRS will have a negative deflection
2. $aV_L$: Lateral portion of the heart
3. $aV_F$: inferior portion of the heart
12-Lead ECG - Augmented Limb Leads
(unipolar leads)
Percordial or Chest lead

- Chet leads
  - V1, V2, and V3: right precordial leads
  - V4, V5, and V6: left precordial leads
15 or 18 leads ECG
15 or 18 leads ECG

• **Placement:**
  • Right Precordial Leads (V4R, V5R, V6R)
    – V4R: right midclavicular line, fifth intercostal space (use V3 lead)
    – V5R: right anterior axillary line, straight line from V4R (use V2 lead)
    – V6R: right midaxillary line, straight line from V5R (use V1 lead)
  • Posterior leads (V7, V8, V9)
    – V7: left posterior axillary line, straight line from V6 (use V4 lead)
    – V8: left midscapular line, straight line from V7 (use V5 lead)
    – V9: left paraspinal line, straight line from V8 (use V6 lead).

• **Indications**
  – Suspected Right ventricle MI
  – Posterior left ventricle
### Clinical Lead Groups

<table>
<thead>
<tr>
<th>I</th>
<th>aVR</th>
<th>V1</th>
<th>V4</th>
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<tr>
<td>Lateral</td>
<td></td>
<td>Septal</td>
<td>Anterior</td>
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<tr>
<td>II</td>
<td>aVL</td>
<td>V2</td>
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Electrical Axis

- Represent the general direction of the wave excitation
- The axis is normal when the wave moves from SA node down to AV node down to the ventricles
- Axis is easily assessed in lead I and aVF by the direction of the QRS
  - Normal axis: up right in both leads
  - Lt axis deviation: positive I & aVF negative
  - Rt axis deviation: negative I & aVF positive
  - Extreme Rt axis deviation: both negative
Lt Axis Deviation

- Caused by
  - LBBB,
  - Lt Ventricular enlargement
  - Inferior MI
• Caused by
  – RBBB, and anterior MI
  – Rt Ventricular enlargement
  – COPD, pulmonary arterial hypertension or large pulmonary embolism.
Quiz???
Components of ECG

1 mm = 0.1 mV, 5 mm = 0.2 Sec
What do they mean?

- **P wave**: the sequential activation (depolarization) of the right and left atria
- **QRS complex**: right and left ventricular depolarization (normally the ventricles are activated simultaneously)
- **ST-T wave**: ventricular repolarization
- **U wave**: origin for this wave is not clear - but probably represents "afterdepolarizations" in the ventricles
- **PR interval**: time interval from onset of atrial depolarization (P wave) to onset of ventricular depolarization (QRS complex)
- **QRS duration**: duration of ventricular muscle depolarization
- **QT interval**: duration of ventricular depolarization and repolarization
- **RR interval**: duration of ventricular cardiac cycle (an indicator of ventricular rate)
- **PP interval**: duration of atrial cycle (an indicator of atrial rate)
P Wave

- Associated with atrial depolarization
- Duration less than 0.12 sec
- Amplitude is normally less than 0.25 mV
- Positive in I, II, aVL, V4 – V6
- Can be negative in V1
- A negative P-wave can indicate depolarization arising from the AV node
PR Interval

- Represent the time of impulse to leave the SA node, the travel through the atria, AV node, bundle branch and Purkinje fibers.
- The flat line between P wave and the QRS represent the delay in the AV node.
- Duration less than 0.12 – 0.20 sec
- Long PR interval is seen in heart block disorders
QRS complex

- Associated with ventricular depolarization
- Duration range: 0.04 – 0.12 sec
- Represent the time of impulse to travel through Rt & Lt ventricles
- The 1st negative deflection is Q, 1st positive deflection is R and the negative deflection after R is S
QRS complex
ST segment

- Represent complete depolarization of ventricles and beginning of repolarization
- Should not be elevated more than 1mm or depressed more than 0.5 mm of the baseline
- Elevation of depression of ST segment usually indicate CAD
ST Depression & Elevation

Measure: 2 mm beyond QRS
Significant: 1 mm
Ischemia
Hypothermia
Hypokalemia
Tachycardia
Subendocardial infarct
Reciprocal ST elevation
Ventricular Hypertrophy
Bundle branch block
Digitalis

Measure: 2 mm beyond QRS
Significant: 1 mm limb leads or 2 mm chest
Infarction
Vasospastic angina
Pericarditis
QT Interval

- Associated with ventricular depolarization
- Duration should be less than the half of previous RR interval
- Based on heart rate
- Varies according to gender
- Does not exceeds 0.43 sec for male and female
- Prolonged in case of hypocalcemia
• The duration of the QT interval is 0.56 second. This prolongation is due to hypocalcemia.

• The tent-shaped T waves are the result of hyperkalemia (6.7 mEq/L).
T wave

- Associated with ventricular repolarization
- Positive in leads I, II, aVL, aVF, V3, V6 and negative in aVR
- May be positive or inverted in V1
- Inverted T wave in the positive leads indicate ischemic changes
U wave

- Associated with ventricular repolarization
- Many times it is not seen because of low electrical voltage
- May be elevated in hypokalemia or inverted CAD and hypertension
mm/mV  1 square = 0.04 sec/0.1mV
What do you see???
What do you see???
Step 1: Calculate Rate

• Option 1
  – Count the # of R waves in a 6 second rhythm strip, then multiply by 10.
  – Reminder: all rhythm strips in the Modules are 6 seconds in length.

Interpretation?

\[ 9 \times 10 = 90 \text{ bpm} \]
Step 1: Calculate Rate

- Option 2
  - Find a R wave that lands on a bold line.
  - Count the # of large boxes to the next R wave. If the second R wave is 1 large box away the rate is 300, 2 boxes - 150, 3 boxes - 100, 4 boxes - 75, etc. (cont)
Hear Rate

- Remember the sequence: 300, 150, 100, 75, 60, 50 (for regular rhythm)
- Count QRS in 6 sec and multiply by 10 (i.e., 30 large squares)
Quiz
Determine regularity

- Look at the R-R distances (using a caliper or markings on a pen or paper).
- Regular (are they equidistant apart)? Occasionally irregular? Regularly irregular? Irregularly irregular?

Interpretation?

Regular