The Electrocardiogram

Fast & Easy ECGs – A Self-Paced Learning Program
Electrocardiogram

- A tracing of the heart’s electrical activity
Electrocardiogram

- Detects heart’s electrical activity through electrodes positioned on patient’s skin
ECG Paper

Heated writing tip

Moving stylus

Vertical

Voltage

Time

Horizontal
ECG Paper

- Each small square = 0.04 sec in duration and 0.1 mV in amplitude
- Five small squares = One large box and 0.20 seconds in duration
- Horizontal measurements determine heart rate
Isoelectric Line

- Flat line that occurs:
  - When no electrical activity is occurring
  - When impulses are too weak to be detected
- Used as a baseline to identify changing electrical movement
P Wave

• Produced by:
  – initiation of impulse in SA node
  – depolarization of RA and LA
  – Impulse passing through AV junction

• Waveform is upright and round
PR Segment

• Flat (isoelectric) line seen as impulse travels through His-Purkinje system
QRS Complex

- Follows PR segment and consists of:
  - Q wave
    - First negative deflection following PR segment
  - R wave
    - First positive deflection following Q wave or PR segment
  - S wave
    - First negative deflection that extends below the baseline following the R wave
ST Segment and T Wave

- ST segment is flat line that follows QRS complex
- T wave is larger, slightly asymmetrical waveform that follows ST segment
QT Interval

• The distance from onset of QRS complex until end of T wave
  – Measures time of ventricular depolarization and repolarization
• Has normal duration of 0.36 to 0.44 seconds
Typical ECG

- Upright, round P waves occurring at regular intervals at a rate of 60 to 100 beats per minute
- PR interval of normal duration (0.12 to 0.20 seconds) followed by a QRS complex of normal upright contour, duration (0.06 to 0.12 seconds) and configuration
- Flat ST segment followed by an upright, slightly asymmetrical T wave
Calibration or Registration Mark

- Helps ensure ECG machine is properly calibrated
- Serves as reference point on ECG tracing
Artifact

- Markings on ECG tracing that are not a product of heart’s electrical activity
  - Patient movement is among its many causes
  - Can mimic life-threatening dysrhythmias
ECG Machines

• A variety of machines are available
  – Some monitor from one to five different leads
  – Others are capable of monitoring up to twelve or more leads simultaneously
ECG Leads

• Each lead provides a different view of the heart:
  – Electrodes are placed on chest, arms and legs
  – Sites vary depending on which view of the heart's electrical activity is being assessed
ECG Leads

- Direction an ECG waveform takes depends on whether electrical currents are traveling toward or away from a positive electrode.
ECG Leads

- Planes provide a cross-sectional view of heart
  - Frontal plane
  - Horizontal plane
Limb Leads

- View the frontal plane
- Include leads I, II, III, aVR, aVL, and aVF
- Provide inferior, superior, and lateral views of heart
Precordial Leads

- View horizontal plane and include leads $V_1$, $V_2$, $V_3$, $V_4$, $V_5$, and $V_6$
- Provide inferior, superior, and lateral views of heart
Unipolar Leads

- Use one positive electrode and a reference point which is calculated by the ECG machine
Uses for Different Leads

• A given lead may be used to highlight:
  – A specific part of ECG complex
  – Electrical events of a specific cardiac cycle
  – Conditions such as an enlargement of heart muscle or presence of ischemia, injury and infarction
Bipolar Leads

- Record difference in electrical potential between a positive and negative electrode
- Uses a third electrode called a ground
- Include leads I, II and III
Limb Leads - Lead I

- Positive electrode - left arm (or under left clavicle)
- Negative electrode - right arm (or below right clavicle)
- Ground electrode - left leg (or left side of chest in midclavicular line just beneath last rib)
- Waveforms are positive
Limb Leads - Lead II

- Positive electrode - left leg (or on left side of chest in midclavicular line just beneath last rib)
- Negative electrode - right arm (or below right clavicle)
- Ground electrode - left arm (or below left clavicle)
- Waveforms are positive
Limb Leads - Lead III

• Positive electrode - left leg (or left side of the chest in midclavicular line just beneath last rib)
• Negative electrode - left arm (or below left clavicle)
• Ground electrode - right arm (or below right clavicle)
• Waveforms are positive or biphasic
Limb Leads - Augmented Leads

- Includes $aV_R$, $aV_L$ and $aV_F$
- Unipolar
- Enhanced by ECG machine because waveforms produced by these leads are normally small
Limb Leads - Lead aVR

- Positive electrode placed on right arm
- Waveforms have negative deflection
Limb Leads - Lead aV_L

- Positive electrode placed on left arm
- Waveforms have positive deflection
Limb Leads - Lead $aV_F$

- Positive electrode located on left leg
- Waveforms have a positive deflection
Precordial Leads

- Includes leads $V_1$, $V_2$, $V_3$, $V_4$, $V_5$ and $V_6$
- Positioned in order across the chest
- Unipolar
  - Opposing pole is center of heart as calculated by ECG
Modified Chest Leads (MCL)

- MCL1 and MCL6 provide continuous cardiac monitoring
- Place positive electrode in same position as precordial leads $V_1$ or $V_6$
Summary

• Electrodes placed on patient’s skin detect heart’s electrical activity.

• Graphic record or tracing is called an electrocardiogram.

• Abnormalities in cardiac rate and/or rhythm are called dysrhythmias.
Summary

• ECG paper consists of horizontal and vertical lines that form a grid.

• Horizontal measurements used to determine heart rate and duration of various waveforms, segments and intervals.

• Vertically on ECG paper, distance between lines, or boxes, represents amplitude in millimeters (mm) or electrical voltage in millivolts (mV).
Summary

• Conduction of electrical impulse through the heart can be seen on ECG as P wave, PR interval, QRS complex, ST segment and T wave.

• Artifact is markings on ECG tracing that have no relationship to electrical activity of the heart.
Summary

• Each lead provides a different view of heart.

• Impulses traveling toward a positive electrode are recorded on ECG as upward deflections.

• Impulses traveling away from a positive electrode or toward a negative electrode are recorded as downward deflections.
Summary

• Limb leads are produced by placing electrodes on right arm (RA), left arm (LA) and left leg (LL).
  – Include leads I, II, III, augmented vector right (aVR), augmented vector left (aVL) and augmented vector foot (aVF).

• Precordial leads include leads V₁, V₂, V₃, V₄, V₅, and V₆.