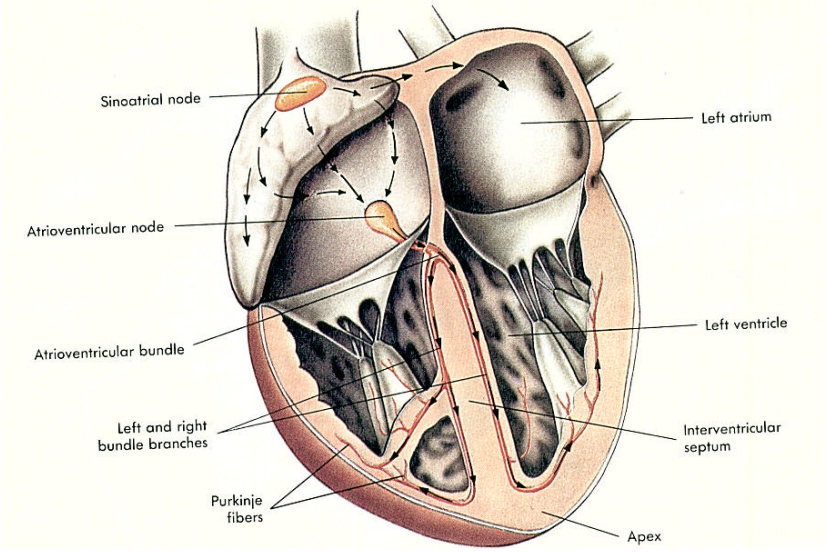
BASIC
12 LEAD ECG IN ACS PATIENTS



PARTICIPANT LECTURE PACKET

PRESENTED BY:

Life Safety Solutions

"Quality training, because life depends on it!"

Sean P. Newton, BS, NREMT-P
Life Safety Solutions, LLC

12 lead ECG skin preparation and lead placement:

Suggested skin preparation procedures:

- Disrobe patient from the waist up (utilize hospital gown if available)
- Utilize adult size ECG electrodes fresh from sealed package
- Insure area where electrodes are begin applied is free from hair (shave if needed)
- Wipe skin area with a dry 4x4 sponge
- Apply electrodes and seat conductive gel into skin

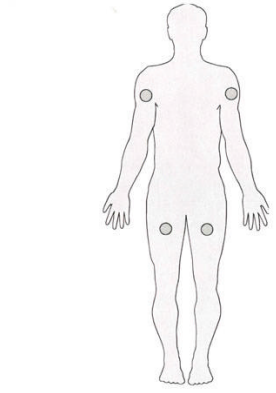
Steps to reduce artifact:

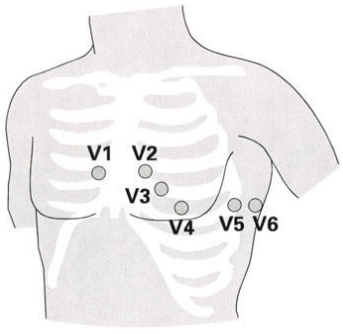
- Diligently adhere to good skin preparation techniques
- Insure ECG cables are secured with clip and not "dangling" from patients chest
- Insure patient is relaxed and not moving or staining to "look" at ECG (watch for subtle signs of movement i.e. shivering, toe tapping, hands grasping rails)
- All 12 lead ECGS should be completed with the patient in a supine / semi-fowler's position(s)

12 lead electrode placement:

I, II, III, AvR, AvL, AvF	Place on limbs NOT THORAX or ABDOMINAL AREA
V1	4th inter-costal space just to the right of the sternum
V2	4th inter-costal space just to the left of the sternum
V4	5th inter-costal space @ mid-clavicular line
V3	Directly in between V2 and V4 in a straight line
V5	5th inter-costal space @ anterior axillary line
V6	5th inter-costal space @ mid-axillary line
V4R	5th inter-costal space @ mid-clavicular line on right side of chest

Limb Lead Placement **Chest Lead Placement**





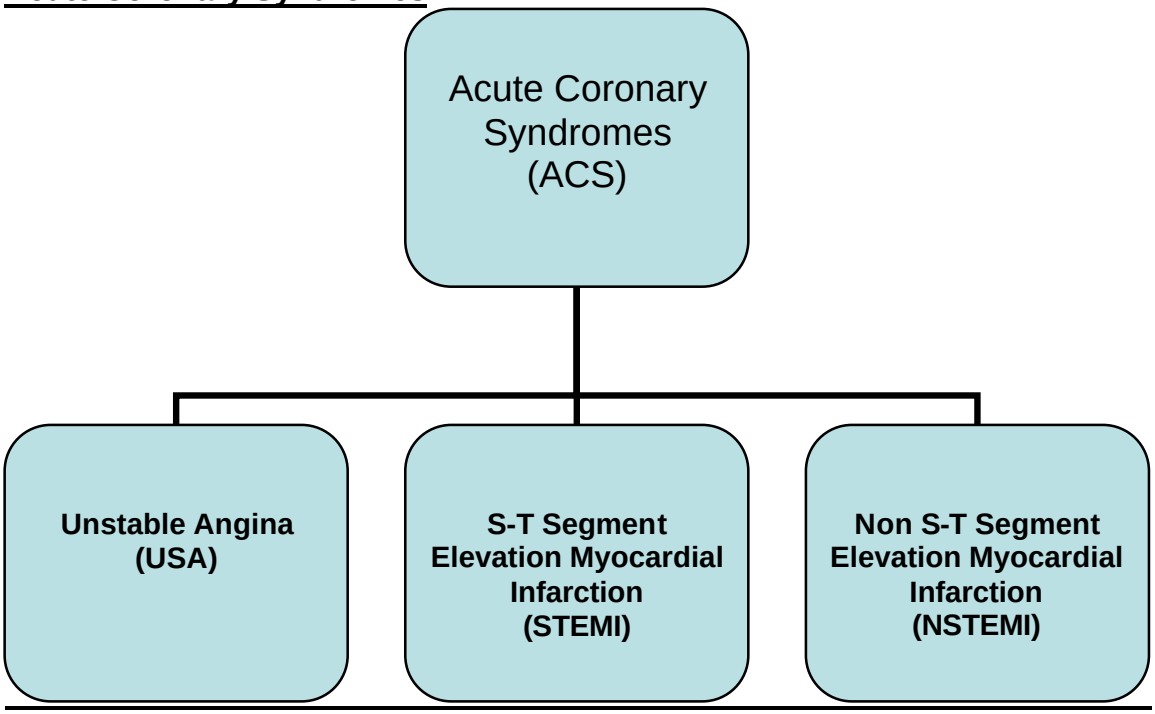
12 Lead ECG

"THE VIEWS"

THINK OF THE LEADS AS TINY DIGITAL CAMERAS.....WHERE THEY SIT IS WHERE THEY TAKE THE PICTURE FROM!

Lead I View: Upper Left Lateral Wall Coronary Artery: Left Circumflex	**AVR**	**V1** View: Septal Wall Coronary Artery: Left Anterior Descending	**V4** View: Anterior Wall Coronary Artery: Left Anterior Descending
Lead II View: Inferior Wall Coronary Artery: Right Coronary	**AVL** View: Upper Left Lateral Wall Coronary Artery: Left Circumflex	**V2** View: Septal Wall Coronary Artery: Left Anterior Descending	**V5** View: Lower Left Lateral Wall Coronary Artery: Left Circumflex
Lead III View: Inferior Wall Coronary Artery: Right Coronary	**AVF** View: Inferior Wall Coronary Artery: Right Coronary	**V3** View: Anterior Wall Coronary Artery: Left Anterior Descending	**V6** View: Lower Left Lateral Wall Coronary Artery: Left Circumflex

Acute Coronary Syndromes

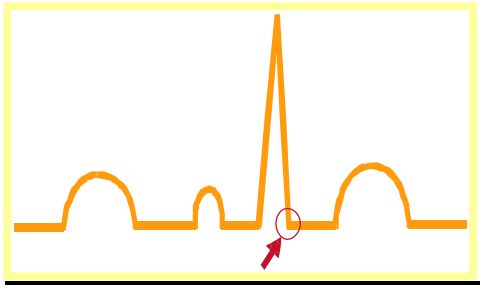


- Continuum of a disease process known as Coronary Artery Disease (CAD)
- All have similar initiating events
  - Plaque Rupture
  - Platelet Aggregation
  - Vasoconstriction
- All sudden ischemic disorders of the heart

Myocardial Infarction Recognition and Localization

- Infarction can produce changes in rate and rhythm
- Infarct recognition in the ECG relies upon the detection of morphologic changes (i.e., changes in shape) of the QRS complex, the "T" wave, and the "S-T" segment.
- Changes occur in relation to certain events during infarction.
- Changes appear in those leads looking directly at the infarct site in either a direct view or a reciprocal change.

The "J" Point

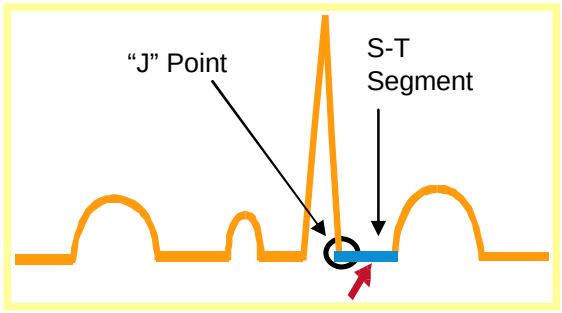


- Location where the "R" wave or "S" wave come back to the baseline and form a 90° angle
- Point utilized on the ECG to locate the S-T segment
- S-T Segment lies just to the right of the "J" point

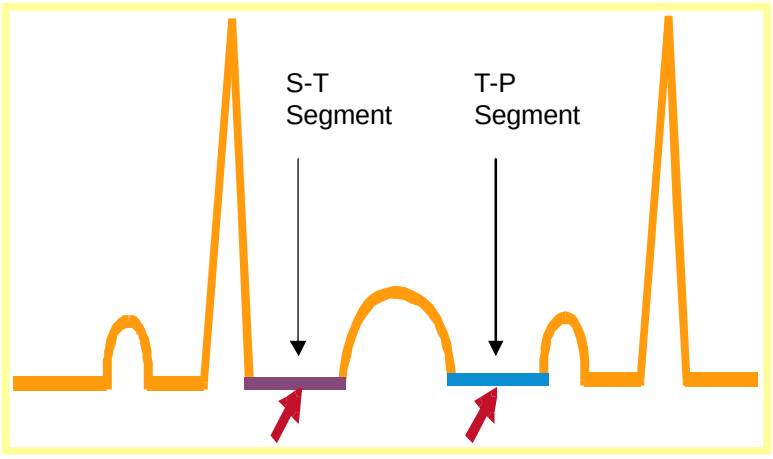
The “T” wave

- Initial changes can include the development of a tall “T” wave.
- In addition to an increase in height, the “T” wave may also become more symetric or pointed.
- These changes may occur within the first few minutes of infarction, during what has been described as the hyper-acute phase of infarction.
- “T” wave inversion may also occur during the acute phase of infarction, suggesting the presence of ischemia.
- “T” wave inversion may precede the development of “S-T” segment elevation or they may occur simultaneously.

The “S-T” Segment



- The primary indicator of myocardial injury in process is the “S-T” segment.
- “S-T” segment elevation may occur within the first hour or first few hours of infarction.
- “S-T” segment elevation is considered to occur during the acute phase of infarction.
- “S-T” segment elevation provides the strongest ECG evidence for the early recognition of myocardial infarction.
- “S-T” elevation is considered to be >1mm (1 small box) from the baseline of the ECG.
- In order for “S-T” segment elevation to be considered an “indicative change”, it must be greater than 1mm in 2 or more anatomically contiguous leads.



Compare the S-T segment to the T-P segment.

Ask yourself, is the S-T segment elevated, depressed, or normal when compared to the T-P segment?

The 3 I’s of ACS

S-T depression = Ischemia Phase
S-T elevation = Injury Phase
Pathologic Q waves = Infarct Phase

The (3) Three I's of Acute Coronary Syndromes

Ischemia = Represented by inverted "T"-waves or depressed "S-T" segment on the diagnostic 12 lead ECG.

Ischemia is typically a warning sign of the potential of something bigger about to happen i.e. Injury or Infarct. Cardiac stress test are utilized to screen for Ischemia patterns on the 12 lead ECG when increased workload is placed on the heart (increased myocardial oxygen demand).

Injury = Represented commonly by "S-T" segment elevation of greater that >1mm /1Mv present in at least two anatomically contiguous leads (leads looking at the same general area).
Injury can also be represented by the formation of a new onset Left Bundle Branch Block (LBBB).

The Injury phase of the ACS is where the stop watch begins to tick and actual damage is occurring to the myocardial tissue layers. It is imperative that upon recognition of an "injury pattern", that all focus be driven toward getting the patient to a facility with 24 hour emergent cardiac catheterization capabilities (24 hr. cath lab). The treatment is to reopen the occluded vessel and return perfusion to the injured portion of the myocardium as soon as possible.

Infarct = Represented by a "wide" "pathologic" Q-wave on the diagnostic 12 lead ECG. This Q wave must be wider than >.04sec. or 40ms (one small box) and present in two anatomically contiguous leads in order to be considered "indicative".

Pathologic Q-waves are the scar that is left behind that tells us the patient has infracted tissue. These are commonly referred to as "age undetermined" MI's. This necrotic dead tissue is now electrically silent on the ECG and is represented by a pathologic Q-wave.

The Pathologic "Q" wave

- "Q" waves serve as evidence that "tissue death" has occurred.
- "Q" waves can still develop during the acute phase of infarction.
- "Q" waves are often seen in the first few to several hours of infarction.
- "Q" waves can occur naturally in healthy adults however, a "Q" wave which is 40ms or .04s greater in width (1 small box or more wide) is suggestive of infarction.
- In time, the "T" wave regains its normal contour and the "S-T" segment returns to the isoelectric line. The "Q" wave remains as evidence that an infarct has already occurred.

Table 1 – Localizing the Infarct Site

Leads Displaying Indicative Changes	Location of the Infarct Site	Primary Coronary Artery Involved
II, III, AVF	Inferior Wall	Right Coronary Artery – (RCA)
V4R, V5R, V6R	Inferior / Right Ventricle	Right Coronary Artery – (RCA)
V1 & V2	Septal Wall	Left Coronary Artery (left anterior descending - LAD)
V3 & V4	Anterior Wall	Left Coronary Artery (left anterior descending - LAD)
I, AVL,V5, V6	Lateral Wall of Left Ventricle	Left Coronary Artery (left circumflex - LCRX)

Table 2 – Coronary Artery Distribution

Left Coronary Artery	Right Coronary Artery
Septal Wall of Left Ventricle	Right Ventricle
Anterior Wall of Left Ventricle	Inferior Wall of Left Ventricle
Lateral Wall of Left Ventricle	Posterior Wall of Left Ventricle
Posterior Wall of Left Ventricle	

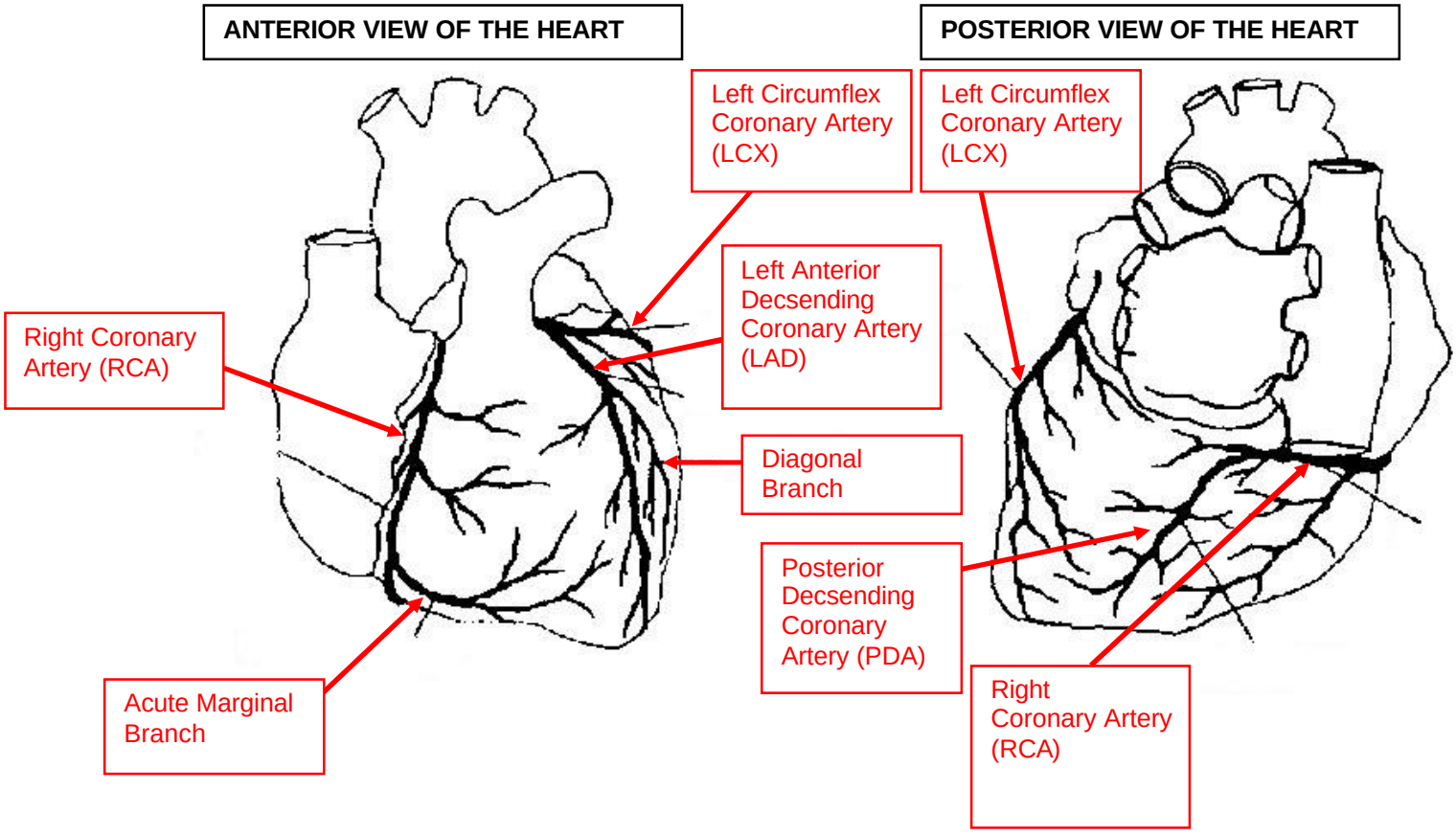


Table 3 – Distinguishing Features of Right vs. Left Coronary Artery Occlusions

	Left Coronary Artery	Right Coronary Artery
Leads Showing Indicative Changes	V1-V6, I, AVL	II, III, AVF, V4R-V6R (RVI)
Localization	Septal, Anterior, Lateral , Posterior	Inferior, Posterior, Right Ventricular
Pain Control	ASA, Nitroglycerin, Morphine (appropriate)	ASA (appropriate) Nitroglycerin and Morphine used with extreme caution if (RVI) present
AV Blocks	Infrequent, usually wide QRS. Often unstable. Atropine may be ineffective due to location and degree of block. Use TCP immediately	Frequent, usually a narrow QRS. Generally stable. Atropine usually effective, can proceed to TCP if needed. May not require treatment if stable.
Hypotension	200-500ml fluid bolus. Consider the use if positive inotropic agents.	Vigorous fluid therapy if RVI is present. Consider the use if positive inotropic agents.

Bundle Branch Blocks

- In the setting of myocardial infarction, a new onset of bundle branch block (BBB) is a very significant finding.
- Infarct induced BBB carries with it an increased mortality rate of between 40% - 60%. The rate of cardiogenic shock increases as well, up to 70%.
- It is not the BBB itself that causes poor outcomes, but rather the BBB that indicates an extensive MI.
- Patients experiencing septal and antero-septal infarctions are most likely to develop a BBB.
- BBB in the setting of infarction can be used to identify patients with a higher likelihood of developing a complete heart block.
- BBB can mimic the infarction pattern, in particular a LBBB can produce “S-T” segment elevation and wide “Q” waves.
- Unless a previous 12 lead ECG is available it can be difficult to ascertain whether or not the infarction or the BBB came first.
- Not all forms of BBB are caused by infarction or ischemic heart disease.

Recognizing a Bundle Branch Block

- First rule, forget about the notched QRS !!!!
- A notched QRS does not necessitate the presence of a BBB.
- The QRS must be supra-ventricular in origin (cannot be ventricular)
- Look for a wide QRS, greater that 120ms (.12) or (3 small boxes).
- As a rule, use the widest QRS complex with the most discernible beginning and end on the 12 lead to determine the QRS width.
- V1 is the single best lead to use when determining if a BBB is a LBBB or RBBB.
- RSR patterns are characteristic of a RBBB.
- QS patterns are characteristic of a LBBB.

"The Turn Signal Method"

(Easier method of determining RBBB from LBBB. – while looking at lead V1)

- Determine the direction of terminal force, to do this, find the "J" point of the QRS complex and move backward, note whether the final electrical activity of the QRS is an upward or downward deflection.
- If it is a RBBB then terminal force will be upward, if it is a LBBB then the terminal force will be downward. (Just like a turn signal lever in a car)
- The third category of BBB is Nonspecific Intra-ventricular Conduction Delay (NSIVCD).
- NSIVCD does not display the typical V1 morphologies generally produced by BBB.
- The morphologies may not be due to a complete BBB but rather an incomplete BBB.
- Atypical patterns of BBB can be attributed to NSIVCD.

Infarct Imposters

- There are a number of conditions that can cause "S-T" segment elevation. These can include, Hypothermia, increased ICP, electrolyte imbalance, medications.
- Five common conditions that can mimic myocardial infarction by producing "S-T" segment elevation are: LBBB, ventricular rhythms, left ventricular hypertrophy (LVH), pericarditis, and early repolarization.

Left Bundle Branch Block LBBB:

- When LBBB is present, "S-T" segment elevation is often seen in leads with negatively deflected QRS complexes. Can generally be seen in leads V1, V2, and V3 but can extend into V4 and beyond.
- RBBB rarely produces this pattern of "S-T" elevation because most of the leads remain positively deflected.

Ventricular Rhythms:

- Impulses originating in the ventricles may be the result of either natural pacemaker sites or of implanted pacemakers.
- Ventricular rhythms may exhibit "S-T" segment elevation that is not due to any infarct related causes.
- "S-T" segment elevation is seen when the QRS is negatively deflected.

Left Ventricular Hypertrophy (LVH):

- An enlargement of the left ventricle. This enlargement results from a prolonged state of overfilling or from its pumping against increased resistance.
- Several formulas exist for calculating LVH. The following formula is presented here due to its ease of use.
- Step #1 = Compare V1 and V2 and determine which has the deepest "S" wave then determine the depth of the **deeper** "S" wave in millimeters (count the small boxes, 1 small box = 1mm)
- Step #2 = Compare V5 and V6 and determine which has the **tallest** "R" wave then determine the height of the taller "R" wave in millimeters.
- Step #3 = Add the height of the **taller** "R" wave and the **deeper** "S" wave , if the **sum** is **greater** than 35, then suspect LVH.

Pericarditis:

- In the case of pericarditis, portions of the pericardium become inflamed, as does the adjoining epicardial surface of the heart. This can cause diffuse "S-T" segment elevation.
- Pericarditis is often seen in post MI and post cardiac surgery patients.
- "S-T" segment elevation is typically diffuse and not strictly grouped into leads which are anatomically contiguous.
- Pericarditis can also produce a depressed "P-R" segment.
- Pericarditis may also cause notching of the "J" point. This can indicate a non infarct cause of "S-T" elevation.
- Chest pain is commonly the chief complaint with pericarditis, and is described as a "sharp" pain

Description	Myocardial Infarction	Pericarditis
Chest Pain (nature)	"pressure" type pains	"stabbing" pains
Chest Pain (radiation)	Left arm, shoulder, jaw	Base of neck, trapezious
Chest Pain (aggravation)	Unaffected with movement or respirations	Affected by movement respiration, swallowing. May improve with leaning forward
S-T segment elevation	Appears in anatomically contiguous leads	Diffuse across entire ECG
P-R segment depression	Uncommon	Common – may give appearance of S-T segment elevation

Benign Early Repolarization Syndrome (BERS):

- Produces infarct like patterns on the ECG of healthy, asymptomatic patients
- Considered to be a normal variant and does not indicate underlying pathology.
- Causes "S-T" segment elevation most often seen in the chest leads.
- Produces tall "T" waves much like those seen in the hyperacute phase of MI.
- Often resembles the presentation of anterior or anterolateral MI.
- Much like pericarditis, it can produce a notched "J" point.
- Higher incidence in young African-American males.

An 8 Step Analysis of 12 lead ECG's

RULE #1 – NEVER RELY ON THE INTEPRATIVE STATEMENT PRINTED ON THE 12 LEAD ECG!!!!

Step #1 = Check Rate and Rhythm

- Treat life threatening arrhythmias FIRST.

Step #2 = Evaluate ECG Measurements & Heart Rate

- QRS Duration = ≤ .12sec or ≤ 120ms
- PRI Duration = ≤ .20sec or ≤ 200ms
- Is the heart rate normal, slow or fast?

Step #3= Evaluate Leads II and V1

- What is the ECG rhythm?
- Calculate the rate. Does it match the computers calculation?

Step #4 = Group the ECG Leads Into Where They Are "Looking"

II, III, AVF – Inferior
V4R, V5R, V6R – Right Ventricle
I, AVL, V5, V6 – Lateral
V1, V2 – Septal
V3, V4 – Anterior

Ask yourself the following questions:

- Are there Q-waves? Pathologic or Physiologic?
- Is the S-T segment depressed, elevated or normal when compared to the T-P segment?
- Are the T-waves inverted?

Step #5 = Ask a Few Additional Questions???

- Is there a presence of indicative changes?
- Can it be localized to a specific area? "CRYSTAL BALL THEORY"
- What coronary artery is involved?

Step #6 = Miscellaneous Conditions

- LBBB
- Ventricular Rhythms
- Left Ventricular Hypertrophy (LVH)
- Pericarditis
- Early Repolarization

Step #7 = Clinical Presentation

- Maintain a high index of suspicion, especially in those patients with significant cardiac risk factors (i.e. diabetes, HTN, obese, hereditary, elderly)
- Be a good detective – Remember Anginal Equivalents and Atypical Presentations

Step #8 = If There Is Acute Infarction

- Notify the receiving ER or Cardiac Catheterization Lab early on!
- Anticipate possible complications.
- Develop a customized treatment plan.
- Be deliberate, fast and professional
- Remember Time is Muscle!!!!!