PeaceHealth

ADVANCED 12 LEAD EKG CLASS

The ability to identify and become familiar with the finer nuances of EKG interpretation and advance our practice in EKG interpretation.

Consider other causes for an abnormal ECG

Bundle Branch Block

- For Bundle Branch Block to exist, there must be a rhythm that is supraventricular in origin and has a QRS duration of greater than 120ms.

To determine which bundle:

- Look in lead V1
- Examine the QRS
- If the QRS has a positive deflection it is a right BBB, negative is left BBB.

ST segment elevation or depression cannot be reliably determined if a bundle branch block exists, therefore these 12-Lead ECG's are non-diagnostic.

Left Ventricular Hypertrophy

- Measure the deepest QRS complex in V1 or V2. (Count the number of small boxes starting at the baseline.)
- Measure the tallest QRS complex in V5 or V6. (Count the number of small boxes starting at the baseline.)
- Add these two numbers together.
- If they add up to 35 or greater, LVH is present.

LVH is normally measured accurately by the LP12. (Check the Dx.)

ST segment changes may be mimicked by LVH, therefore LVH may make the 12-Lead ECG non-diagnostic.

Pacemaker rhythms and Ventricular rhythms

- Ventricular rhythms originate from a ventricular pacemaker and have a QRS duration of greater than 120 ms.
- Paced rythms have pacemaker spikes before the P-waves, the QRS, or both.
- If a Ventricular pacemaker is present, you cannot make a diagnosis of myocardial infarction

ECG MONITORING -12 LEAD
12/13/2013 [EMT-I, PARAMEDIC]

Single Monitoring leads help establish the rate and regularity of the heartbeat. They also help identify if there is an arrhythmia.

The 12-Lead ECG is used to evaluate patients for the possibility of acute myocardial infarction (AMI) and improve the evaluation of arrhythmias.

INDICATION

1. Evaluate patient for the possibility of acute myocardial infarction (AMI), with or without chest pain.
2. Evaluation of arrhythmias (including trauma, electrical electrolyte abnormalities (e.g. hyperkalemia), and many other conditions.)

PROCEDURE

Limb Leads

The Limb Leads record activity from a vertical plane of reference.

Lead	Placement
RA/White	Right mid-clavicular line (MCL), below clavicle; or above anterior wrist
LA/Black	Left (MCL), below clavicle; or above anterior wrist.
LL/Red	Between 6th and 7th intercostal space, left MCL line; or ankle or thigh.
RL/Green	Between 6th and 7th intercostal space, right MCL line; or ankle or thigh.

Limb Leads

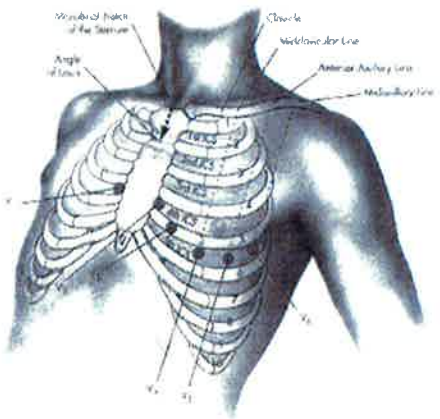
ECG MONITORING -12 LEAD
12/13/2013 [EMT-I, PARAMEDIC]

Precordial Leads

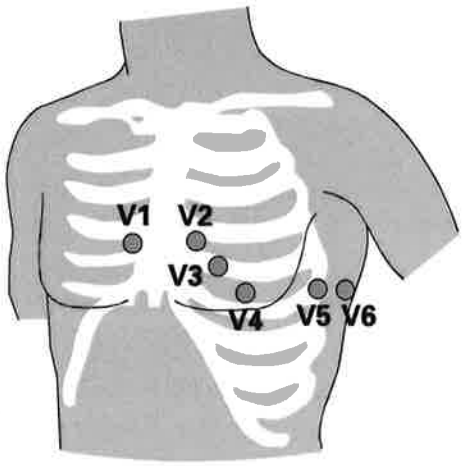
Certain landmarks help with the location of electrode placement

- Angle of Louis - this structure is a ridge on the sternum directly below the manubrial notch at the top of the sternum. Directly below and to the sides of the Angle of Louis is the second intercostal space. Use this to count down two more spaces for placement of V1 & V2.
- Mid-Clavicular Line - from MCL runs down to 5th intercostal space for V4.
- Axilla - left armpit, point where axilla meet the chest determines the Anterior Axillary line. V5 is positioned in horizontal alignment with V4 on the left Anterior Axillary line. Midway down the axilla is the Mid-Axillary Line. V6 is placed in horizontal alignment with V5 on the Mid-Axillary Line.

	Placement
V1	4th Intercostal space to the right of the sternum.
V2	4th Intercostal space to the left of the sternum
V3	Midway between V2 and V4
V4	On the mid-clavicular line, at the 5th intercostal level.
V5	On the anterior axillary line, at the 5th intercostal level.
V6	On the mid-axillary line, at the 5th intercostal level.



Wall affected	Leads	Artery(s) involved	Reciprocal changes
Anterior	**$V_2 - V_4$**	Left coronary artery, Left anterior descending (LAD)	II, III, AVF
Anterolateral	**I, AVL, $V_3 - V_6$**	Left anterior descending (LAD) and diagonal branches, circumflex and marginal branches	II, III, AVF
Anteroseptal	**$V_1 - V_4$**	Left anterior descending (LAD)	
Inferior	**II, III, AVF**	Right coronary artery (RCA)	I, AVL
Lateral	**I, AVL, V_5, V_6**	Circumflex branch or left coronary artery	II, III, AVF
Posterior	**V_8, V_9**	Right coronary artery (RCA) or circumflex artery	$V_1 - V_4$ ST segment depression (R > S in V_1 and V_2).
Right ventricular	**V_4R**	Right coronary artery (RCA)	-----



ECG MONITORING -12 LEAD
12/13/2013 [EMT-I, PARAMEDIC]

AMI Recognition

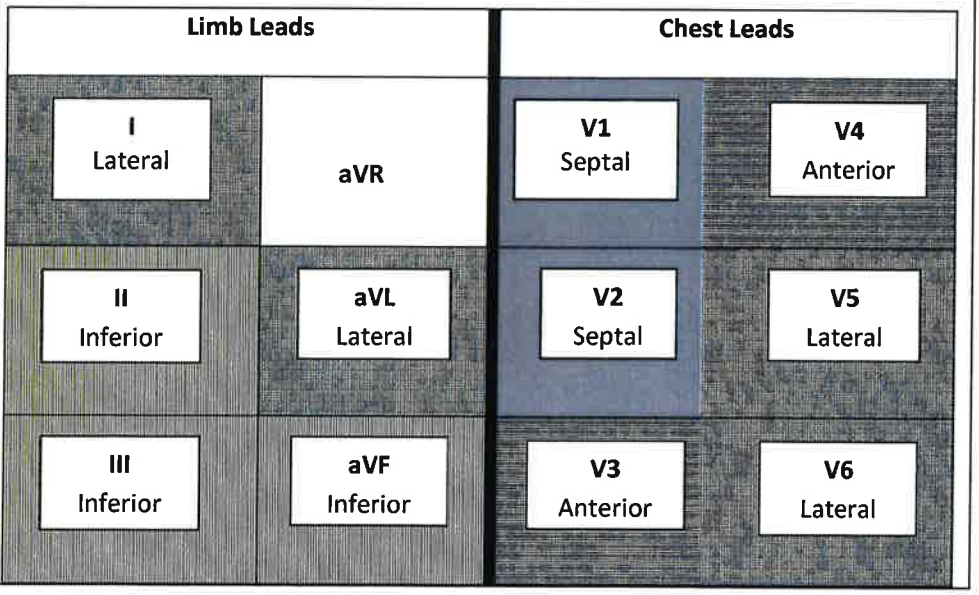
1. Common abnormal findings:
   - ST Elevation (presumptive evidence of AMI)
   - ST Elevation with Q Waves
   - ST Depression (ischemia)
   - T wave inversion (Subendocardial infarct or ischemia)
   - Peaked T wave (Hyperacute Infarction)
   - The presence of Q waves with ST elevation usually indicates an old infarction.

2. Basic Lead Groups

Leads	Areas of the Heart Muscle Seen
II, III, aVF	Inferior leads - lower portion of the heart.
V1 & V2	Septal leads - muscle between right & left ventricles.
V2, V3, V4	Anterior leads - front of the heart.
V4, V5, V6	Lateral pre-cordial leads - lateral aspects of the heart.
I & aVL	High lateral leads - lateral aspect from above

3. Location:

AMI Recognition



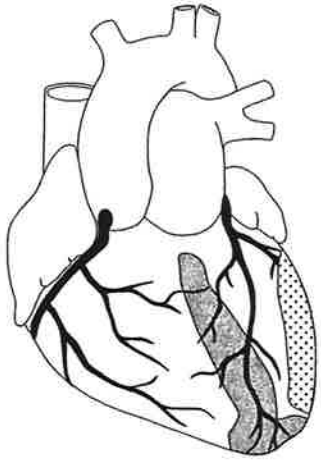
CARDIAC CHEST PAIN 12/03/2013	
Follow Assessment, General Procedures Protocol	
EMR	• Assess and support ABC's • Administer oxygen, high flow – **See Oxygen Therapy Protocol** • Position of comfort
EMT	• Obtain 12 lead ECG - **See ECG/12-Lead** • Aspirin • Nitroglycerin (Assist patient with their own prescription)
A-EMT	• IV – NS with standard tubing or saline lock TKO • Nitroglycerin
EMT-I/ PARAMEDIC	• Cardiac monitoring - **See ECG/12-Lead** • IO as indicated for shock and no IV access -**See EZ-IO/IO Infusion** • Pain management – **See Acute Pain Management Protocol**

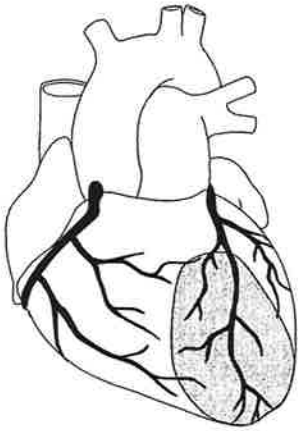
CATH ALERT CRITERIA

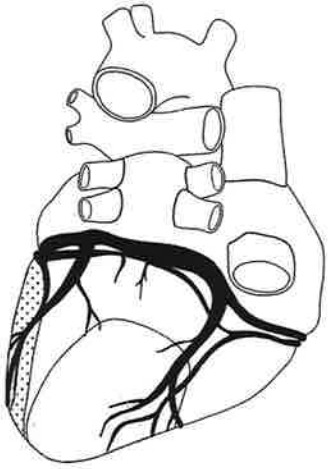
- Chest pain or suspected cardiac discomfort;
- (and) No LBBB;
- (and) 1 mm ST elevation in 2 anatomically adjacent leads
- (or) ECG printout consistent with acute STEMI

ACTIVATION

- Call receiving hospital and provide following information:
- Patient Name, DOB, weight, expected ETA
- Deliver 12 lead to ED staff
- Consider a 2nd IV
- Transport with defib pads anterior/posterior position
- RiverBend (541) 222-1581
- McKenzie Willamette (541) 726-4470







I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

PNEUMONICS

ST-Elevation:
E - Electrolytes (hyperkalemia)
L - LBBB
E - Early repolarization (high take off)
V - Ventricular hypertrophy (LVH)
A - Aneurysm
T - Treatment (eg pericardiocentesis)
I - Injury (AMI, contusion)
O - Osborne waves (hypothermia)
N - Non-occlusive vasospasm

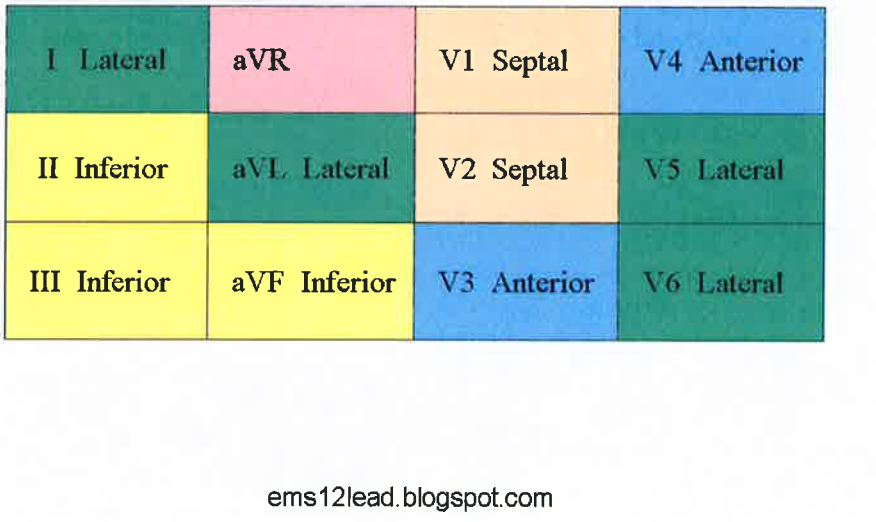
ST-Depression:
D - Drooping valve (MVP)
E - Enlargement of LV with strain
P - Potassium loss (hypokalemia)
R - Reciprocal ST- depression (in I/W AMI)
E - Embolism in lungs (pulmonary embolism)
S - Subendocardial ischemia
S - Subendocardial infarct
E - Encephalon hemorrhage (intracranial hemorrhage)
D - Dilated cardiomyopathy

Inverted T-waves:
I - Ischemia
N - Normality [esp. young, black]
V - Ventricular hypertrophy
E - Ectopic foci [eg calcified plaques]
R - RBBB, LBBB
T - Treatments [digoxin]

Troubleshooting Artifact:

V1 has artifact? Check V1 electrode. Same for V2 through V6.
If Leads I & III have artifact, check left shoulder.
If Leads I & II have artifact, check right shoulder.
If Leads II & III have artifact? Check left leg electrode.

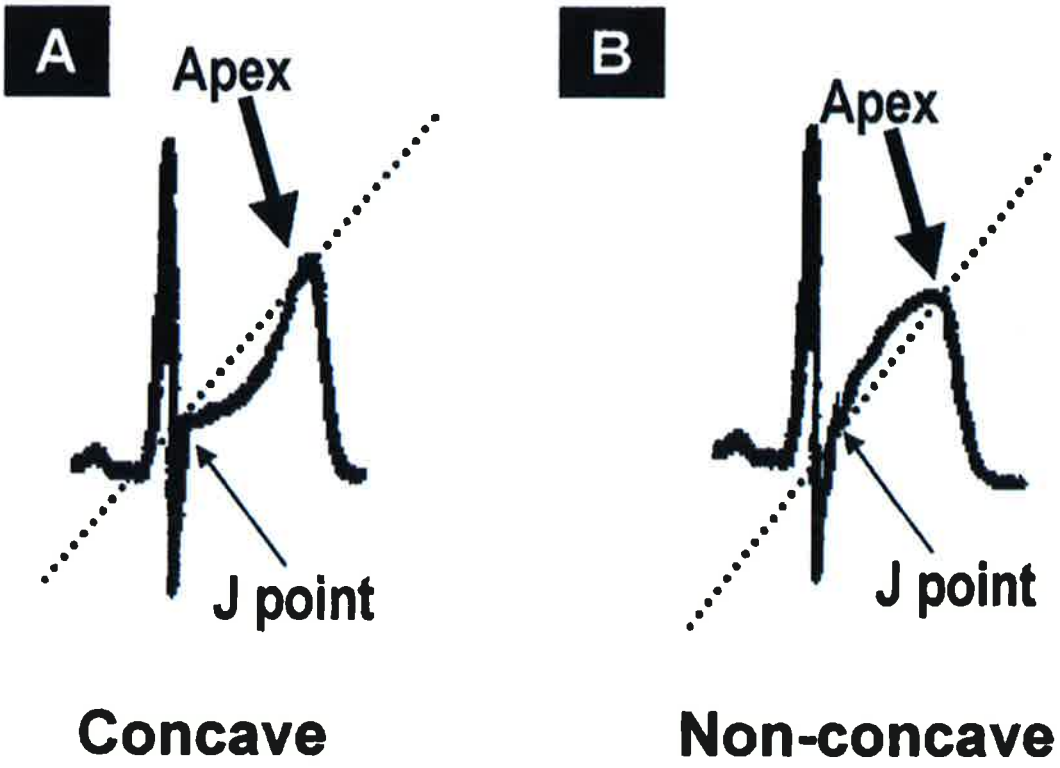
Contiguous Leads



Reciprocal Changes

SITE	FACING	RECIPROCAL
SEPTAL	V1, V2	NONE
ANTERIOR	V3, V4	NONE
ANTEROSEPTAL	V1, V2, V3, V4	NONE
LATERAL	I, aVL, V5, V6	II, III, aVF
ANTEROLATERAL	I, aVL, V3, V4, V5, V6	II, III, aVF
INFERIOR	II, III, aVF	I, aVL
POSTERIOR	NONE	V1, V2, V3, V4

ST-Segment Morphology



****The J point is the first change in direction after the QRS complex****

Myocardial Infarction is not the most common cause of ST-Elevation. >80% of ECGs with STE are not patient's experiencing an MI.

- Concave ST-elevation is usually benign, but does not rule out MI.
- Non-concave ST-elevation indicates possible MI
- *This yields a sensitivity of 77% and specificity of 97%*

Typical ST morphology:

- **AMI** - convex or straight ST elevation ("frowny face")
- **Benign early repolarization** - concave ST elevation ("smiley face")
- **Pericarditis** - concave ST elevation ("smiley face") and often associated with PR depression
- **BBB** - concave ST elevation ("smiley face") with discordant QRS complex, usually < 5 mm elevation
- **LV aneurysm** - Usually of V1-V2 and is unchanged if compared to prior EKG's. Usually has evidence of prior anterior infarction (poor R wave progression and Q waves)

Left Ventricular Hypertrophy

- Deepest S wave in V1/V2 plus tallest R wave in V5/V6 ≥ 35mm
- And/or R wave in aVL ≥ 12mm.

"Strain" *is a pattern of asymmetric ST segment depression and T wave inversion. LV strain is most commonly seen in one or more leads that look at the left ventricle (leads I, aVL, V4, V5, V6); less commonly it can be seen in inferior leads.*

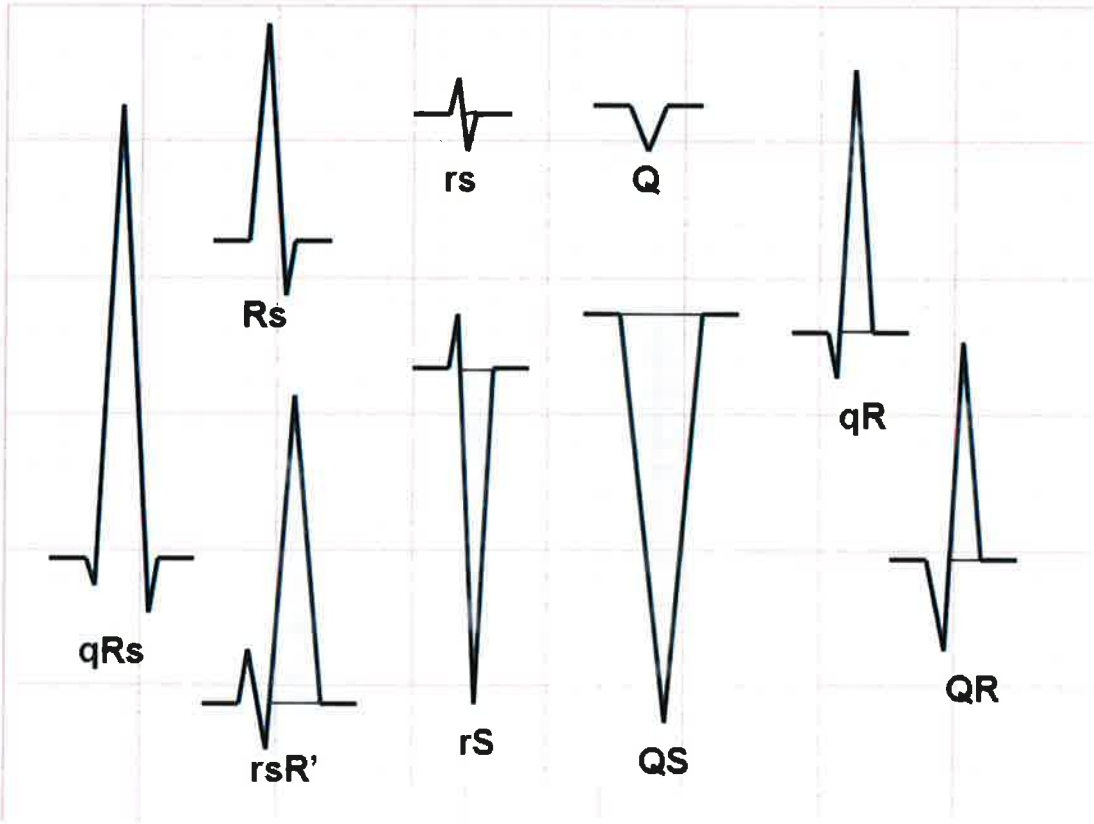
Look at the ECG below:

- The deepest S wave in V1 or V2 is 29mm in V2.
- The tallest R wave in V5 or V6 is 25mm in V5.
- These total 54mm
- This is > 35mm so LVH is suspected.

Differentiating Bundle Branch Blocks:

- Locate a complex in lead V1
- The terminal wave determines whether it is a right or left bundle branch block.
- Draw a line through the isoelectric line backwards from the T-wave.
- Shade in the last wave before the T-wave.
- The last deflection before the T-wave is the terminal deflection or wave.
- A terminal R wave (positive deflection) indicates a right BBB.
- A terminal S wave (negative defection) indicates a left BBB.
- The "turn signal" method is the easiest to follow.
    - You push your turn signal *down* to turn *left*
    - You pull your turn signal *up* to turn *right*

Below is an example of different QRS morphologies and where the terminal wave would be. The shaded areas indicate the terminal waves.



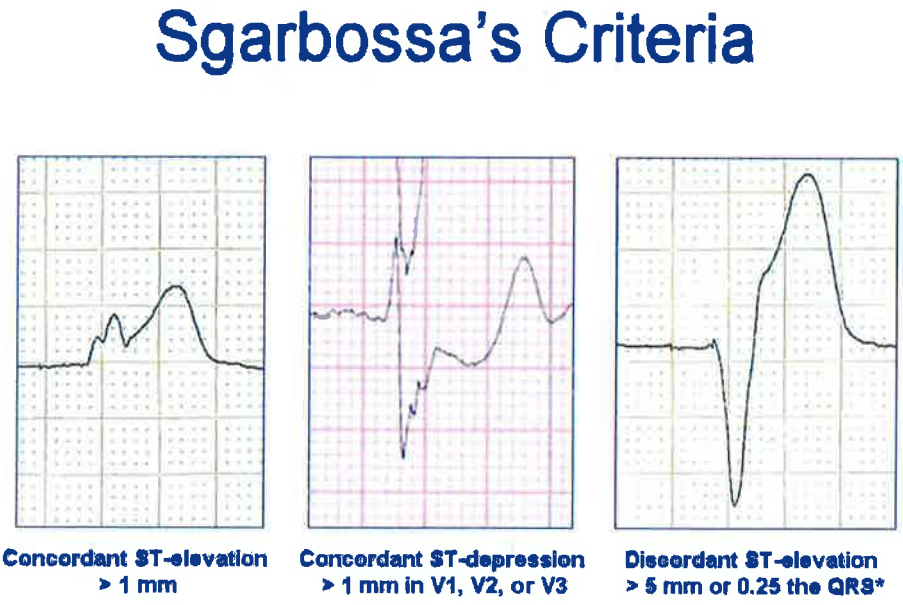
Left Bundle Branch Block

- Delayed conduction due to a block of both the Left Anterior Fascicle & Left Posterior Fascicle.
- Supraventricular rhythm with QRS duration > 120 ms and negatively terminal wave in V1.
- Discordant T-waves may cause ST-elevation
- New LBBB = contact medical control
- Many internal pacemakers may present with a LBBB pattern

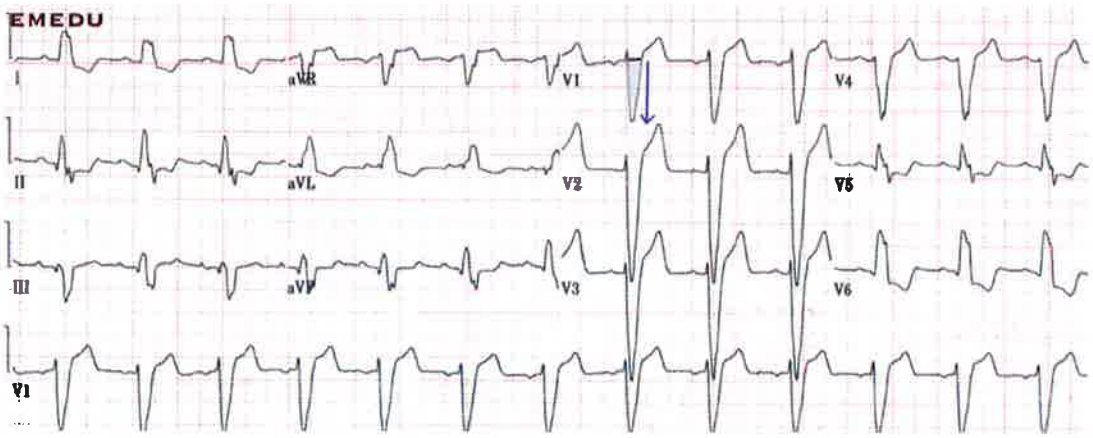
MI criteria for LBBB and/or Paced rhythms:

- STE $\geq$ 0.25 (25%) of the preceding S wave in V1-V4
- Concordant ST-elevation >1mm in any two related leads.
- *CAN'T call STEMI Alert based on this criteria*

Sgarbossa's criterion has been used in the past, but is difficult to teach and to follow. This is an example below:

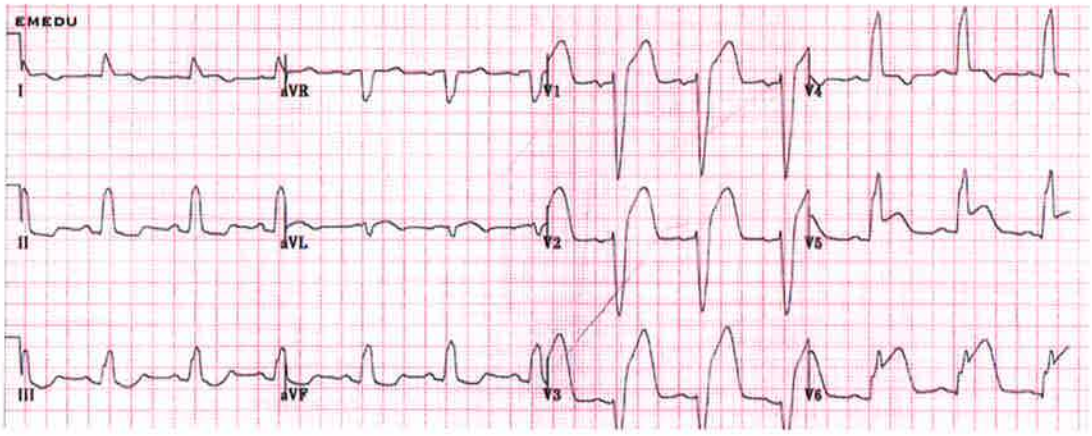


Take a look at the ECG Below:



- Note QRS width greater that 120 ms (3 small boxes)
- Supraventricular rhythm (P waves present, obvious in lead II)
- Terminal S wave in V1
- T wave discordance throughout entire ECG
- = LBBB pattern
- *note: with this rate, check for possible pacemaker*

Now take a look at this one:



- Is LBBB present?
- This is an example of an AMI in the presence of LBBB

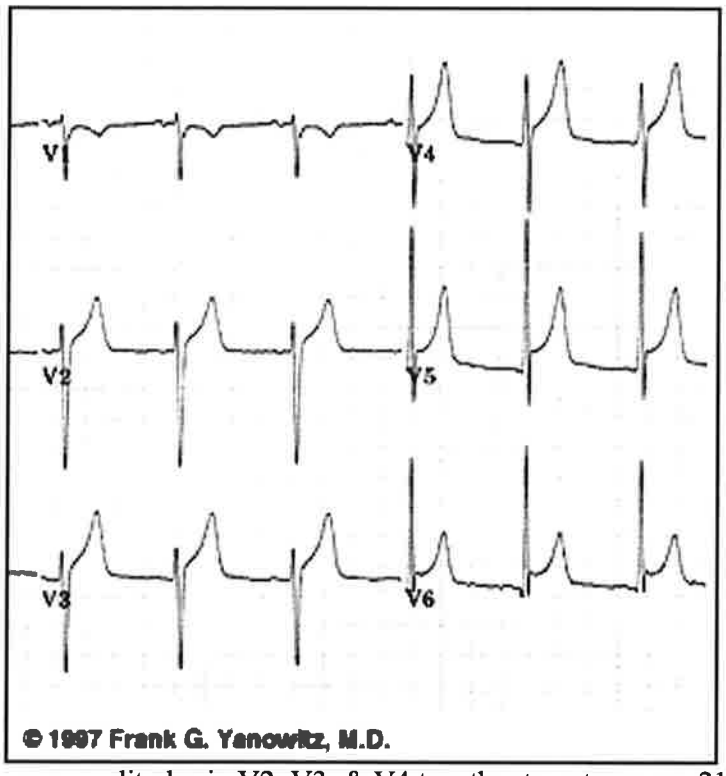
Benign Early Repolarization

- Concave (smiley), up-sloping ST segment (seen in V3)
- Notched J points
- Rarely > 4 mm in height
- Usually in V1-V4
- Often associated with LVH or BBB
- Larger T-waves with more elevated segments
- More common in young males and African Americans
- Should NEVER see Q-waves develop or T-waves become biphasic

Criteria to determine BER vs. MI:

- Mean amplitude of R-wave in V2-V4 > 5mm = Probable BER
- Mean amplitude of R-wave in V2-V4 < 5mm = Probable MI
- This yields a sensitivity 70% and specificity > 95%

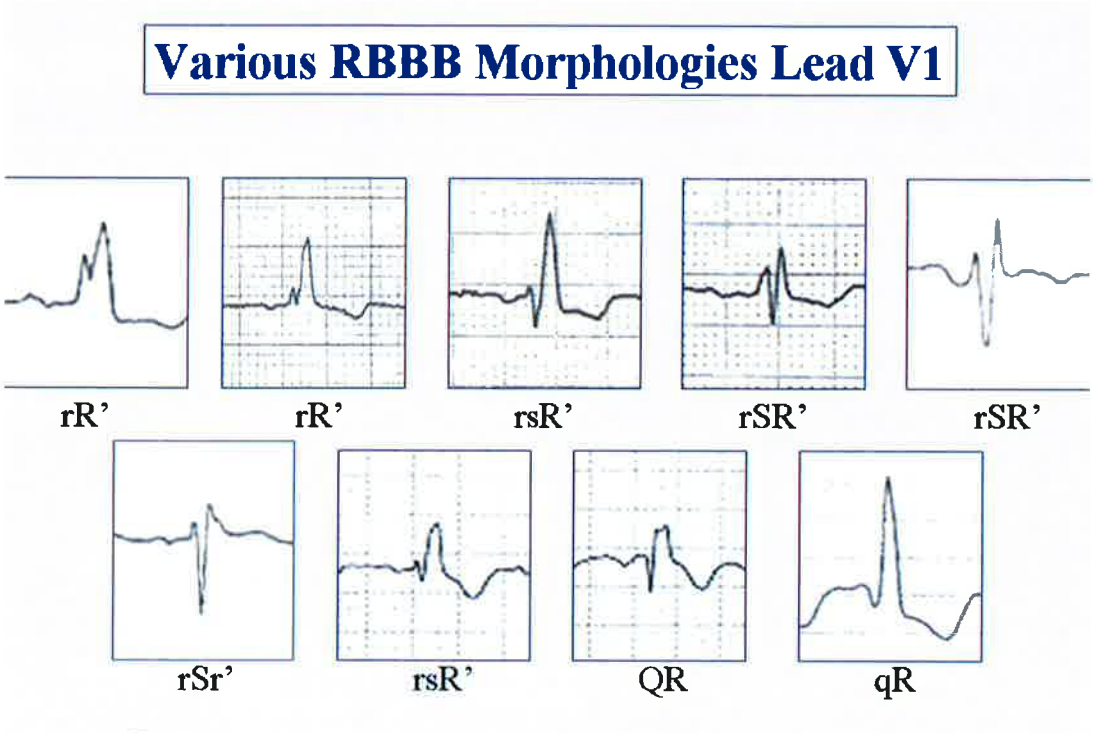
Add the amplitude of the R wave in V2, V3, & V4 together and divide by 3. If your number is greater than 5 than it is most likely early repol. If it is less than 5 it is highly likely that the patient is suffering from an acute MI.

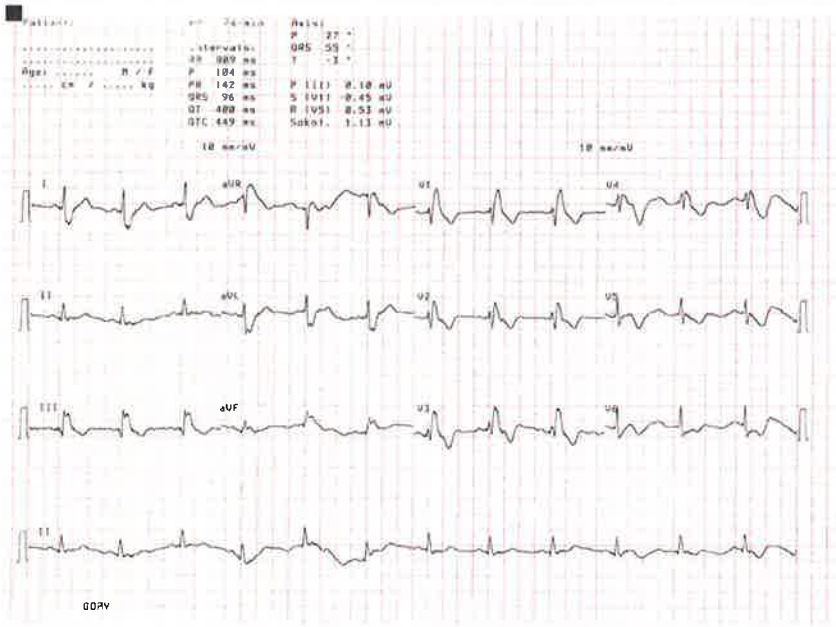


- Add R wave amplitudes in V2, V3, & V4 together to get approx. 21
- Divide by 3 and get 7
- 7 is greater than 5, this is BER!
- *Note: STE in some of the leads is much greater than usually seen with BER*

Right Bundle Branch Block

- A conduction delay due to blockage of the only right fascicle.
- ST-segment usually not altered by the normal T wave discordance of RBBB. QRS duration > 120 ms with positive QRS deflection in V1

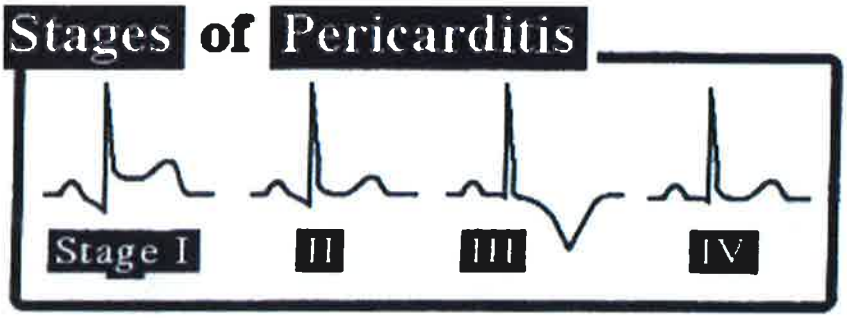




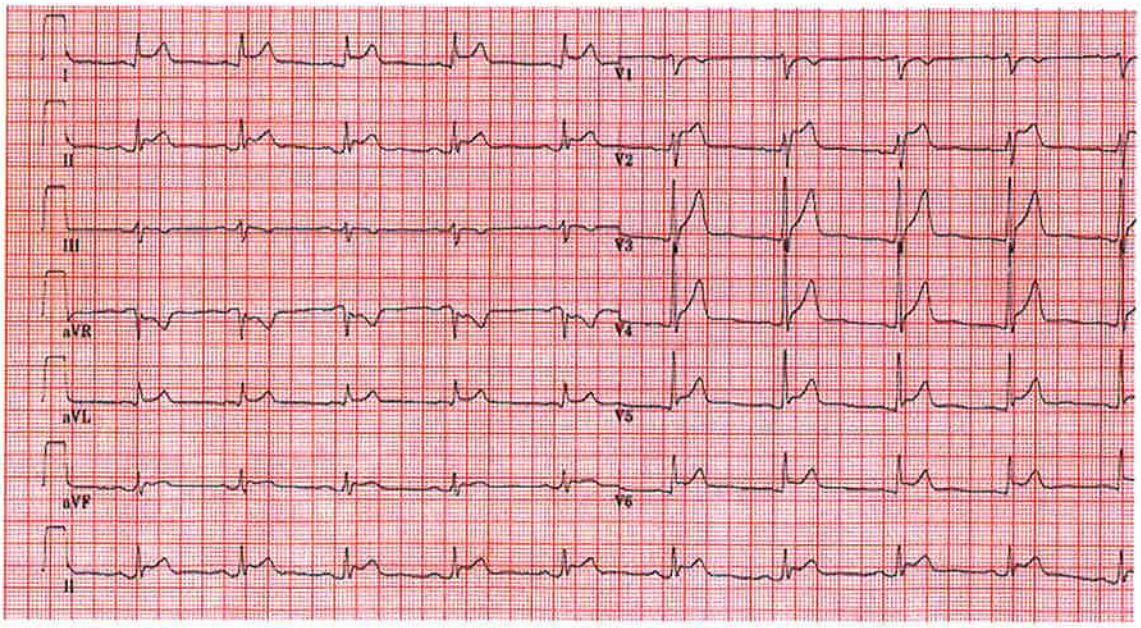
Above is an example of how a RBBB can mimic a STEMI

Acute Pericarditis

- Inflammation of the pericardium (pericardial sac).
- May present with global STE
- STE may appear pronounced due to PR-depression.
- Tip - STE will be present in leads I & II, even though these leads are reciprocal to each other.
- Stage I everything is UP (ST elevation in almost all leads)
- Stage II Transition ("pseudonormalization").
- Stage III Everything is DOWN (inverted T waves).
- Stage IV Normalization.



Example of typical STE-Mimic due to pericarditis below

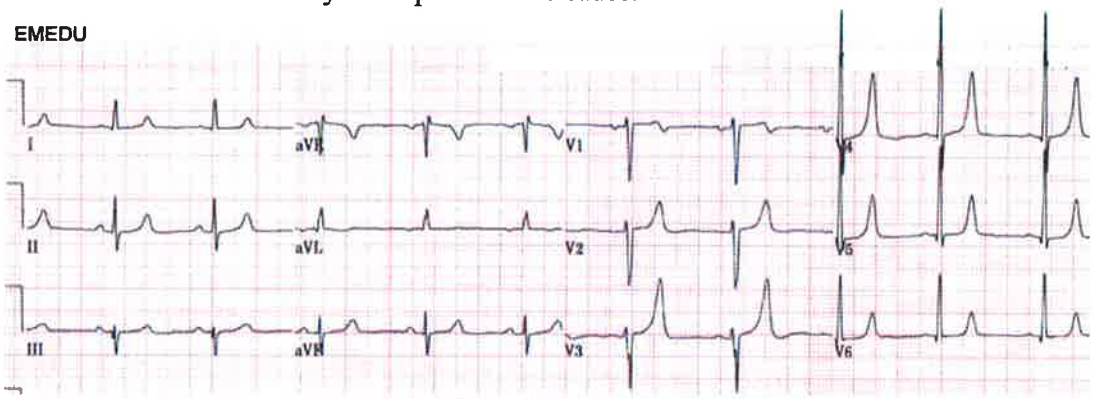


I.A.M. Otte, RN, AMC, The Netherlands ECGPEDIA.ORG

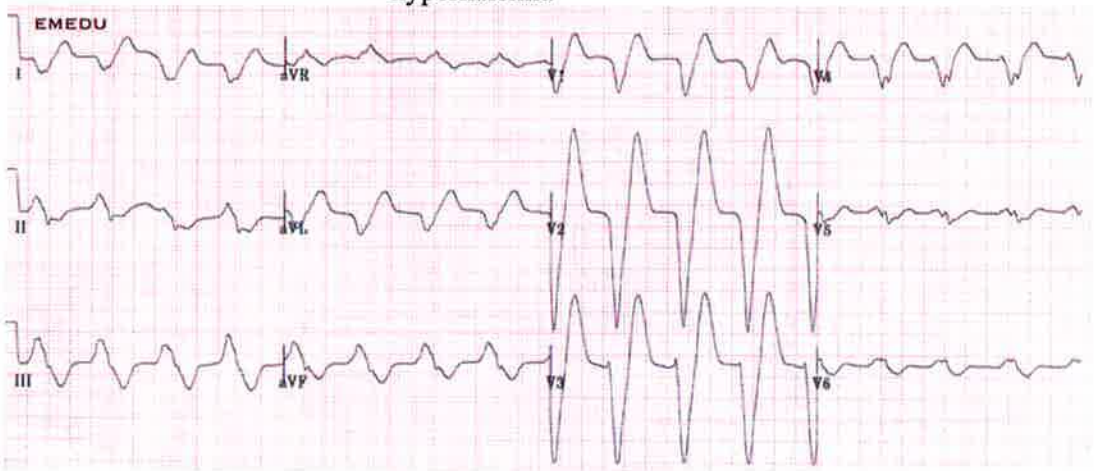
- Note the STE in almost every lead
- ST-depression in aVR is another indicator.
- Upwardly convex ST-segments

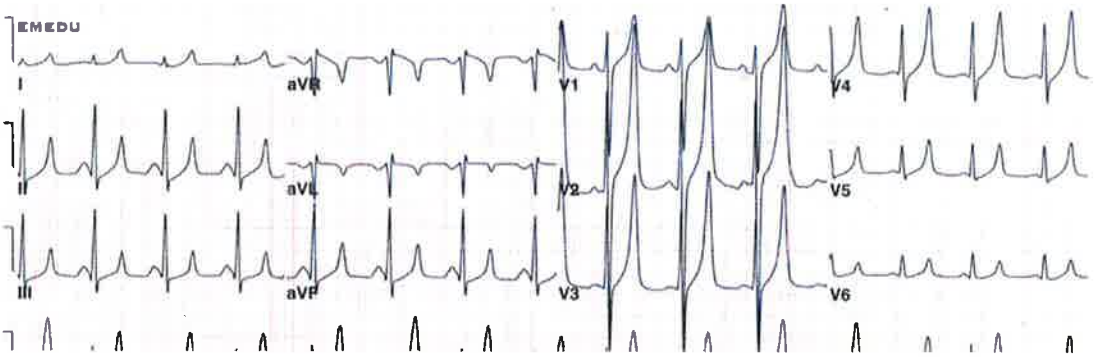
Hyperkalemia

- Peaked, usually narrow, symmetrical T-waves. (Found in 22% of cases)
- Severe hyperkalemia may present with straight line from tip of S wave (nadir) to peak of T-wave, AKA Sine wave.
- Sometimes presents with wide complexes, possibly lacking P waves. Z-Fold pattern is common with severe hyperkalemia.
- Usually, the bigger the T-wave, the bigger the QRS complex
- Smaller-P waves, larger U-waves and widening of QRS may be present.
- Prominent S-waves in Lead I & Left precordials
- Use medical history to help determine cause.



Sine Waves below from severe hyperkalemia

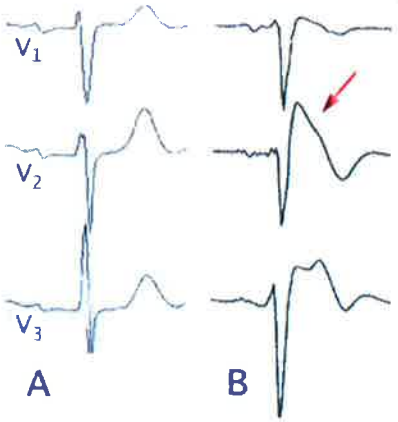




Brugada Syndrome

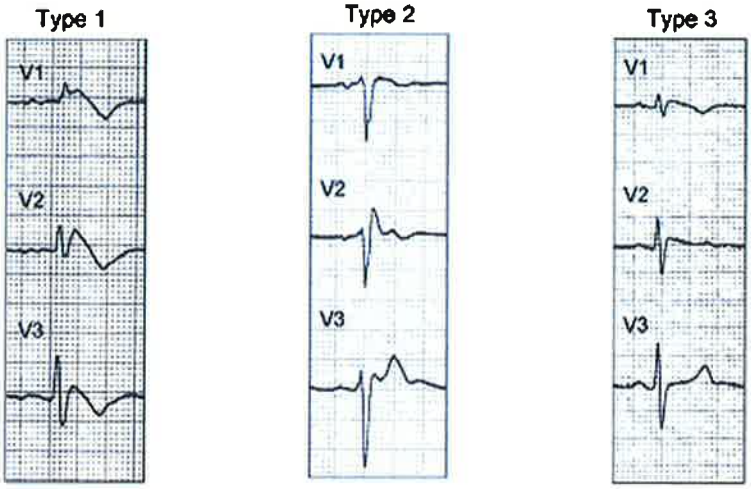
- AKA Sudden Unexpected Death Syndrome
- Death occurs from ventricular fibrillation
- Sodium-related conduction abnormality
- VERY UNCOMMON

The B column to the right shows the most common Presentation of Brugada Syndrome.



Brugada syndrome has 3 different ECG patterns:

- Type 1 has a coved type ST elevation with at least 2 mm J-point elevation a gradually descending ST segment and a negative T-wave.
- Type 2 has a saddle back pattern with a least 2 mm J-point elevation and at least 1 mm ST elevation with a positive or biphasic T-wave. Type 2 pattern can occasionally be seen in healthy subjects.
- Type 3 has a saddle back pattern with less than 2 mm J-point elevation and less than 1 mm ST elevation with a positive T-wave. Type 3 pattern is not uncommon in healthy subjects. The pattern seen on the ECG is persistent
- ST elevations in the electrocardiographic leadsV_1-V_3 with a RBBB appearance with or without the terminal S waves in the lateral leads that are associated with a typical RBBB. A prolongation of the PR interval (a conduction disturbance in the heart) is also frequently seen

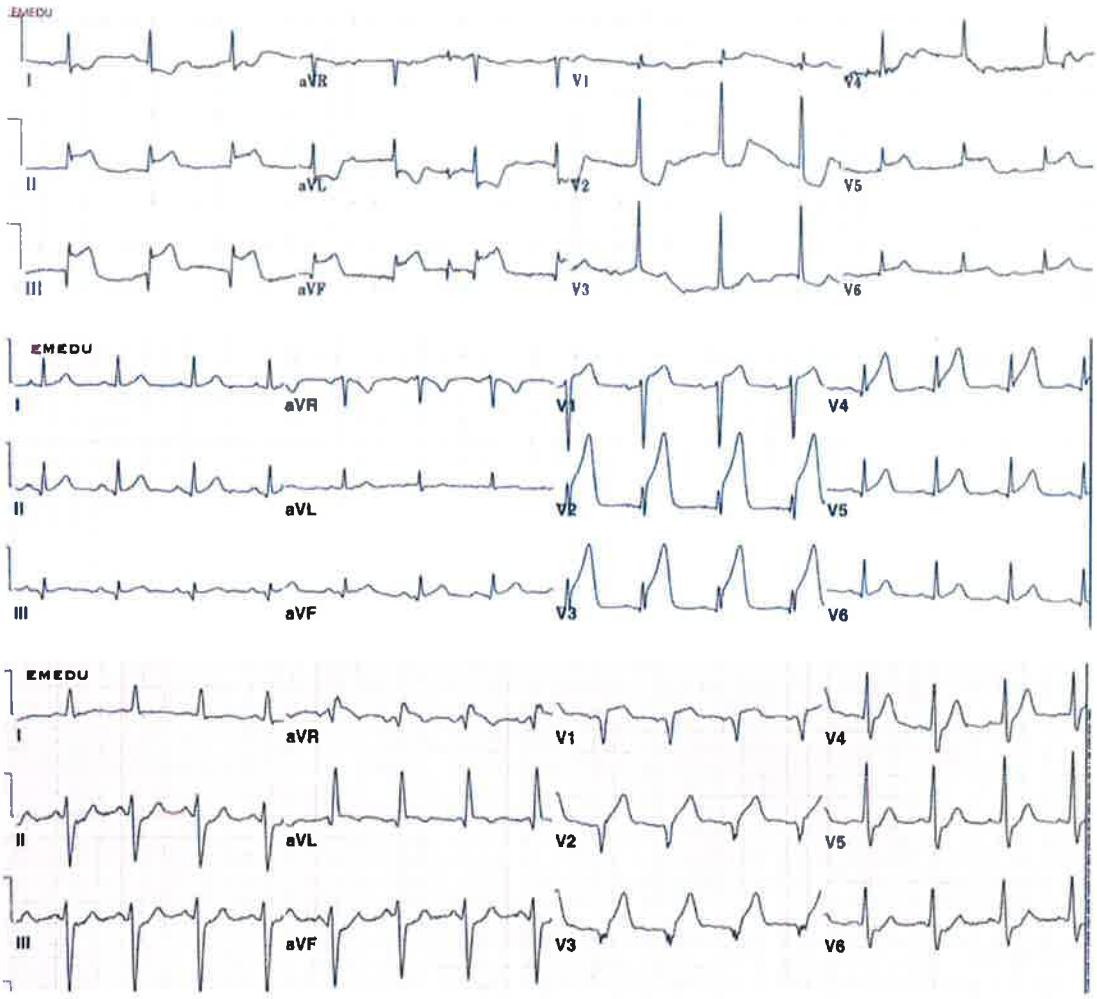


ST-Elevated Myocardial Infarction (STEMI)

- ST-Elevation of 1 mm or more in two or more related leads.
- 2 mm of STE should be noted in V2 or V3

Important Findings:

- If Zoll print out does not read ***Acute MI***, it is highly unlikely that the capture meets STEMI criteria. It is possible that the 12-lead is not a true STEMI even with the AMI reading, however.
- Hyperacute T waves - Peaked, wide, asymmetrical T waves (Hyperkalemia T waves usually present symmetrically and narrow).
- Wellen's phenomenon - Biphasic T wave (sometimes inverted) in V2 & V3, precursor to AMI from LAD stenosis.
- Pathological Q waves - Wide and deep Q waves.



Abnormal Q-waves:

- V2: Any
- V3: Almost any
- V4: If more than 1 mm deep or larger than Q in V5 or > .02 sec wide (0.5 mm)
- aVL: >.04 sec or >50% amplitude of the QRS
- III: Q wave >0.04 sec, depth in this lead is not important

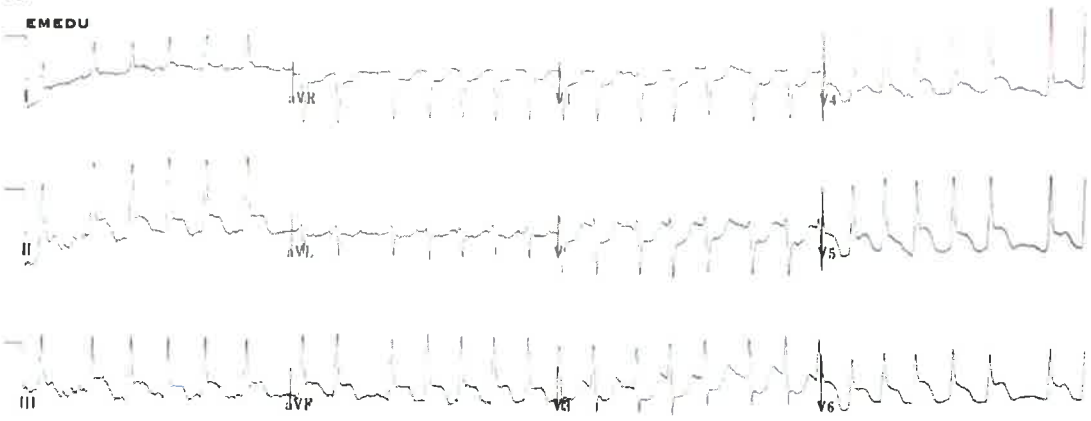
Interesting References:

- http://www.emergencymedicine.ucla.edu/ECGChallenge/
- http://ems12lead.blogspot.com/
- http://ecg-experts.blogspot.com/
- http://hqmeded-ecg.blogspot.com/
- http://ecgblog.com/
- http://health.groups.yahoo.com/group/ekg_club/
- http://paramedicine101.blogspot.com/

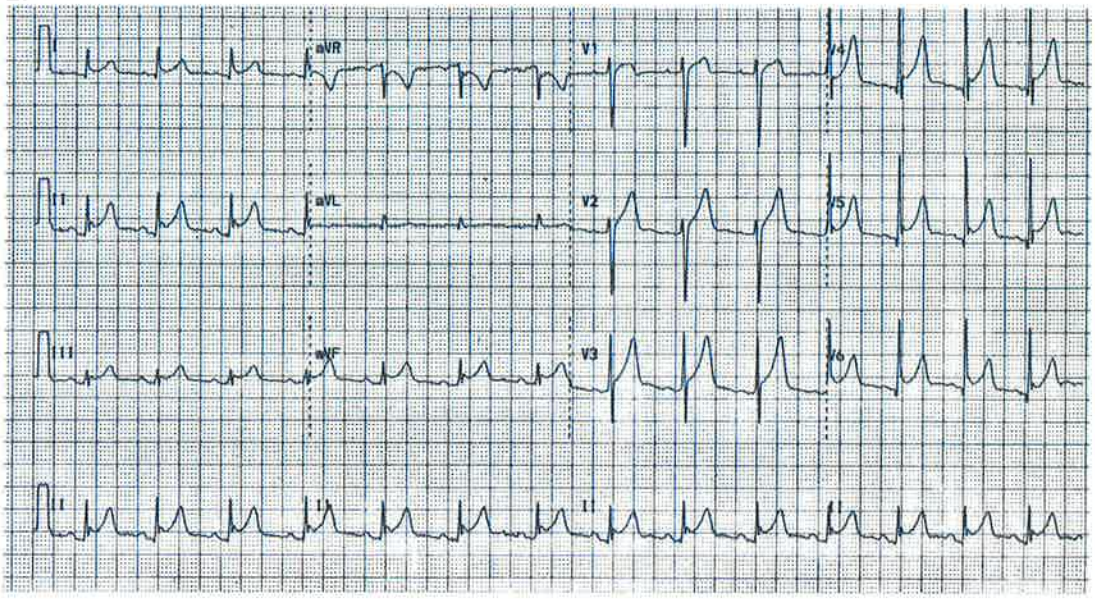
Practice 12-Leads:

The following pages contain numbered 12-lead ECGs with STEMI or STE-Mimic presentations. The answers will only divulge whether they are in fact STEMIs or one of the afore mentioned STE-Mimics. The answers will not go into detail regarding the underlined rhythm, axis, or patient condition.

1.


EMEDU
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

2.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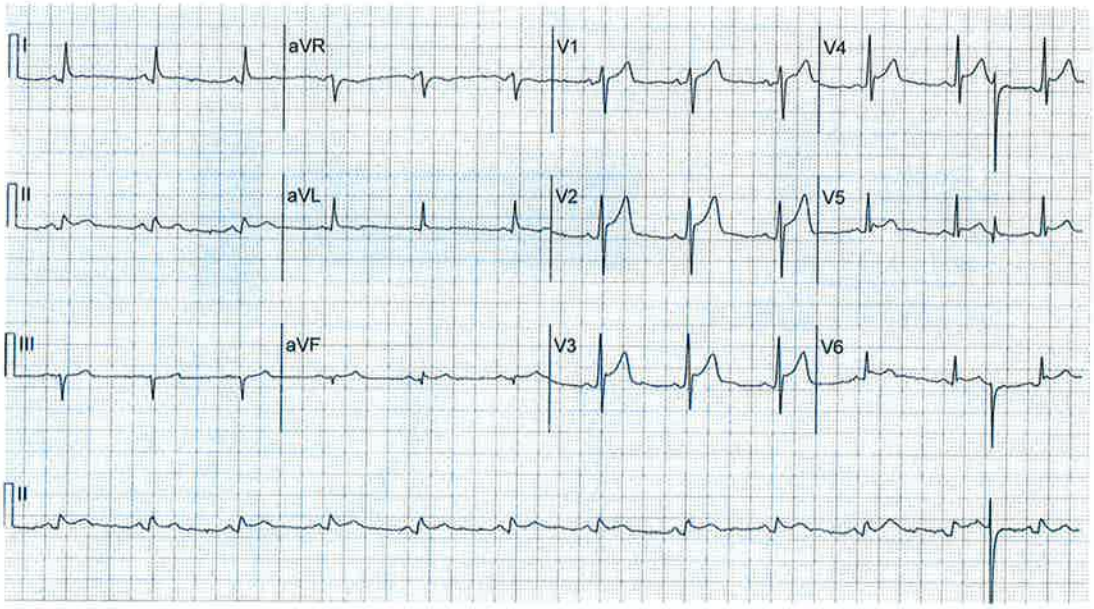
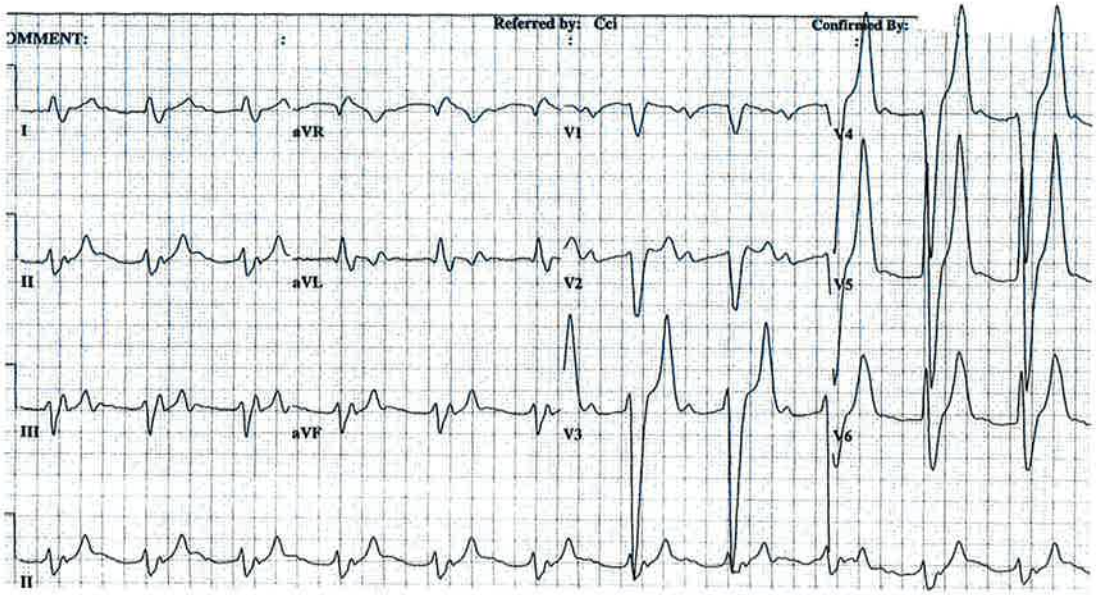
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

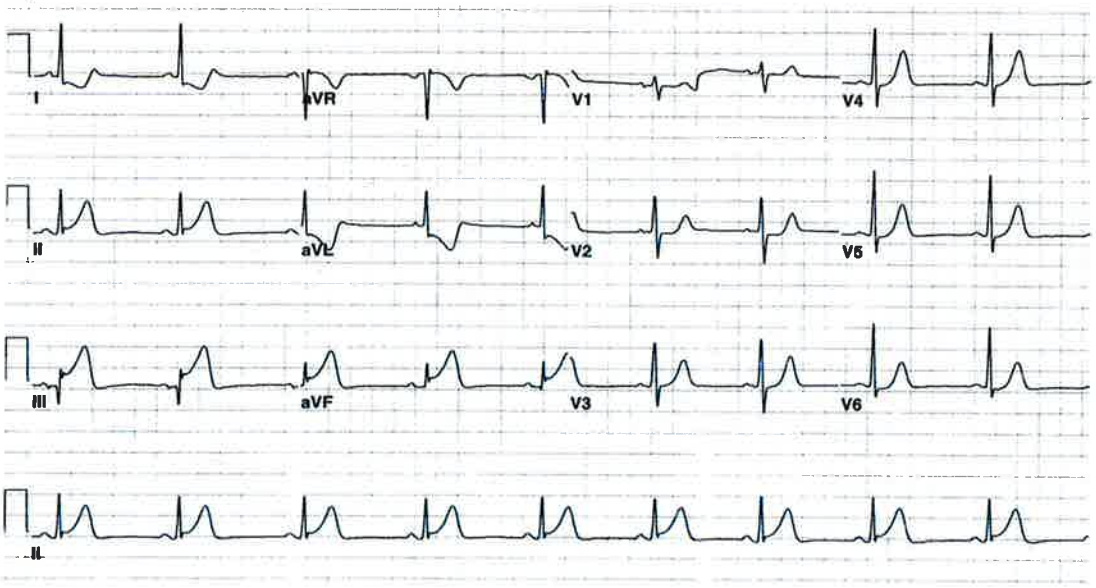
3.


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

4.


OMMENT:
Referred by: Ccl
Confirmed By:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

5.


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

6.


I
aVR
V1
V4
II
aVL
V2
V5
III
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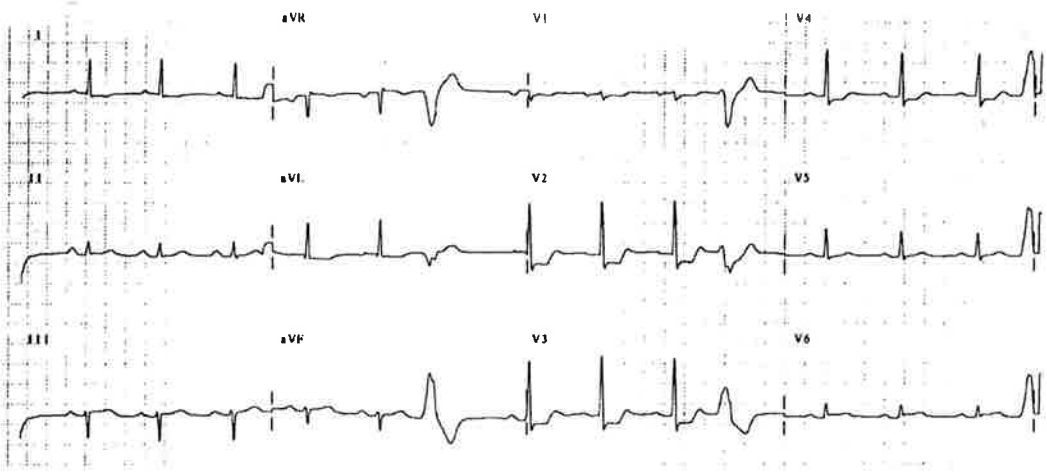
V3
V6

7.


I
aVR
V1
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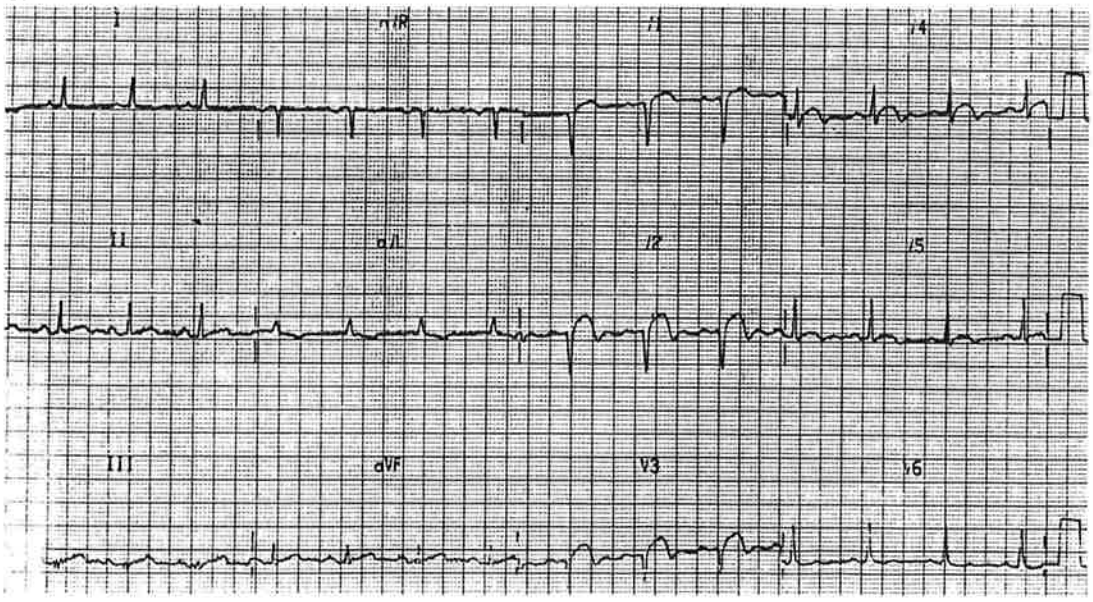
II
aVL
V2
V5
III
aVF
V3
V6

8.


I
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II
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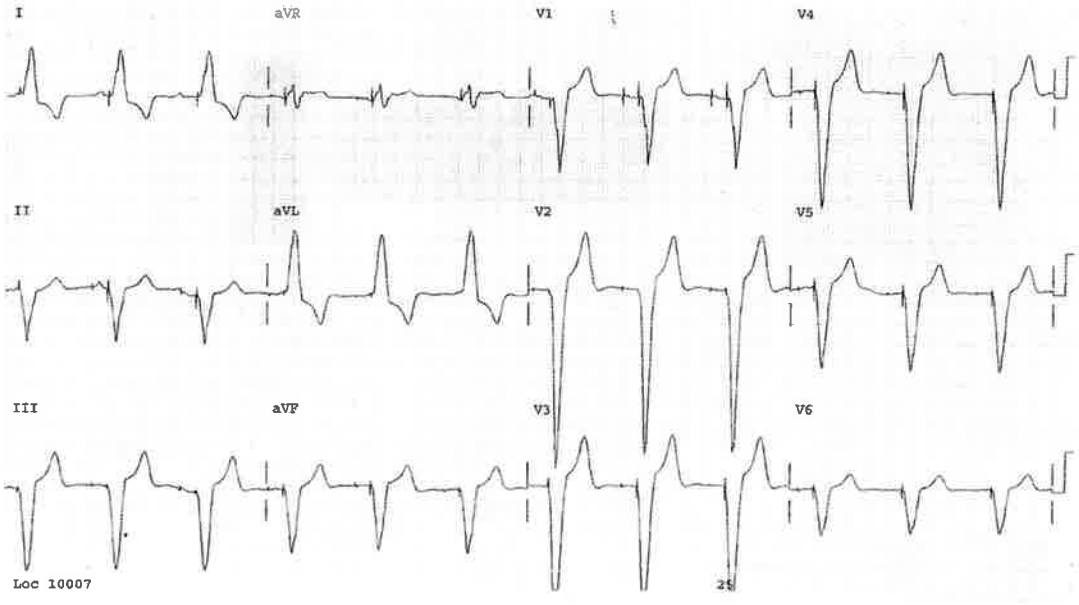
V5
III
aVF
V3
V6

9.


I
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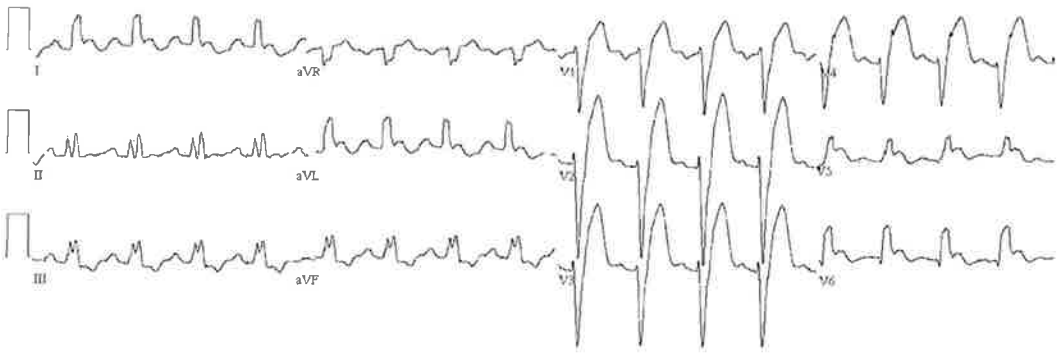
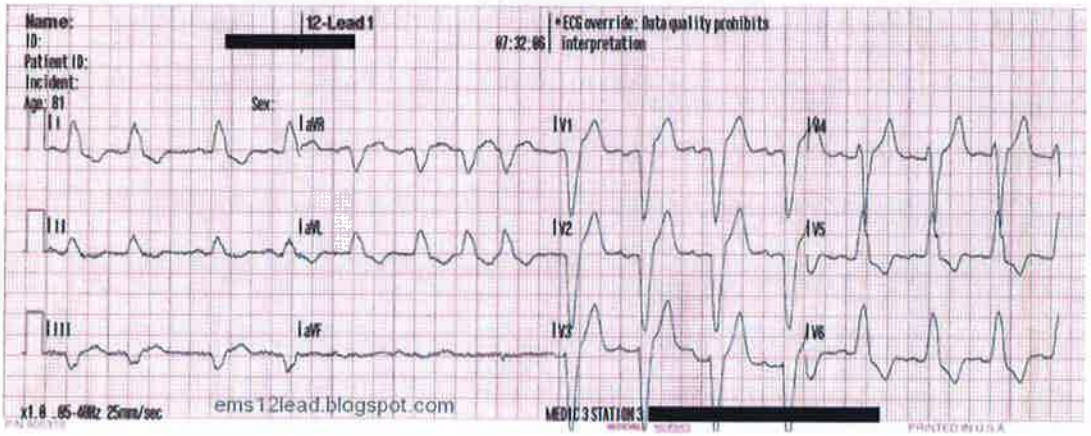
V4
II
aVL
V2
V5
III
aVF
V3
V6
Loc 10007

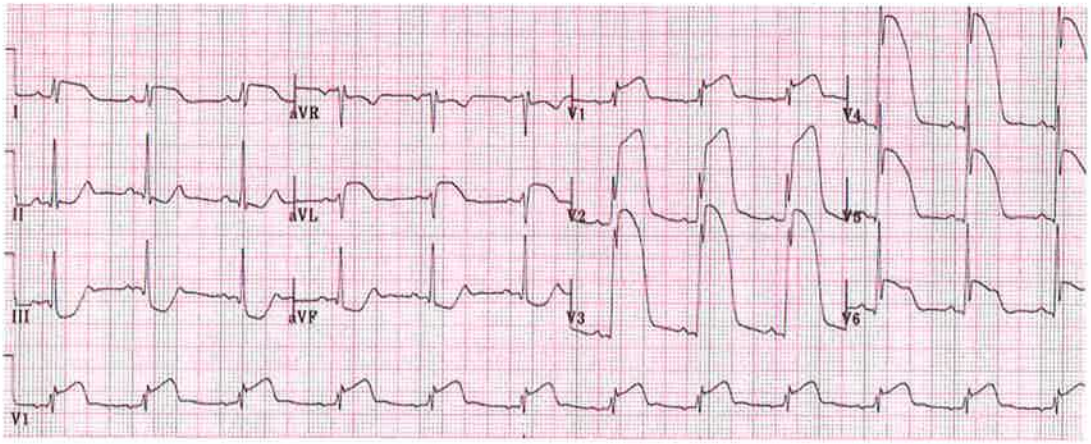
10.


I
aVR
V1
II
aVL
III
aVF
V6

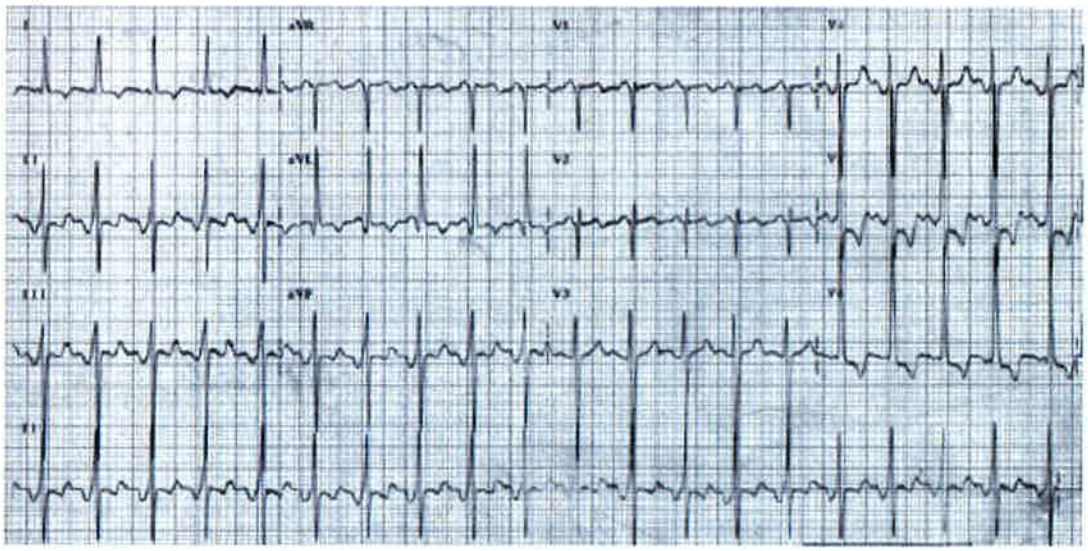
11.


Name:
ID:
Patient ID:
Incident:
Age: 81
Sex:
12-Lead 1
07:32:06
*ECG override: Data quality prohibits interpretation
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
x1.0 .05-40Hz 25mm/sec
ems12lead.blogspot.com
MEDIC 3 STATION 3
PRINTED IN U.S.A.

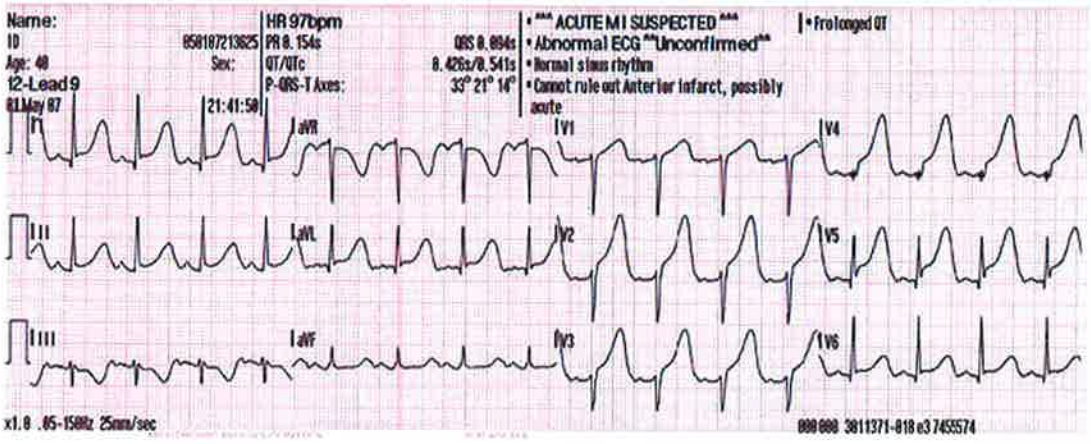
12.


I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
V1

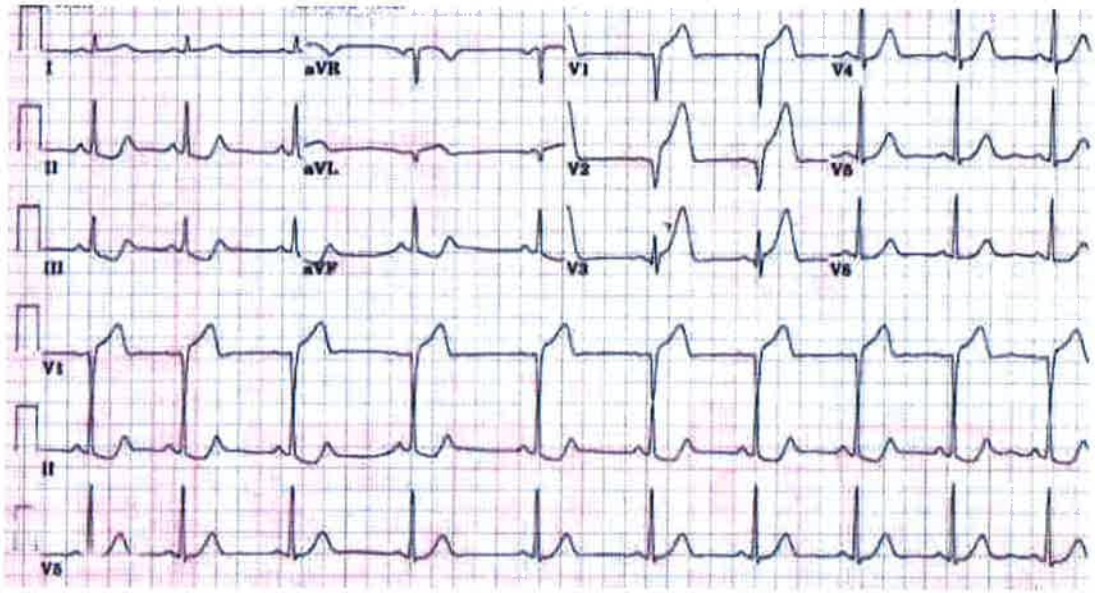
13.



14.


Name:
ID
Age: 48
12-Lead 9
HR 97bpm
PR 0.154s
QT/QTc
P-QRS-T Axes:
QRS 0.094s
0.426s/0.541s
33° 21° 14°
*** ACUTE MI SUSPECTED ***
* Abnormal ECG **Unconfirmed**
* Normal sinus rhythm
* Cannot rule out Anterior infarct, possibly acute
* Prolonged QT
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 .05-150Hz 25mm/sec

15.



Answers:

1. Inferior wall MI with probable Posterior wall involvement.
2. Acute pericarditis. Note the global concave STE and PR-depression
3. Benign Early Repolarization
4. Hyperkalemia. Note peaked T-waves, flat P-waves, and prominent U-waves. Also LBBB would be possible (remember hyperkalemia may cause widening of the QRS.
5. Inferior wall MI
6. LVH
7. Posterior wall MI. Note ST-depression in anterior leads
8. Example of LV aneurism. STEMI should be called without old ECG.
9. Pacemaker. Note atrial and ventricular spikes. Also note complete concordance in all precordial leads. (All QRS complexes are negative in V1-V6).
10. LBBB with changes indicating MI.
11. LBBB
12. Obvious Aneriolateral & Septal MI
13. LVH
14. Obvious MI, as diagnosed by the monitor. Note the mean R-wave amplitude in V2-V4 is < 5mm.
15. MI. Reciprocal changes in inferior leads (downwardly concave ST-depression). Note how QRS complex merges into elevated ST-segment in V1 & V2. Unable to use mean R-wave amplitude rule due to V4 being cut off.