

American College of Cardiology
20th Congress 2017

**Observation Medicine ECG
Instructor Workshop – session 2**

**Serial 12 Lead ECG Interpretation
Part 1**

By: Wayne W Ruppert, CVT, CCCC, NREMT-P

This curriculum provides hospitals with a solution to an ongoing deficiency that many community hospital share:

“who reads the Serial ECGs when there are no physicians available?”

About this Curriculum:

This curriculum provides nurses with evidence-based education and recommended practices for identifying changes in serial ECGs, and identifying ECG changes consistent with Acute Coronary Syndrome.

Observation Medicine ECG Course

BASIS:

- **Current ACC/AHA Guidelines and Recommendations**
- **Multiple additional recent Evidence-Based Publications**
- **ECGs from case files of the author, Wayne Ruppert**
- **Graphic art / images from published textbooks authored by Wayne Ruppert**

Observation Medicine ECG Workshop

Version 1 - Today

- Acute Coronary Syndrome

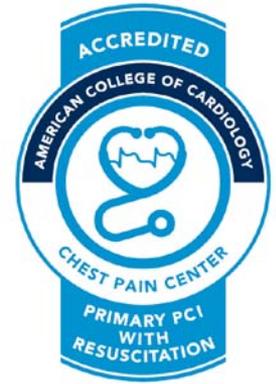
Observation Medicine ECG Workshop

Version 2 - Future

- Acute Coronary Syndrome
- Atrial Fibrillation
- Heart Failure
- QT syndrome abnormalities



**Bayfront Health
Dade City**



- **Wayne Ruppert, Cardiovascular Coordinator
Bayfront Health Dade City, Dade City, Florida
Community Health Systems**

Wayne Ruppert bio:

- Cardiovascular Coordinator 2012-present (coordinated 4 successful accreditations)
- Interventional Cardiovascular / Electrophysiology Technologist, 1995-Present.
- Author of: “[12 Lead ECG Interpretation in Acute Coronary Syndrome with Case Studies from the Cardiac Cath Lab](#),” 2010, TriGen publishing / Ingram Books
- Author of: “[STEMI Assistant](#),” 2014, TriGen publishing / Ingram Books
- Florida Nursing CE Provider # 50-12998
- 12 Lead ECG Instructor, 1994-present (multiple hospitals, USF College of Medicine 1994)
- Website: www.ECGtraining.org

To download this course, go to www.ECGtraining.org, select “Downloads PDF” then select download(s) desired:

WWW.ECGTRAINING.ORG

HELPFUL PDF DOWNLOADS

HOME

12 LEAD ECG IN ACS

STEMI ASSISTANT

ACCREDITATION

WORKSHOPS

ECG ID OF SADS

WORKSHOP OBJECTIVES

TEXTBOOKS

PHYSICIAN REVIEWS

BIO OF WAYNE RUPPERT

TESTIMONIALS

DOWNLOADS - PDF

HELPFUL INFORMATION

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[Download Sudden Cardiac Death Prevention - ACC / SCPC 19th Congress](#)

[Download Initial Stabilization of the Atrial Fib Patient - SCPC 19th Congress](#)

[Download QTc Monitoring Policy for Patients on QT Prolonging Meds](#)

[Download A-Fib / Flutter ER Physician's Order Set - BHDC](#)

[Download A-Fib / Flutter Flowchart Emerg Care BHDC](#)

[Download Team Driven Performance Improvement - SCPC 19th Congress](#)

[Download TDPI in Ambulance Industry Journal](#)

[Download TJC Sentinel Event Alert - Disruptive Physicians](#)

[Download ACLS 2015 Algorithm Cheat Sheets](#)

[Download 2015 ACLS Algorithms with ECG examples](#)

[Download Neighbors Saving Neighbors Program](#)

[Download Basic ECG Course with 2015 ACLS Algorithms](#)

[Download STEMI Assistant](#)

[Download ECG ID of SADS CONDITIONS](#)

[Download ECG Review of Hypertrophy](#)

[Download 14 Point AHA Screening Form for Genetic and Congenital Heart Conditions](#)

[Download Preoperative ECG Evaluation 2016](#)

[Download Perioperative Considerations for Patients with CIEDs](#)

[Download 12 Lead ECG in ACS Handout](#)

[Download LQTS in Anesthesia](#)



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All cardiovascular subject-related images, graphics and diagrams were created by the author, Wayne Ruppert, and have been taken from his two published textbooks, “[STEMI Assistant](#)” and “[12 Lead ECG Interpretation in ACS with Case Studies from the Cardiac Cath Lab](#),” are Copyright protected, and may not be removed from this PowerPoint presentation. This presentation may not be used as part of a profit-generating program without prior written consent from the author.

Wayneruppert@aol.com

Suggested **Prerequisite Knowledge:**

Basic ECG Rhythm Interpretation Skills.

This course does not teach how to interpret basic ECG rhythms. Although it is not necessary to know Basic ECG Rhythms to understand the material in this course, it is strongly suggested that this course be used as “the next level” of education for health care providers who are already proficient in basic single-lead ECG rhythm strip interpretation.

Objectives (Part 1):

- Review what recent evidence-based papers say about “non-physician interpreted ECGs”
- Discuss relevance, indications and evidence-based practices of Serial 12 Lead ECGs
- Risk Stratification in the LRCP and NSTEMI-ACS patient populations
- Review how to obtain a 12 and 18 lead ECG
- Review how to read the Baseline ECG

Role of the Nurse in Observation Medicine ECG Interpretation

- Patients transferred to Obs Units are typically no longer under care of the ED physician

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- **Smaller community hospitals often do not have in-house physicians at night, on weekends**

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- **Nurse 12 Lead ECG interpretation competency levels vary significantly**

Role of the Nurse in Observation Medicine ECG Interpretation

- Patients transferred to Obs Units are typically no longer under care of the ED physician
- Smaller community hospitals often do not have in-house physicians at night, on weekends
- Obs Unit nurses typically assess patients, review ECGs and decide if physician must be called
- Nurse 12 Lead ECG interpretation competency levels vary significantly
- **This course defines educational standards and competencies for nurses reading ECGs**

2015 AHA Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Nonphysician STEMI ECG Interpretation

“When physicians are not present or not available to interpret an ECG, other methods for interpretation must be used so that timely patient care is not adversely affected. The 2015 ILCOR systematic review examined whether nonphysicians such as paramedics and nurses could identify STEMI on an ECG so that earlier identification of STEMI could be made with acceptable rates of either underdiagnosis (false-negative results) or overdiagnosis (false-positive results).”

American Journal of Emergency Medicine, 2005
Jul;23(4):443-448

Real-time paramedic compared with blinded physician
identification of ST-segment elevation myocardial
infarction: results of an observational study.

“Paramedic sensitivity was 0.80 (95% CI, 0.64-0.96); specificity was 0.97 (95% CI, 0.94-1.00) with positive likelihood ratio of 25.2 and negative likelihood ratio of 0.21. Overall accuracy was similar for paramedic and physician reviewers (0.94, 0.93, 0.95). ***Highly trained paramedics in an urban emergency medical services system can identify patients with STEMI as accurately as blinded physician reviewers.***”

Additional References; the Nurse Interpreted ECG:

- “Improving nurses' ability to identify anatomic location and leads on 12-lead electrocardiograms with ST elevation myocardial infarction” M Pelter et al. / Euro J Cardiovasc Nurs: 9 (2010) 218-225
- Interpreting 12-lead electrocardiograms for acute ST-elevation myocardial infarction: what nurses know” Stephens et al. J Cardiovasc Nurs 2007 May-Jun;22(3):186-193

Serial ECGs

“The practice of obtaining multiple ECGs at different points in time for the purpose of identifying dynamic changes to waveforms that could signify evolving Acute Coronary Syndrome and/or other potentially dangerous conditions.”

Serial ECGs

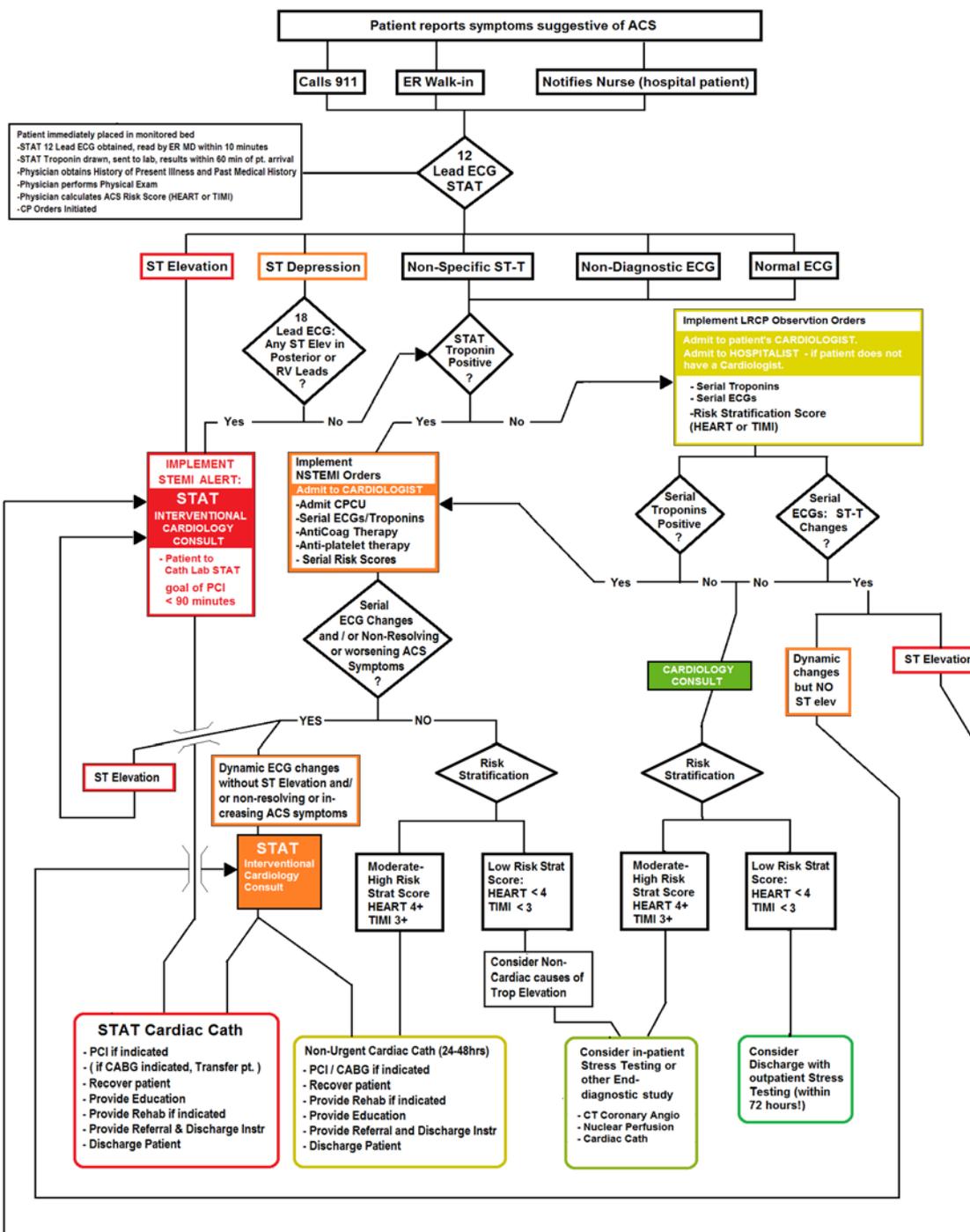
- Multiple evidence-based publications spanning several decades have validated the usefulness of Serial ECGs for diagnosing the presence of ACS.
 - [Fesmire et al, *Ann Emerg Med* Jan 1998;31:3-11](#)
 - [Amsterdam et al, *AHA Circulation*. 2010;122:1756-1776](#)

Serial ECGs in the Evaluation of ACS

- **Low Risk Chest Pain patients in the Observation Unit**
 - Diagnose ACS

Serial ECGs in the Evaluation of ACS

- **Low Risk Chest Pain patients in the Observation Unit**
 - Diagnose ACS
- **NSTE-ACS patients**
 - Determine degree of patient condition stability and the need for urgent cardiac catheterization



Patient reports symptoms suggestive of ACS

Calls 911

ER Walk-in

Notifies Nurse (hospital patient)

Patient immediately placed in monitored bed
-STAT 12 Lead ECG obtained, read by ER MD within 10 minutes
-STAT Troponin drawn, sent to lab, results within 60 min of pt. arrival
-Physician obtains History of Present Illness and Past Medical History
-Physician performs Physical Exam
-Physician calculates ACS Risk Score (HEART or TIMI)
-CP Orders Initiated

12 Lead ECG STAT

ST Elevation

ST Depression

Non-Specific ST-T

Non-Diagnostic ECG

Normal ECG

18 Lead ECG: Any ST Elev in Posterior or RV Leads ?

STAT Troponin Positive ?

Implement LRPC Observation Orders
Admit to patient's CARDIOLOGIST.
Admit to HOSPITALIST - if patient does not have a Cardiologist.
- Serial Troponins
- Serial ECGs
- Risk Stratification Score (HEART or TIMI)

IMPLEMENT STEMI ALERT: STAT INTERVENTIONAL CARDIOLOGY CONSULT
- Patient to Cath Lab STAT goal of PCI < 90 minutes

Implement NSTEMI Orders Admit to CARDIOLOGIST
- Admit CPCU
- Serial ECGs/Troponins
- AntiCoag Therapy
- Anti-platelet therapy
- Serial Risk Scores

Serial ECG Changes and / or Non-Resolving or worsening ACS Symptoms ?

Serial Troponins Positive ?

Serial ECGs: ST-T Changes ?

CARDIOLOGY CONSULT

Dynamic changes but NO ST elev

ST Elevation

Yes

No

Yes

No

Yes

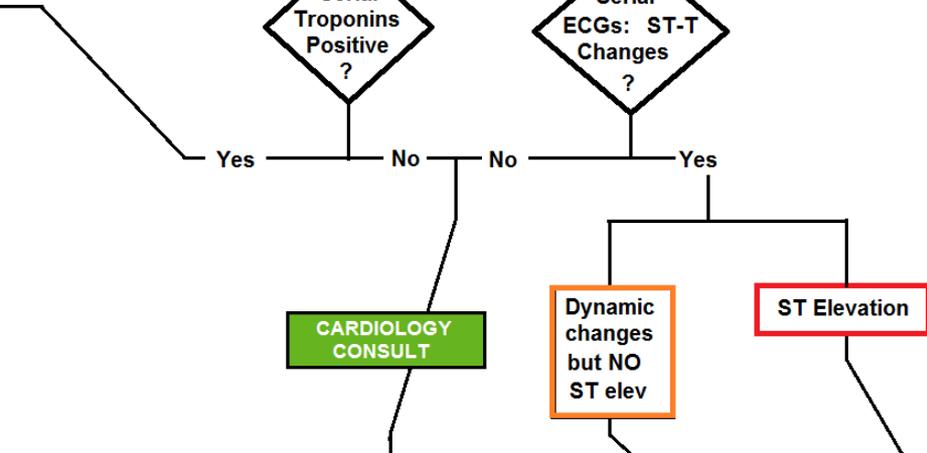
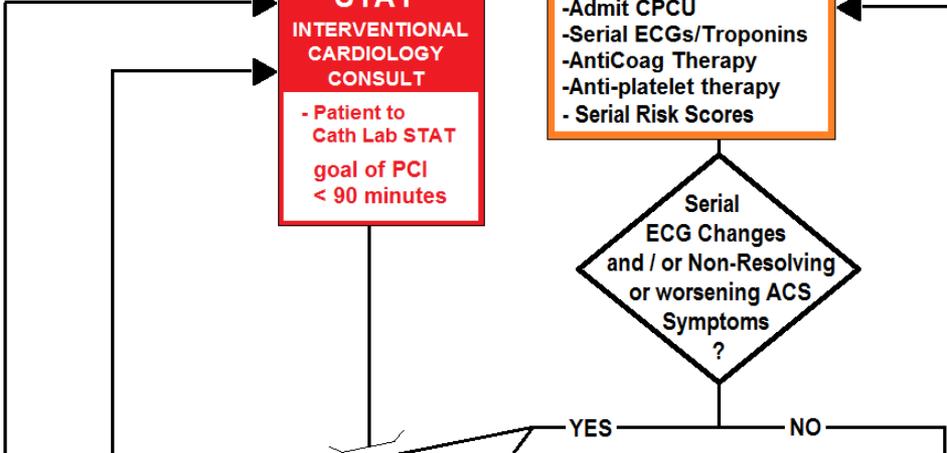
No

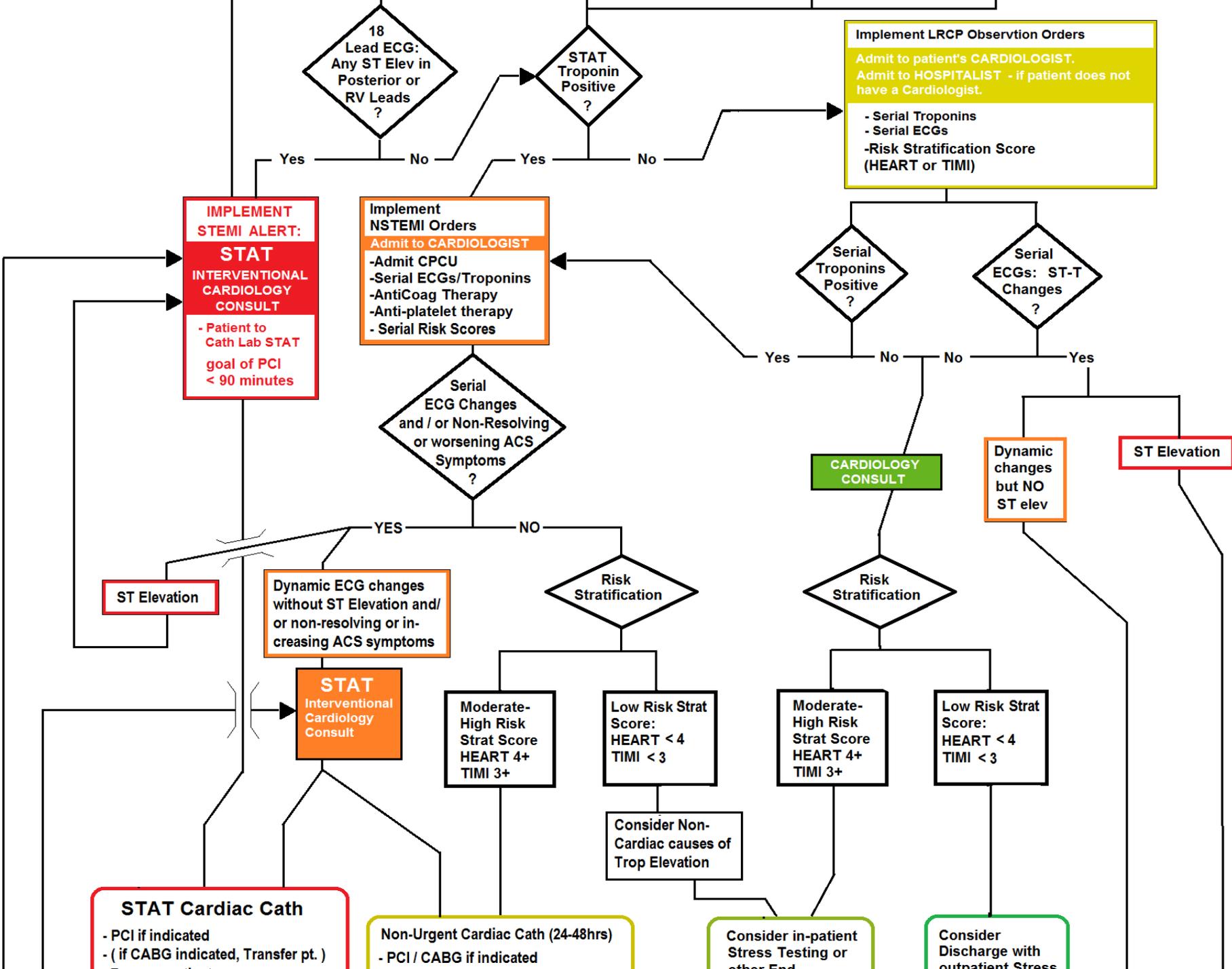
No

Yes

YES

NO





18 Lead ECG: Any ST Elev in Posterior or RV Leads ?

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Implement LRPC Observation Orders
 Admit to patient's **CARDIOLOGIST**.
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 - Risk Stratification Score (HEART or TIMI)

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Serial Troponins Positive ?

Serial ECGs: ST-T Changes ?

Serial ECG Changes and / or Non-Resolving or worsening ACS Symptoms ?

CARDIOLOGY CONSULT

Dynamic changes but NO ST elev

ST Elevation

ST Elevation

Dynamic ECG changes without ST Elevation and/ or non-resolving or increasing ACS symptoms

Risk Stratification

Risk Stratification

STAT Interventonal Cardiology Consult

Moderate-High Risk Strat Score
 HEART 4+
 TIMI 3+

Low Risk Strat Score:
 HEART < 4
 TIMI < 3

Moderate-High Risk Strat Score
 HEART 4+
 TIMI 3+

Low Risk Strat Score:
 HEART < 4
 TIMI < 3

Consider Non-Cardiac causes of Trop Elevation

STAT Cardiac Cath
 - PCI if indicated
 - (if CABG indicated, Transfer pt.)

Non-Urgent Cardiac Cath (24-48hrs)
 - PCI / CABG if indicated

Consider in-patient Stress Testing or other End

Consider Discharge with outpatient Stress

Download Universal ACS Flowchart

This will download in PNG (photographic image) format. You can edit and make changes using the “Paint” program, which is a free app found on every Windows computer.

Serial ECG Objectives:

- Identify DYNAMIC ST-T Wave changes
- Identify STEMI
- Identify rate / rhythm changes, and all other ECG changes.
- [Download Sample “Serial ECGs / Troponins & Management of LRCP Patient” Protocol](#)

Serial ECG Strategy for the Observation Unit:

Patients WITHOUT ACS symptoms:

- **“0-3-6” strategy.** (0 = ECG upon arrival at ED, then repeat ECGs at 3 and 6 hours).
Recommendation: DO ECGs and TROPONINS at same time (0-3-6 hours)
- **If ACS symptoms develop, do STAT 12 Lead ECG and follow Acute Chest Pain Protocol (download example)**

Serial ECG Strategy for the Observation Unit (ACS):

Patients WITH symptoms of ACS:

- Obtain and interpret initial 12 Lead ECG within 10 minutes of patient arrival /symptom onset.
- If available, implement Continuous 12 Lead ECG / ST-segment monitoring. *Otherwise . . .*
- If initial ECG is negative, but ACS symptoms persist, “*repeat ECGs (eg, 5- to 10-minute intervals) have been recommended, because serial changes of ischemia or injury may evolve.*” [Amsterdam et al, “Testing of Low Risk Patients Presenting to the ED with Chest Pain, Circulation 2010;122:1756-1776”](#)

“Nurse-reviewed SERIAL ECGs” – *what are we talking about ?*

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- **A PHYSICIAN has formally interpreted the FIRST 12 Lead ECG.**

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- This curriculum teaches a NURSE how to COMPARE the 2nd, 3rd, and all subsequently obtained ECGs to the initial **PHYSICIAN-INTERPRETED ECG.**

“Nurse-reviewed SERIAL ECGs” –

what are we talking about ?

- A PHYSICIAN has formally interpreted the FIRST 12 Lead ECG.
- This curriculum teaches a NURSE how to COMPARE the 2nd, 3rd, and all subsequently obtained ECGs to the initial **PHYSICIAN-INTERPRETED ECG.**
- This curriculum reviews commonly noted ECG markers of Acute Coronary Syndrome (ACS)

***Before we start,
you should know . . .***

***Sometimes,
ECGs
LIE to us !***

***ECGs and USED CAR SALESMEN
often have MUCH in common !***



THE ECG in PERSPECTIVE:

PROBLEMS with ECG:

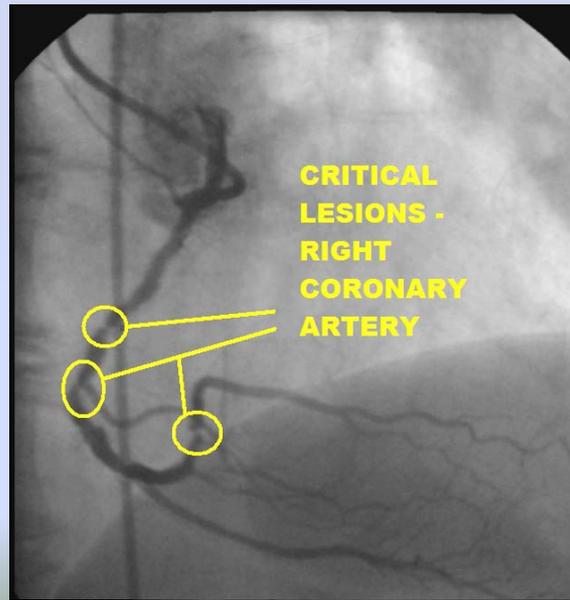
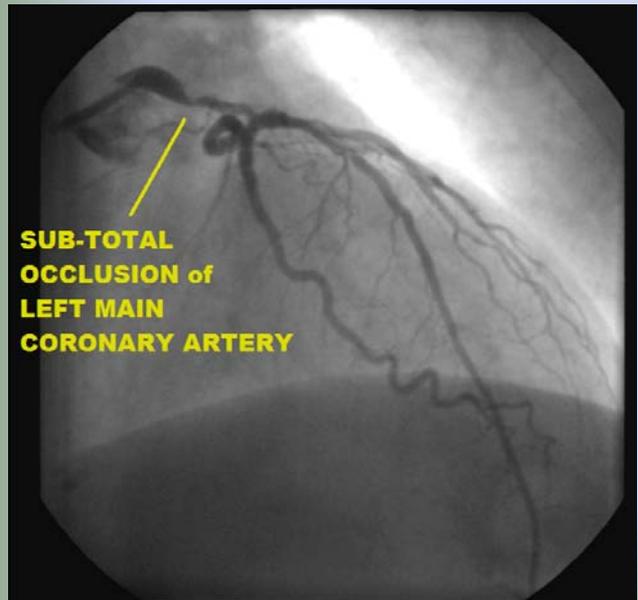
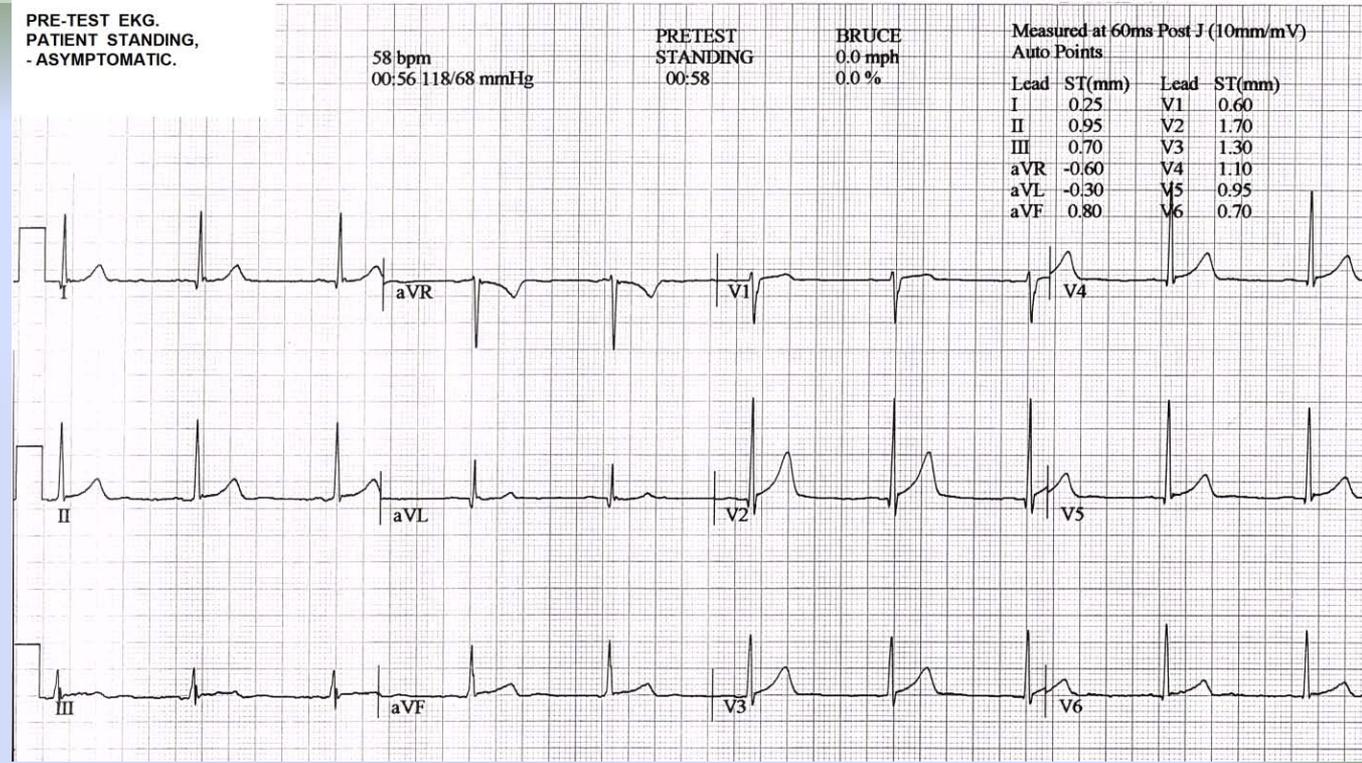
↓ SENSITIVITY
(FALSE NEGATIVES)

↓ SPECIFICITY
(FALSE POSITIVES)

PROBLEMS WITH SENSITIVITY . . .

NORMAL ECG.

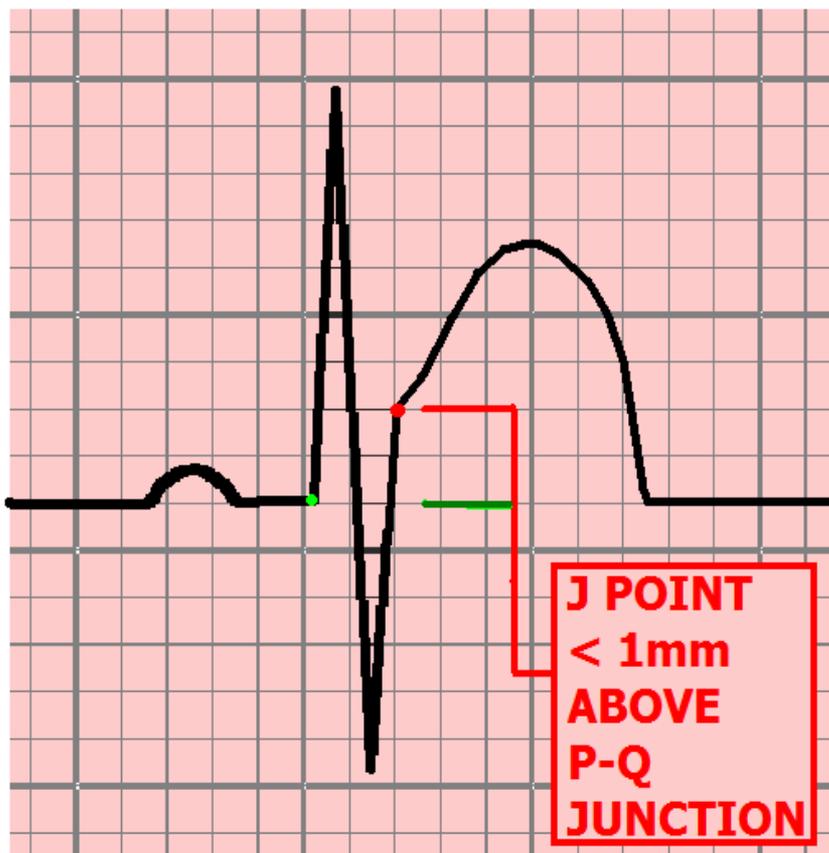
But



LETHAL TRIPLE VESSEL DISEASE

PROBLEMS WITH SPECIFICITY . . .

S-T SEGMENT ELEVATION - COMMON ETIOLOGIES:



CONDITION:

- **ACUTE INFARCTION**
- **HYPERKALEMIA**
- **BRUGADA SYNDROME**
- **PULMONARY EMBOLUS**
- **INTRACRANIAL BLEED**
- **MYOCARDITIS / PERICARDITIS**
- **L. VENT. HYPERTROPHY**
- **PRINZMETAL'S ANGINA**
- **L. BUNDLE BRANCH BLOCK**
- **PACED RHYTHM**
- **EARLY REPOLARIZATION & "MALE PATTERN" S-T ELEV.**

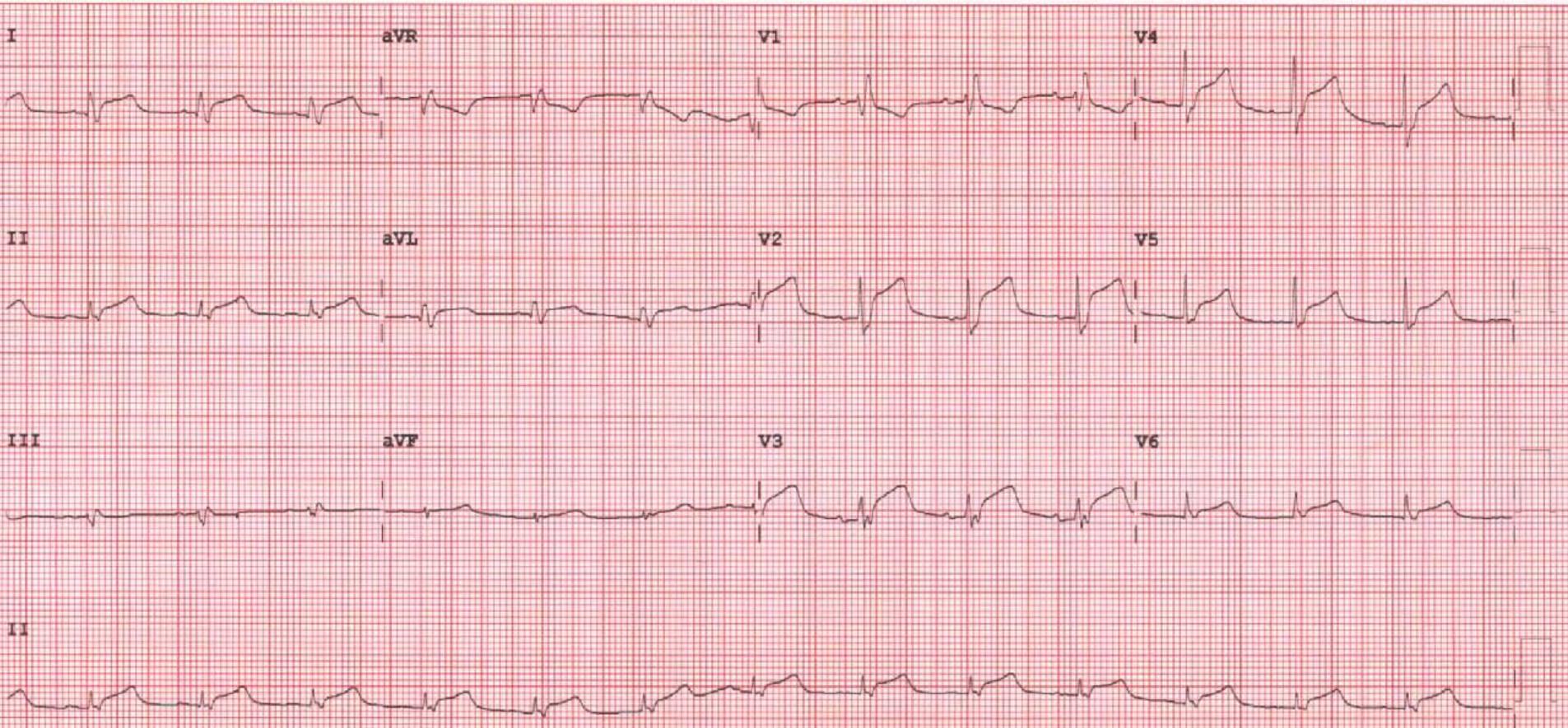
Rate 83 . SINUS RHYTHM.....normal P axis, V-rate 50- 99
 . RIGHT BUNDLE BRANCH BLOCK.....QRSD>120, terminal axis(90,270)
 PR 152 . ANTEROLATERAL INFARCT, ACUTE.....Q >35mS, ST >0.20mV, V2-V6
 QRSD 122
 QT 412
 QTc 485

FAXED
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 J

--AXIS--
 P 59
 QRS 14
 T 33
 12 Lead; Standard Placement

- ABNORMAL ECG -
 >>> Acute MI <<<

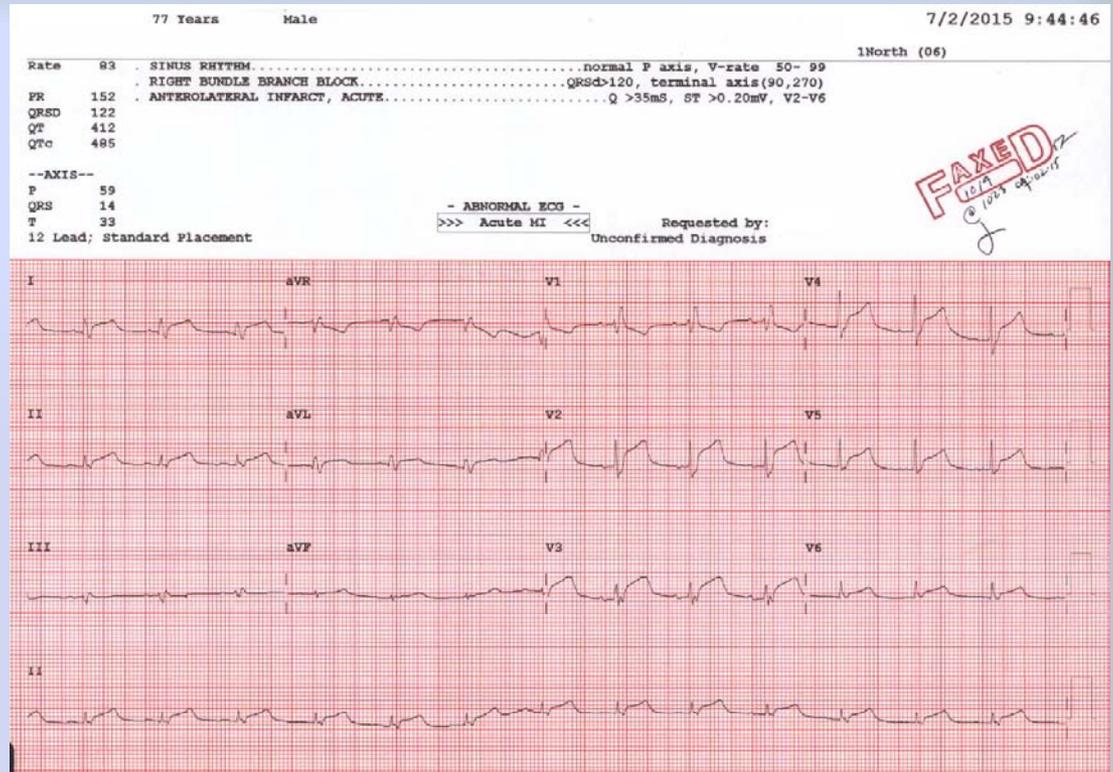
Requested by:
 Unconfirmed Diagnosis



Patient:

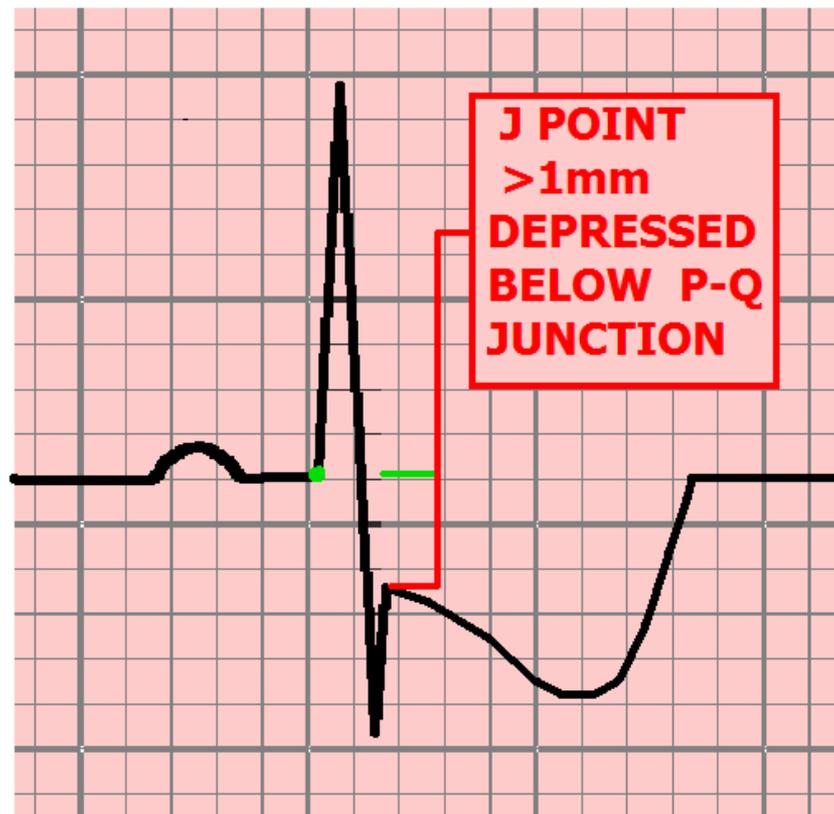
- Asymptomatic
- Troponin normal
- Cardiac Cath angiography = “no obstructive CAD.”
- Discharge diagnosis:

EARLY REPOLARIZATION. This degree of ST Elevation in early repolarization is **VERY RARE:** The only such ECG I have seen in approximately 13,000 cardiac catheterizations.



PROBLEMS WITH SPECIFICITY . . .

S-T SEGMENT DEPRESSION - COMMON ETIOLOGIES:



CONDITION:

- **RECIPROCAL CHANGES of ACUTE MI**
- **NON-Q WAVE M.I. (NON-STEMI)**
- **ISCHEMIA**
- **POSITIVE STRESS TEST**
- **VENTRICULAR HYPERTROPHY (STRAIN PATTERN)**
- **WOLFF-PARKINSON-WHITE**
- **OLD MI (NECROSIS vs. ISCHEMIA)**
- **DIGITALIS**
- **R. BUNDLE BRANCH BLOCK**

PROBLEMS WITH SPECIFICITY . . .

T WAVE INVERSION - COMMON ETIOLOGIES:



CONDITION:

- **MYOCARDITIS**
- **ELECTROLYTE IMBALANCE**
- **ISCHEMIA**
- **POSITIVE STRESS TEST**
- **CEREBRAL DISORDER**
- **MITRAL VALVE PROLAPSE**
- **VENTRICULAR HYPERTROPHY**
- **WOLFF-PARKINSON-WHITE**
- **HYPERVERTILATION**
- **CARDIOACTIVE DRUGS**
- **OLD MI (NECROSIS vs. ISCHEMIA)**
- **DIGITALIS**
- **R. BUNDLE BRANCH BLOCK**
- **NO OBVIOUS CAUSE**

PROBLEMS WITH SPECIFICITY . . .

HYPER-ACUTE T WAVES - COMMON ETIOLOGIES:



CONDITION:

-  **HYPERKALEMIA**
-  **ACUTE MI**
-  **TRANSMURAL ISCHEMIA**
-  **HYPERTROPHY**

**Despite the ECG's problematic
issues with**

Lack of Sensitivity

&

Lack of Specificity,

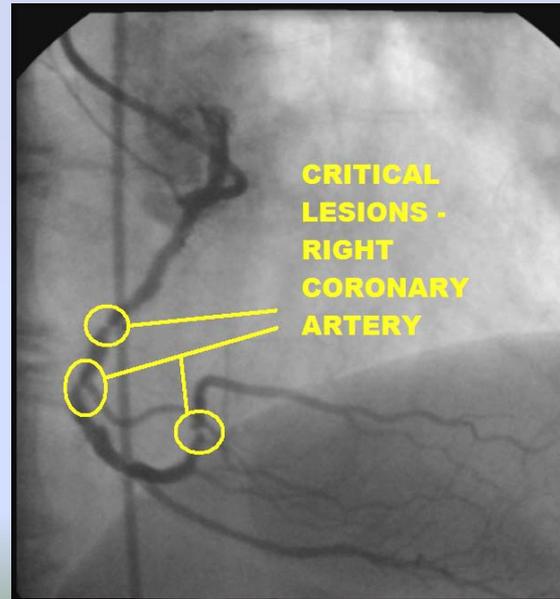
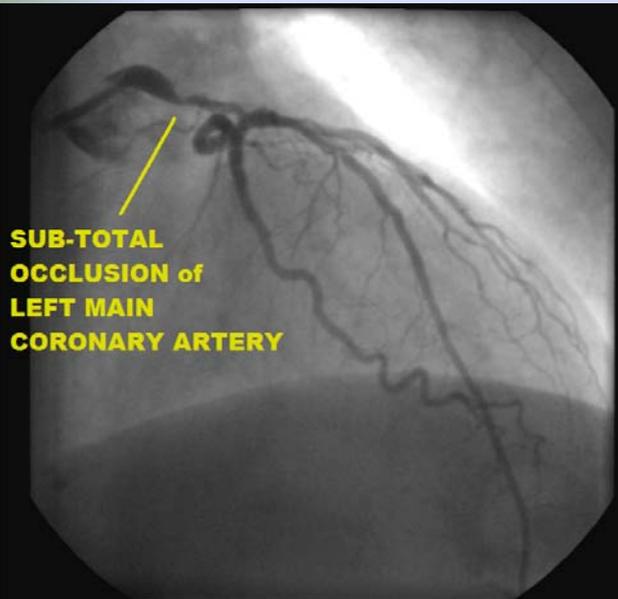
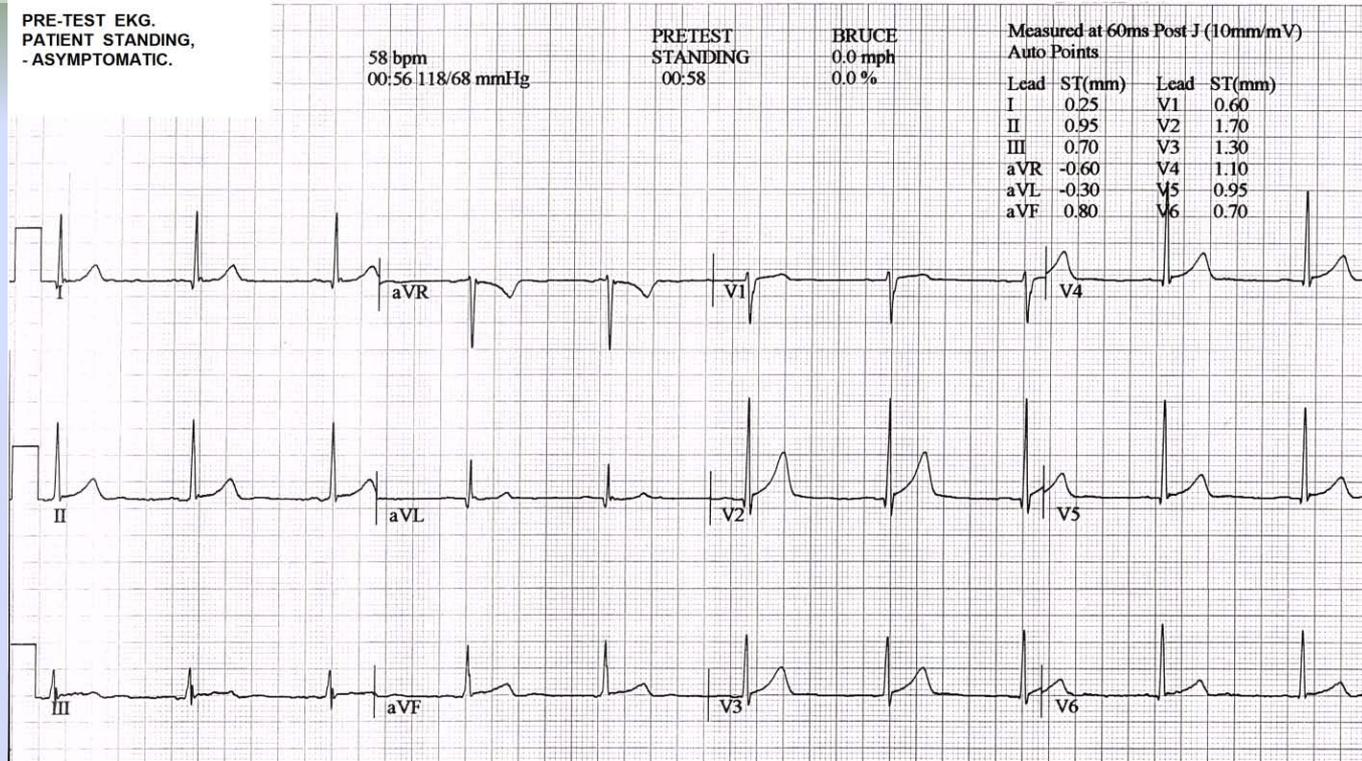
***The 12 Lead ECG remains
one of our QUICKEST, most cost-
efficient front-line Triage Tools
that we have today.***

- ***We utilize ACS Risk Stratification to compensate for the ECG's lack of sensitivity and specificity, to aid us in clinical decision-making and to improve our diagnostic accuracy.***



NORMAL ECG.

Advanced TRIPLE VESSEL DISEASE



HEART SCORE:

5

**Outcome: Successful
Emergency Bypass Surgery**

HEART

HEART score for chest pain patients			
History	Highly suspicious	2	
	Moderately suspicious	1	
	Slightly suspicious	0	
ECG	Significant ST-deviation	2	
	Non specific repolarisation disturbance / LBTB / PM	1	
	Normal	0	
Age	≥ 65 years	2	
	> 45 and < 65 years	1	
	≤ 45 years	0	
Risk factors	≥ 3 risk factors or history of atherosclerotic disease*	2	
	1 or 2 risk factors	1	
	No risk factors known	0	
Troponin	≥ 3x normal limit	2	
	> 1 and < 3x normal limit	1	
	≤ 1x normal limit	0	
		Total	

*Risk factors for atherosclerotic disease:

Hypercholesterolemia	Cigarette smoking
Hypertension	Positive family history
Diabetes Mellitus	Obesity

H = chest pain = 2

E = ECG normal = 0

A = 63 = 1

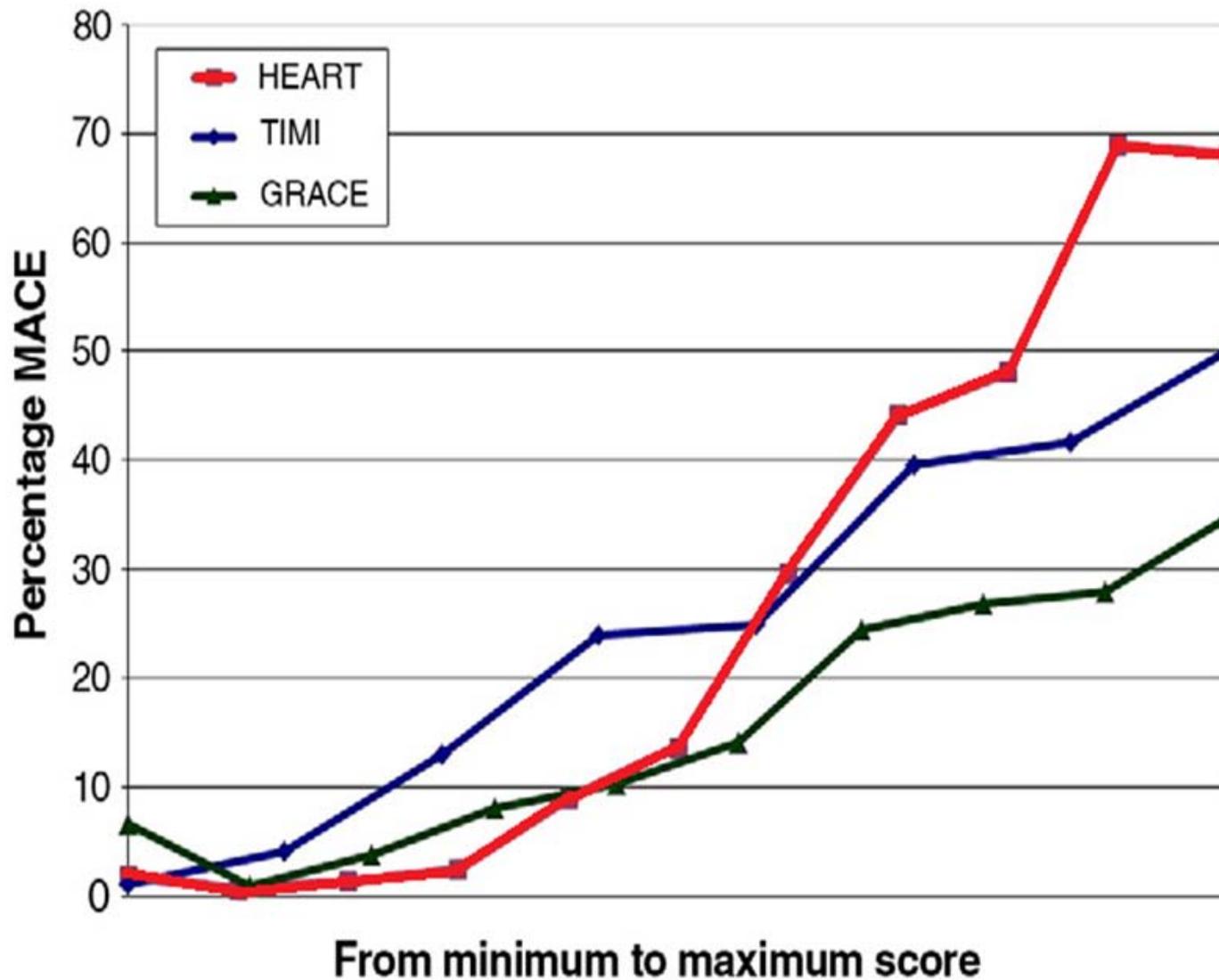
R = 3 risk factors = 2

T = Trop. NL = 0

HEART Score: = 5

TIMI Score = 2

Comparison of PREDICTIVE RELIABILITY of the HEART SCORE to the Modified TIMI and GRACE ACS Risk Scores:



C-Statistic scores achieved in this study:

HEART: 0.83

TIMI: 0.75

GRACE: 0.70

C-Statistic interpretation:

A score of “1.00” would mean the score predicts outcome with 100% perfection. A score of 0.50 is the same as a “50/50 coin toss.” A score of LESS THAN 0.50 means that the score predicts the opposite outcome.

HEART vs. TIMI vs. GRACE

“The overall summary of the HEART Score is that it demonstrates superior predictive power over the TIMI and GRACE Scores in both ends of the scale. Patients with high HEART Scores had higher incidence of needing PCI or CABG, and those with lower HEART Scores had much lower rates of MACE.”

ACS Risk Stratification –

Evidence Based Practices:

- Mahler et al. Circulation Outcomes 2015 The HEART Pathway – Randomized Trial
- Backus BE, Six AJ et al. Crit Path Cardiol 2010 Chest Pain in the ER: Validation of HEART Score
- Backus BE, Six AJ et al. Int J Cardiol 2013 Prospective Validation of HEART Score in Emerg Dept
- MacDonald et al. Emerg Med J 2014 Modified TIMI Cannot be Used to ID Low Risk CP in Emerg Dept

ACS Risk Stratification:

Is recommended for:

- **NSTE-ACS:** CLASS 1 Recommendation as per the 2014 AHA/ACC Guidelines for Management of Patients with NSTEMI ACS.
- **Low Risk Chest Pain:**

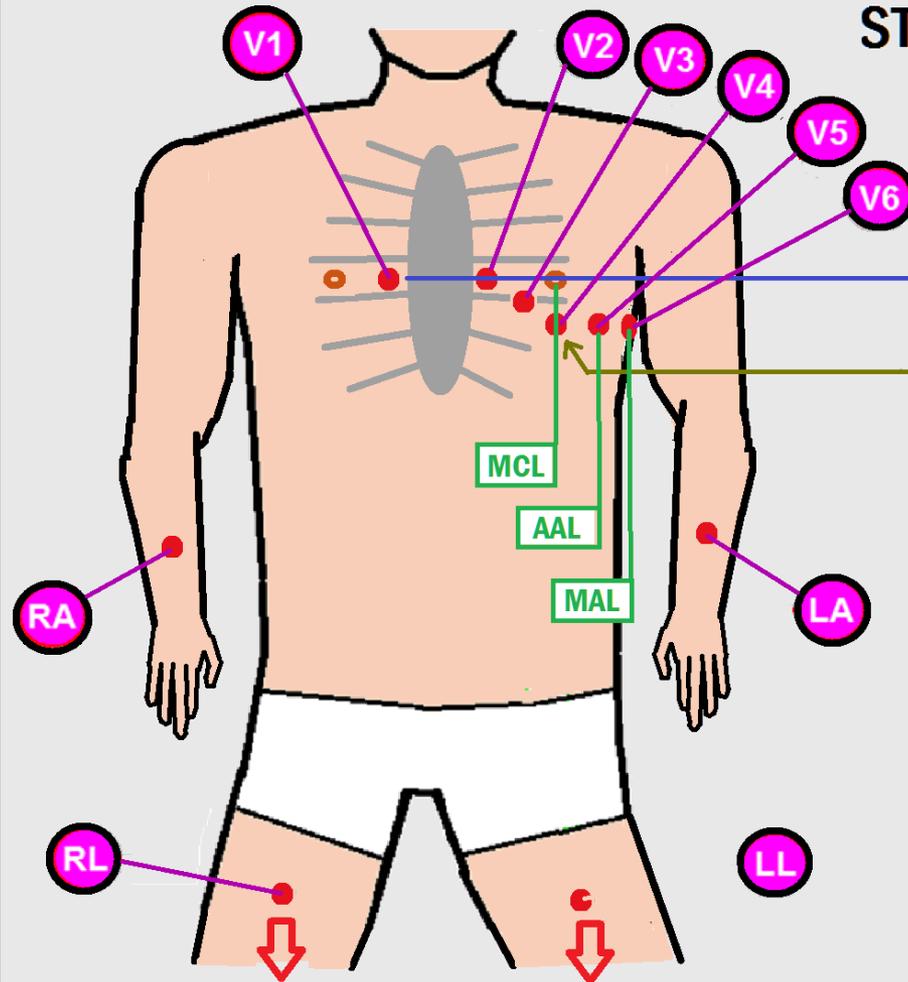
ACS Risk Stratification:

- **NOT recommended for STEMI. Per Dr. Barbra Backus, HEART Score Inventor**, during an in-person conversation I had with her at the 2015 AHA Scientific Sessions in Orlando, FL:

“Taking time to calculate a Risk Stratification Score in STEMI is delaying reperfusion”

**OBTAINING
THE
12 LEAD ECG**

Obtaining the 12 Lead ECG



STANDARD LEAD PLACEMENT --- 12 LEAD ECG

4 th INTERCOSTAL SPACE

V4 is at 5th INTERCOSTAL SPACE. V5 & V6 are on the SAME HORIZONTAL PLANE.

- PATIENT SHOULD LAY AS FLAT AS POSSIBLE
- LIMB LEADS SHOULD BE PLACED AS DISTALLY AS POSSIBLE

Obtaining the 12 Lead ECG

- **Limb leads should be on the limbs.**

Obtaining the 12 Lead ECG

- Limb leads should be on the limbs.
- **When emergency circumstances dictate that limb leads be placed on patient's torso, the words "LIMB LEADS ON PATIENT'S TORSO" should be noted on the ECG.**

Obtaining the 12 Lead ECG

Recent AHA/ACC/HRS literature indicates QRS AMPLITUDE, Q WAVE DURATION, AXIS and WAVEFORM DEFLECTION can be altered when limb leads are placed on the patient's torso (Mason-Likar lead placement).

Therefore every effort should be made to place limb leads on the limbs.

AHA/ACC/HRS Scientific Statement

Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

affected by monitoring lead placement; however, tracings that use torso electrodes differ in important ways from the standard 12-lead ECG. In addition to body position differences that affect the ECG,¹⁰⁹ monitoring electrodes placed on the trunk do not provide standard limb leads, and distortion of the central terminal alters the augmented limb leads and the precordial leads.^{110,111} Tracings with Mason-Likar and other alternative lead placement may affect QRS morphology more than repolarization compared with the standard ECG; these differences can include false-negative and false-positive infarction criteria.^{81,112} Motion artifact of the limbs is a particular problem for routine recording in neonates, infants, and

AHA/ACC/HRS Scientific Statement

Recommendations for the Standardization and Interpretation of the Electrocardiogram Part I: The Electrocardiogram and Its Technology

Recommendations

ECGs recorded with torso placement of the extremity electrodes cannot be considered equivalent to standard ECGs for all purposes and should not be used interchangeably with standard ECGs for serial comparison. Evaluation of the effect of torso placement of limb leads on waveform amplitudes and

Leads V1 & V2 on 12 Lead ECG:

- **Proper lead placement of precordial Leads V1 and V2 are 4th intercostal space on opposite sides of the sternum.**
- **Incorrect placement of Leads V1 and V2 will result in: reduction of R wave amplitude (resulting in poor R wave progression) leading to misdiagnosis of previous anterior / septal infarction.**

AHA/ACC/HRS Scientific Statement

Recommendations for the Standardization and Interpretation of the Electrocardiogram

Part I: The Electrocardiogram and Its Technology

the often profound alterations in waveforms that can result from precordial electrode misplacement.^{85,86} A common error is superior misplacement of V_1 and V_2 in the second or third intercostal space. This can result in reduction of initial R-wave amplitude in these leads, approximating 0.1 mV per interspace, which can cause poor R-wave progression or erroneous signs of anterior infarction.⁸⁷ Superior displacement of the V_1 and V_2 electrodes will often result in rSr' complexes with T-wave inversion, resembling the complex in lead aVR. It also has been shown that in patients with low diaphragm position, as in obstructive pulmonary disease,^{88,89}

Initial 12 Lead ECG

- **Obtain and interpret within 10 minutes of patient presentation**

Initial 12 Lead ECG

- Obtain and interpret within 10 minutes of patient presentation
- **Interpreted by physician / advanced practitioner**

Initial 12 Lead ECG

- Obtain and interpret within 10 minutes of patient presentation
- Interpreted by physician / advanced practitioner
- **Determines presence of STEMI and/or other imminent life-threatening condition**

Initial 12 Lead ECG

- Obtain and interpret within 10 minutes of patient presentation
- Interpreted by physician / advanced practitioner
- Determines presence of STEMI and/or other imminent life-threatening condition
- **Should be compared to any previously recorded ECGs in the patient's medical records**

Initial 12 Lead ECG, continued:

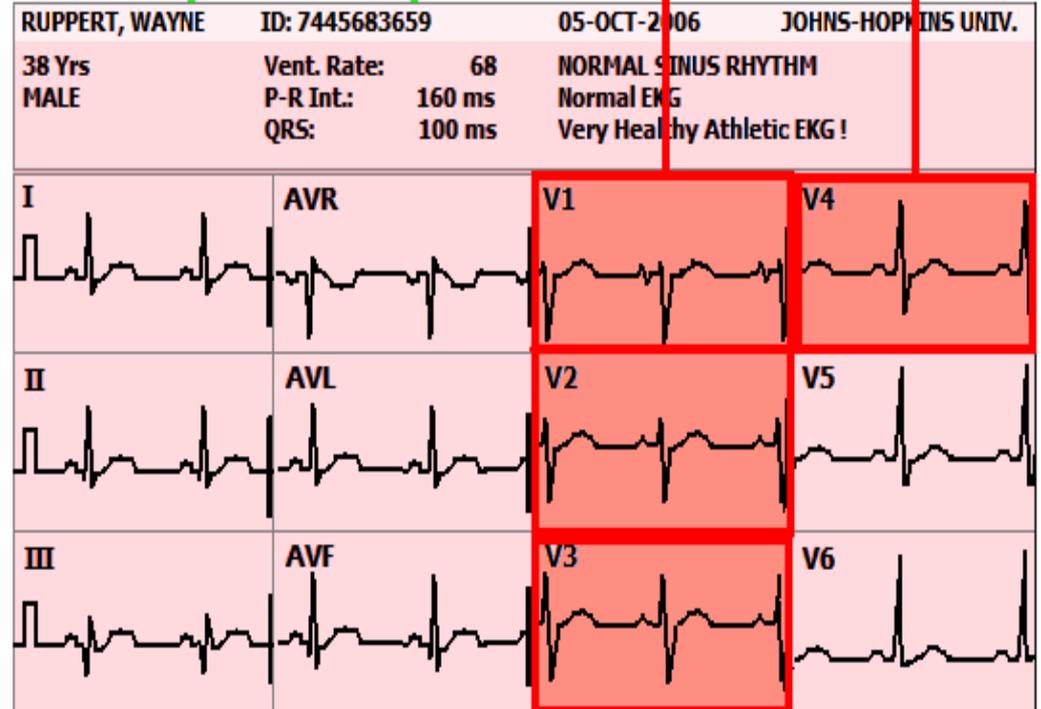
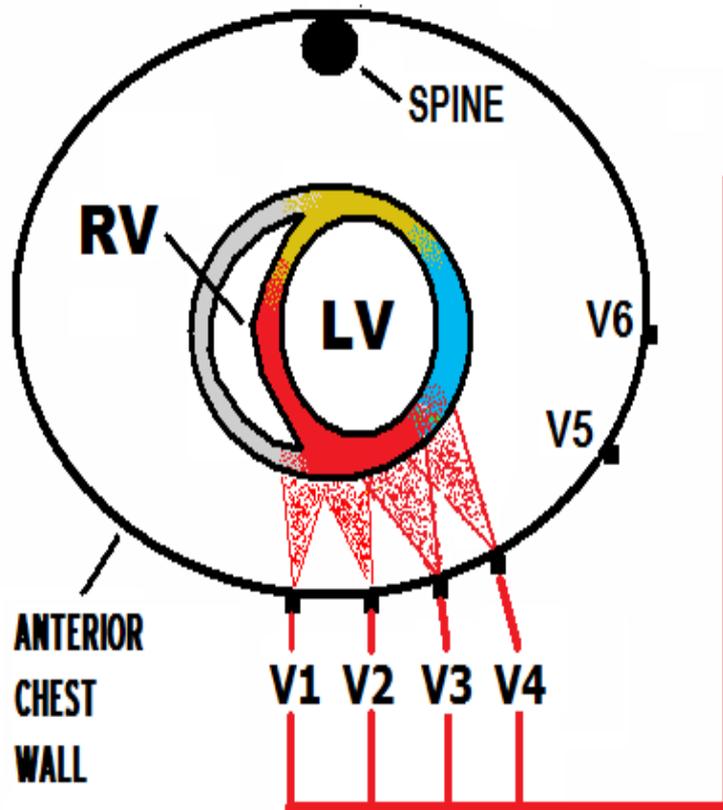
- **Additional Serial ECGs should be compared to the BASELINE ECG for determining the presence of Dynamic J Point, ST-Segment and T Wave Changes**

Initial 12 Lead ECG, continued:

- Additional Serial ECGs should be compared to the BASELINE ECG for determining the presence of Dynamic J Point, ST-Segment and T Wave Changes
- **Serves as “footprint” for determining ECG lead(s) to be used during Continuous ECG Monitoring**
 - Ischemia
 - QT interval

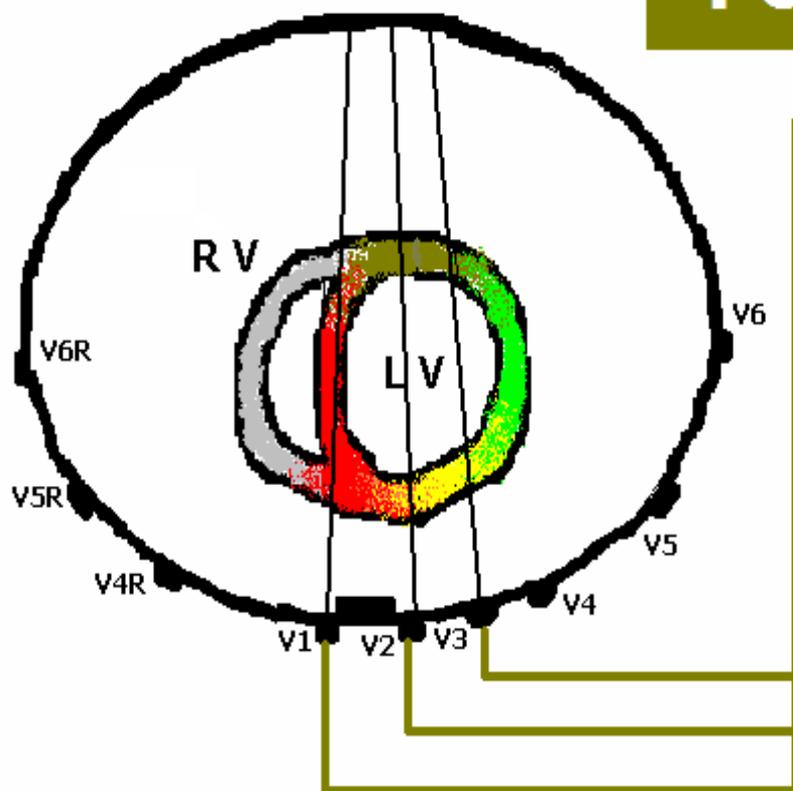
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL of the LEFT VENTRICLE

V1, V2 - ANTERIOR / SEPTAL
V3, V4 - ANTERIOR

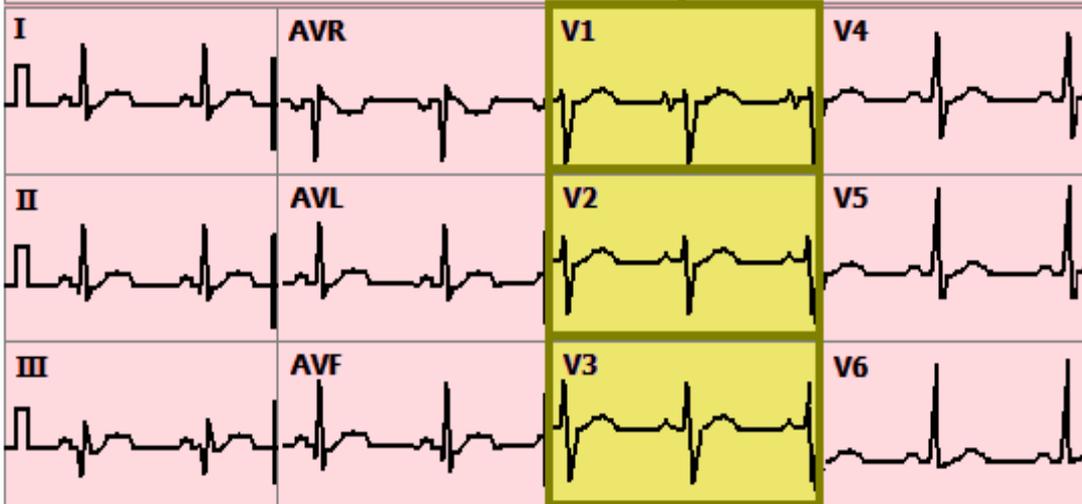


LEADS V1 - V3 *view the*

POSTERIOR WALL



RUPPERT, WAYNE	ID: 7445683659	05-OCT-2006	JOHNS-HOPKINS UNIV.
38 Yrs MALE	Vent. Rate: 68 P-R Int.: 160 ms QRS: 100 ms	NORMAL SINUS RHYTHM Normal EKG Very Healthy Athletic EKG !	

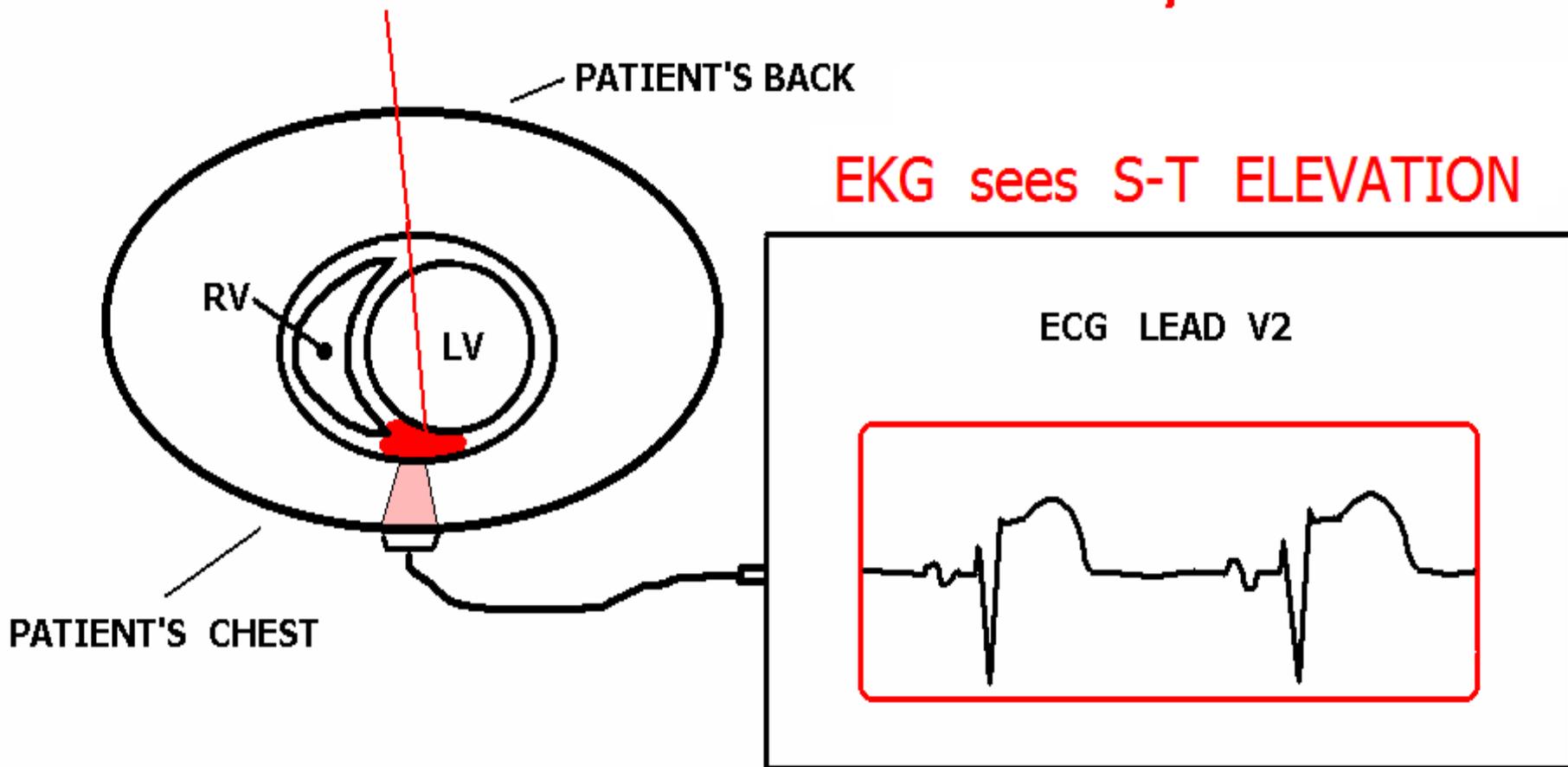


via **RECIPROCAL CHANGES.**

HOW EKG VIEWS INDICATIVE CHANGES

EXAMPLE:

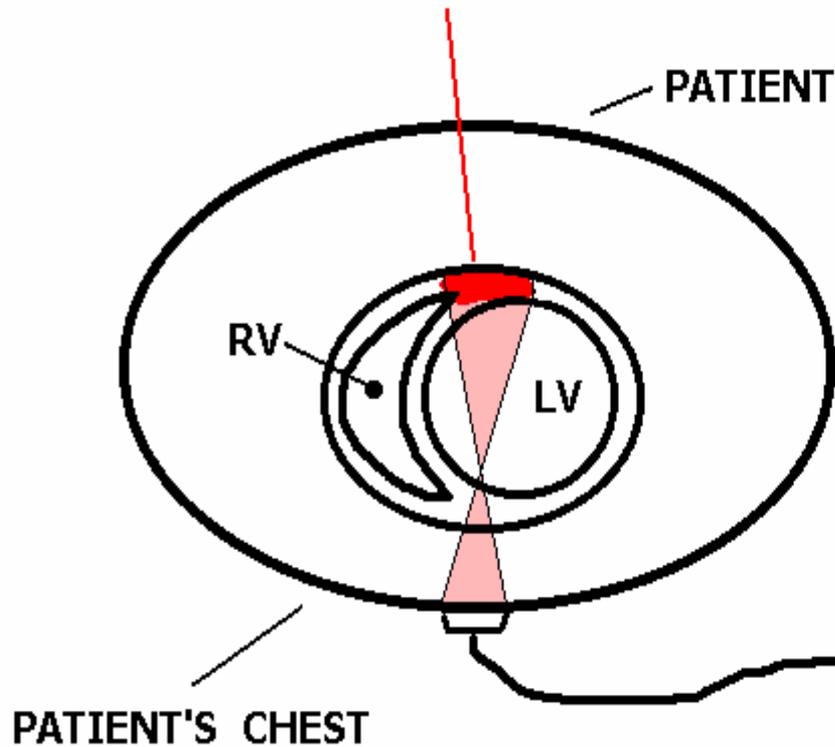
AREA OF ACUTE INFARCTION - ANTERIOR/SEPTAL



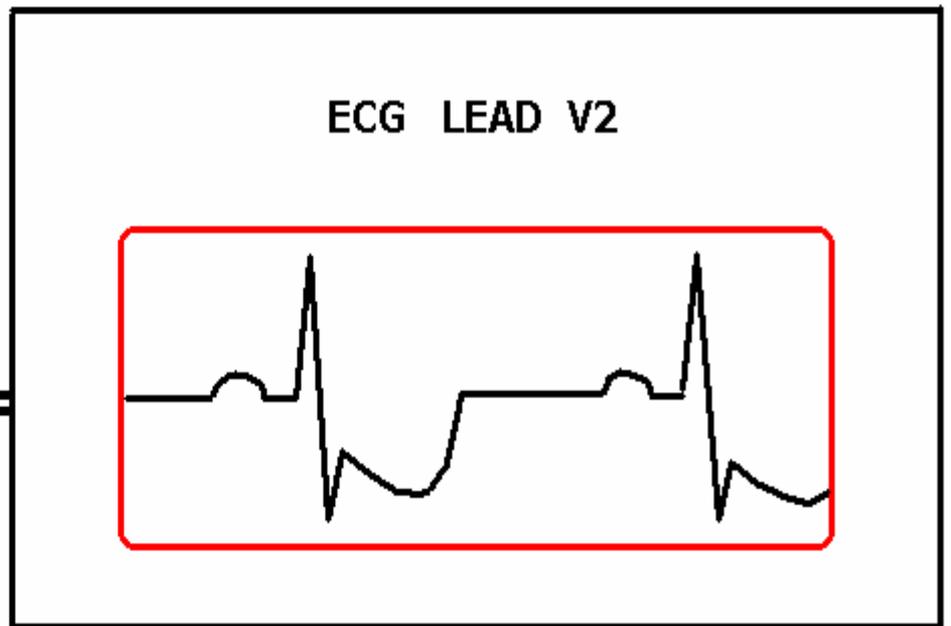
HOW EKG VIEWS RECIPROCAL CHANGES

EXAMPLE:

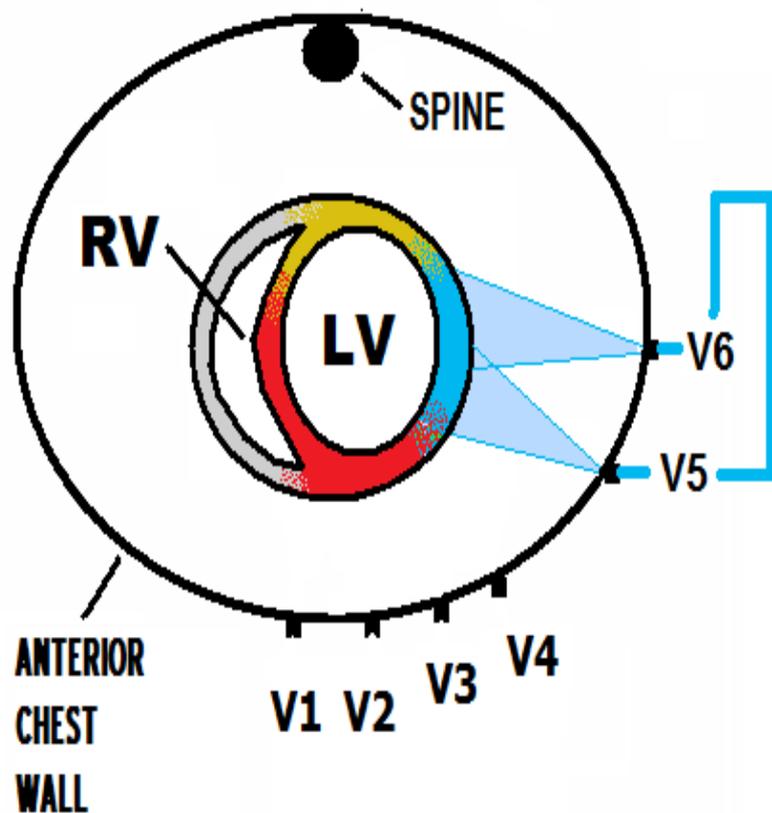
AREA OF ACUTE INFARCTION - POSTERIOR WALL



EKG sees S-T DEPRESSION

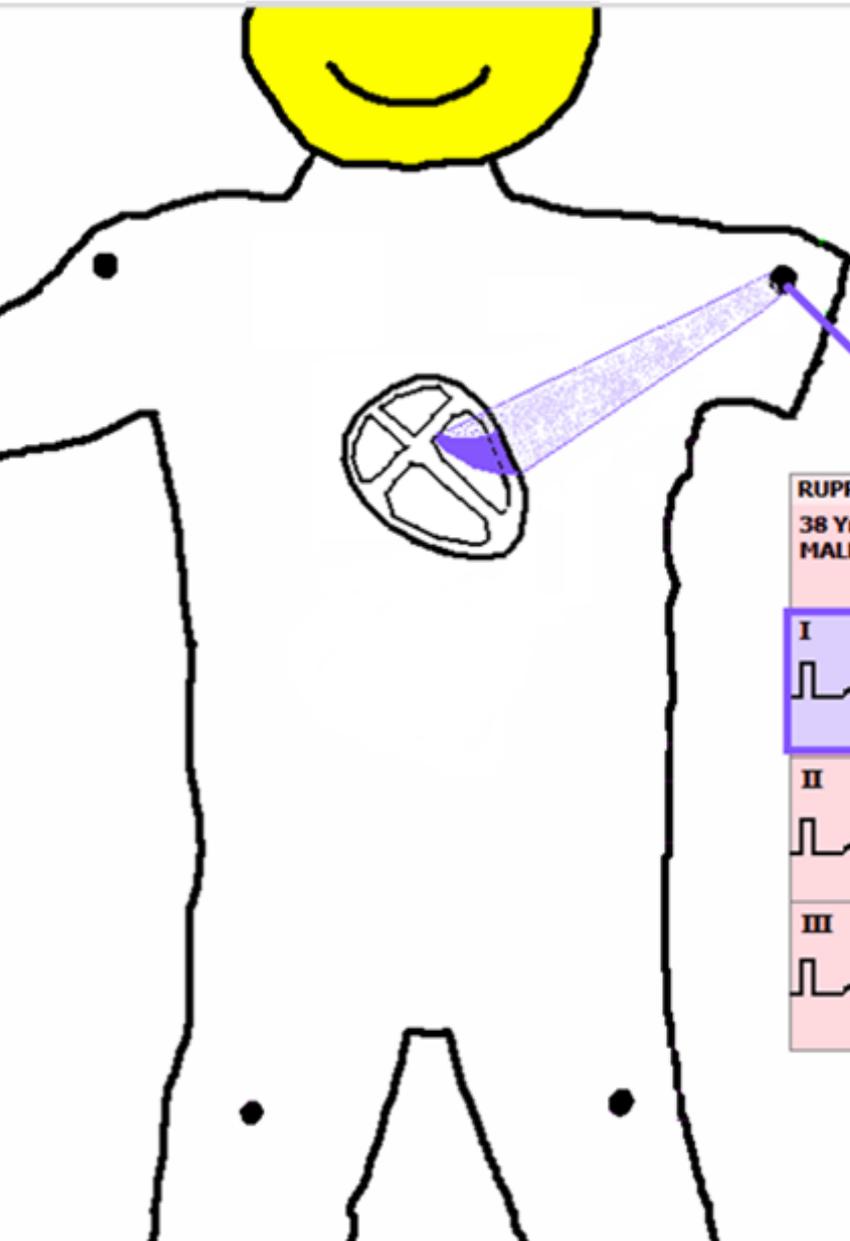


V5 - V6 VIEW THE LATERAL WALL of the LEFT VENTRICLE



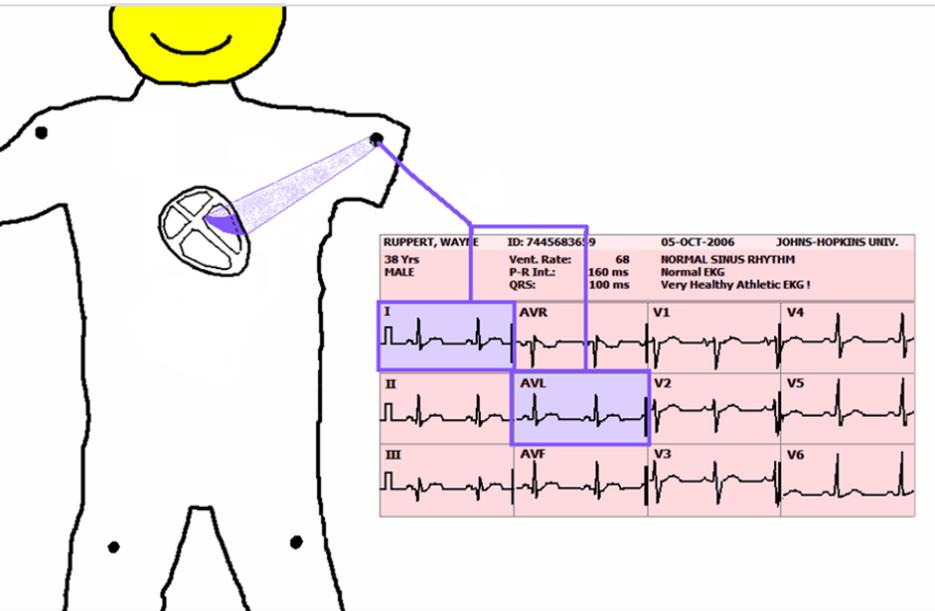
RUPPERT, WAYNE		ID: 7445683659	05-OCT-2006	JOHNS-HOPKINS UNIV.
38 Yrs MALE		Vent. Rate: 68 P-R Int.: 160 ms QRS: 100 ms	NORMAL SINUS RHYTHM Normal EKG Very Healthy Athletic EKG!	
I	AVR	V1	V4	
II	AVL	V2	V5	
III	AVF	V3	V6	

Leads I & AVL view the ANTERIOR-LATERAL JUNCTION

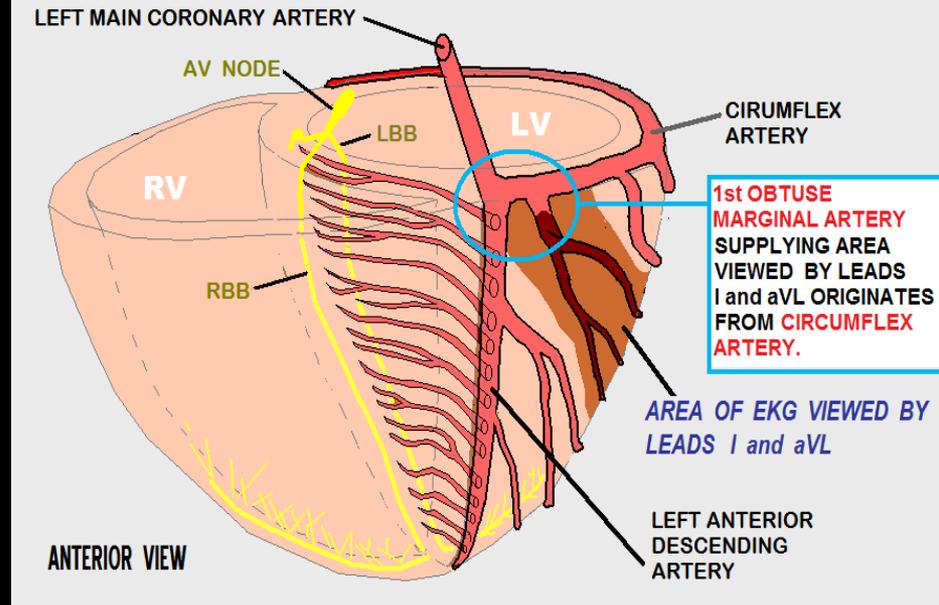


RUPPERT, WAYNE	ID: 744568369	05-OCT-2006	JOHNS-HOPKINS UNIV.
38 Yrs MALE	Vent. Rate: 68 P-R Int.: 160 ms QRS: 100 ms	NORMAL SINUS RHYTHM Normal EKG Very Healthy Athletic EKG !	
I	AVR	V1	V4
II	AVL	V2	V5
III	AVF	V3	V6

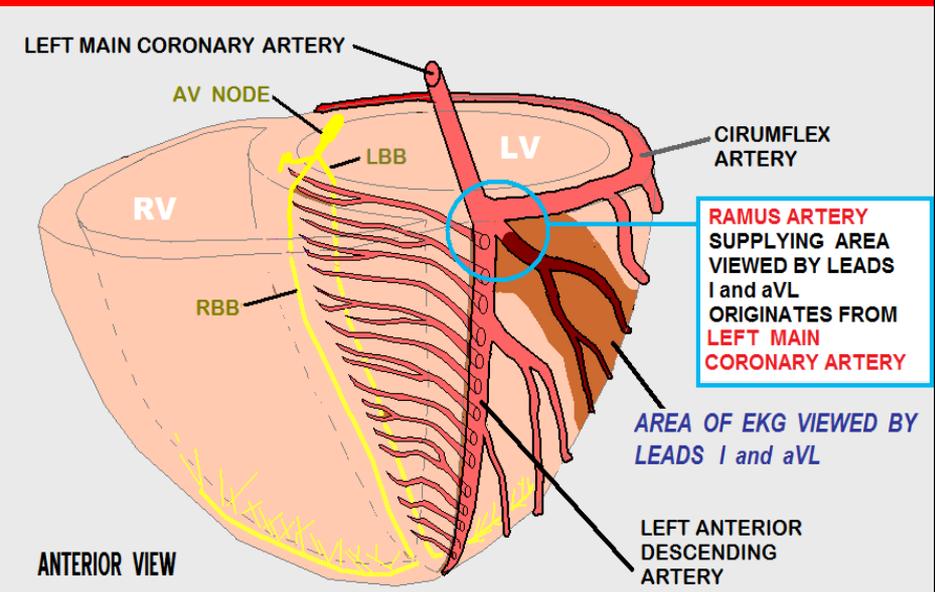
Leads I & aVL view the ANTERIOR-LATERAL JUNCTION



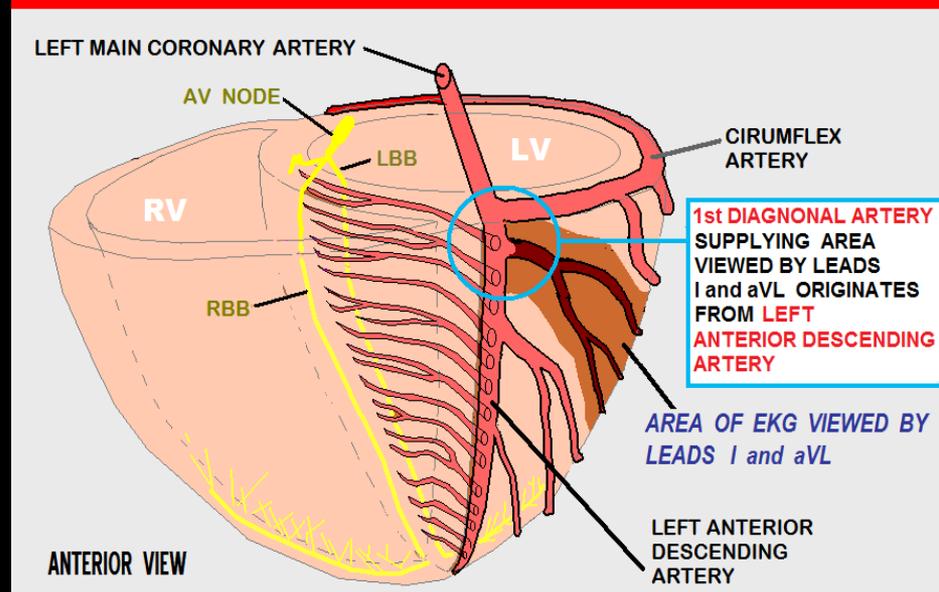
OCCLUSION of OBTUSE MARGINAL ARTERY



OCCLUSION of RAMUS ARTERY

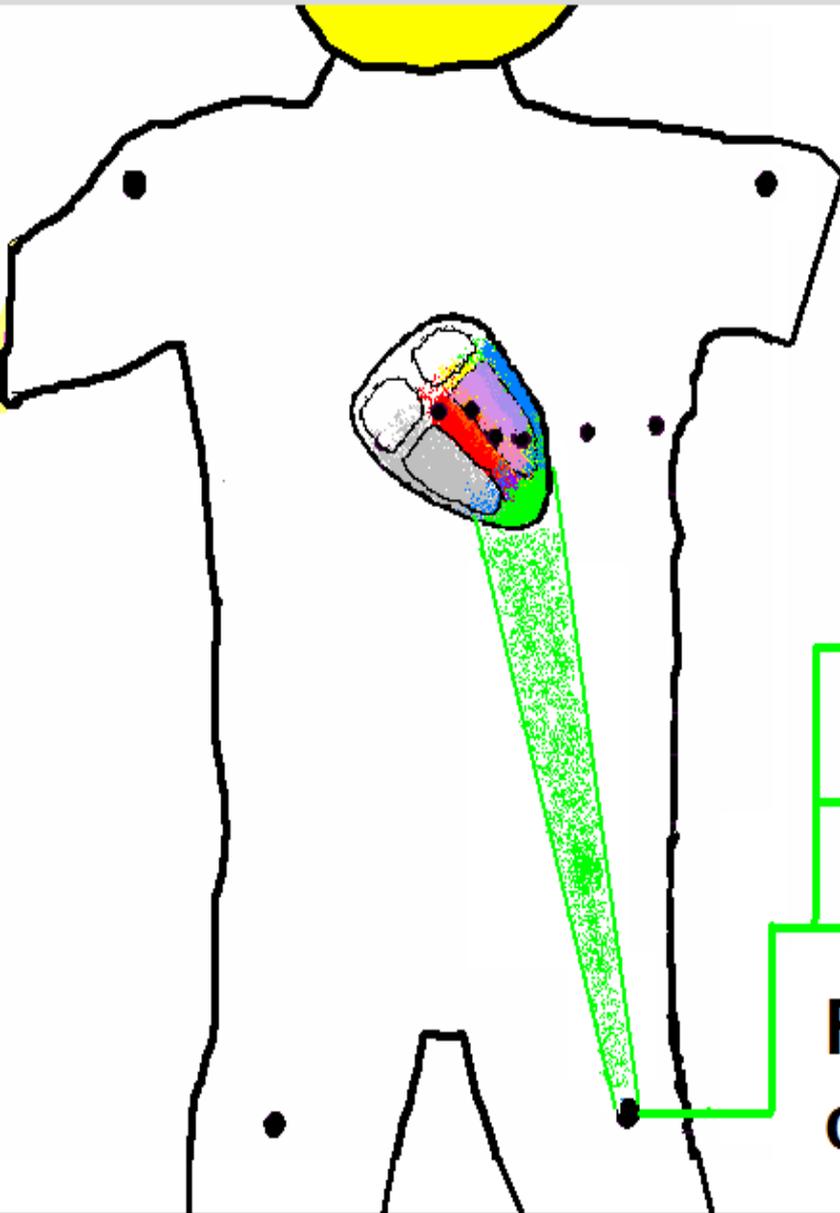


OCCLUSION of DIAGONAL ARTERY



LEADS II, III, and aVF VIEW

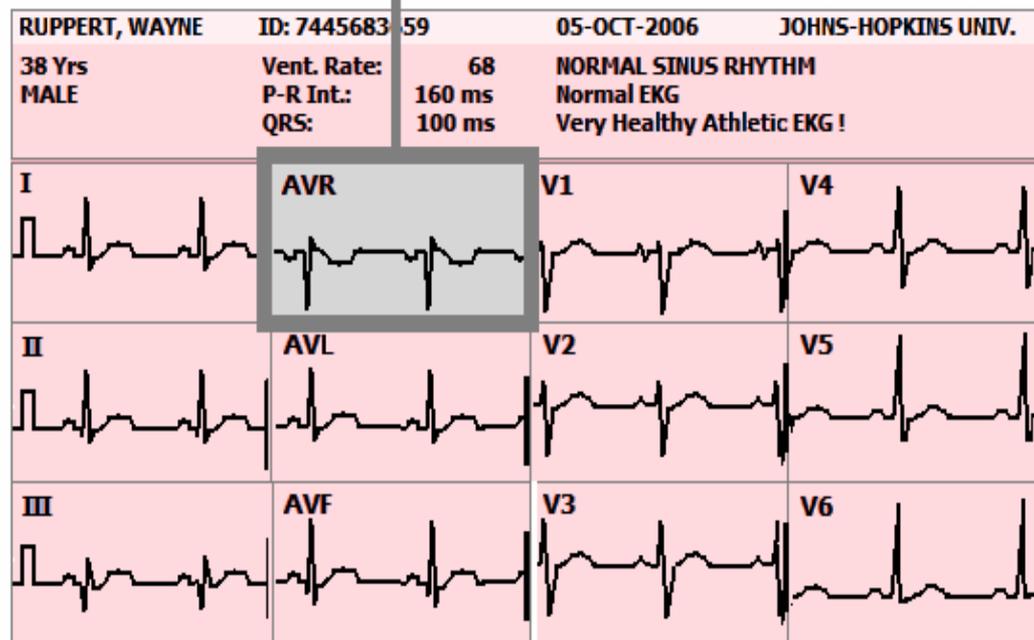
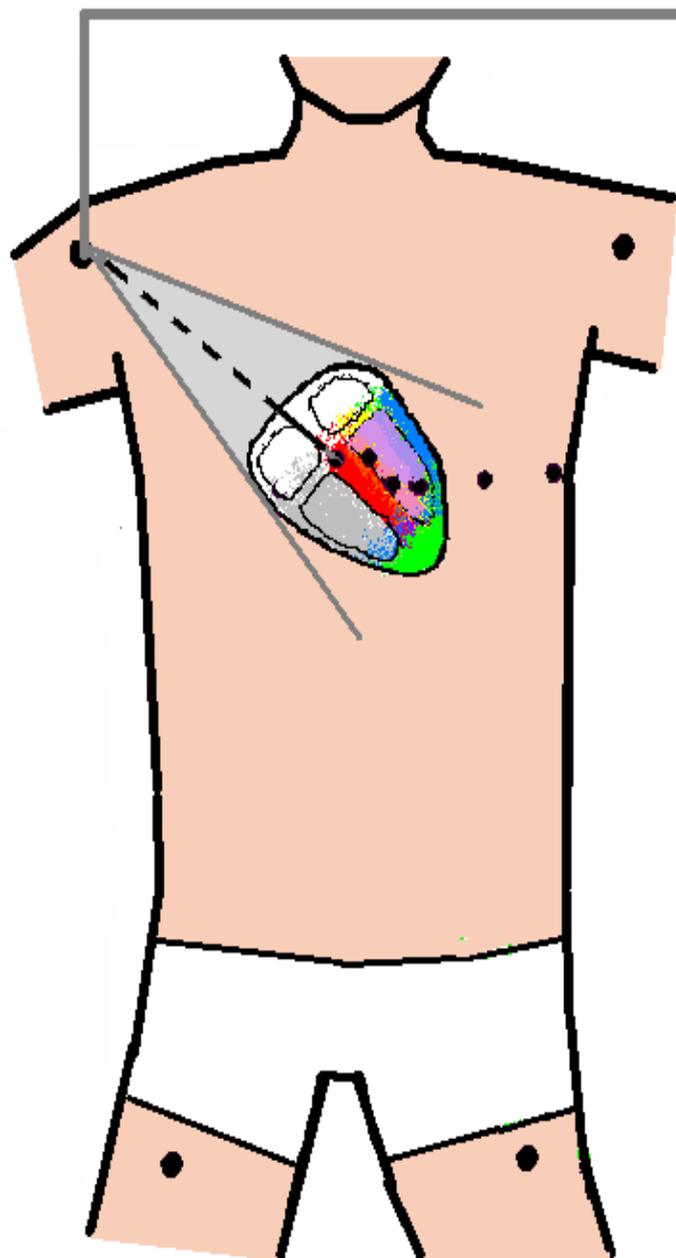
INFERIOR WALL of the LEFT VENTRICLE



RUPPERT, WAYNE		ID: 7445683659	05-OCT-2006	JOHNS-HOPKINS UNIV.
38 Yrs		Vent. Rate: 68	NORMAL SINUS RHYTHM	
MALE		P-R Int.: 160 ms	Normal EKG	
		QRS: 100 ms	Very Healthy Athletic EKG !	
I	AVR	V1	V4	
II	AVL	V2	V5	
III	AVF	V3	V6	

**FED by the RCA (75 - 80 % pop)
or the CIRCUMFLEX (10 - 15 %)**

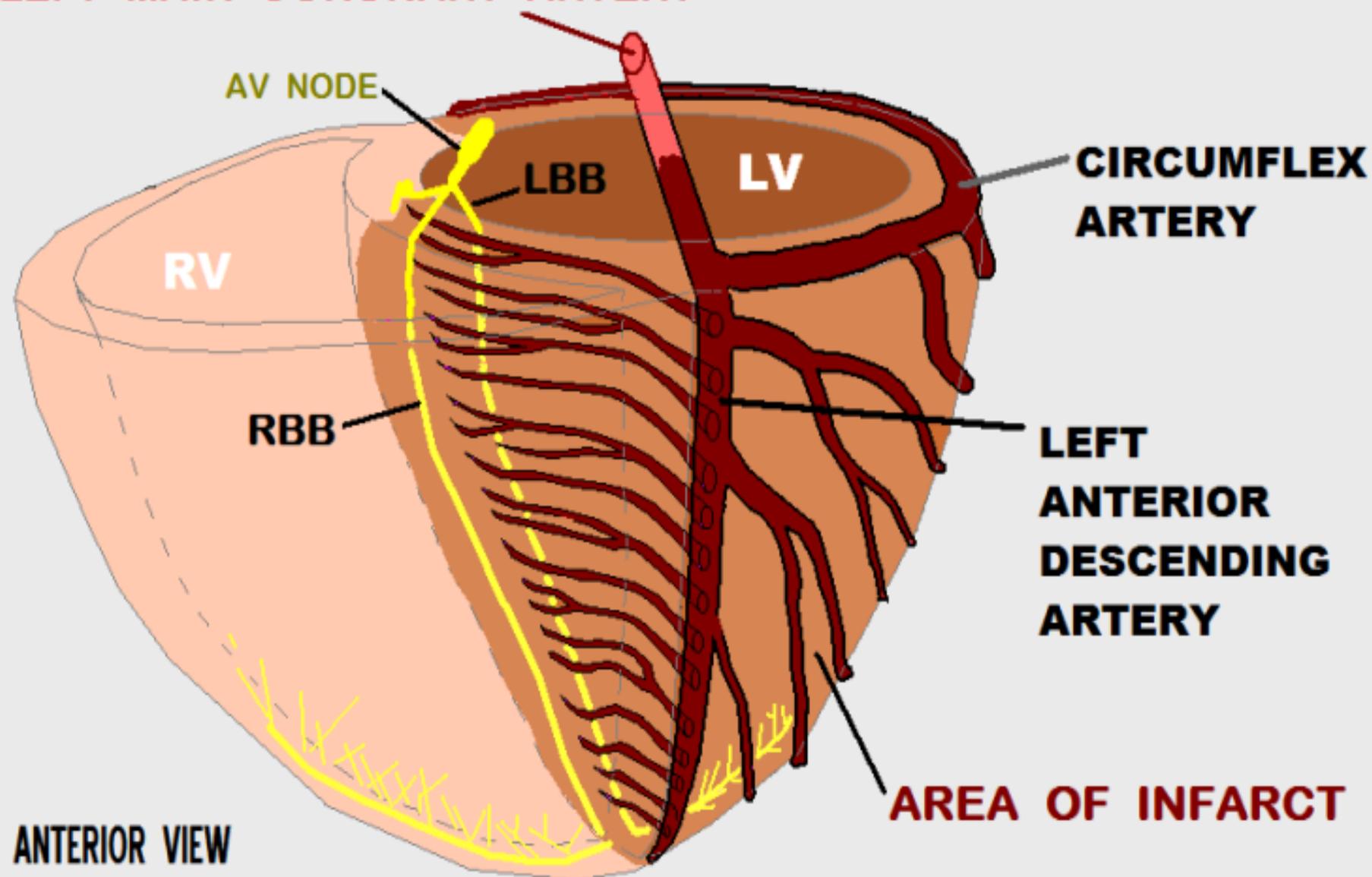
Lead AVR Views the BASILAR SEPTUM (region of the Bundle of His):



In STEMI with ST-Segment
Elevation in Lead AVR,
This is indicative of
Left Main Coronary Artery
Occlusion . . .

OCCLUSION of the LEFT MAIN CORONARY ARTERY

LEFT MAIN CORONARY ARTERY

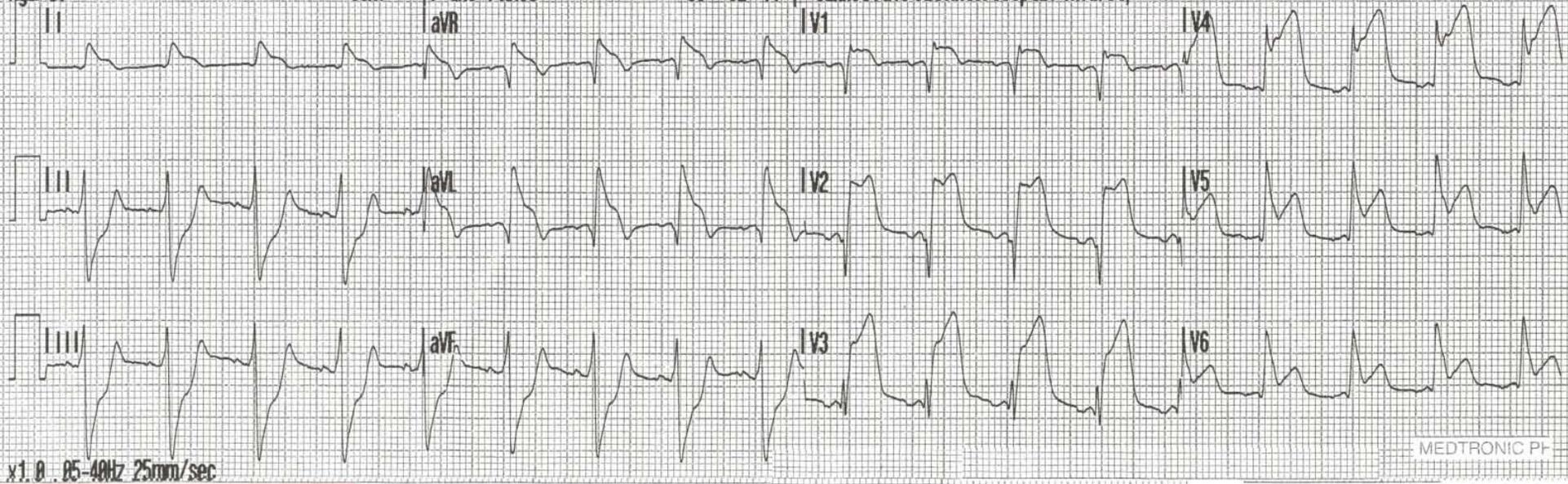


Name: 12-Lead 4
 ID: 06 Oct 07
 Patient ID: PR 0.154s
 Incident: QT/QTc
 Age: 37 Sex: P-QRS-T Axes
 aVR

HR 107 bpm
 12:44:13
 QRS 0.102s
 0.332s/0.443s
 89° -62° 44°

• *** ACUTE MI SUSPECTED ***
 • Abnormal ECG **Unconfirmed**
 • Sinus tachycardia
 • Left anterior fascicular block
 • Cannot rule out Anteroseptal infarct,

**ACUTE STEMI caused by
 LEFT MAIN CORONARY
 ARTERY OCCLUSION**



ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

- ST ELEVATION in LEADS I, aVL, V1 - V6
- ST ELEVATION in aVR GREATER THAN 0.5 mm
- ST ELEVATION in aVR GREATER THAN LEAD V1
- LEFT ANTERIOR FASCICULAR BLOCK PATTERN

MEDTRONIC PH

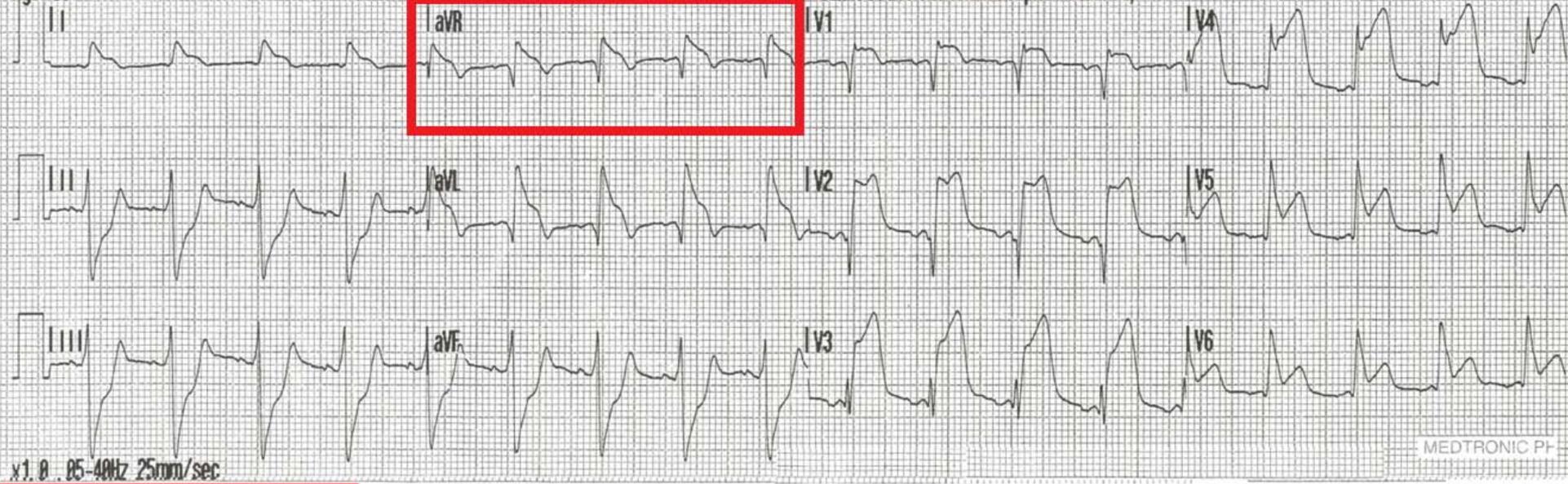
Name:
ID:
Patient ID:
Incident:
Age 37

12-Lead 4
06 Oct 07
PR 0.154s
QT/QTc
P-QRS-T Axes
Sex:

HR 107 bpm
12:44:13
QRS 0.182s
0.332s/0.443s
89° -62° 44°

- *** ACUTE MI SUSPECTED ***
- Abnormal ECG **Unconfirmed**
- Sinus tachycardia
- Left anterior fascicular block
- Cannot rule out Anteroseptal infarct,

**ACUTE STEMI caused by
LEFT MAIN CORONARY
ARTERY OCCLUSION**

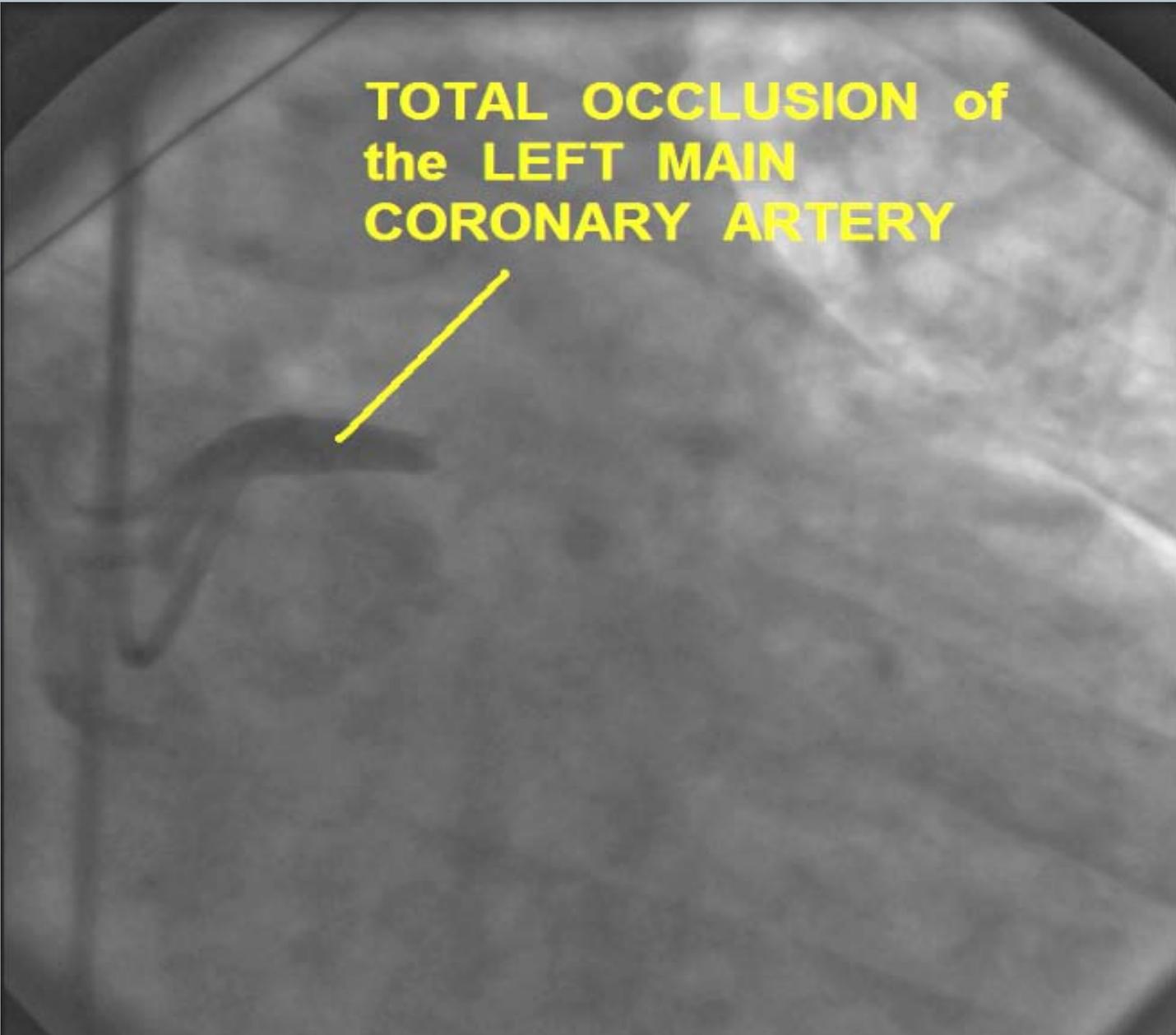


ECG CLUES of ACUTE STEMI caused by LEFT MAIN CORONARY ARTERY OCCLUSION:

- ST ELEVATION in LEADS I, aVL, V1 - V6
- ST ELEVATION in aVR GREATER THAN 0.5 mm
- ST ELEVATION in aVR GREATER THAN LEAD V1
- LEFT ANTERIOR FASCICULAR BLOCK PATTERN

MEDTRONIC PF

**TOTAL OCCLUSION of
the LEFT MAIN
CORONARY ARTERY**





ECG Clues . . .

for IDENTIFYING STEMI CAUSED BY LEFT MAIN CORONARY ARTERY occlusion:

- ☑ ST ELEVATION in ANTERIOR LEADS (V1 - V4) and LATERAL LEADS (V5 & V6)
- ☑ ST DEPRESSION or ISOELCTRIC J POINTS may be seen in V LEADS . . . mainly V2 and/or V3 caused by *COMPETING FORCES* of ANTERIOR vs. POSTERIOR WALL MI.*+
- NOTE: it is very unusual to see ST DEPRESSION in V LEADS with isolated ANTERIOR WALL MI when caused by occluded LAD.
- ☑ ST ELEVATION in AVR is GREATER THAN ST ELEVATION in V1*+
- ☑ ST ELEVATION in AVR GREATER THAN 0.5 mm
- ☑ ST ELEVATION in LEAD I and AVL (caused by NO FLOW to DIAGONAL / OBTUSE MARGINAL BRANCHES)*
- ☑ ST DEPRESSION in LEADS II, III, and AVF. (in cases of LMCA occlusion of DOMINANT CIRCUMFLEX, leads II, III, and AVF may show ST ELEVATION or ISOELECTRIC J POINTS)*+
- ☑ NEW / PRESUMABLY NEW RBBB, and/or LEFT ANTERIOR FASICULAR BLOCK*+

* Kurisu et al, HEART 2004, SEPTEMBER: 90 (9): 1059-1060

+ Yamaji et al, JACC vol. 38, No. 5, 2001, November 1, 2001:1348-54

[Yamaji et al, JACC vol 38, No 5, 2001: 1348-54](#)

[Electrocardiogram patterns in acute left main occlusion: J Electrocardiol. 2008 Nov-Dec;41\(6\):626-9.](#)

In patients without STEMI, ST Elevation in AVR, when seen with global indications of ischemia (ST Depression in 8 leads or more), is indicative of advanced multi-vessel disease or significant Left Main Coronary Artery stenosis

“In patients with:

- Angina at rest

- ST Elevation in AVR and ST

Depression in 8 or more ECG leads

(global ischemia), it is reported

with a *75% predictive accuracy* of

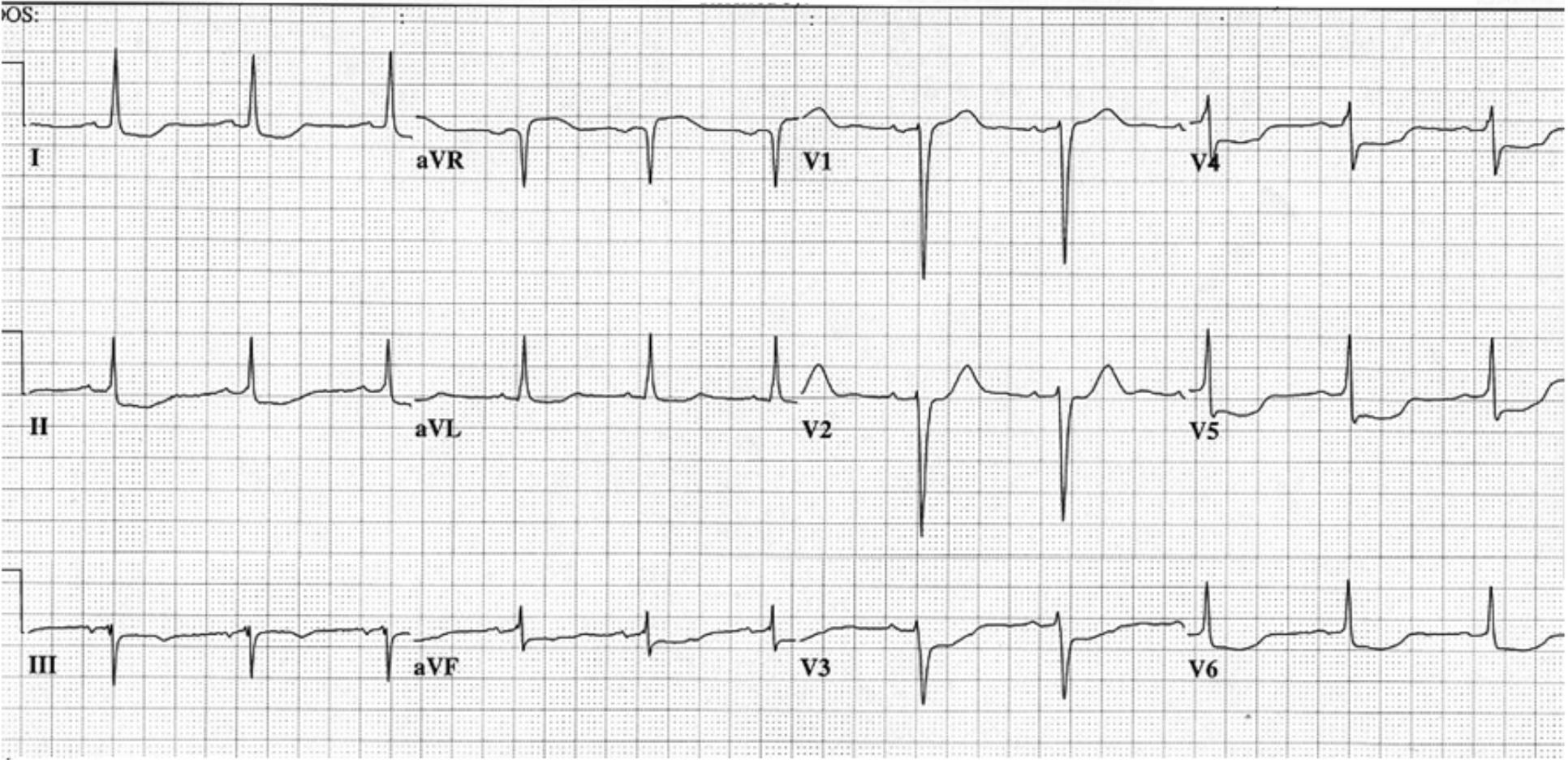
3-vessel or left main coronary

artery stenosis” . . .

- Wagner et al, 2009 ACC/AHA Standardization and Interpretation of the ECG, Part VI, ACS.

67 yr
Female Hispanic
Room:S7
Loc:3 Option:23

Vent. rate 67 BPM
PR interval 188 ms
QRS duration 106 ms
QT/QTc 458/483 ms
P-R-T axes 27 -3 -111

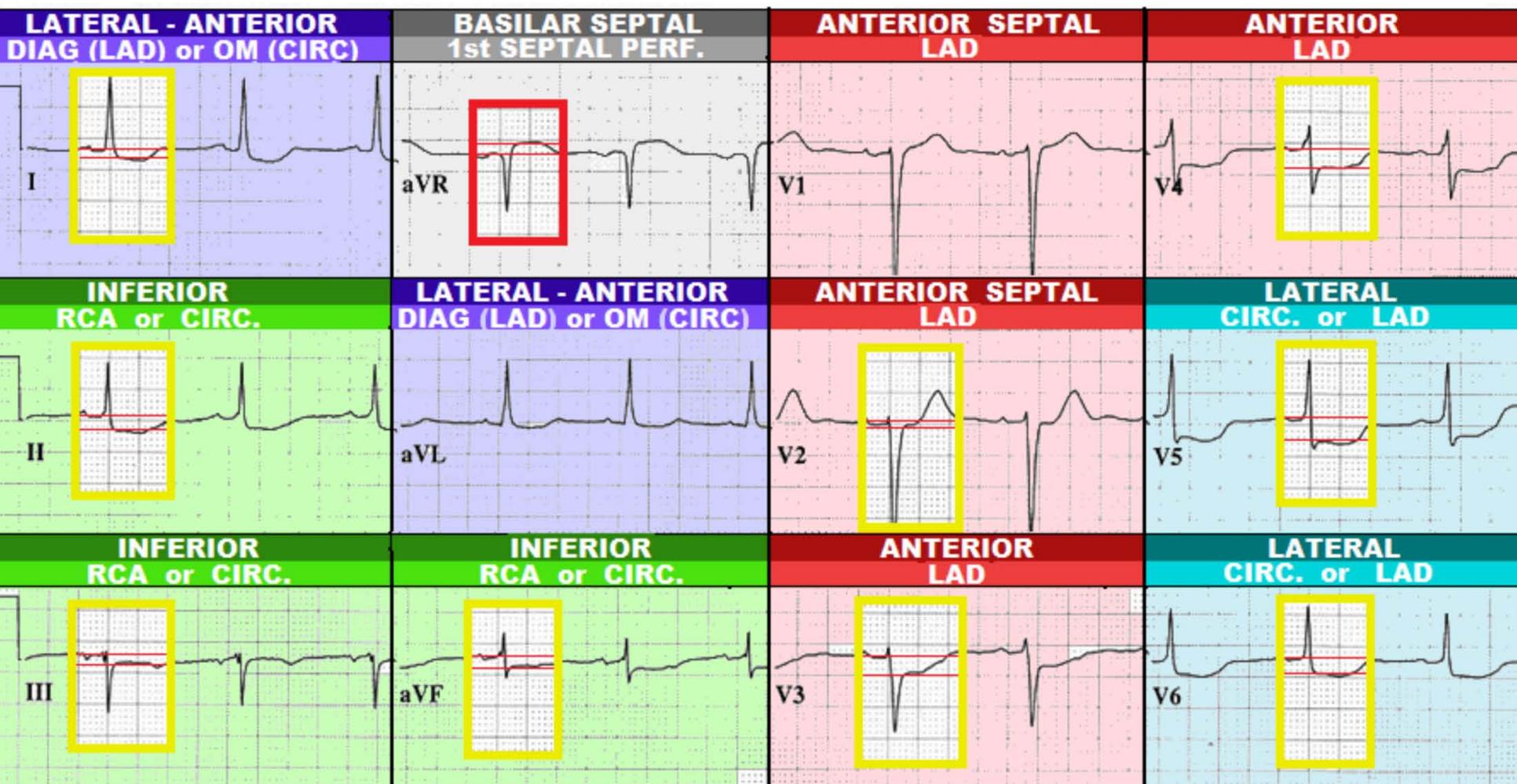


67 yr
 Female Hispanic
 Room:S7
 Loc:3 Option:23

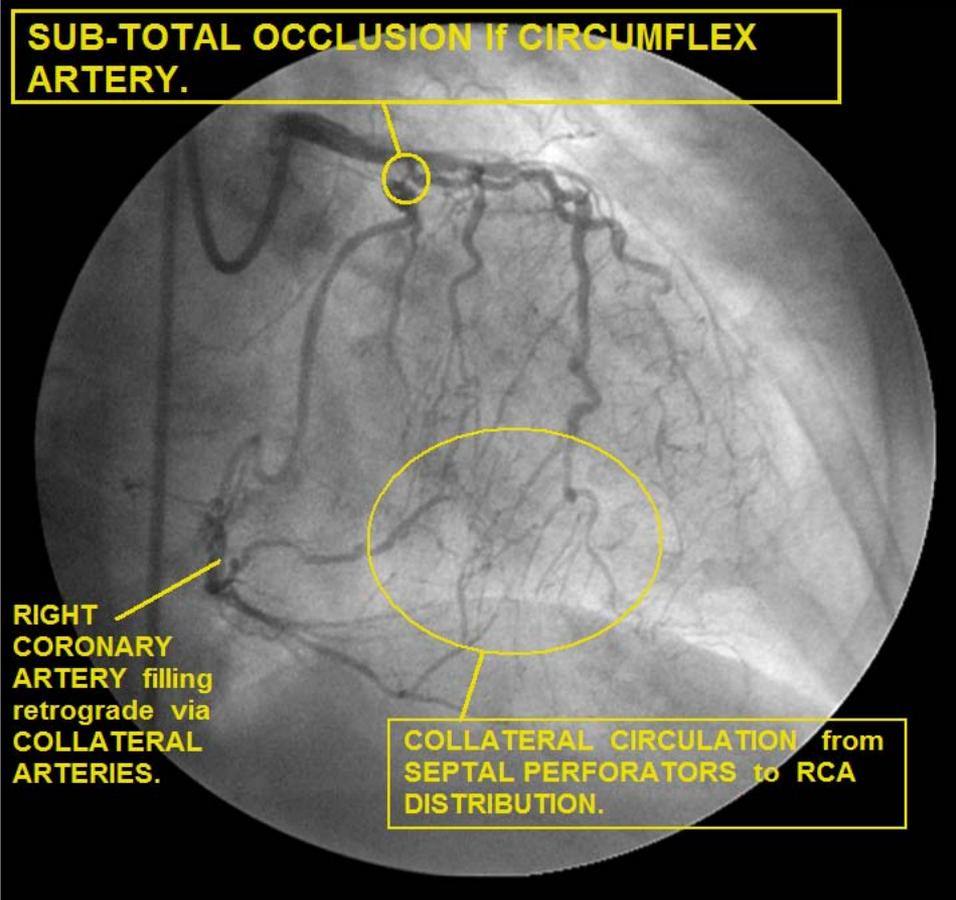
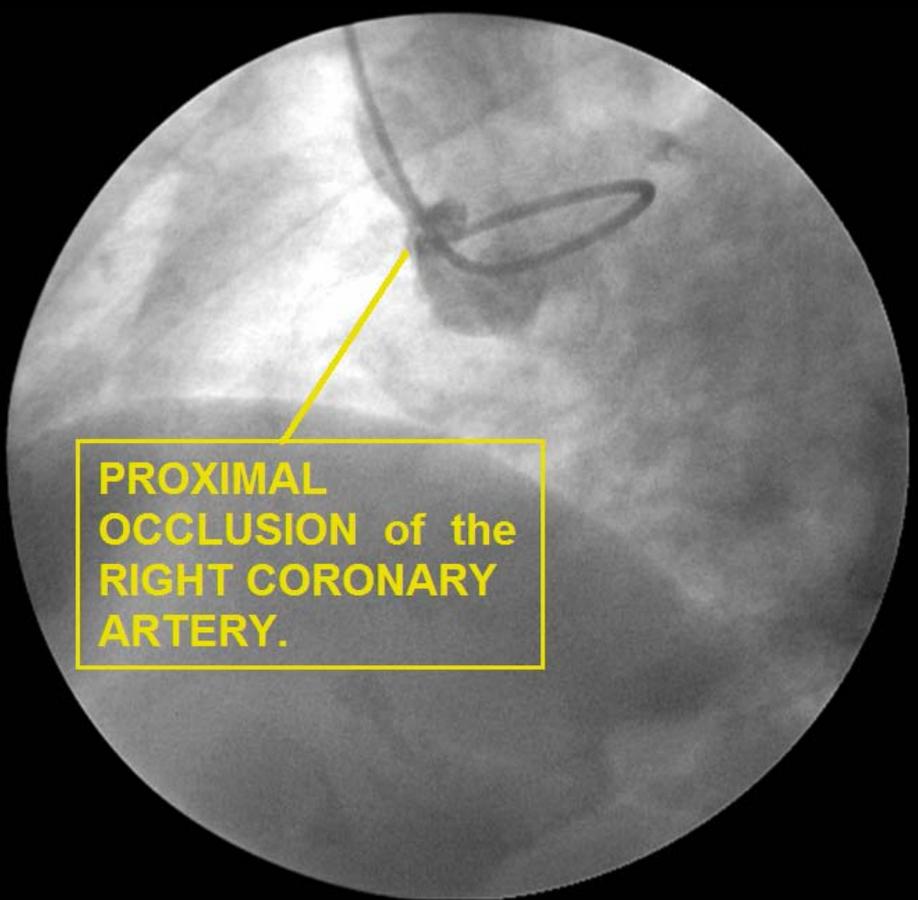
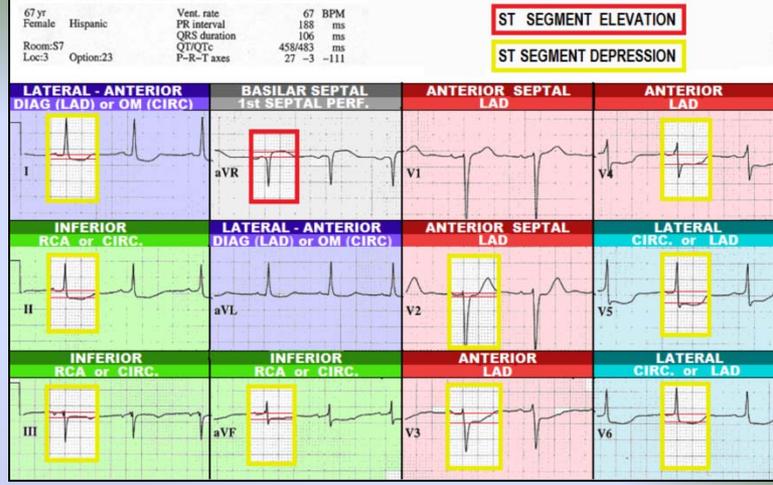
Vent. rate 67 BPM
 PR interval 188 ms
 QRS duration 106 ms
 QT/QTc 458/483 ms
 P-R-T axes 27 -3 -111

ST SEGMENT ELEVATION

ST SEGMENT DEPRESSION



Critical Triple Vessel Disease = *STAT Coronary Artery Bypass Surgery*



ANTICIPATED COMPLICATIONS of GLOBAL ISCHEMIA with POSSIBLE NSTEMI -- INTERVENTIONS to be CONSIDERED:

Patients with CHEST PAIN at REST and this ECG presentation have a 75% incidence of severe LMCA STENOSIS and/or TRIPLE - VESSEL DISEASE -- in such cases Coronary Artery Bypass Surgery (CABG) is frequently indicated.

PREHOSPITAL: if patient has no hospital preference consider transport to Chest Pain Center WITH Open Heart Surgery capabilities IF nearby.

HOSPITAL: consider use of SHORT-ACTING intravenous GP IIb/IIIa receptor agonists

- ACTIVE CHEST PAIN

ACUTE CHEST PAIN PROTOCOL

- ISCHEMIA - CONSIDER DYSRHYTHMIAS

ACLS PROTOCOL

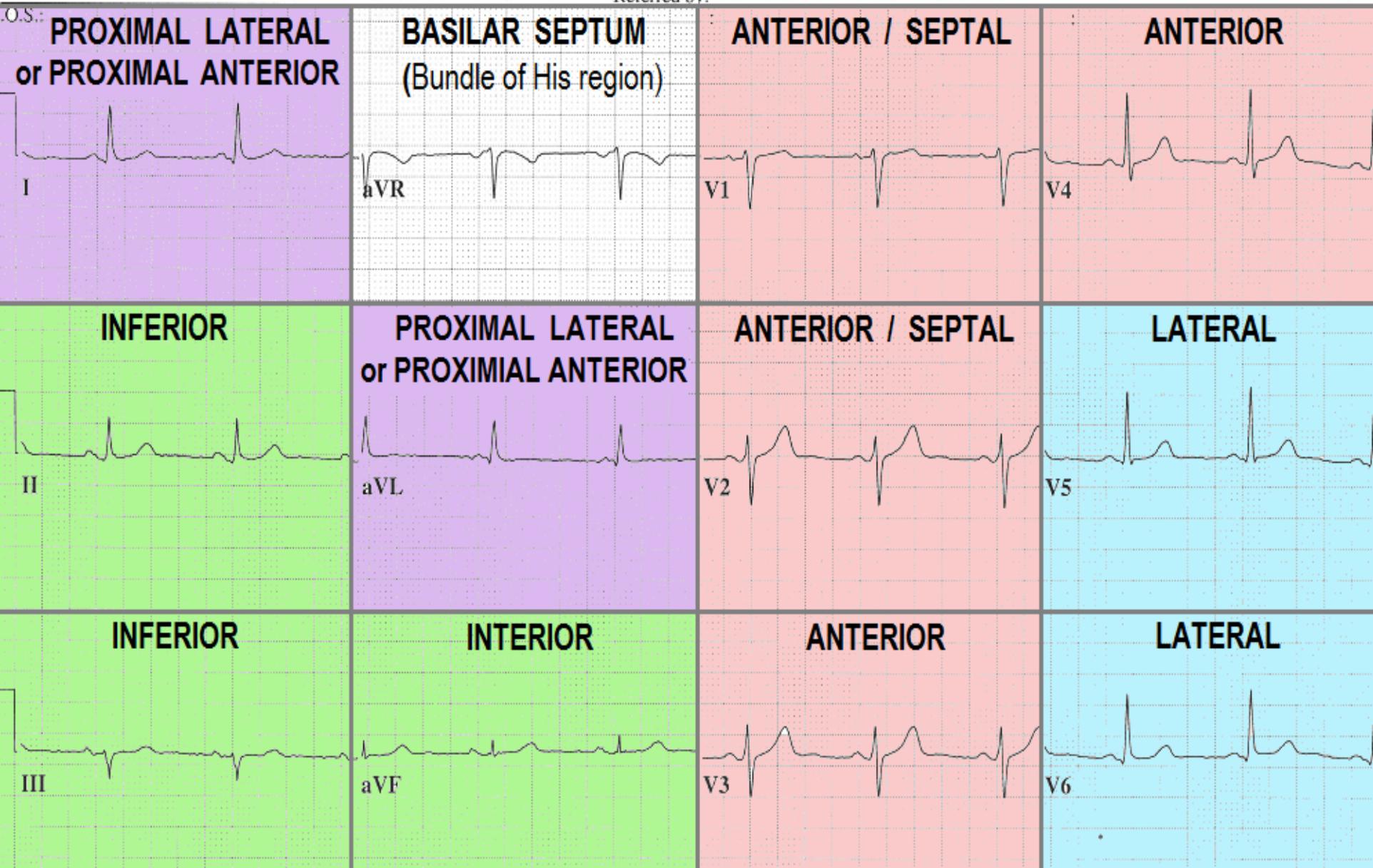
- INCREASED PROBABILITY of IMMEDIATE MYOCARDIAL INFARCTION

1. **AGGRESSIVE SERIAL TROPONIN and SERIAL ECG PROTOCOLS (2014 AHA /ACC / NSTEMI-ACS Guidelines)**
2. **Positive TROPONIN: consider STAT / early Cardiac Catheterization**

Excerpt from [*STEMI Assistant*](#)

Vent. rate	64	BPM	Normal sinus rhythm
PR interval	130	ms	Normal ECG
QRS duration	96	ms	No previous ECGs available
QT/QTc	396/408	ms	
P-R-T axes	40 11 61		

Referred by:



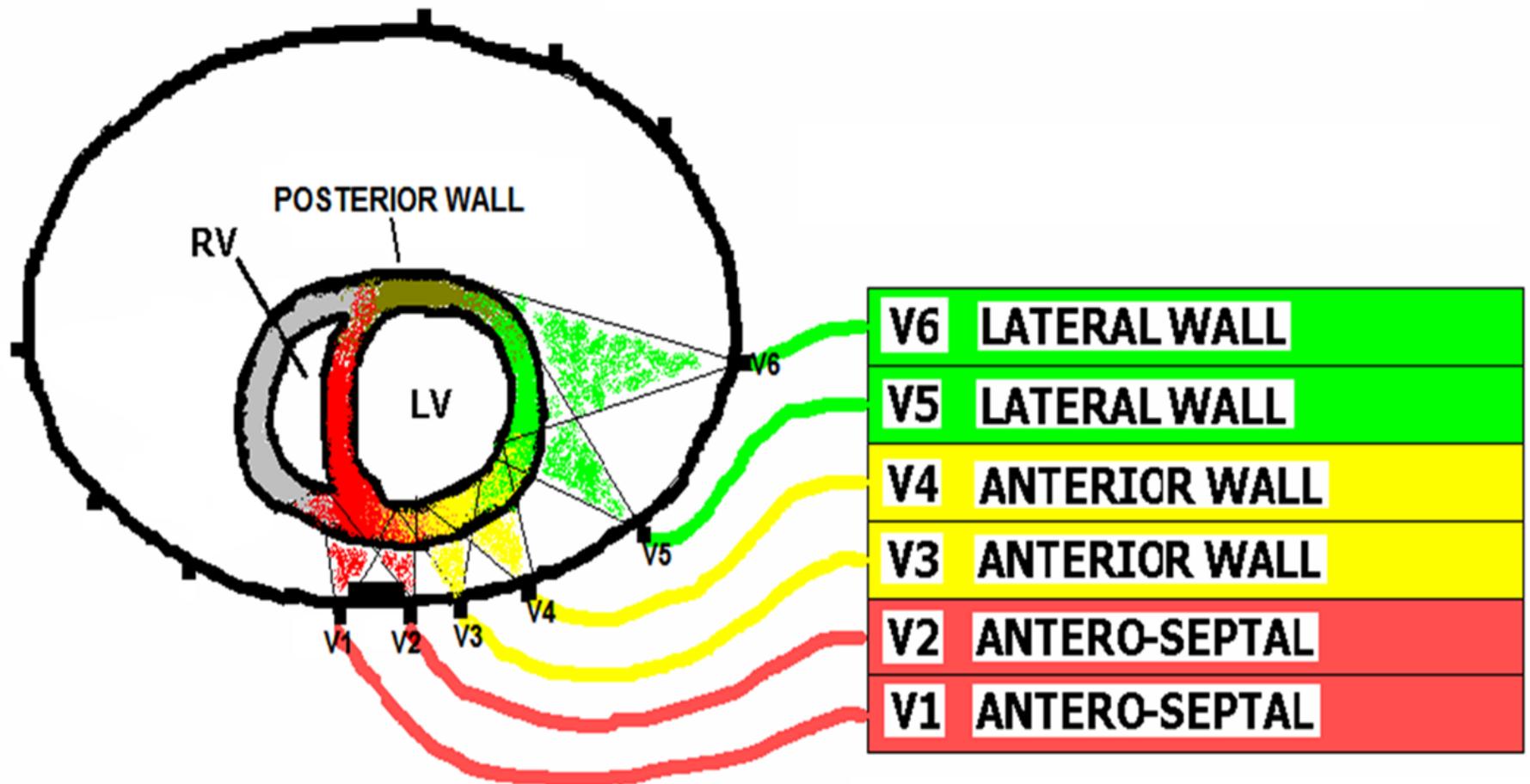
A standard

12 LEAD EKG

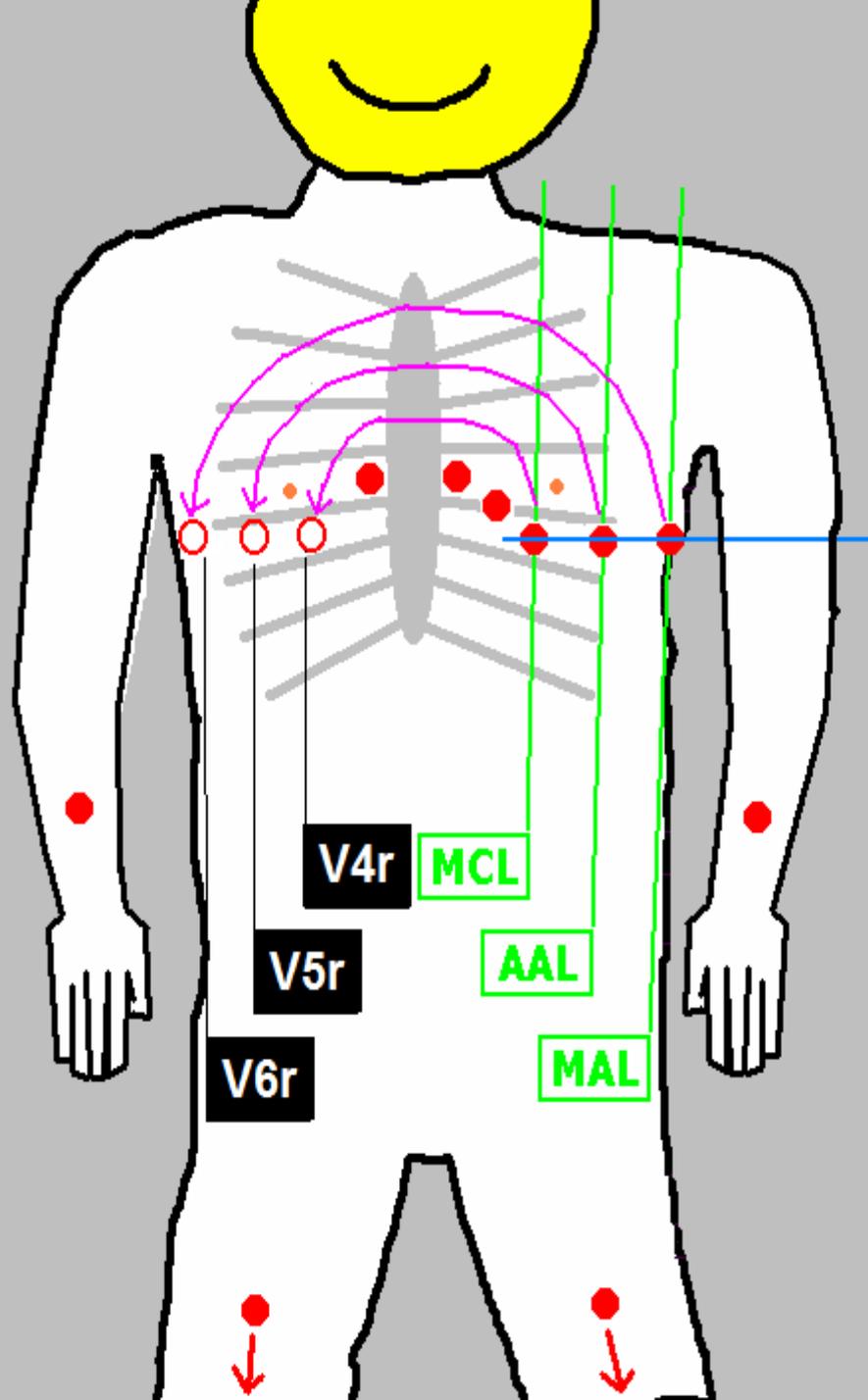
Does NOT show the

RIGHT VENTRICLE

The standard 12 Lead ECG does NOT show the RIGHT VENTRICLE



***To see the RIGHT VENTRICLE,
it is necessary to
OBTAIN a
RIGHT-SIDED ECG . . .***



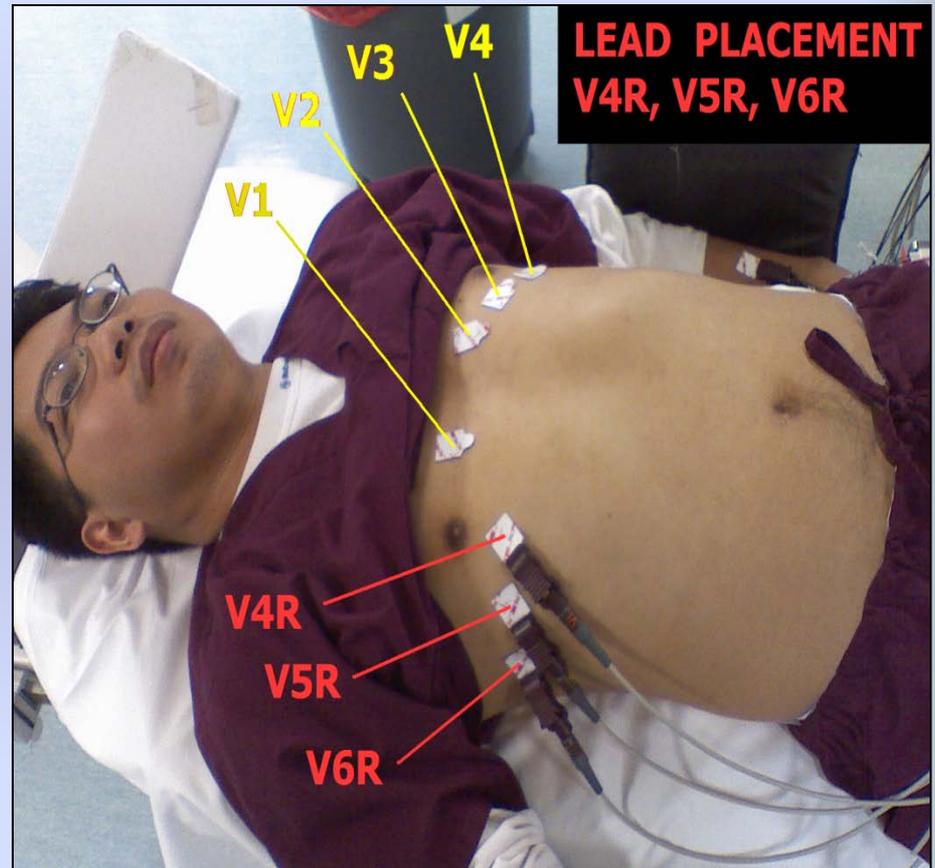
To do a
RIGHT - SIDED EKG . .

**MOVE leads
V4, V5, and V6**

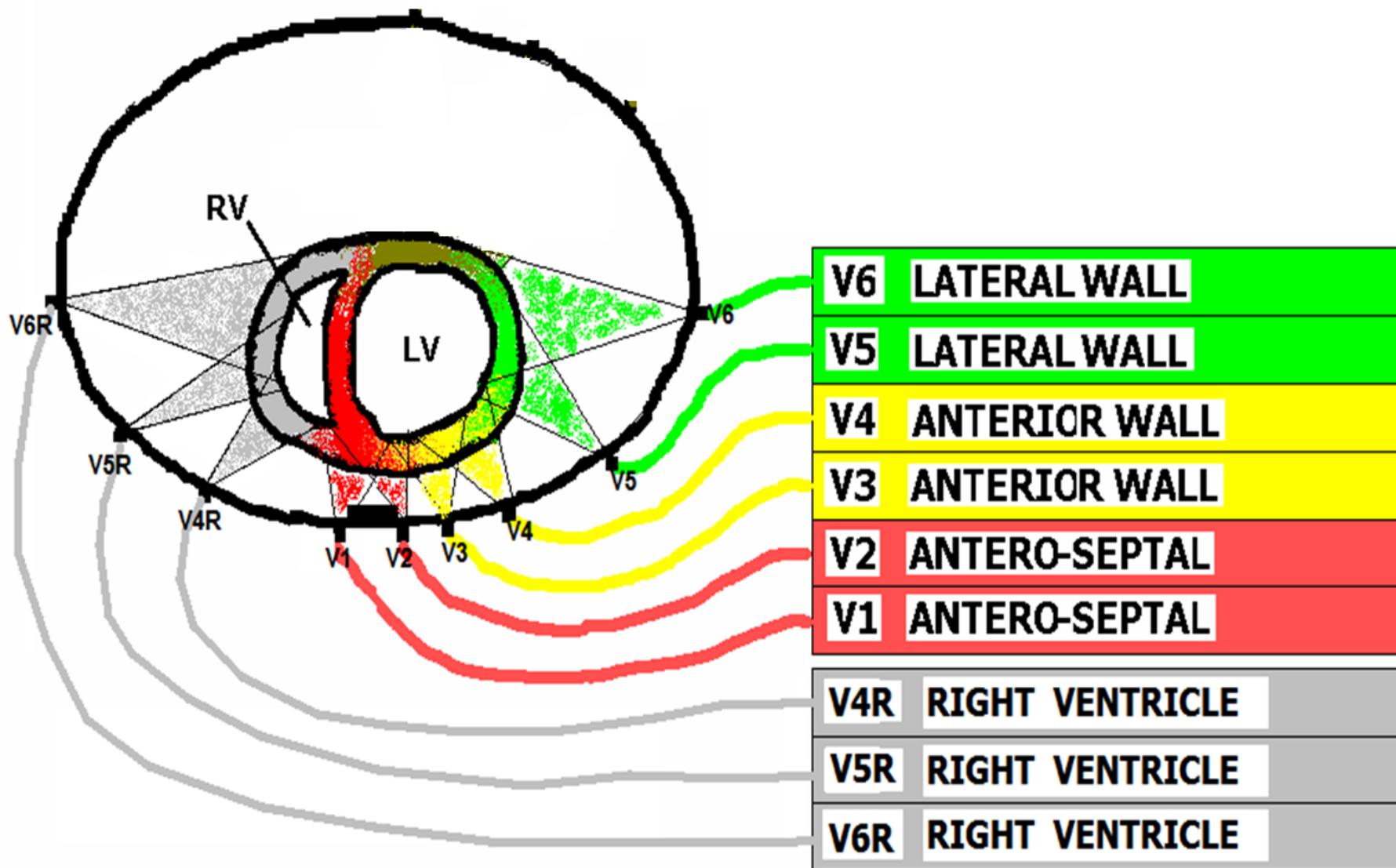
**to the corresponding
placement on the
RIGHT SIDE of patient's
chest . . .**

Right Ventricular Lead Placement

- After initial 12 Lead obtained:
- Reposition leads V1, V2 & V3 to the V4R, V5R & V6R locations on the patient's R chest wall.
- **ST elevation >0.5 mv ABNORMAL**



**Leads V4R, V5R, & V6R "see"
the RIGHT VENTRICLE.**



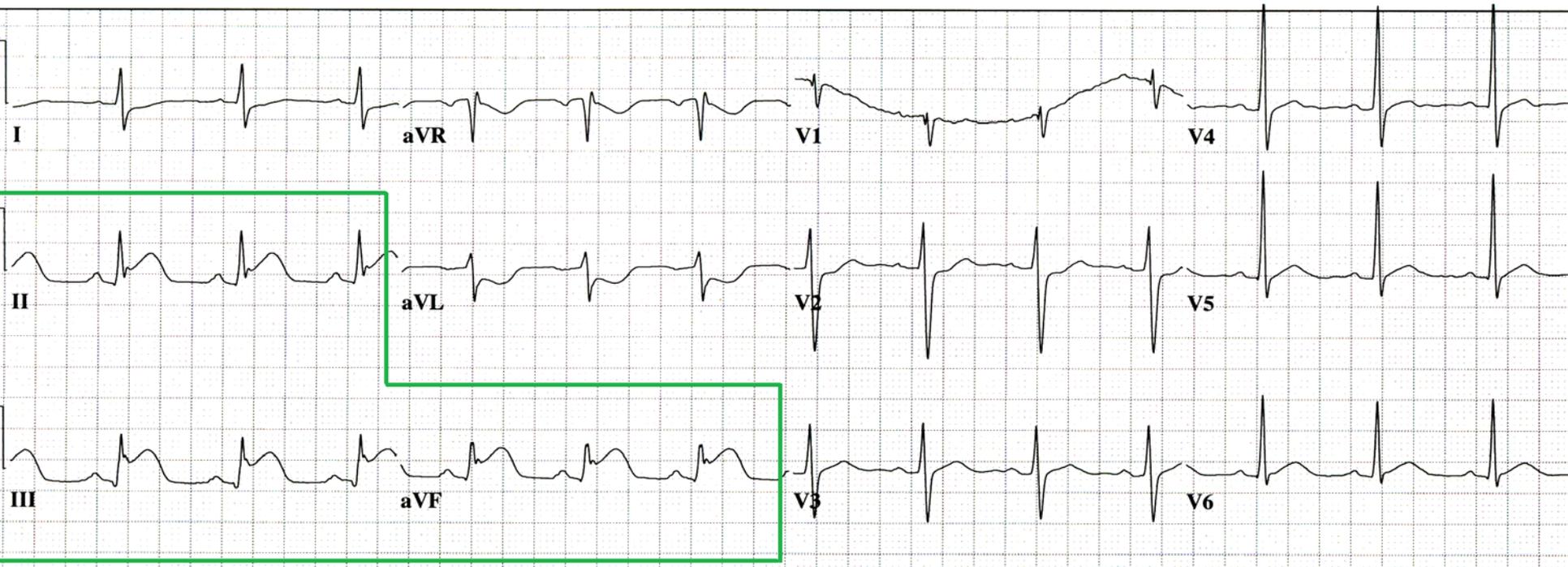
**INDICATIONS
for
OBTAINING
a
RIGHT-SIDED ECG . . .**

ALL INFERIOR WALL STEMI Patients:

46 yr
Male
Caucasian
Loc:3
Option:23

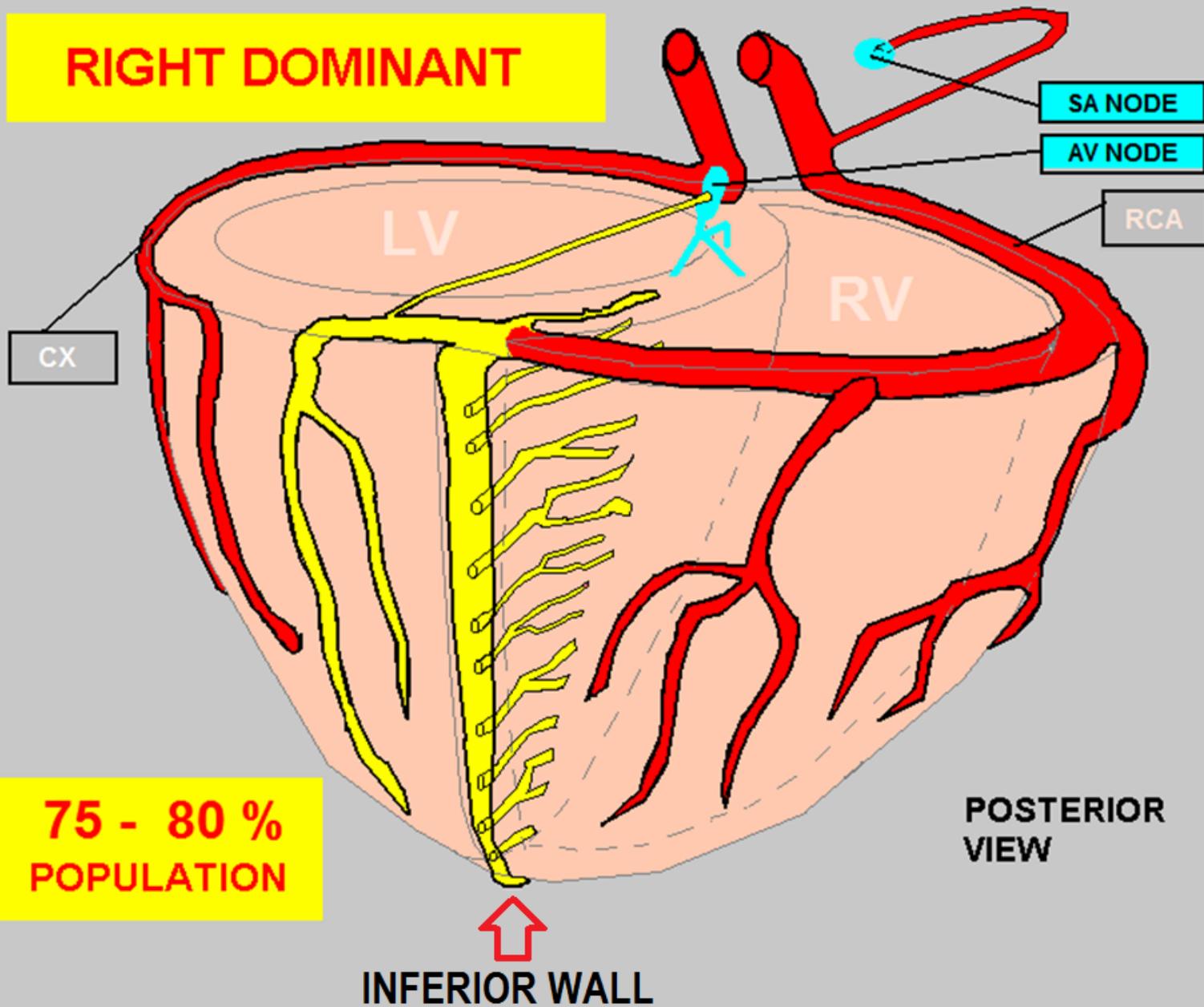
Vent. rate	82	BPM
PR interval	168	ms
QRS duration	96	ms
QT/QTc	384/448	ms
P-R-T axes	76 81	88

**ST-Segment Elevation in Leads II, III and AVF
Consistent with: INFERIOR STEMI**

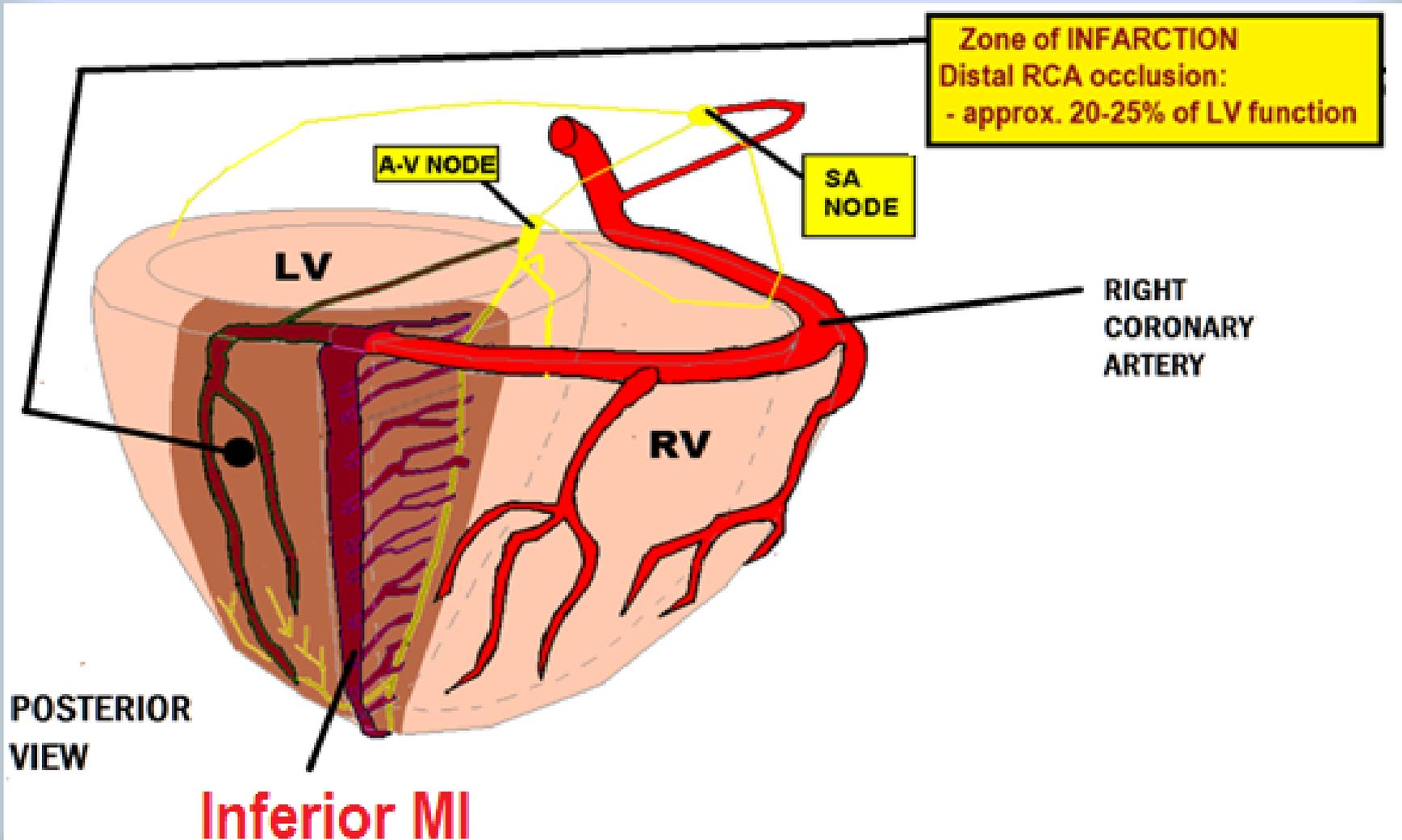


**ST Elevation Leads II, III & AVF = OBTAIN
RIGHT-SIDED ECG**

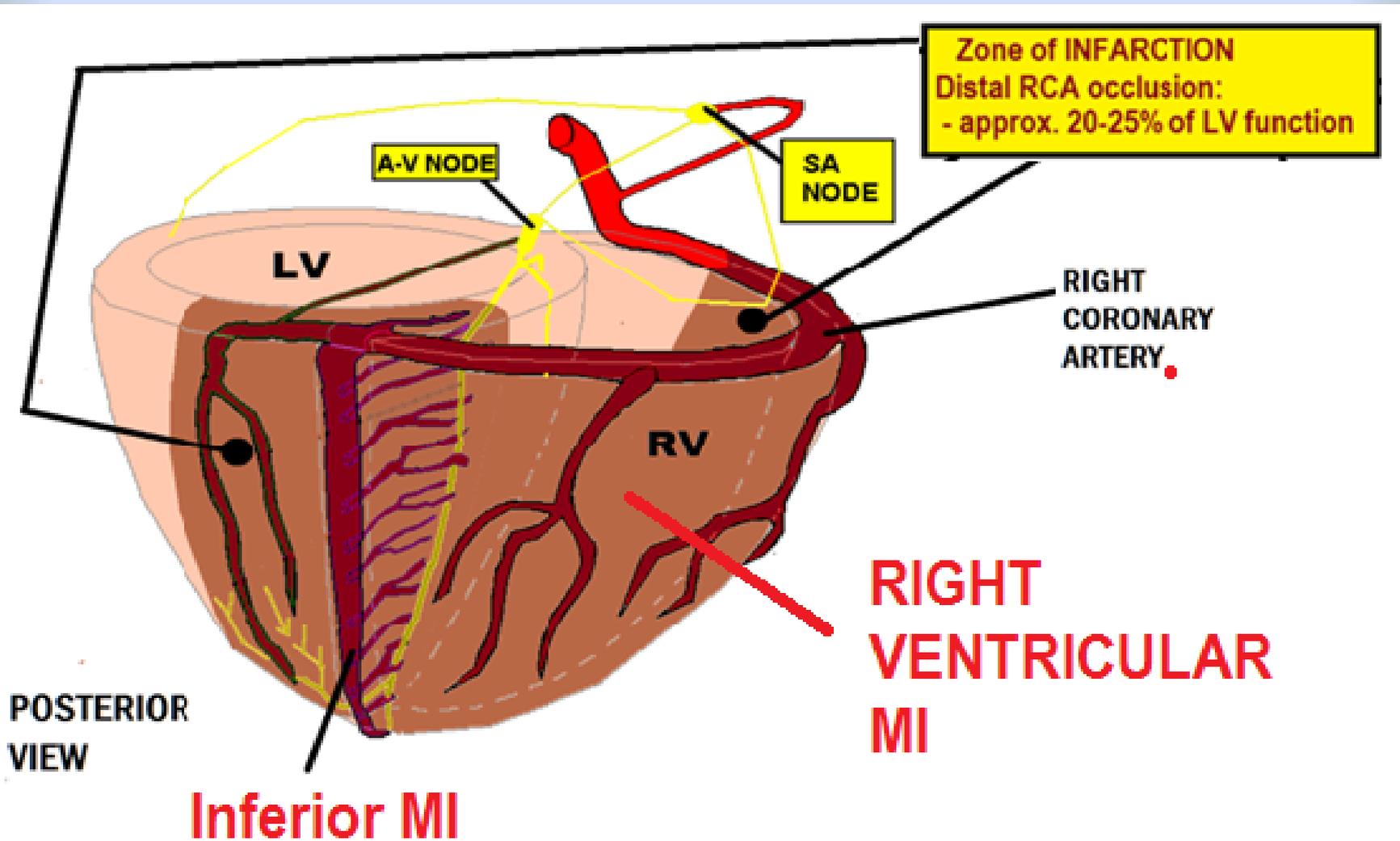
RIGHT DOMINANT



Distal Right Coronary Artery Occlusion



Proximal Right Coronary Artery Occlusion



ST Elevation Lead II, III, AVF

**75 – 80% of the population have a
DOMINANT Right Coronary Artery (RCA).**

**A dominant RCA nearly always supplies
blood to the INFERIOR WALL.**

ST Elevation Lead II, III, AVF

**75 – 80% of the population have a
DOMINANT Right Coronary Artery (RCA).**

**A dominant RCA nearly always supplies
blood to the INFERIOR WALL.**

***The RCA nearly ALWAYS supplies blood to
the RIGHT VENTRICLE !***

ID:

46 yo

Male Caucasian

Room:

Opt:

Technician:

Vent. rate 87 bpm
 PR interval 176 ms
 QRS duration 94 ms
 QT/QTc 330/397 ms
 P-R-T axes 79 81 102

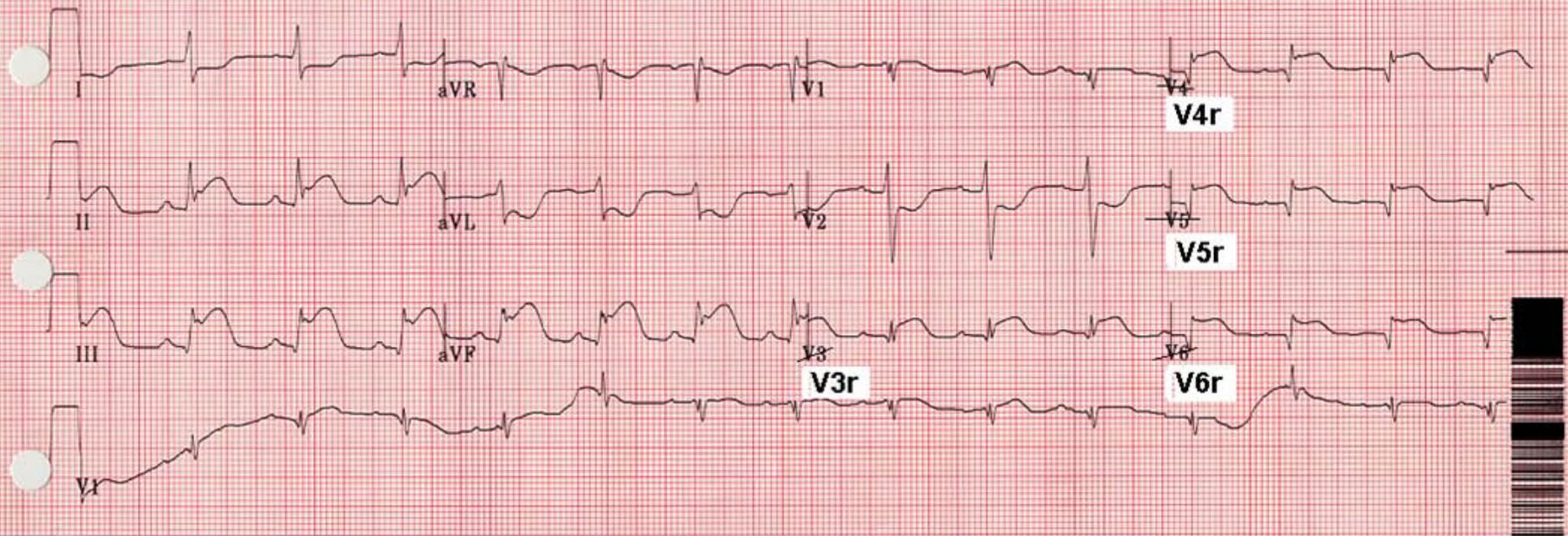
Normal sinus rhythm
~~Anterolateral infarct, possibly acute~~
 Inferior injury pattern
 ***** Acute MI *****
 Abnormal ECG

Right Ventricular Infarct

V LEADS
R SIDE

Referred by:

Unconfirmed



RIGHT VENTRICULAR STEMI is indicated when ST Segment Elevation of 0.5mv is present.

IN *EVERY* CASE of

INFERIOR WALL STEMI

You must first *RULE OUT*

RIGHT VENTRICULAR MI

BEFORE giving any:

- NITROGLYCERIN
- Diuretics

**Nitroglycerin & Diuretics
are
CLASS III CONTRINDICATED
in
RIGHT VENTRICULAR MI !!***

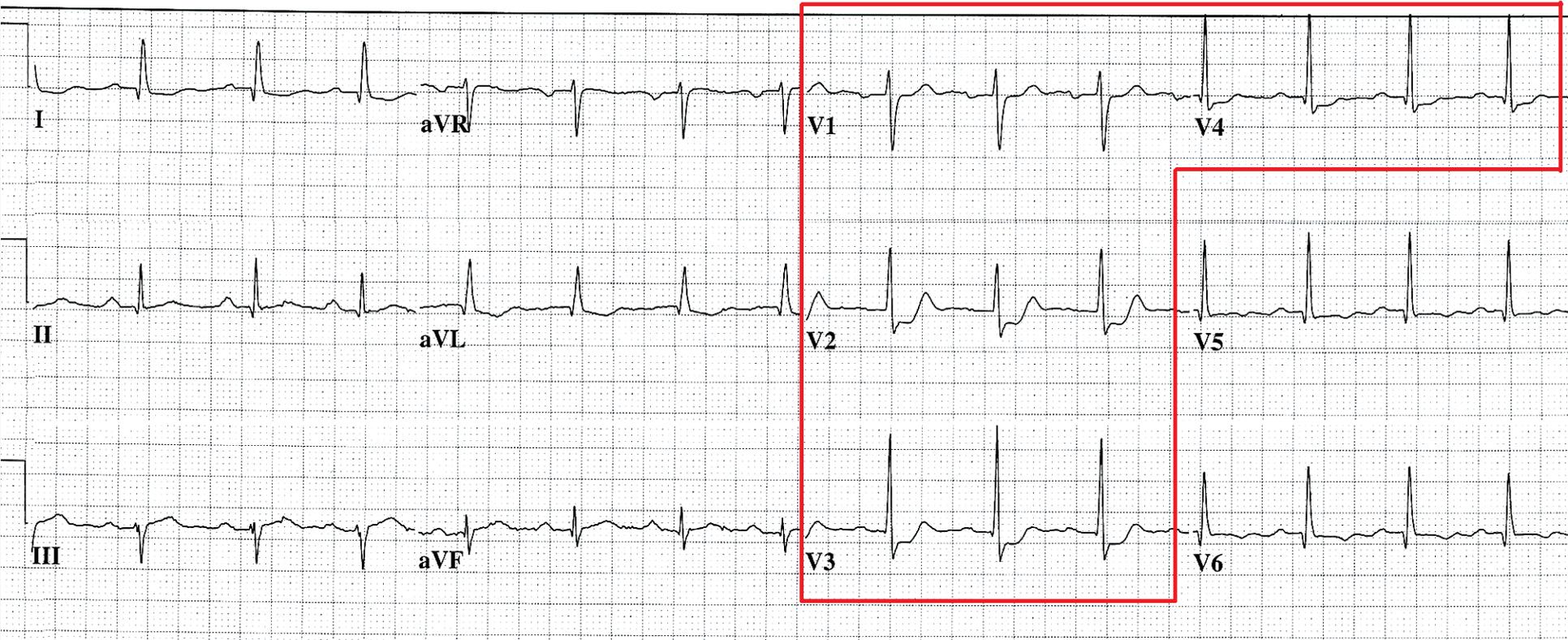
**They precipitate SEVERE
HYPOTENSION**

*** A.H.A. ACLS 2010 / 2015**

ST Depression in V1 – V4

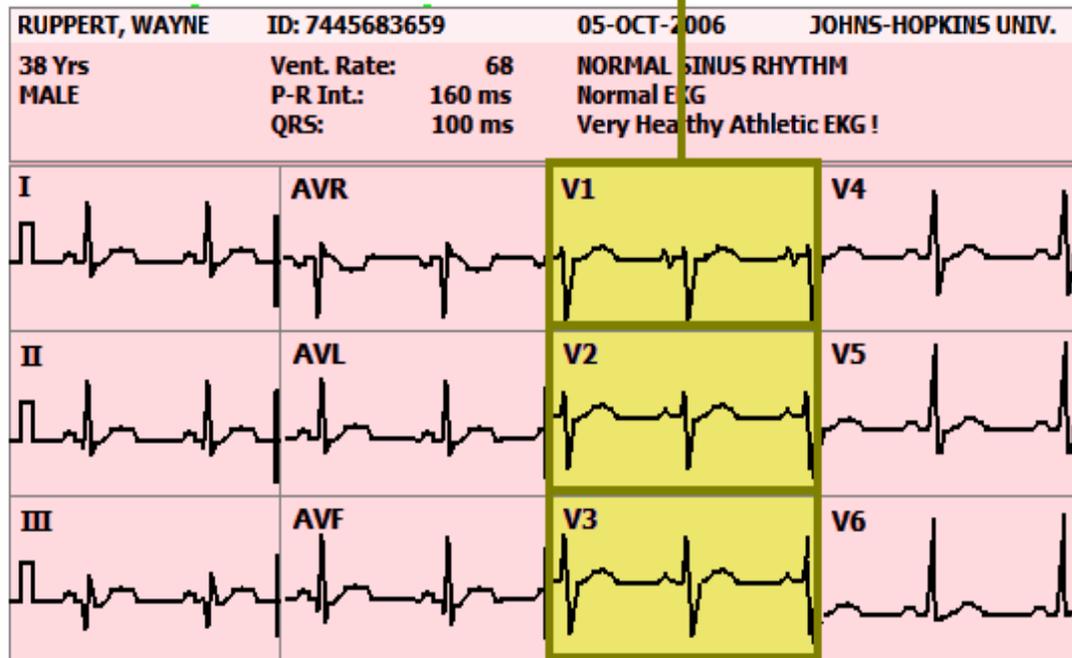
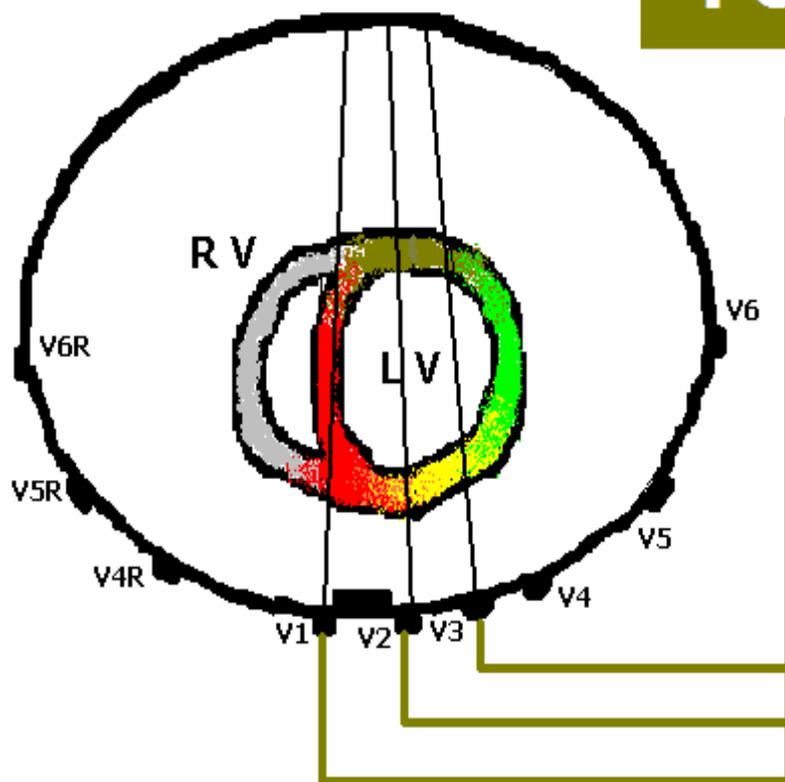
63 yr
Male Hispanic
Room: VAM
Loc: 3 Option: 23

Vent. rate	88	BPM
PR interval	200	ms
QRS duration	94	ms
QT/QTc	352/425	ms
P-R-T axes	63 2	118



LEADS V1 - V3 *view the*

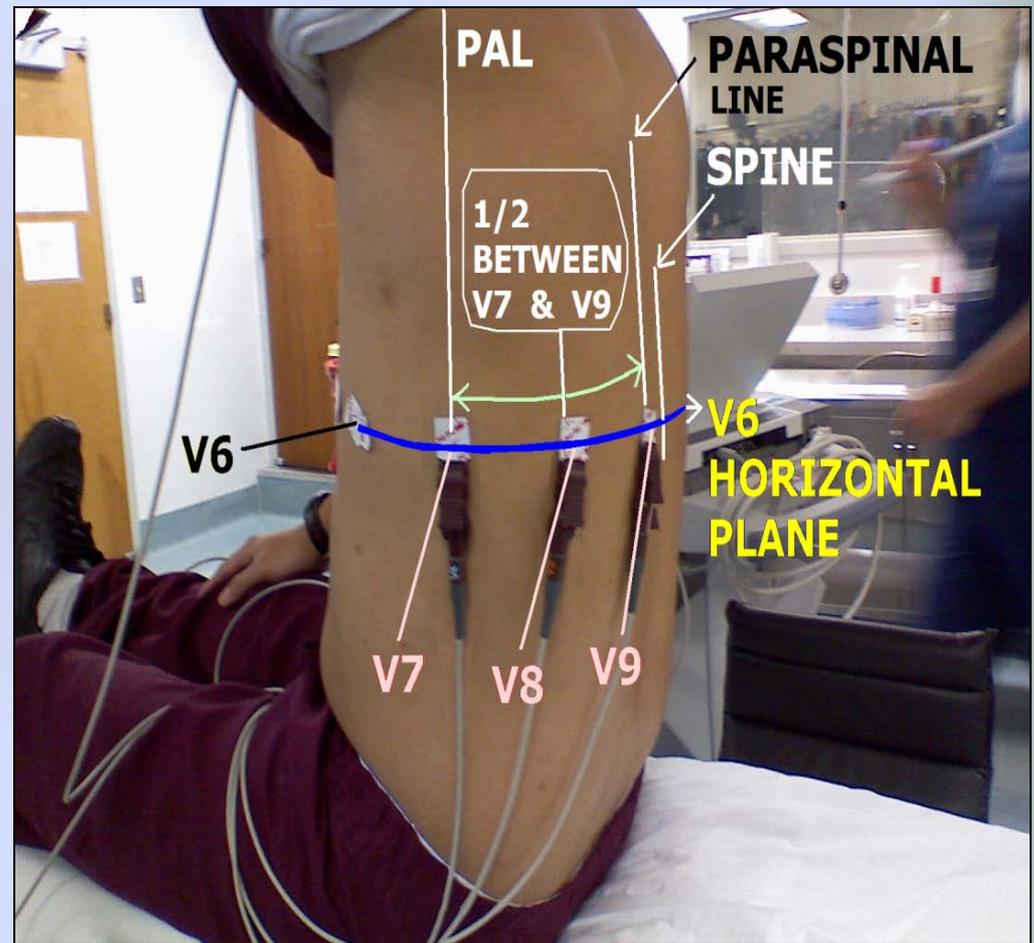
POSTERIOR WALL

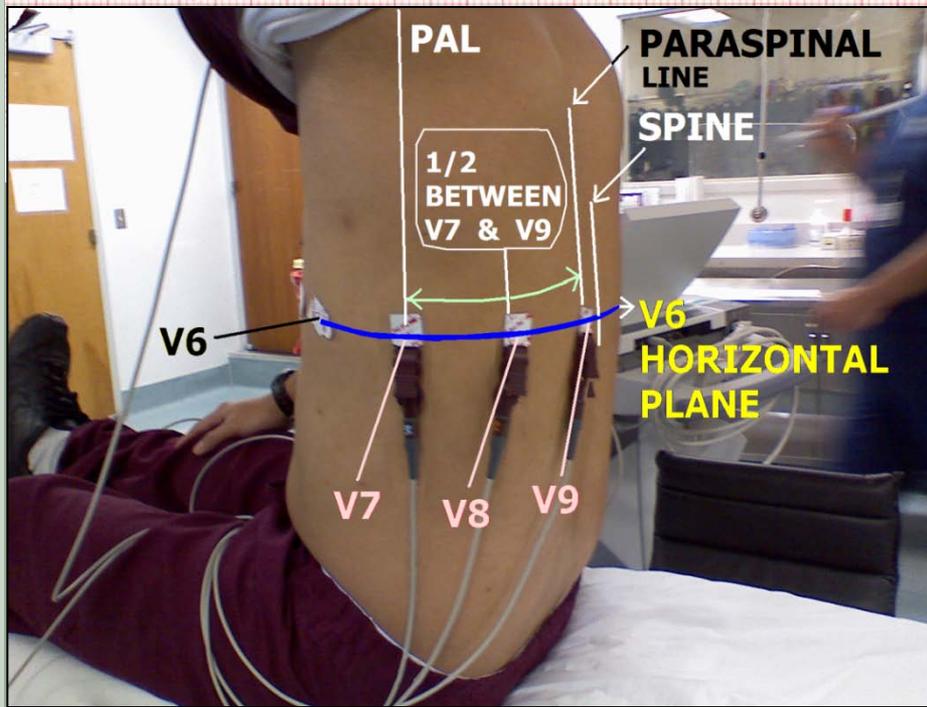
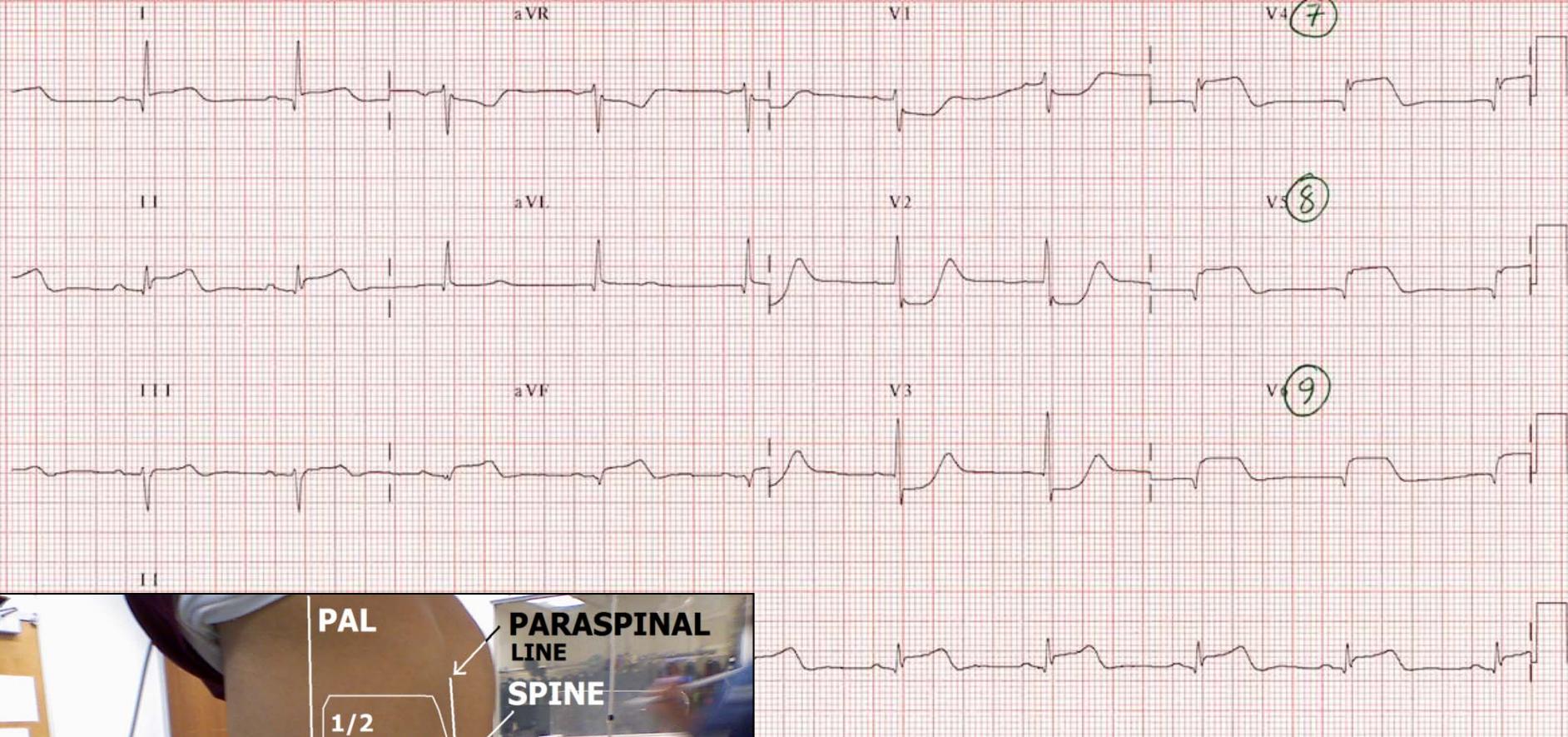


via **RECIPROCAL CHANGES.**

Posterior Lead ECG Lead Placement

- After initial 12 Lead obtained:
- Reposition leads V4, V5 & V6 to the v7, v8 & V9 locations on the patient's back.
- **ST elevation >0.5 mv ABNORMAL**





ST Elevation of 0.5mv or more in POSTERIOR LEADS (V7-V9) is consistent with POSTERIOR WALL STEMI

ST Depression in V1 – V4

Could indicate:

- **Anterior Ischemia**
- **Anterior Infarction (NSTEMI)**
- **Posterior Wall STEMI**

ST Depression in V1 – V4

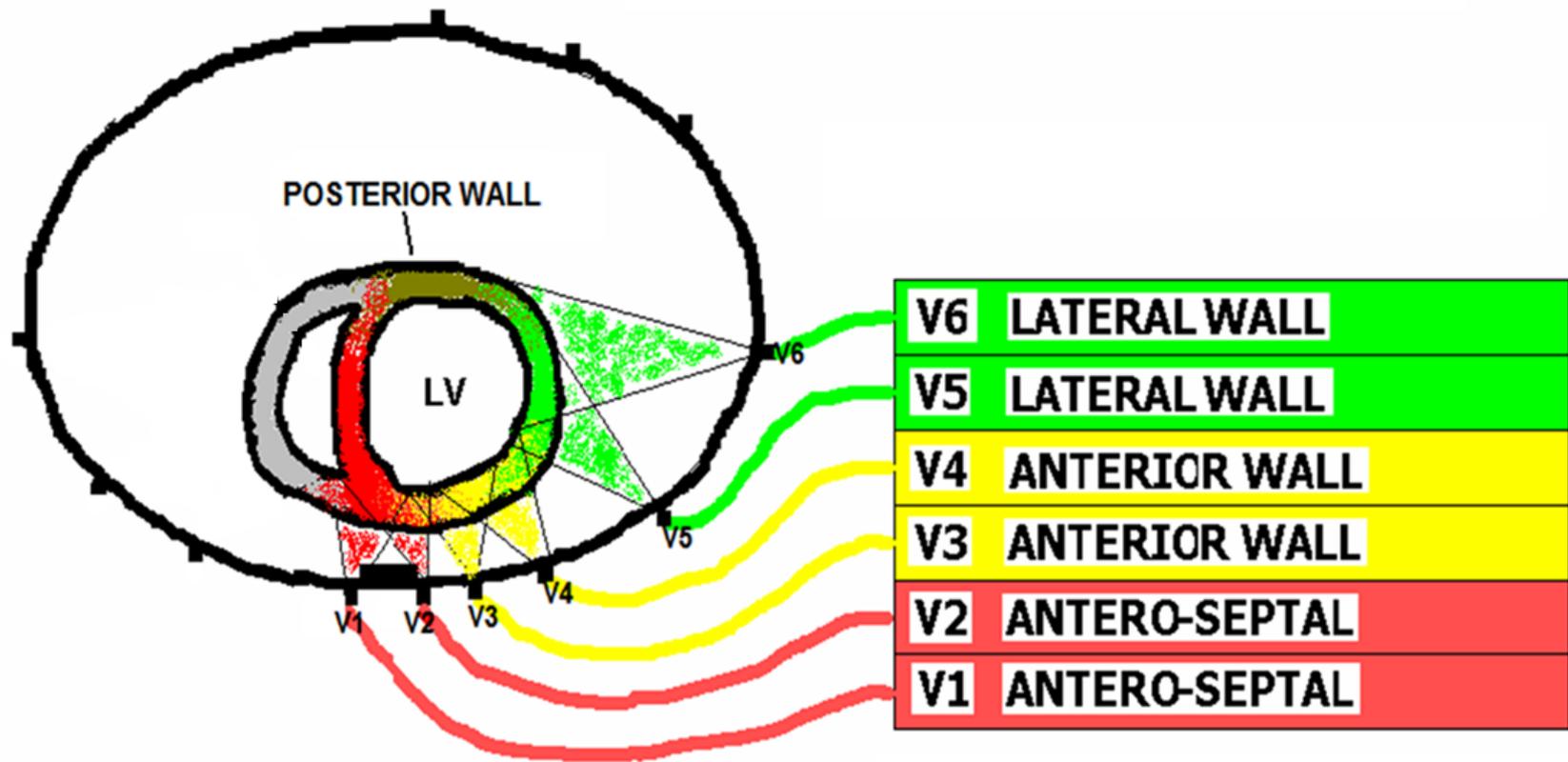
Could indicate:

- Anterior Ischemia
- Anterior Infarction (NSTEMI)
- Posterior Wall STEMI

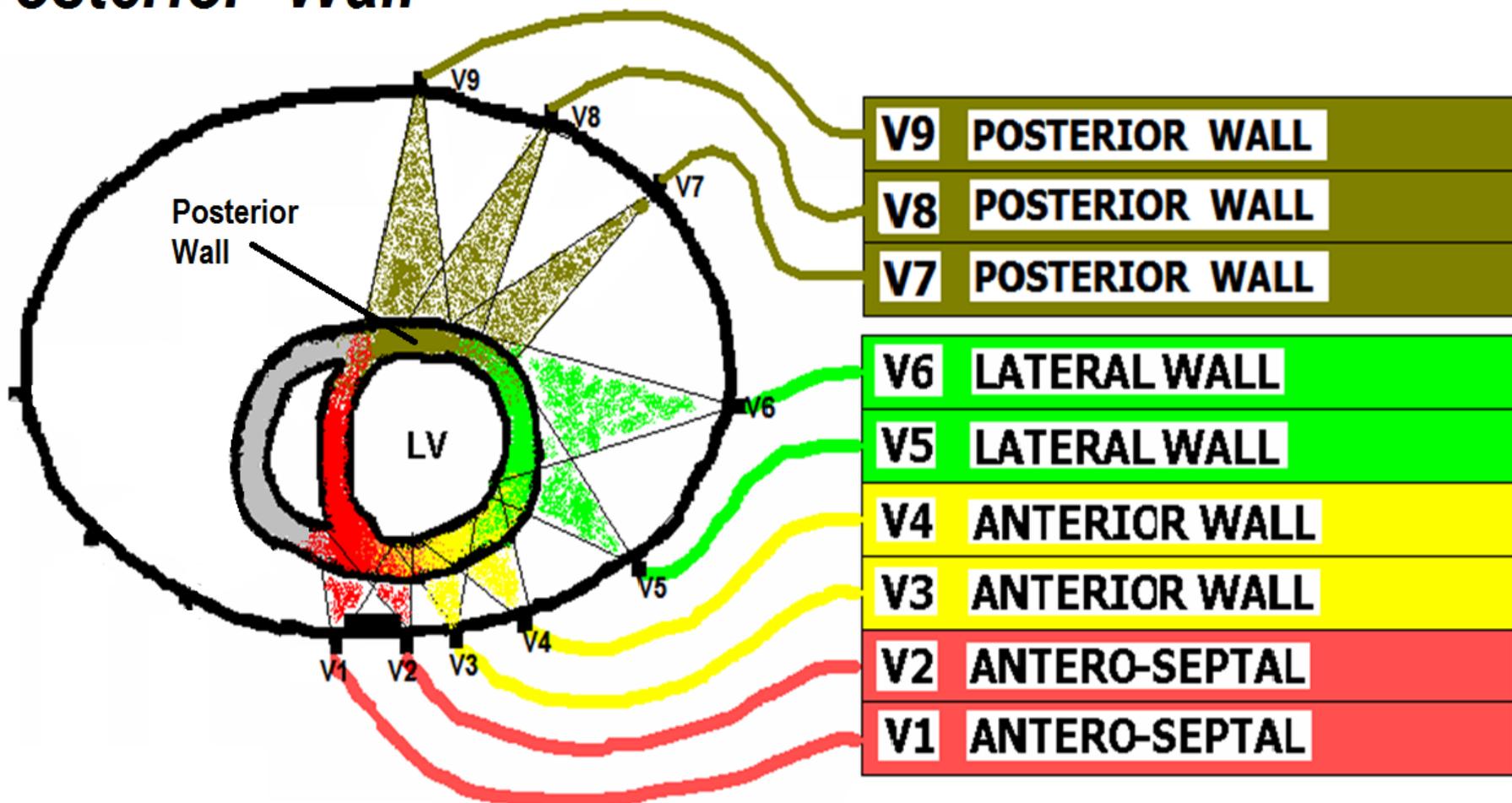


Obtain an a POSTERIOR LEAD ECG to rule out POSTERIOR WALL STEMI !

The STANDARD 12 Lead ECG does NOT directly view the POSTERIOR WALL . . .



Leads V7, V8 & V9 directly "see" the Posterior Wall



Suggested Routine Practice –
OBTAIN 18 LEAD ECG when
the following presents:

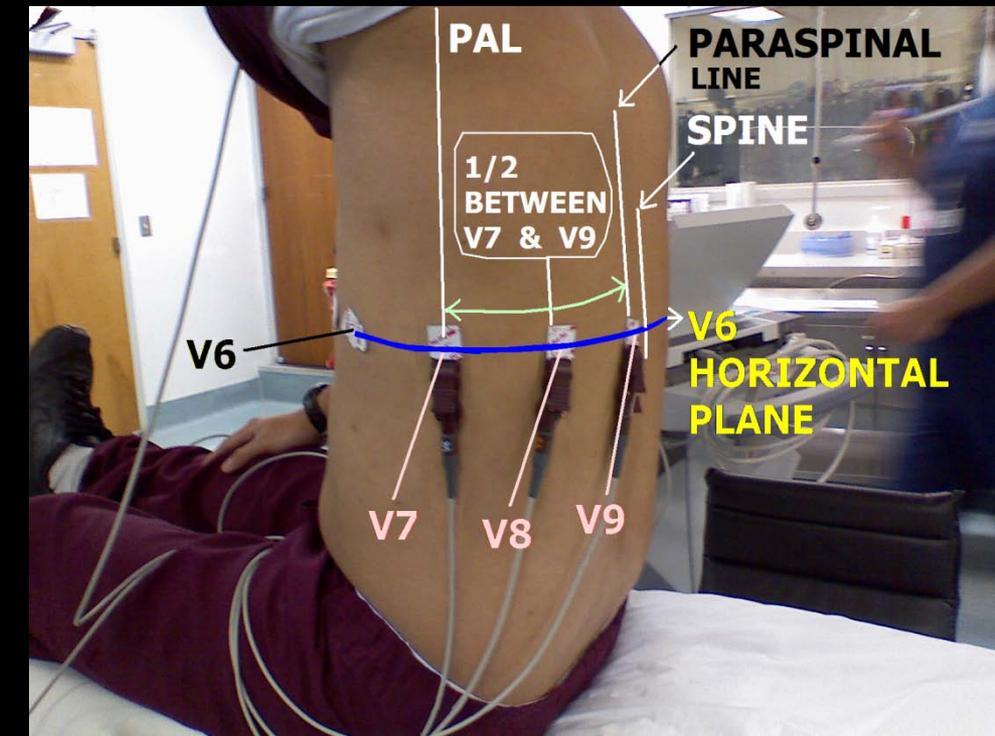
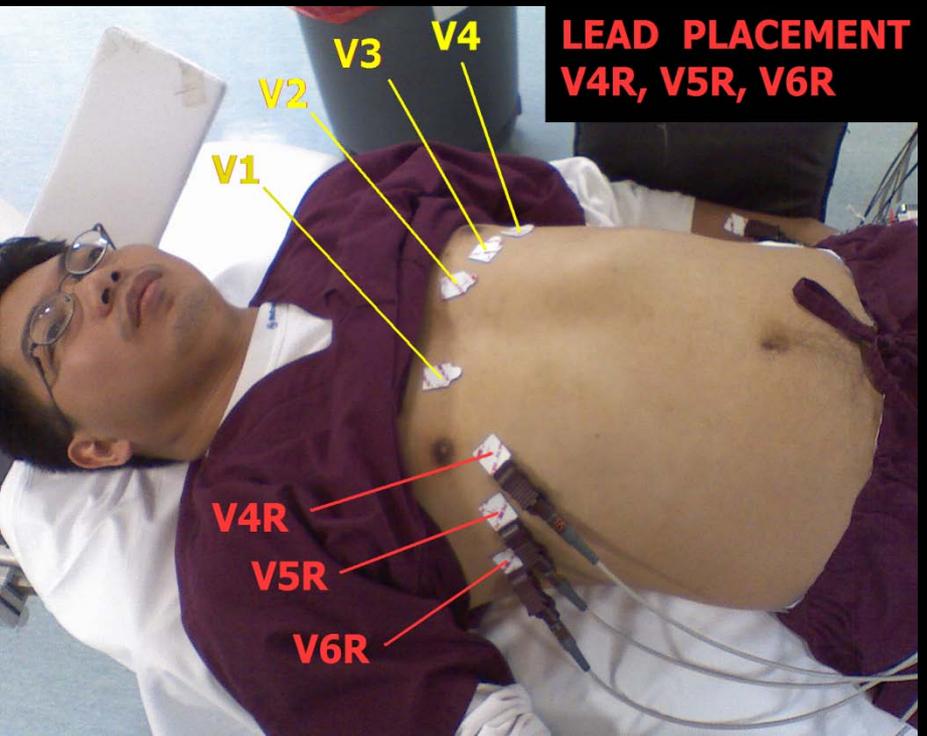
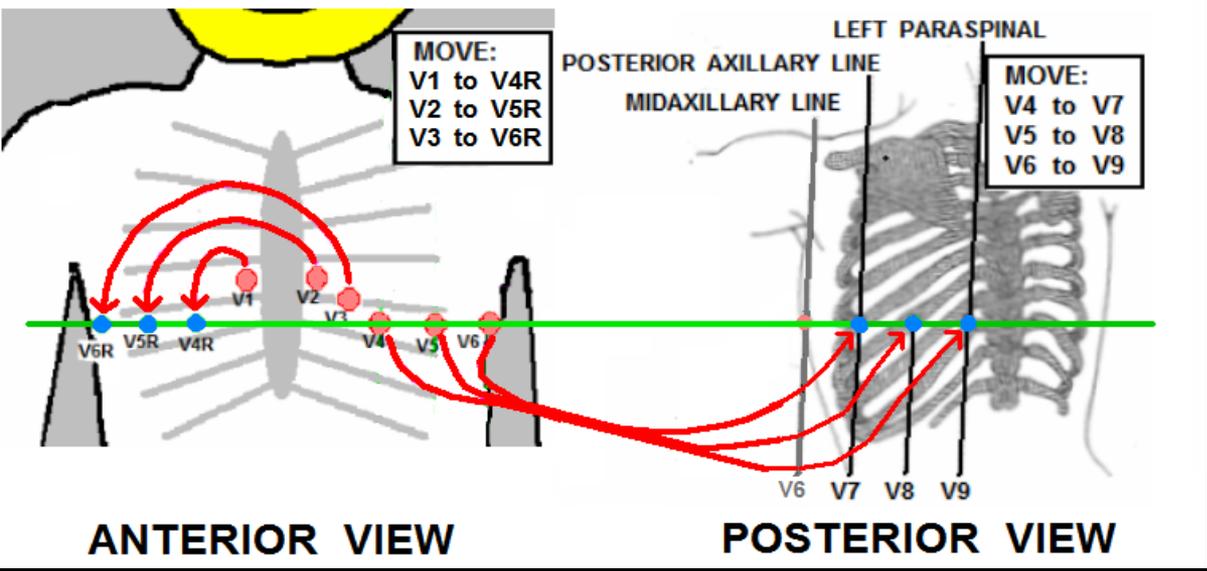
- **INFERIOR WALL STEMI**
- **ST DEPRESSION** in any of
the **ANTERIOR LEADS**
(V1 – V4)

To do an 18 Lead ECG with a
STANDARD 12 Lead ECG
machine,

FIRST, do you 12 Lead ECG in
the traditional manner,

and then you will REPOSITION
the CHEST LEADS like this

HOW TO REPOSITION 6 CHEST LEADS to OBTAIN 3 R VENTRICLE and 3 POSTERIOR LEADS



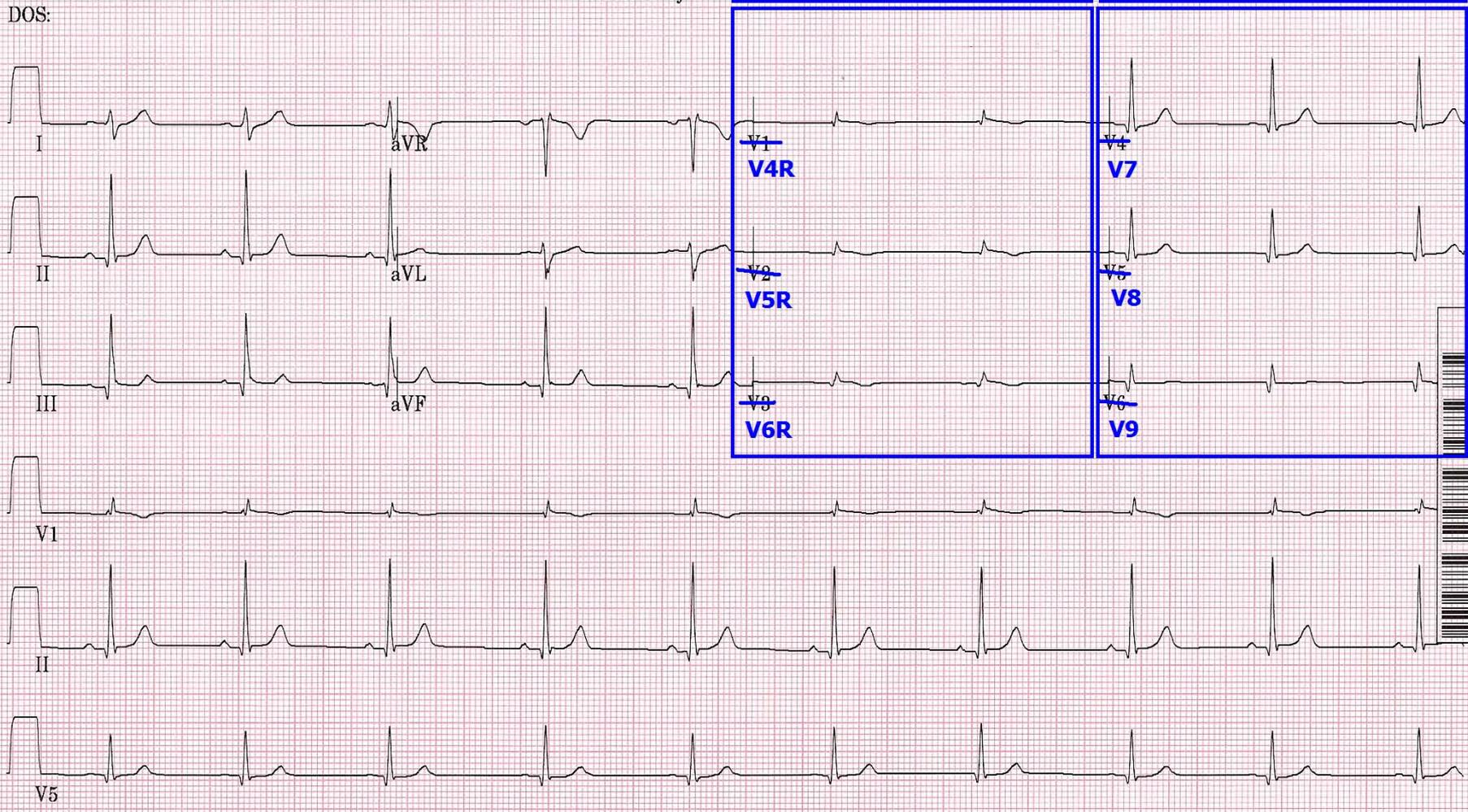
34years
Male Asian
Room: Opt:
Vent. rate 58 bpm
PR interval 146 ms
QRS duration 82 ms
QT/QTc 372/365 ms
P-R-T axes 29 82 50

Sinus bradycardia
~~RSR' or QR pattern in V1 suggests right ventricular conduction delay~~
~~Cannot rule out Anteroapical infarct, age undetermined~~
~~Abnormal ECG~~

Technician: WR

Referred by:

RIGHT VENTRICLE **POSTERIOR WALL**



Common Factors that Affect the ECG:

- **Heart Rate**
- **Body Temperature**
- **Hydration / Fluid Volume Status**
- **Electrolytes**
- **Medications**
- **Conduction System Disorders**
- **Myocardial Ischemia / Infarction / Necrosis**
- **Valvular function / Hypertrophy**
- **Congenital abnormalities /conditions**
- **Cardiomyopathies**

***The BASELINE ECG
should be
OBTAINED and
INTERPRETED by a PHYSICIAN
within TEN MINUTES of
the patient's
initial presentation.***

The ***NORMAL*** 12 Lead ECG (pertaining to ACS) :

- Heart Rate 60-99
- QRS width <120ms
- J Points iso-electric
- ST Segments: slight positive inclination
- T waves upright (except Lead AVR)
- QRS deflection: varies (compare to BASELINE ECG or previously recorded ECGs)

The BASELINE ECG:

You should review the Baseline ECG and note the following:

- **Physician interpretation / notes**
- **Heart Rate**
- **QRS duration (width)**
- **J Points / ST-Segments / T waves *in EACH LEAD***
- **QRS Deflections of each lead.**
- **Computerized Interpretation**

Non-Physician Review of 2nd, 3rd & all additional (Serial) ECGs:

- **Compare the following items on each subsequently recorded ECG to the BASELINE ECG:**
 - Heart rate
 - QRS duration (width)
 - QRS amplitude (height)
 - J Points, ST Segments and T Waves of each lead
 - QRS deflections of each lead
 - Computerized interpretation

The *NORMAL* 12 Lead ECG:

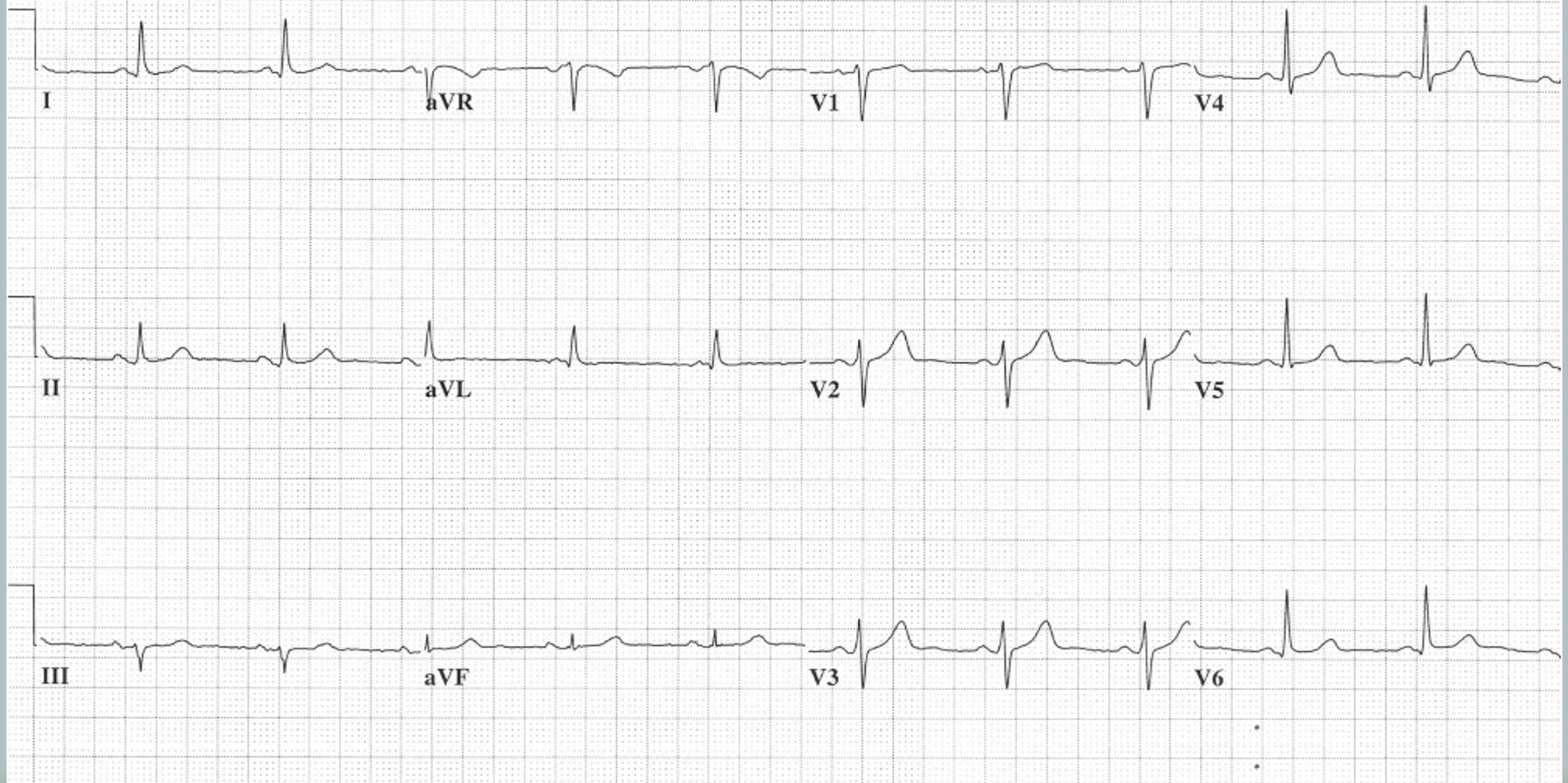
38 yr
Male

Room:ER

Vent. rate	64	BPM
PR interval	130	ms
QRS duration	96	ms
QT/QTc	396/408	ms
P-R-T axes	40 11	61

Normal sinus rhythm
Normal ECG
No previous ECGs available

D.O.S.:



End of “Serial ECG Intepretation

Part 1” (20th Congress ECG Session 2):

*Curriculum continues in
“Serial ECG Interpretation Part 2”
(20th Congress ECG Session 3)*

Oct 26, 2017 - 11:30am-12:30pm

See you tomorrow ! 😊

For more information:

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Workshops available.