Understanding EKG

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What is an EKG?

- Recording of the electrical activity of the heart
- **Remember:** myocardial cells are sensitive and polarized at rest
  - Negative inside, positive outside
- Cells can depolarize, repolarize and hyperpolarize
Major components

• Pacemaker cells
  – Specialized cells that depolarize first to keep the cells of the heart “together”

• Conduction system
  – Connect various parts of the heart so that the signal spreads ... like wires

• Myocardial cells
  – Regular cardiac muscle cells
  – Ectopic pacemaker
  – RMP = -90mV for most cells
Electrical activity of heart

- Components of conduction system
  - sinoatrial node
  - atrioventricular node
  - bundle of His
  - R/L bundle branches
  - Purkinje fibers
EKG

• Measures electrical activity of myocardial cells
  – Duration
    • fractions of a second
  – Amplitude
    • mV
  – Configuration
    • shape and appearance of wave
Waves

- Three distinct waves
  - $P =$ atrial depolarization
  - $QRS =$ depolarization of ventricles + repolarization of the atria
  - $T =$ repolarization of ventricles
Intervals and segments

- **Intervals**
  - Wave + connecting straight line

- **Segments**
  - Straight line between two waves
Intervals and segments

- **PR interval**
  - P wave and straight line connecting it with QRS complex
  - Measure amount of time from beginning of atrial depolarization to beginning of ventricular depolarization
Intervals and segments

- **ST segment**
  - Straight line connecting the end of QRS complex and start of T-wave
  - End of ventricular depolarization to beginning of ventricular repolarization
Intervals and segments

- **QT interval**
  - QRS complex + ST segment + T wave
  - Beginning of ventricular depolarization to end of ventricular repolarization
Reading an EKG

• Horizontal axis measures time
  – One small square (1x1mm) = 0.04 seconds
  – One big square (5x5mm) = 0.2 seconds

• Vertical axis measures voltage
  – One small square = 0.1mV
  – One big square = 0.5mV
Placing EKG leads

- **Bipolar leads:**
  - Record voltage between electrodes placed on wrists and legs.
  - Right leg is ground.

- **Unipolar leads:**
  - Voltage is recorded between a single “exploratory electrode” placed on body and an electrode built into the electrocardiograph.
  - Placed on right arm, left arm, left leg, and chest.
  - Allow to view the changing pattern of electrical activity from different perspectives.
Placing EKG leads

- 3-D view of the heart = 12 leads
Placing EKG leads

• Lead II most common monitoring lead
Mean Electrical Axis

- **Average vector of all instantaneous vectors = mean vector**
- **Direction of the mean vector = mean electrical axis**
  - Mean QRS vector usually between +90° and -30°
  - Think of series of vectors in ventricle beginning with septal depolarization, then gradually moving through left ventricle (which will dominate!)
Ventricular vectors

Deflection from isoelectric line; A = slight neg, B=pos, C=pos, D=slight neg
Movement of electrical current
Mean Electrical Axis equal to the sum of all mean electrical vectors
To determine mean electrical axis

• Axis that is perpendicular to lead axis with the smallest net amplitude (positive-negative deflection voltages)
• In preceding slides, this is lead III.
• Therefore, mean electrical axis would be perpendicular to lead III.
  – Lead III has deflection of 120°
  – Perpendicular to that would be -90°
  – Therefore, MEA = +30°
Right and Left Axis Deviation

- **Ventricular hypertrophy**
  - **Left ventricular hypertrophy**
    - Untreated hypertension over many years can cause enlargement of the left ventricle
    - Electrical dominance of left over the right becomes more pronounced = **left axis deviation**
  - **Right ventricular hypertrophy** less common
    - Requires huge change to compensate for dominant left
    - Causes: Severe pulmonary stenosis or primary pulmonary hypertension
    - Right side significantly hypertrophies so that QRS axis shifts to right = **right axis deviation**
Standard Limb & Precordial Leads

Einthoven's triangle (frontal plane)

Left-sided axis deviation

Right-sided axis deviation

Precordial leads: \( V_1 \) - \( V_6 \) (Horizontal plane)
Left axis deviation

Dx: hypertrophic cardiomyopathy with asymmetrical thickening of interventricular septum
Right axis deviation

Dx: repeated pulmonary emboli
EKG

Normal EKG

Atrial fibrillation
Note: irregular, undulating baseline

Atrial flutter
Note: saw-toothed appearance

Second degree AV block
Note: progressive prolongation of P-R interval until a QRS is dropped