ECG Grid

- Left to Right = Time/duration
- Vertical – measure of voltage (amplitude)
  - Expressed in mm
P-Wave

- Depolarization of atrial muscle
- Low voltage (2-3mm in amplitude)
- Duration < .11 seconds
Abnormal P Waves

• P – Pulmonale
  – Tall Peaked
  – Right atrial enlargement secondary to pulmonary HTN (COPD)

• P-Mitrale
  – Broad notched
  – LA enlargement secondary to mitral valve disease
P-wave Abnormalities

• Wolfe – Parkinson-White
  – Ventricles activated early
  – Short PR Interval
  – Delta Wave
Delta Wave

Short PR Interval
QRS Complex

- Depolarization of ventricles
- Larger Muscle Mass
- Amplitude as high as 25mm
- Duration with Normal Conduction < .10
- Amplitudes > 25mm can mean chamber enlargement as in ventricular hypertrophy
QRS Complex

- Low Amplitude
  - Diffuse, severe coronary artery disease
  - Pericardial Effusion
  - Hypothyroid
QRS Complex

- 1\textsuperscript{st} Negative deflection = Q Wave
- 1\textsuperscript{st} Positive deflection = R wave
- Negative deflection after R wave = S wave
- Positive deflection after R wave = R Prime
- Negative deflection after S wave = S Prime
ST Segment

• Time between completion of depolarization and onset of repolarization
  – Normally isoelectric & gently blends into upslope of T wave
  – Point where ST takes off from QRS= J point
• Plays important role in diagnosis of ischemic heart disease
ST Segment

• ST Elevation = hallmark of AMI
• Slight elevation across entire tracing is normal especially in young males
• ST DEPRESSION – indicative of a # of conditions . . . Ischemia, ventricular hypertrophy
T - Wave

- Repolarization of the ventricles
- Same direction as predominant QRS deflection
- Abnormalities – usually inversion with BBB, hypertrophy or AMI
QT Interval

• Beginning of QRS to end of T Wave
• Normal variations with HR and gender
• Abnormalities
  – Prolonged – commonly from drugs like Procan or Quinidine or electrolyte imbalance
  – Increased opportunity for R on T, ventricular re-entry rhythms and sudden death
Vectors and Lead Systems

• Arrows represent direction as well as amplitude
Vectors

- Vector 1 – depolarization of atrial (corresponds to P wave)
- Vector 2 – Ventricular Septum (1\textsuperscript{st} deflection of QRS)
- Vector 3 – Bulk of ventricular muscle
- Vector 4 – Repolarization of ventricular muscle
Limb Leads

- Look at heart in Frontal Planes
- Used to locate axis
- V Leads look at heart in Transverse Plane
Lead Placement

• Correct placement a must
• Small changes in height of R wave are important
• Can be produced with slight movement of leads
Lead Placement

- V1 – Right Sternal Border – 4th ICS
- V2 – Left Sternal Border – 4th ICS
- V3 Midway Between V2 and V4
- V4 Midclavicular line – 5th ICS
- V5 Anterior Axillary line – 5th ICS
- V6 Mid axillary line – 5th ICS
Determining Axis

- Impulse toward electrode = Positive
- Impulse away from electrode = Negative
- The more directly toward or away the greater the amplitude either positive or negative
Axis Deviation

- Normal Axis = 60 Degrees (0-90)
- Further counter clockwise than 0 = Left Axis Deviation
- Further clockwise than 90 = Right Axis Deviation
- > -30 Marked LAD
- >-120 Marked RAD
Axis Deviation

- Determined by Tallest R Wave
  - Normal is Lead II
- PVC’s or VT from Right Ventricle = LAD
- PVC’s or VT from Left Ventricle = RAD
R-Wave Progression

- V1 is small – progressively increasing from right to left until QRS fully upright in V5 and V6
- Point where QRS becomes biphasic = transition zone
- R wave progression is frequently lost in Anterior Wall Infarction
Bundle Branch Blocks

- Incomplete – Conducts slowly
  - QRS between .10 and .12
- Complete – Total failure of affected bundle to conduct impulse
  - QRS > .12
Bundle Branch Blocks

• Right Bundle Branch Blocks
  – Reverse normal pattern of negative QRS in V1
  – RSR in V1
  – Wide S wave in V5 and V6
Left Bundle Branch Block

- RSR in V5 and V6
- Deep negative QS in V1 and V2
- Causes Widespread ST Changes
- Non-Diagnostic for ischemia and infarction
Myocardial Infarction
Coronary Anatomy
Myocardial Infarction

• Usually result of clot formation at site of fixed lesion
Hallmark of Infarction

- Transmural – full thickness of myocardial wall
  - ST Elevation
  - T Wave Inversion
  - Q Wave Formation
Inferior Wall Infarction

- Leads II, III and aVF
- Reciprocal Changes in Anterior Wall
- Most common Presentation is Bradycardia
- Can be associated with RV Infarction
Old Inferior Wall MI
Anterior Wall Infarction

• V2, V3 through V4
• Loss of R Wave progression
• Reciprocal Depression in leads of inferior wall
Lateral Wall

- I and aVL
- V5 and V6
- Usually associated with another infarction
ST Elevation

- QRS Does not return to baseline (J-point)
- 2 or more leads looking at the same wall
- Acute Event
T Wave Inversion

- Frequently bi-phasic
- Same leads as ST elevation
- Still in “process of infarcting”
Q Wave

- Ceases to depolarize
- Essentially electrically inert
- Permanent
Sneaky Causes of ST Elevation

• PERICARDITIS
  – Widespread
  – No reciprocal changes
  – PR Segment Depression