STAT 12 Lead ECG Workshop: Basics & ACS

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Bayfront Health Seven Rivers
Crystal River, Florida

Interventional Cardiovascular
& Electrophysiology
Technologist

Welcome !

WORKSHOP Description

This is a **FOCUSED**, **CRASH COURSE** that **TEACHES YOU** to interpret 12 Lead ECGs to identify INDICATORS of Acute Coronary Syndrome (ACS).

WORKSHOP = ***you will have to do some WORK.***

FOCUSED = ***right to the point, no "extra fluff."***

CRASH COURSE = ***fast paced***

TEACHES YOU = ***you will LEARN and NOT FORGET.***

- *You will do **EXERCISES** throughout course.*

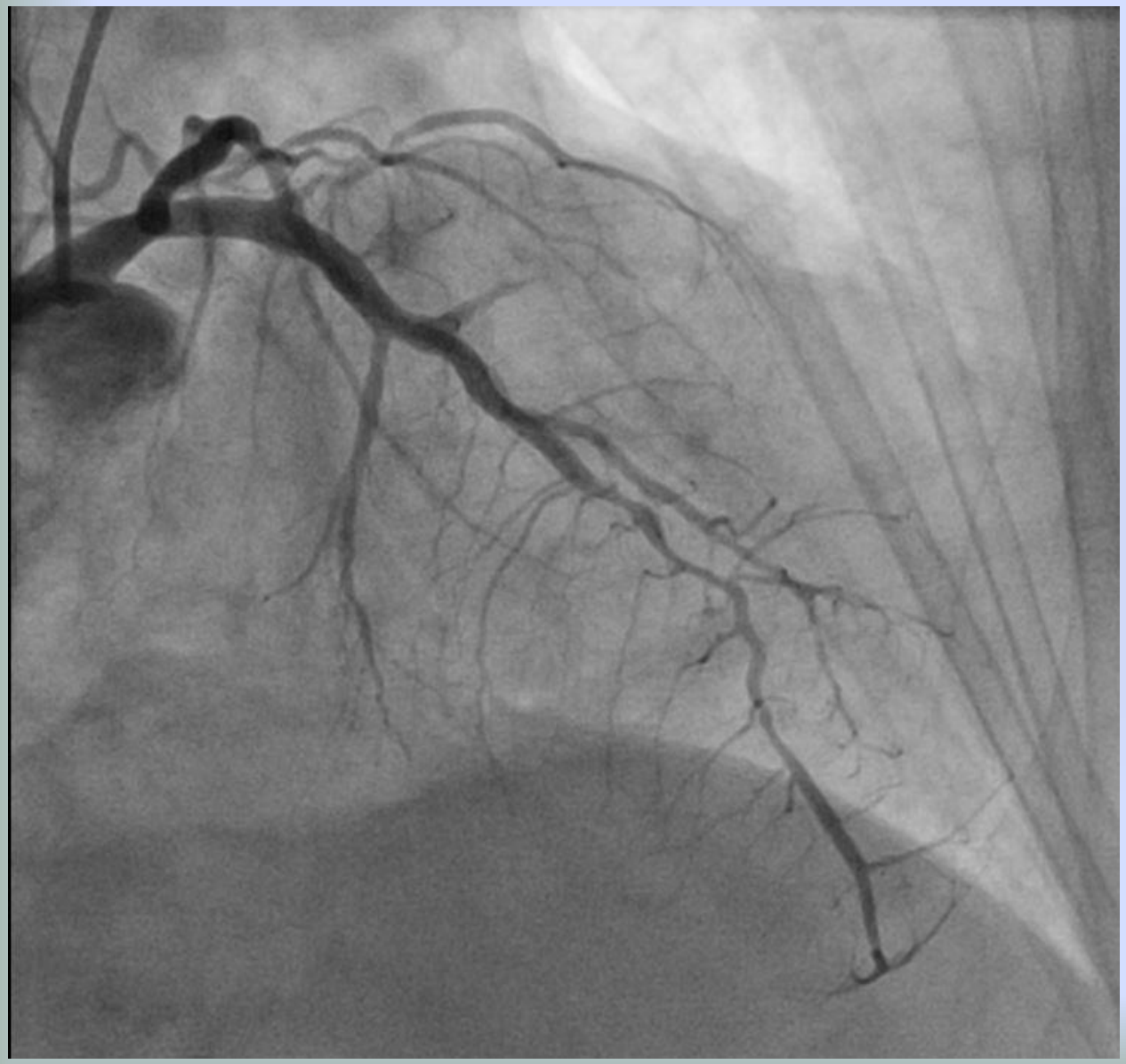
Source of Curriculum:

- Case Studies from Cardiac Catheterization and Electrophysiology Labs, 1996 – Present

Approximately 13,000 Cases between 1996 - Today

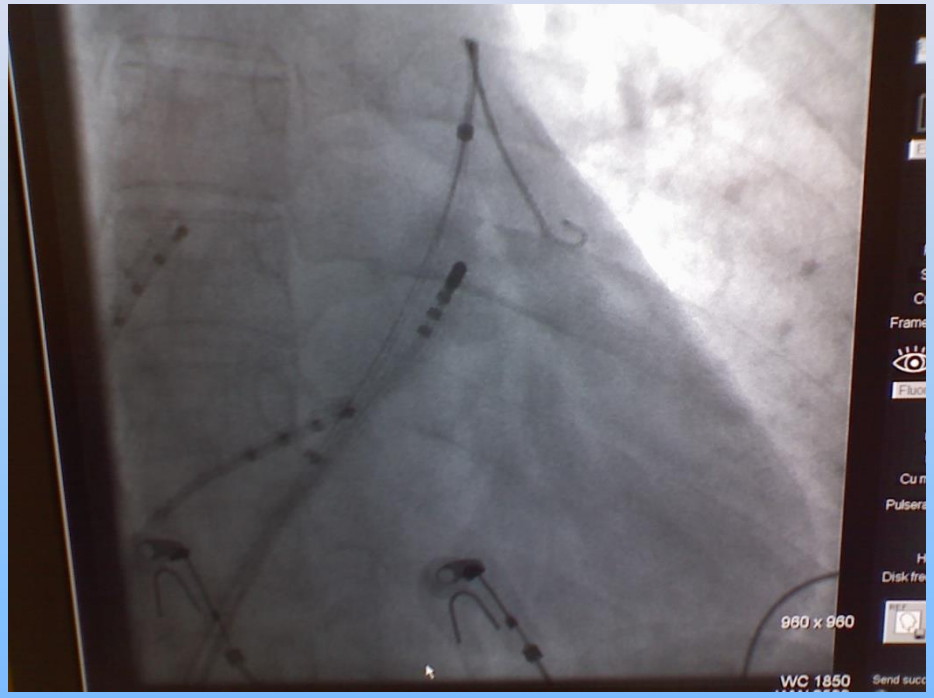
Wayne Ruppert and Dr. James Irwin, St Joseph's Hospital, Tampa, 7/29/2004

Cardiac Cath Lab Advantage:



Allows us to CORRELATE ECG leads with SPECIFIC cardiac anatomic structures.

Electrophysiology Lab



EP Catheters within the heart used for obtaining the Electrogram (the “internal ECG”) Tracing and for Pace-mapping, an integral component of an EP study

Author Wayne Ruppert conducting Pace-mapping during EP study at the St Joseph’s Hospital Heart Institute, Pediatric Electrophysiology Program, Tampa, FL in 2004


NEC
DVD+R
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Source of Curriculum:

- Case Studies from Cardiac Catheterization and Electrophysiology Labs, 1996 – Present
- Current Evidence-based Research
  - Journal of the American College of Cardiology (JACC)
  - American Heart Association (AHA) Circulation
  - ACC/AHA Guidelines
  - New England Journal of Medicine

Source of Curriculum:

- Case Studies from Cardiac Catheterization and Electrophysiology Labs, 1996 – Present
- Current Evidence-based Research
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  - American Heart Association (AHA) Circulation
  - ACC/AHA Guidelines
  - New England Journal of Medicine
- Two peer reviewed, published textbooks

In the CARDIAC CATHETERIZATION LAB, we read our patients' 12 Lead ECGs and then evaluate their coronary arteries and ventricular function during angiography. Stated in plain English, *we rapidly learn how to correlate 12 lead ECG findings with what's really going on inside our patients' hearts.* Seeing ECGs from this perspective adds a new dimension to understanding the complex pathophysiologies of cardiovascular disease.

This book prepares you to:

- INTERPRET 12 Lead ECGs.
- ASSIMILATE DATA derived from the 12 Lead ECG into a comprehensive patient evaluation process designed to maximize diagnostic accuracy, while taking into consideration the 12 Lead ECGs inherent LACK of SENSITIVITY and SPECIFICITY.
- IDENTIFY 13 PATTERNS associated with myocardial ischemia and infarction, including the most subtle ECG changes often missed by clinicians and the ECG machine's computerized interpretation software.
- CORRELATE each lead of the ECG with specific regions of the heart – and the CORONARY ARTERIAL DISTRIBUTION that commonly supplies it. In cases of STEMI, this knowledge prepares you to ANTICIPATE the FAILURE OF CRITICAL CARDIAC STRUCTURES – often *BEFORE THEY FAIL.*

For those who need to master essential material quickly, this book has been written with an expedited learning" feature, *designed to make learning as easy as 1 2 3:*

1. **READ the YELLOW HIGHLIGHTED TEXT**
2. **STUDY the GRAPHIC IMAGES, PICTURES and ECGs**
3. **CORRECTLY ANSWER the REVIEW QUESTIONS at the end of each section.**

This is an invaluable resource for every medical professional who evaluates patients and reads their 12 lead ECGs:

- *Fellows in Emergency, Cardiology, and Family Medicine*
- *Medical Residents*
- *Veteran Physicians wanting a good review in ACS patient evaluation*
- *Physician Assistants and Nurse Practitioners*
- *Emergency Department Nurses*
- *Coronary Care Unit and Cardiac Telemetry Nurses*
- *Walk-in Clinic Physicians and Nurses*
- *Paramedics*

"I think this book will be a wonderful addition to the textbooks that are already available, with a fresh perspective'"

Joseph P. Ornato, MD, FACP, FACC, FACEP
- Professor and Chairman, Department of Emergency Medicine
Medical College of Virginia/Virginia Commonwealth University
- Medical Director, Richmond Ambulance Authority,
Richmond, Virginia

"This book integrates academic ECG principles with real-world clinical practice by incorporation of well chosen cath lab case studies into its curriculum. This combination lets readers see patients and their ECGs through the eyes of an experienced cath lab interventionalist, and provides a balanced approach to patient evaluation that compensates for the ECGs inherent lack of sensitivity and specificity. I highly recommend this book for all Emergency Medicine and Cardiology Fellows. For experienced clinicians, it's a superb review."

Humberto Coto, MD, FACP, FACC
- Chief of Interventional Cardiology
St. Joseph's Hospital
Tampa, Florida

ISBN 978-0-9829172-1-3
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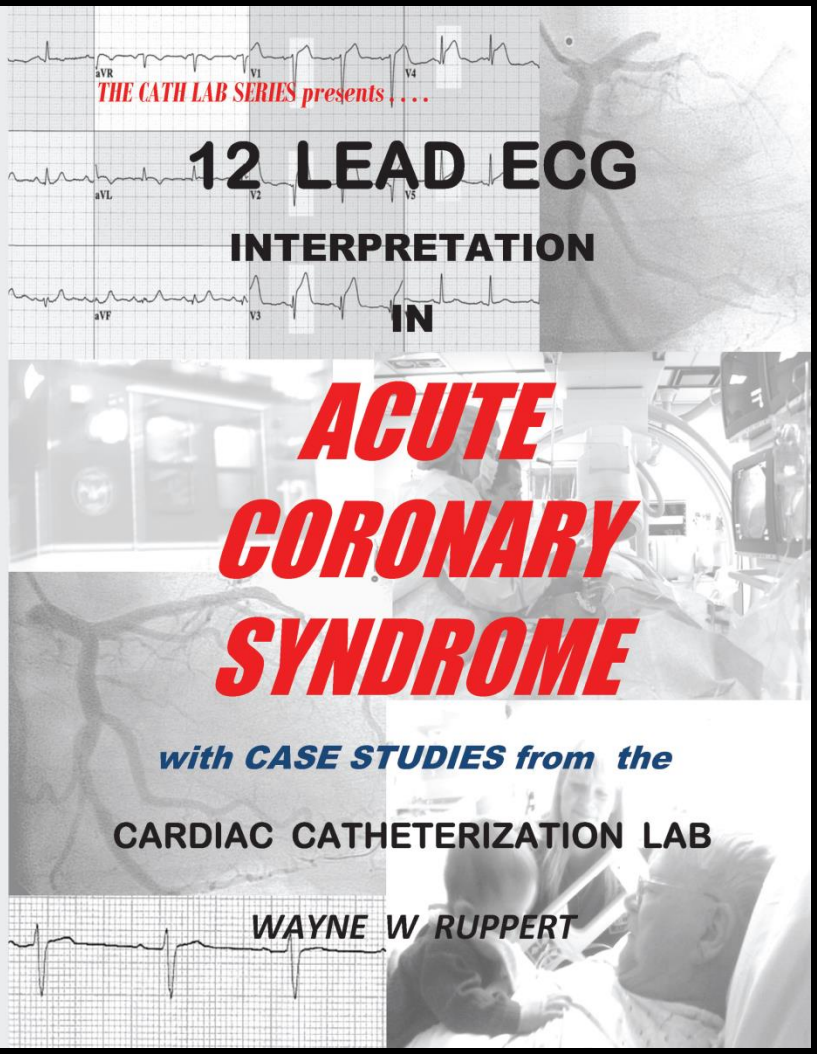
12 LEAD ECG INTERPRETATION in ACUTE CORONARY SYNDROME with CASE STUDIES from the CATH LAB -- WAYNE RUPPERT



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2010 - Current

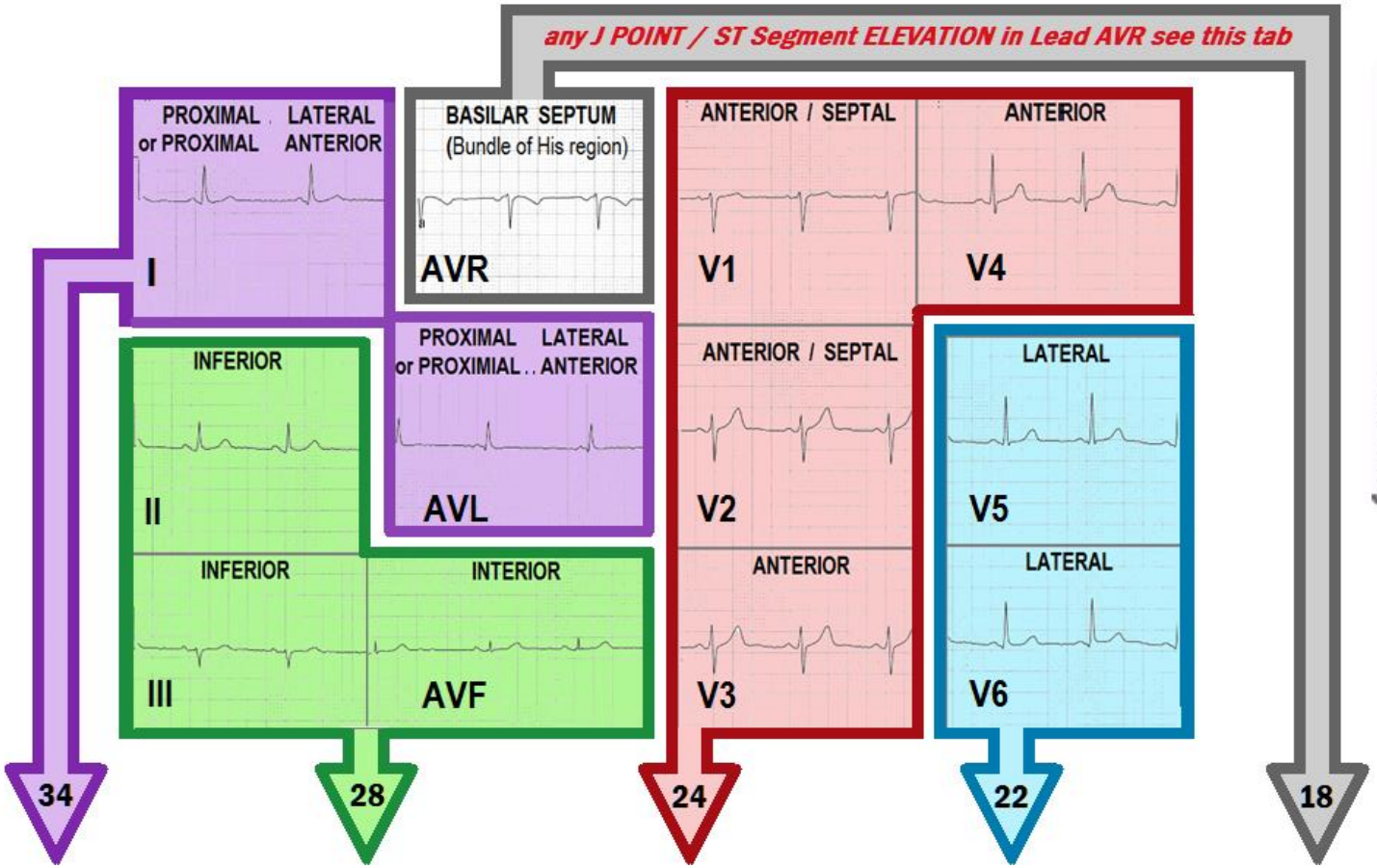
STEMI Assistant

by Wayne Ruppert

UNIVERSAL ACS PATIENT MANAGEMENT ALGORITHM
- - - See PAGE ONE - - -

Select LEAD SET with HIGHEST ST ELEVATION and open to associated page . . .

CRASH CART EMERGENCY REFERENCE



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2015 - Current

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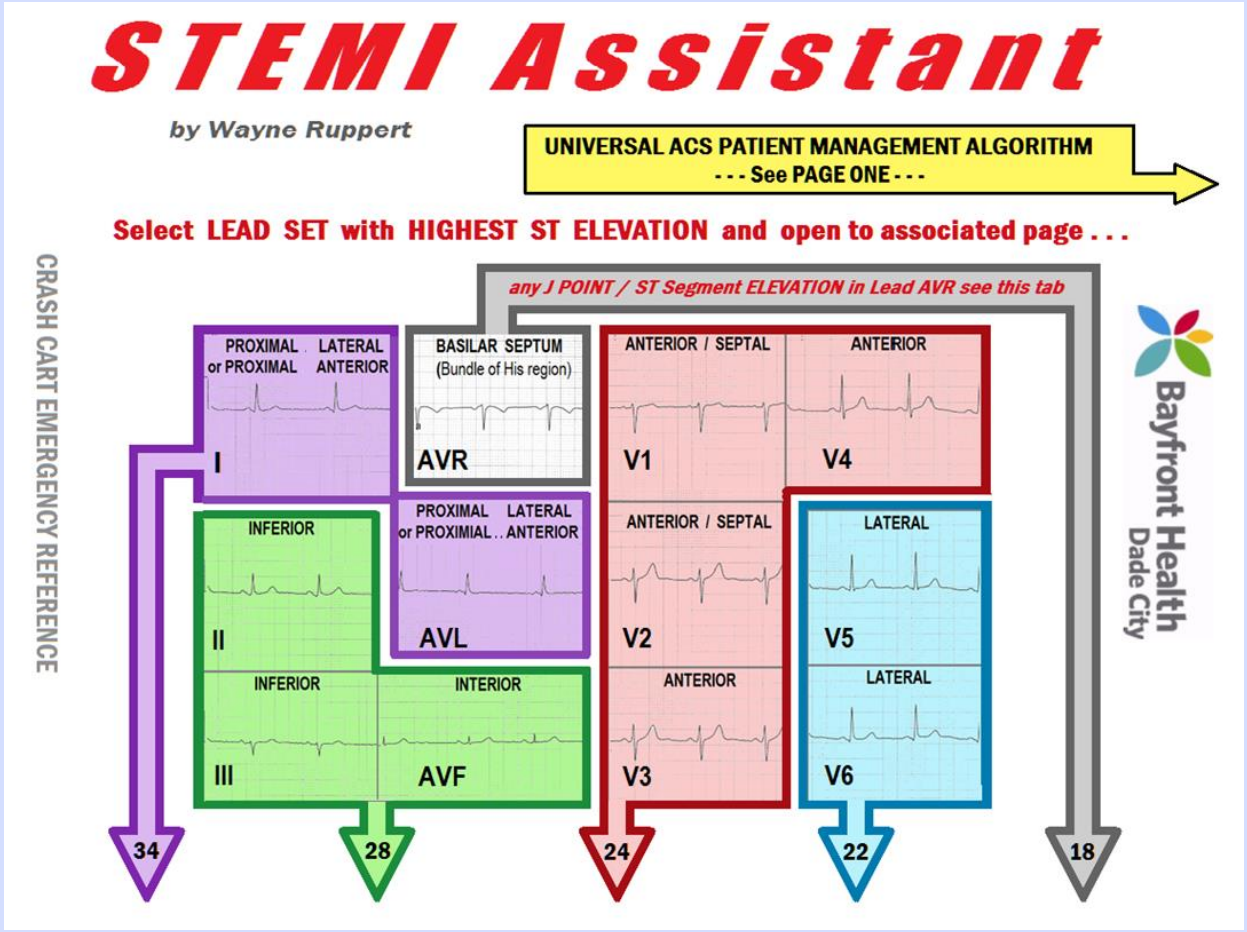

STEMI Assistant – Information Video

www.practicalclinicalskills.com
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Download Nuts & Bolts of Therapeutic Hypothermia - Bayfront Health 2019

Download EMS 12 Lead 101 - 2019

Download BHSR 2019 Basic ECG with Obtaining STAT 12 Lead

Download Hands-Only CPR and AED Course

Download The Lifesaving ECG Part 1

Download The Lifesaving ECG Part 2

Download Advanced 12 Lead ECG in ACS and SADS Key West 2018

Download Basic ECG - Key West 2018

Download 12 Lead ECG - 8 hour class - Part 1 - 2018

Download 12 Lead ECG - 8 hour class - Part II - 2018

Download Advanced Physicians ACLS 2018 SRRMC

Download ACC 20th Congress Serial 12 Lead ECG Course

Download A SHORT Course in LONG QT Syndrome

Download ACC 20th Congress - Continuous ST Segment Monitoring Course

Download ACC 20th Congress - Serial 12 Lead ECG Interpretation Part 1

Download ACC 20th Congress - Serial 12 Lead ECG Interpretation Part 2

Download Sudden Cardiac Death Prevention - ACC / SCPC 19th Congress

Download Initial Stabilization of the Atrial Fib Patient - SCPC 19th Congress

Download Continuous ST-Segment Monitoring Policy

Download QTc Monitoring Policy for Patients on QT Prolonging Meds

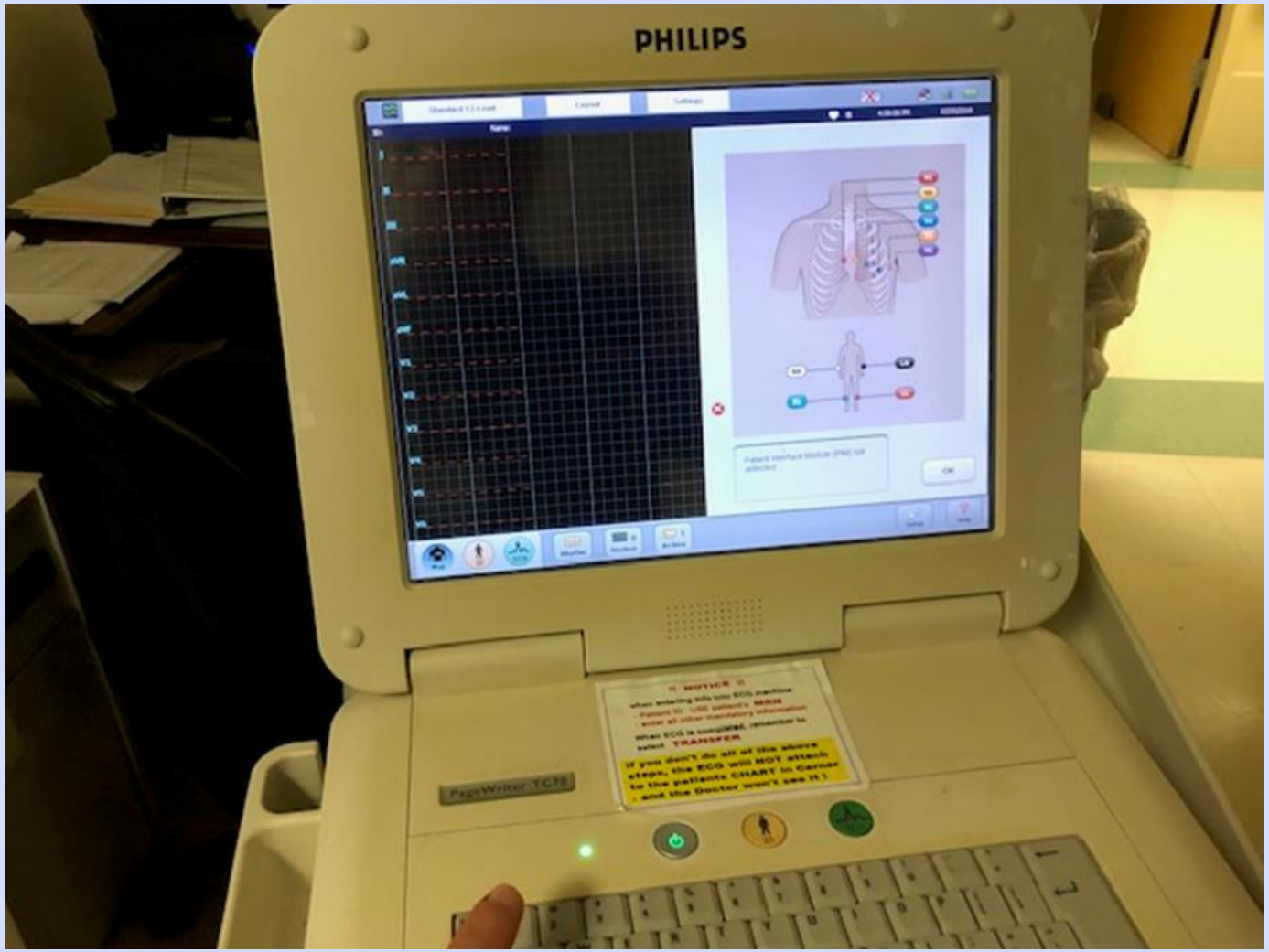
Download QT Monitoring Protocol - Patients on QT Prolonging Meds - 2018

wayneruppert@aol.com

Today's Agenda:

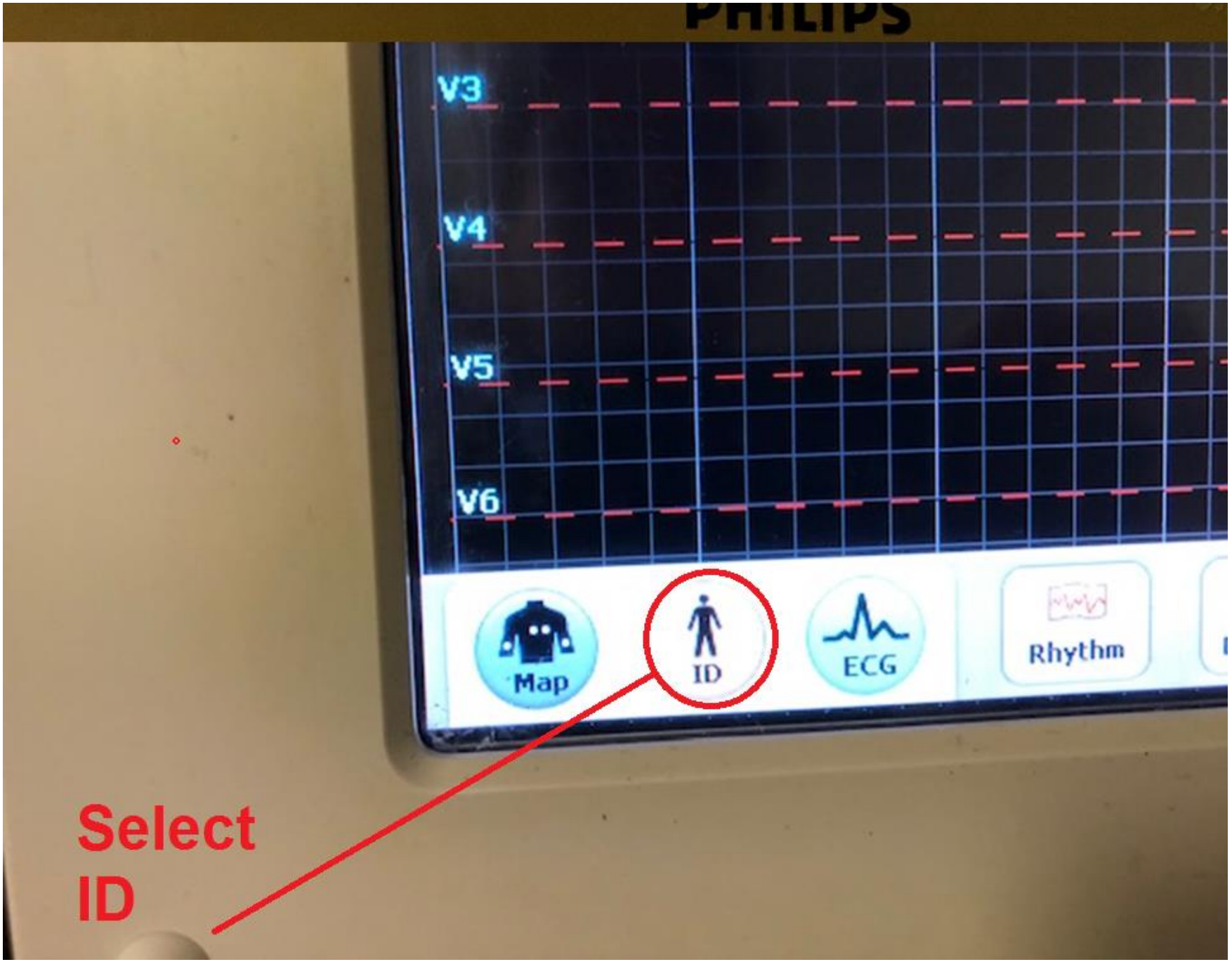
- First half of class (Part 1):
  - 12 Lead ECG Basic Fundamentals
    - Electrophysiology (Depolarization & Repolarization)
      - Waveforms and Intervals Relevant to ACS
    - Cardiac Anatomical Correlations with 12 Lead ECG
- Second half of class (Part 2):
  - ECG indicators of ACS
  - Diagnosis of STEMI
    - With Wide QRS vs. Normal width QRS
    - Clinical Relevance: predicting specific complication based on region of infarction.

Hospital 12 Lead EKG

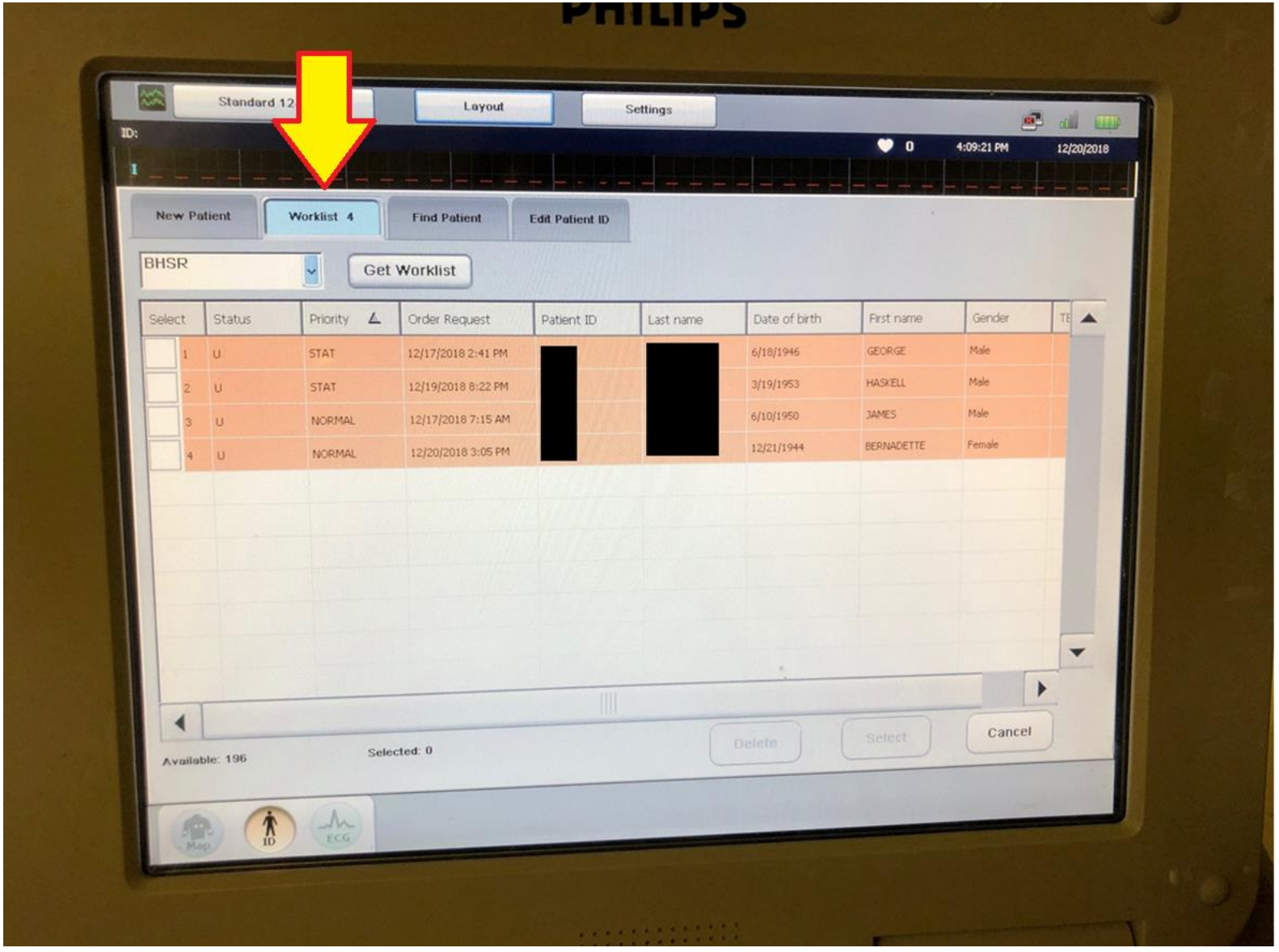


A FEW CRITICAL POINTS ABOUT THE Hospital (or Freestanding ED) EKG:

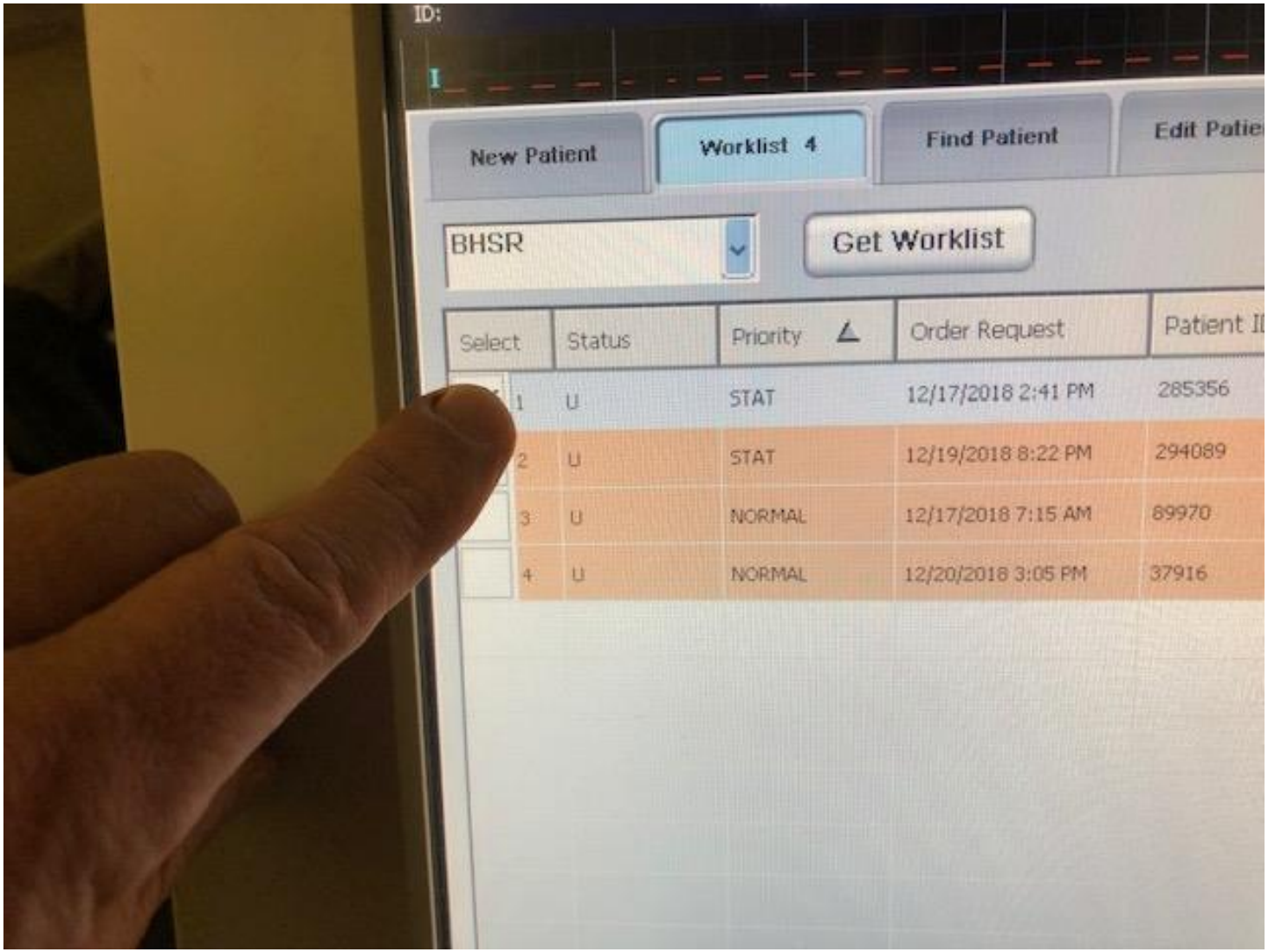
- If EKG order is put in Cerner FIRST you can find the patient on the EKG machine “Worklist”
- May take few minutes to transfer from Cerner to Cardioserver (EKG maching software).
- When patient selected from “worklist” it pre-populates all pertinent information into the EKG machine. GREATLY reduces errors!!!


PHILIPS
V3
V4
V5
V6
Map
ID
ECG
Rhythm
Select
ID

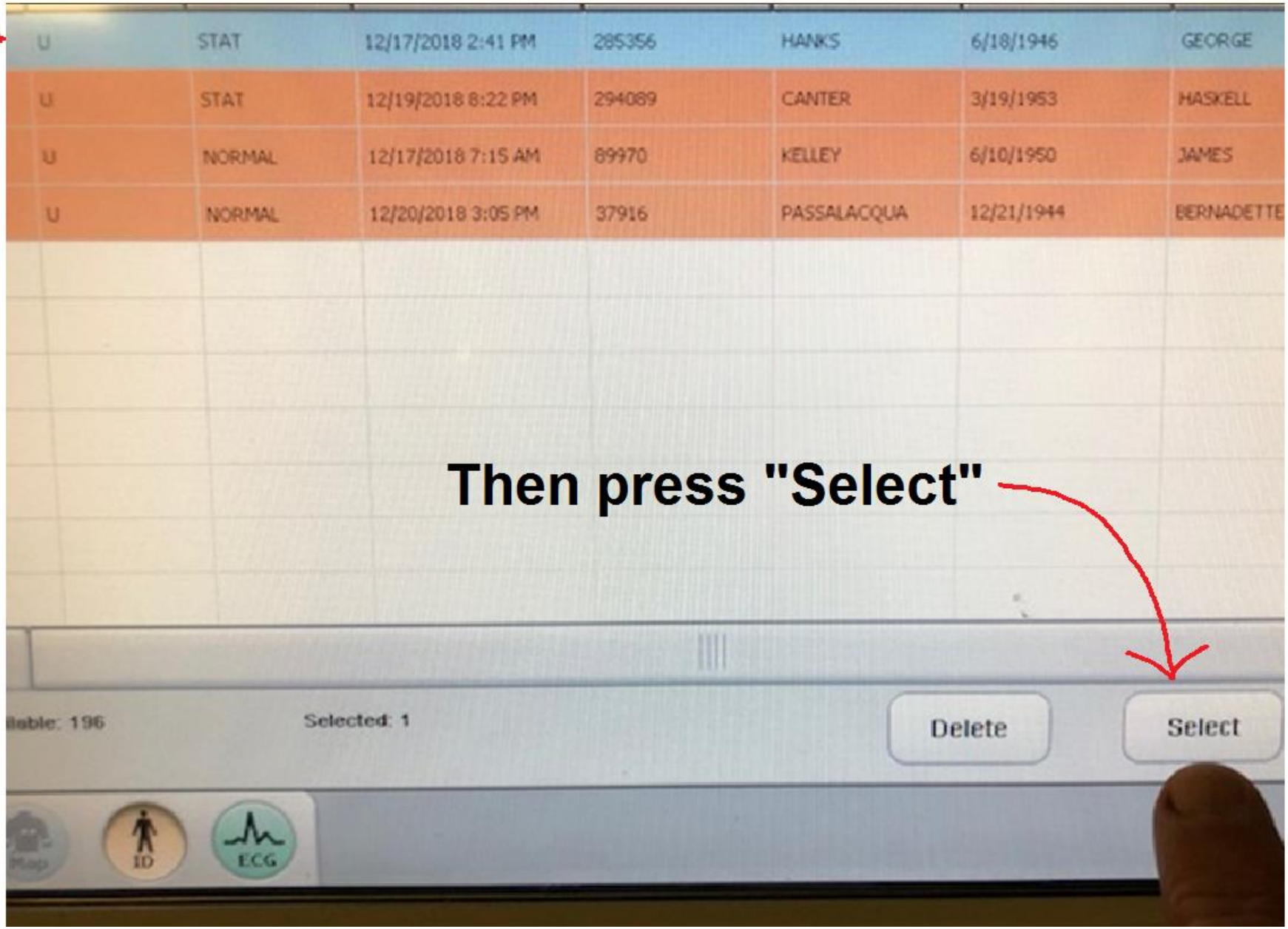
Go to “Worklist” Tab,



Select your patient . . .



Once selected, your patient is highlighted in blue



If patient is NOT on worklist, such as "STAT ECG" for chest pain . . . .

You must MANUALLY enter:

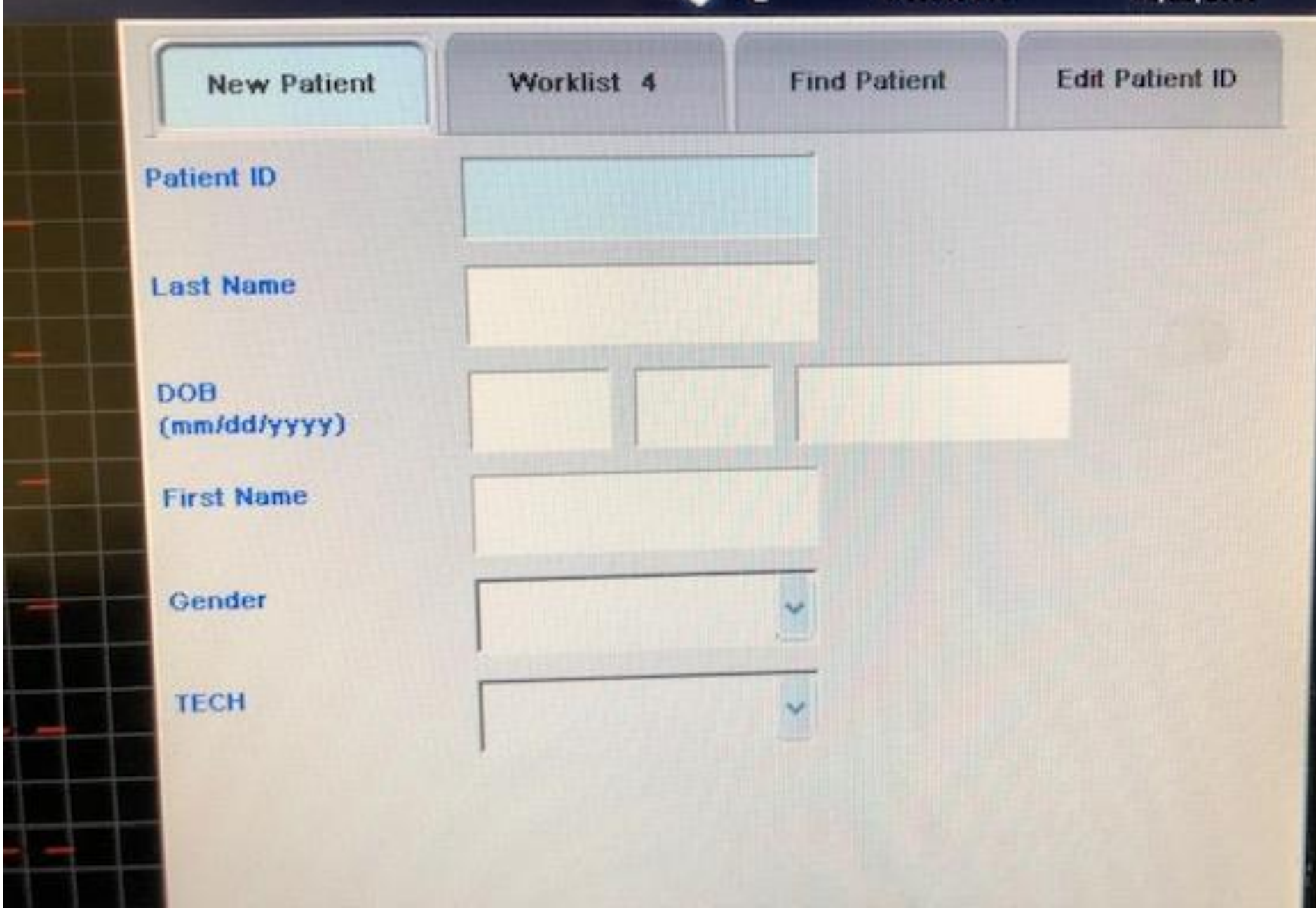
- Patient ID = MRN Number
- Last Name
- Date of Birth (mm/dd/yyyy)
- Gender
- Your ID (first initial, last name)

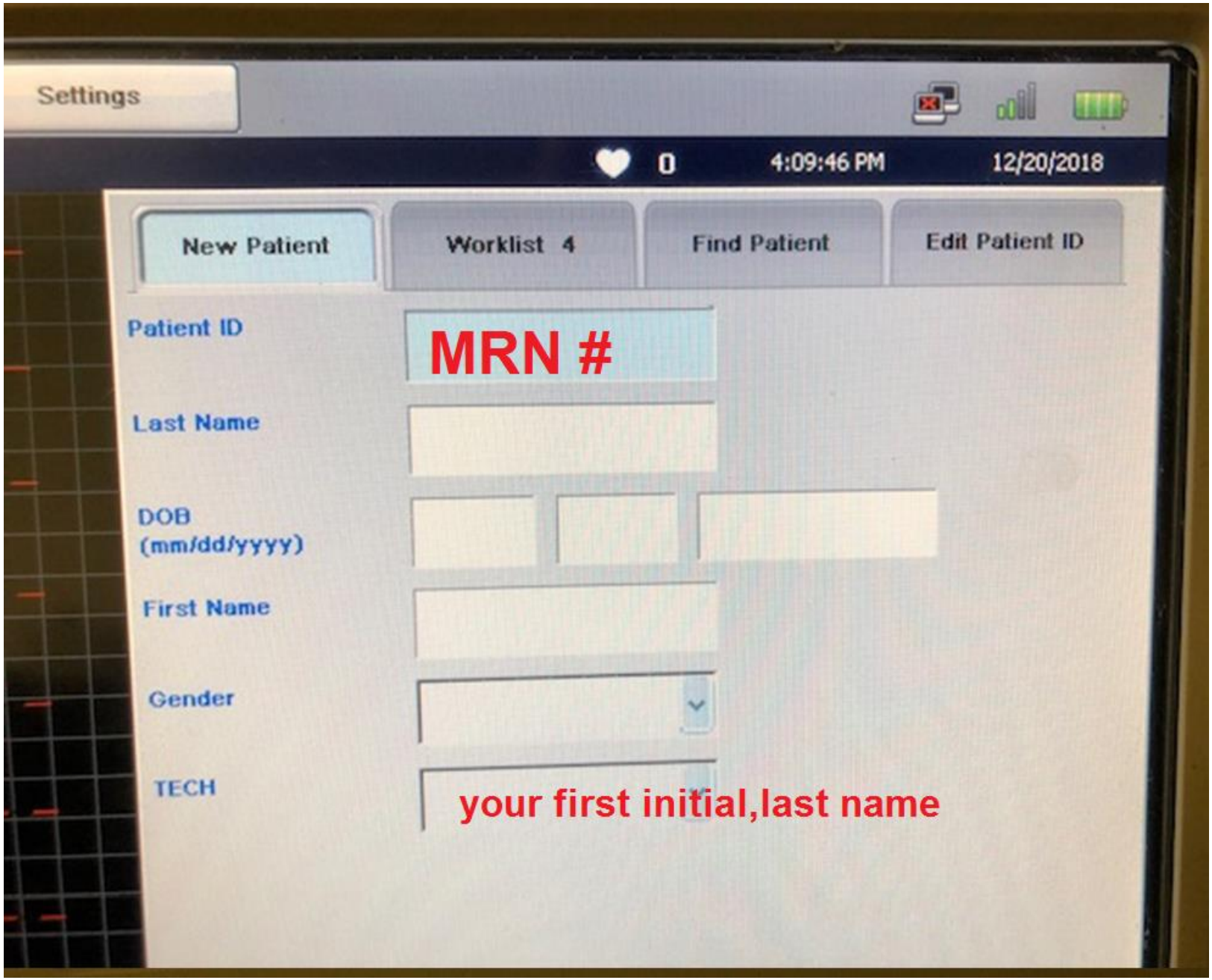
If patient is NOT on worklist, such as "STAT ECG" for chest pain . . . .

You must MANUALLY enter:

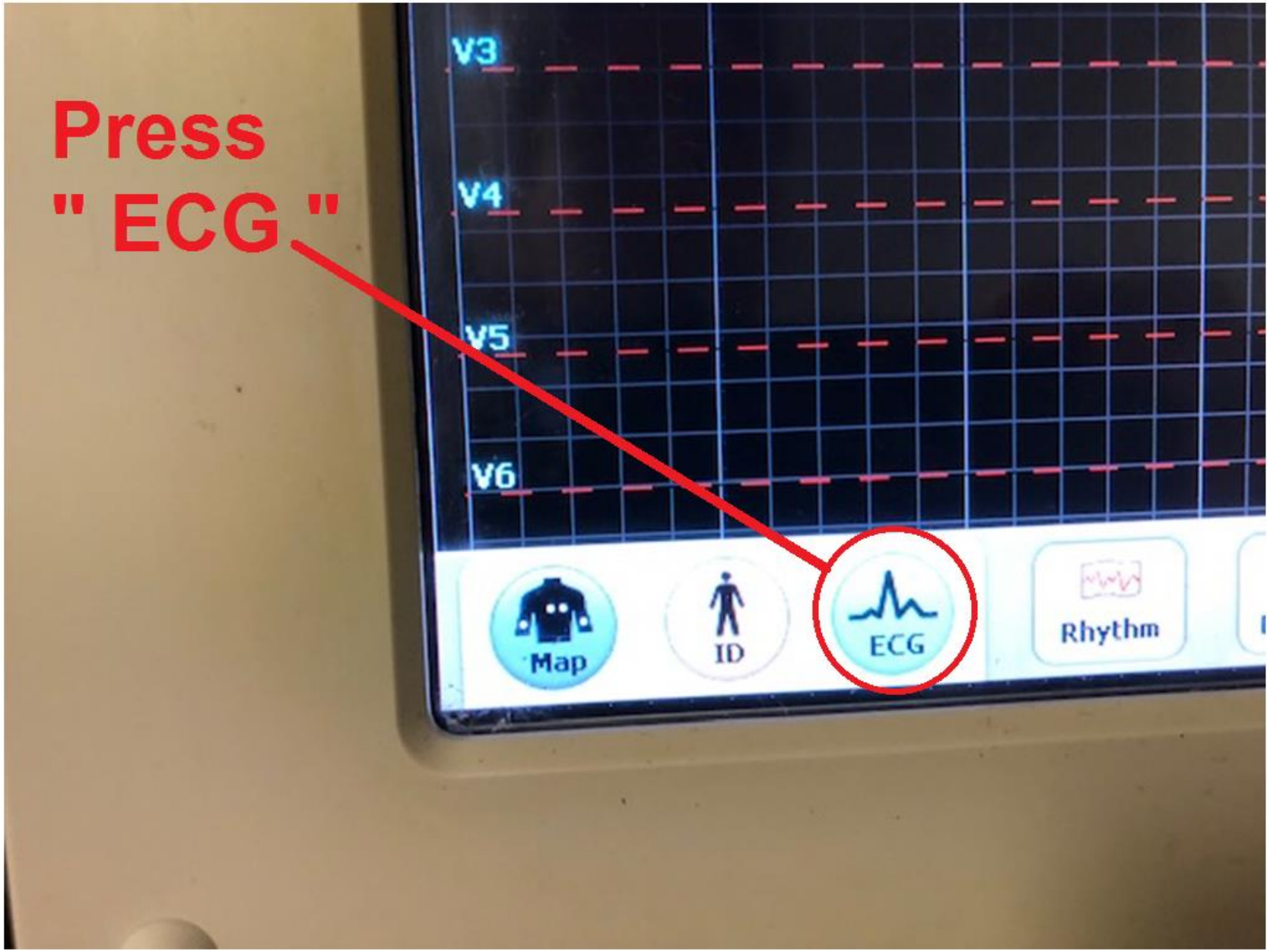
- Patient ID = MRN Number
- Last Name
- Date of Birth (mm/dd/yyyy)
- Gender
- Your ID (first initial, last name)

Then an ORDER must be generated in CERNER !!

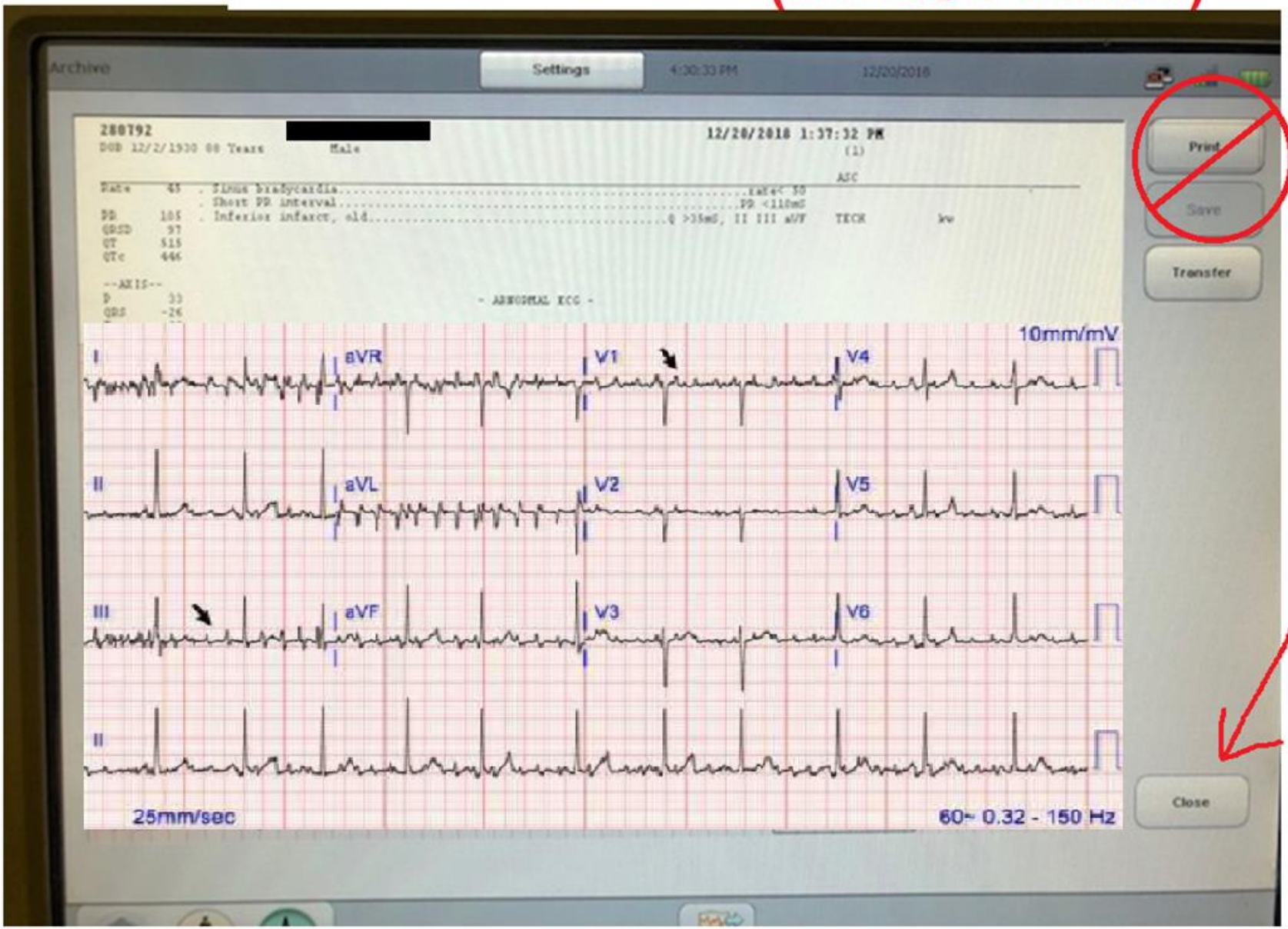

New Patient
Worklist 4
Find Patient
Edit Patient ID
Patient ID
Last Name
DOB
(mm/dd/yyyy)
First Name
Gender
TECH


Settings
0
4:09:46 PM
12/20/2018
New Patient
Worklist 4
Find Patient
Edit Patient ID
Patient ID
MRN #
Last Name
DOB
(mm/dd/yyyy)
First Name
Gender
TECH
your first initial,last name

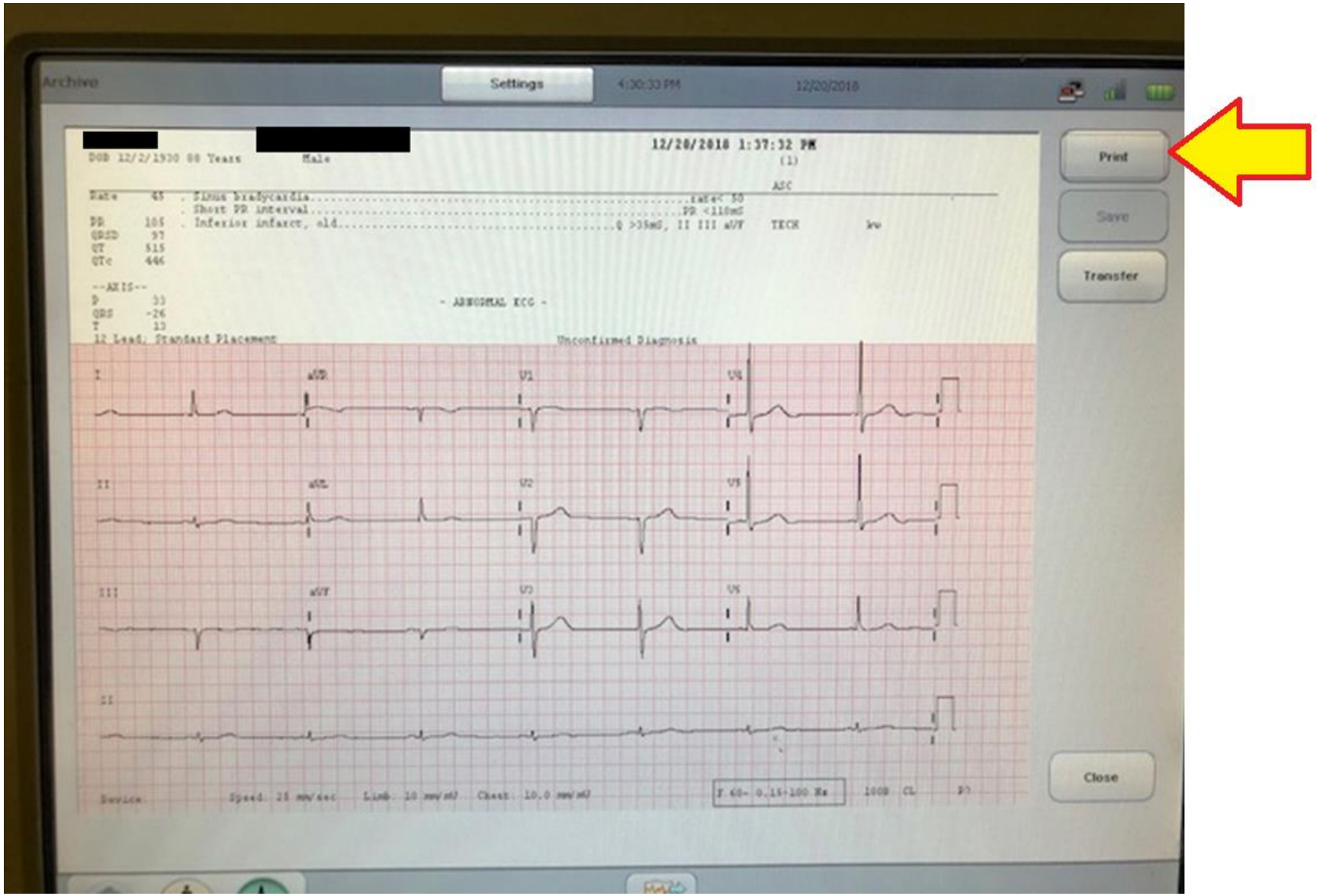
When the waveforms look good . . .



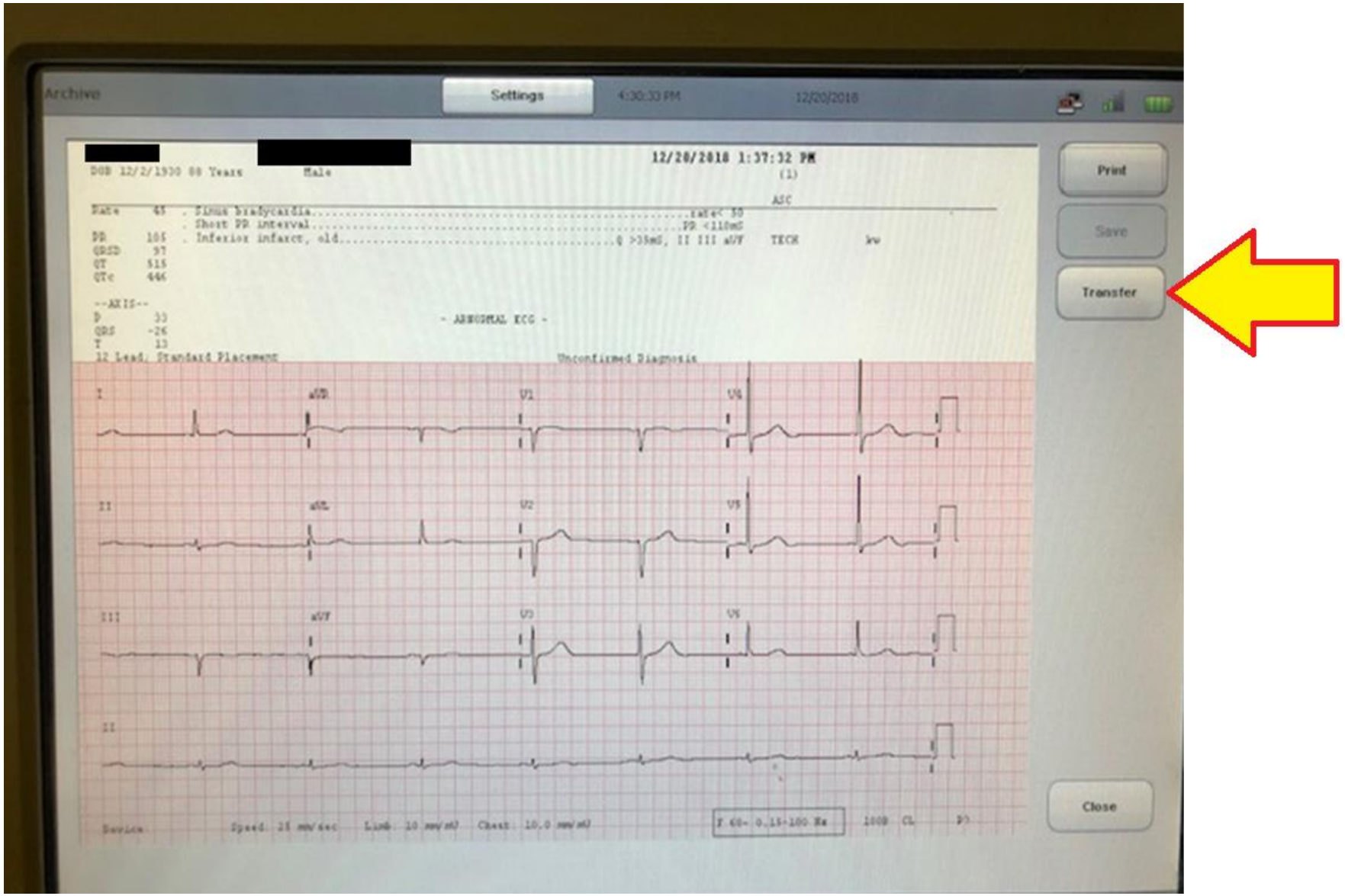
If you don't like the EKG, select CLOSE, (Do NOT Print !)



If you LIKE the ECG, first, “PRINT” it…



And then "TRANSFER" it…….



!! CRITICAL !!

Once the EKG Order has been put in Cerner

And the EKG has been obtained…….

YOU ABSOLUTELY MUST "CHECK IT OFF" of Your Task List (Worklist).

FAILURE TO DO SO – THE EKG WILL NOT ATTACH TO THE PATIENT'S CERNER CHART and WON'T BE AVAILABLE TO DOCTORS OUTSIDE THE ED !!!

Before we go any farther, 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)

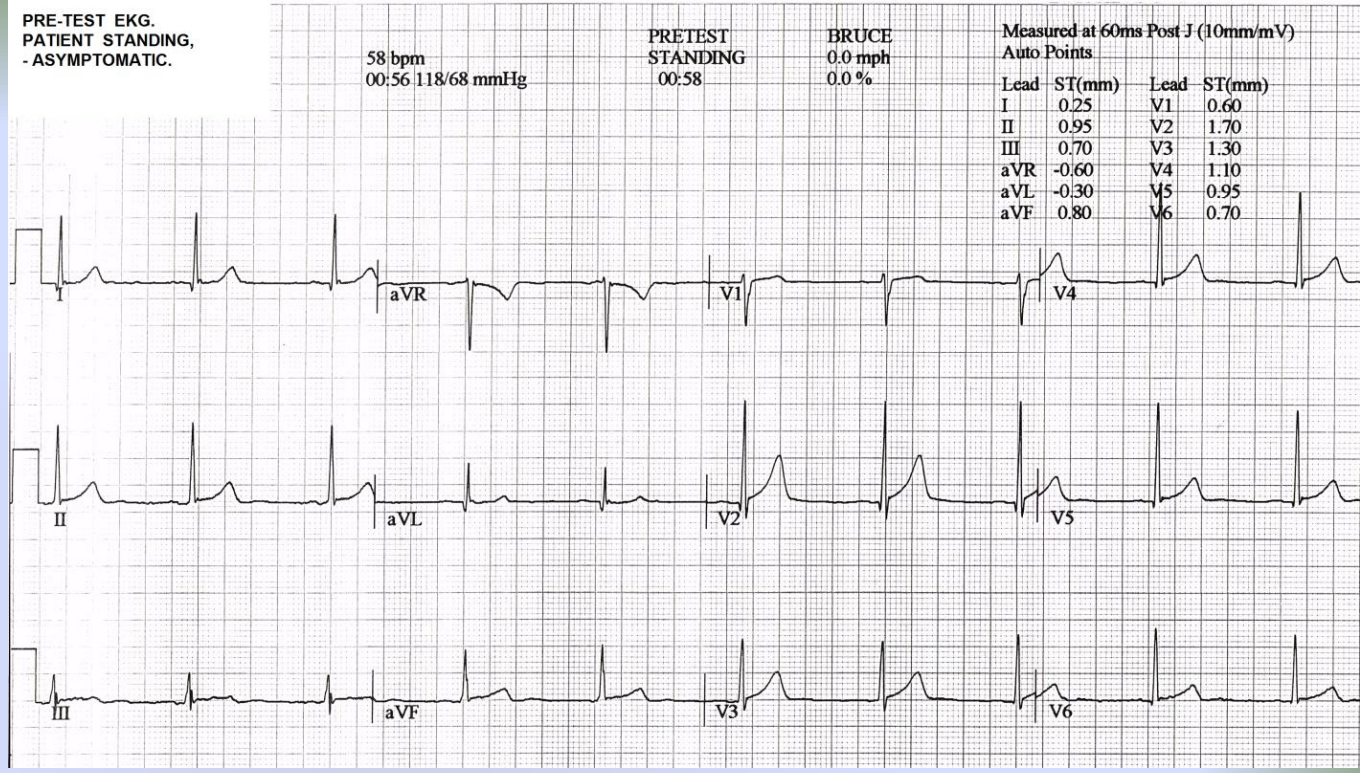
↓ SPECIFICITY

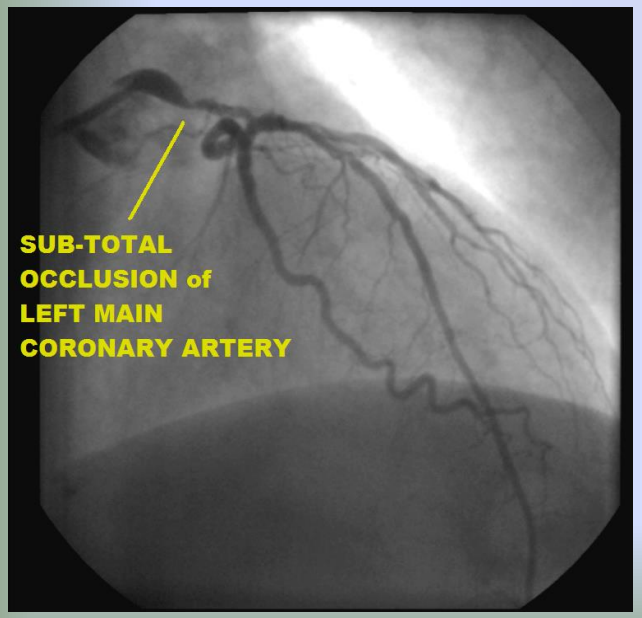
(FALSE POSITIVES)

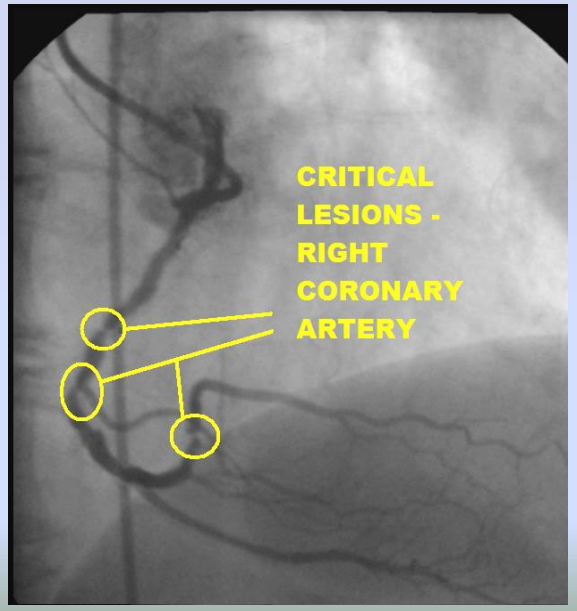
PROBLEMS WITH SENSITIVITY . . .

NORMAL ECG.

But . . . . .



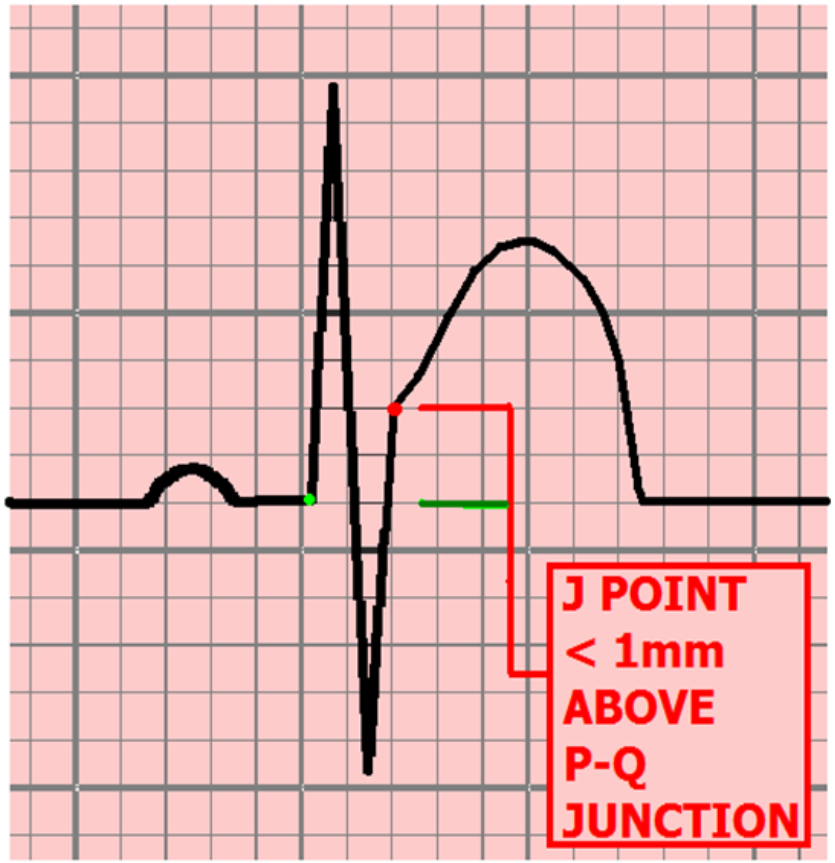




LETHAL TRIPLE VESSEL DISEASE

PROBLEMS WITH SPECIFICITY . . .

S-T SEGMENT ELEVATION - COMMON ETIOLOGIES:

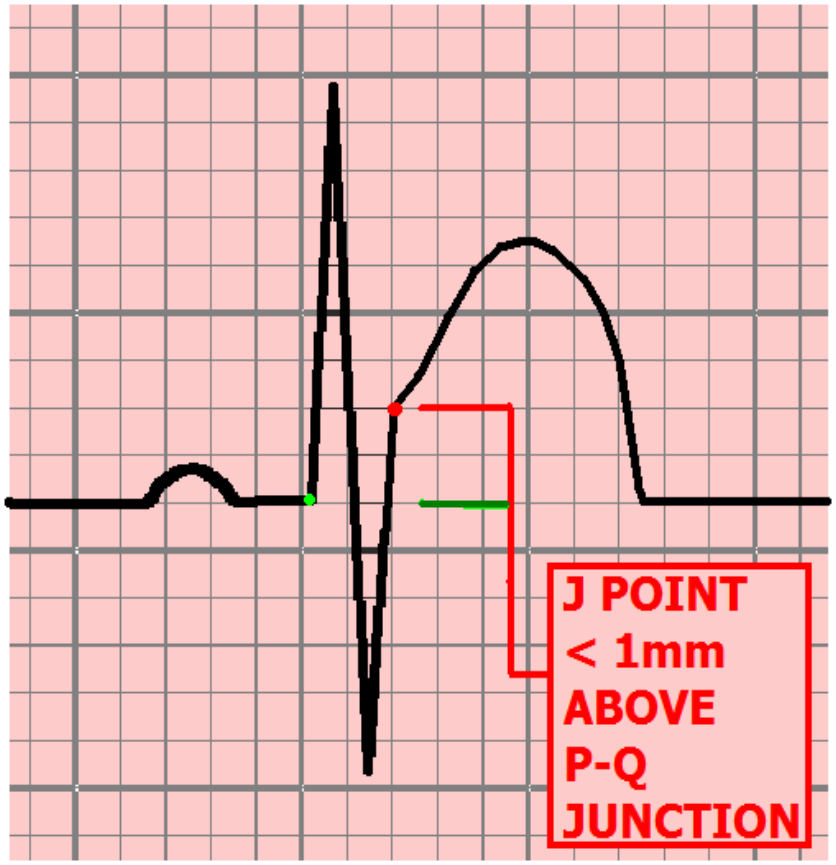


CONDITION:

- **ACUTE INFARCTION (STEMI)**

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.

77 Years Male 7/2/2015 9:44:46

1North (06)

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	

--AXIS--

P	59
QRS	14
T	33

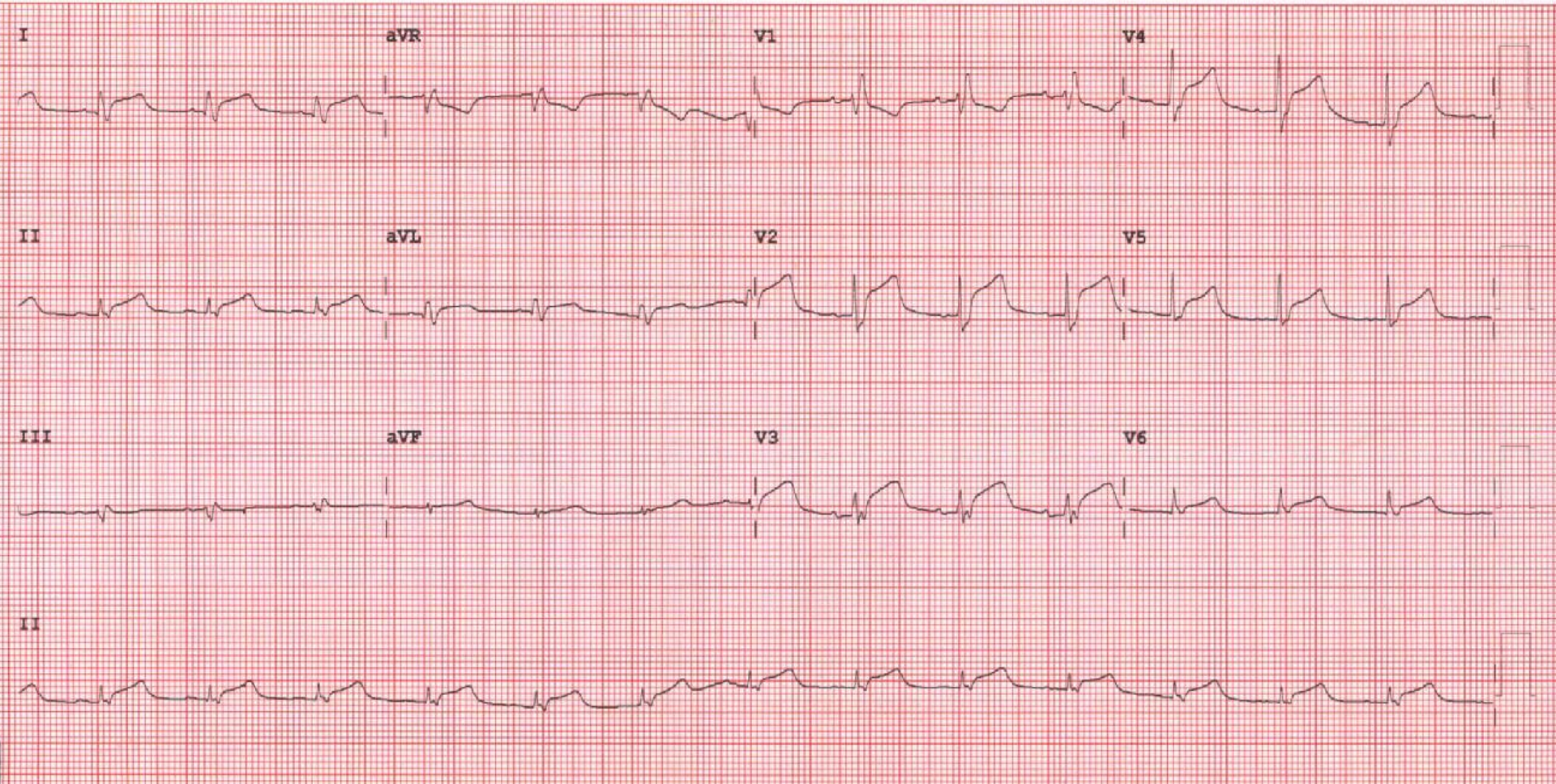
12 Lead; Standard Placement

- ABNORMAL ECG -

>>> Acute MI <<<

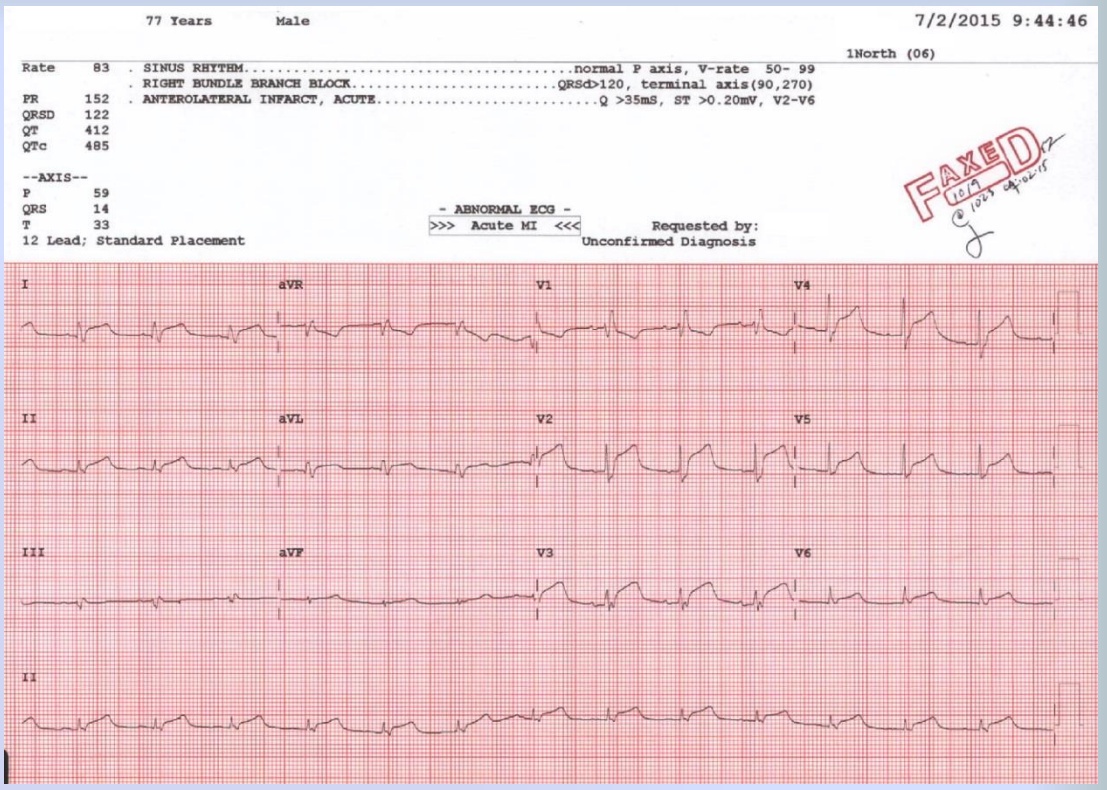
Requested by:
Unconfirmed Diagnosis

FAXED 10/9 @ 1023 CA 10.2.15



Patient:

- **Asymptomatic**
- **Troponin normal**
- **Cardiac Cath angiography = "no obstructive CAD."**
- **Discharge diagnosis:**



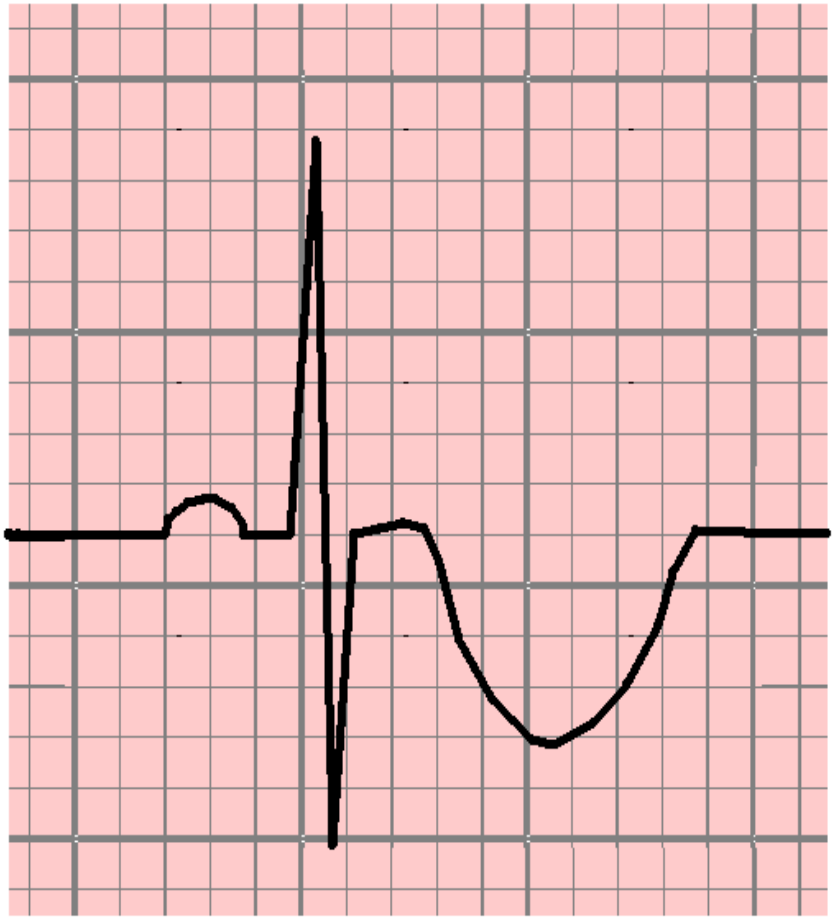
EARLY REPOLARIZATION. This degree of ST Elevation in early repolarization is VERY RARE: The only such ECG I have seen in approximately 13,000 cardiac catheterizations.

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

T WAVE INVERSION - COMMON ETIOLOGIES:



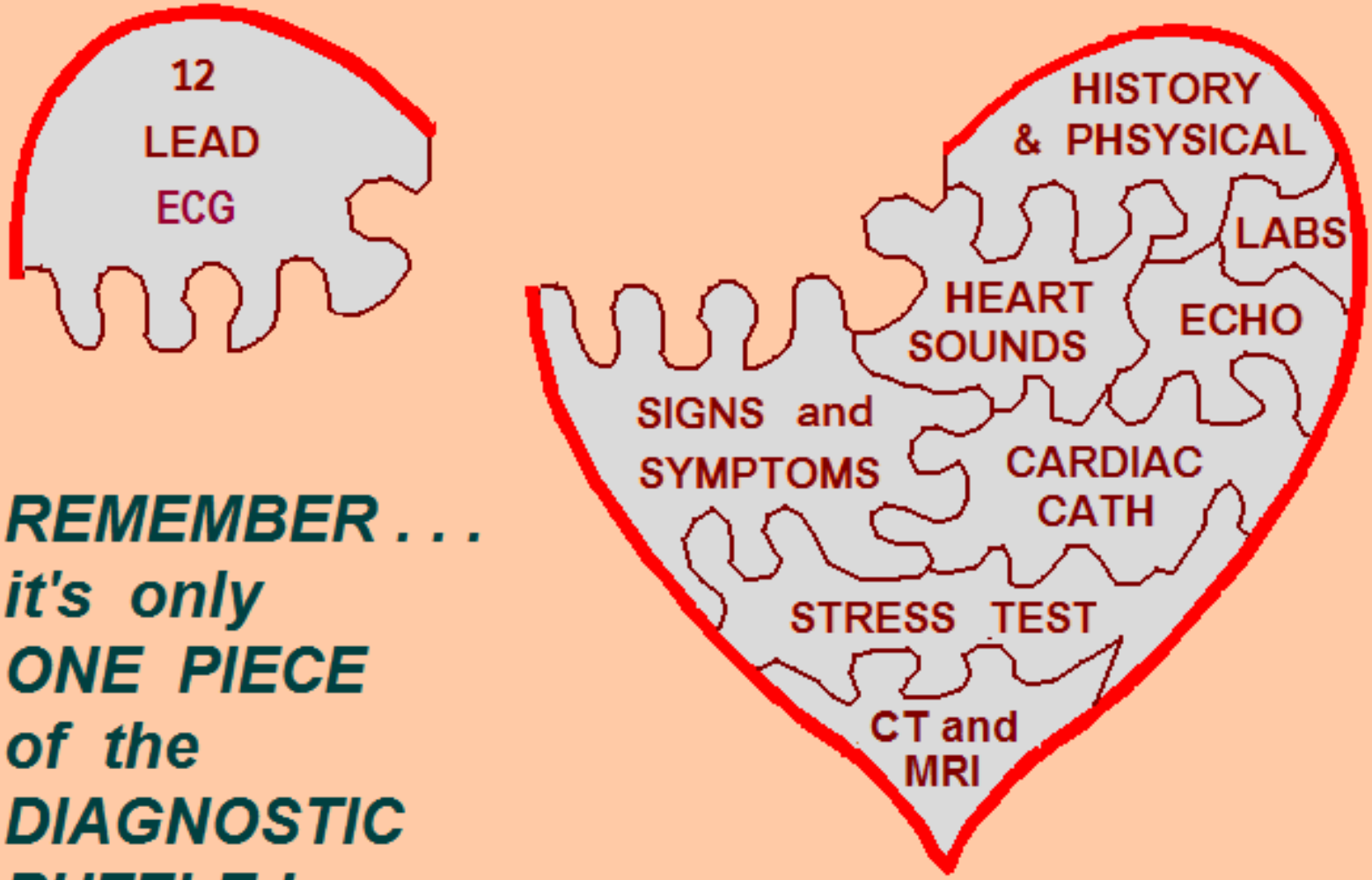
CONDITION:

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

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.

So how do we know when the ECG is telling us the truth ???

REMEMBER . . . . Keep the ECG Results in PROPER PERSPECTIVE . . . .



REMEMBER . . .
it's only
ONE PIECE
of the
DIAGNOSTIC
PUZZLE !

- ***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.***

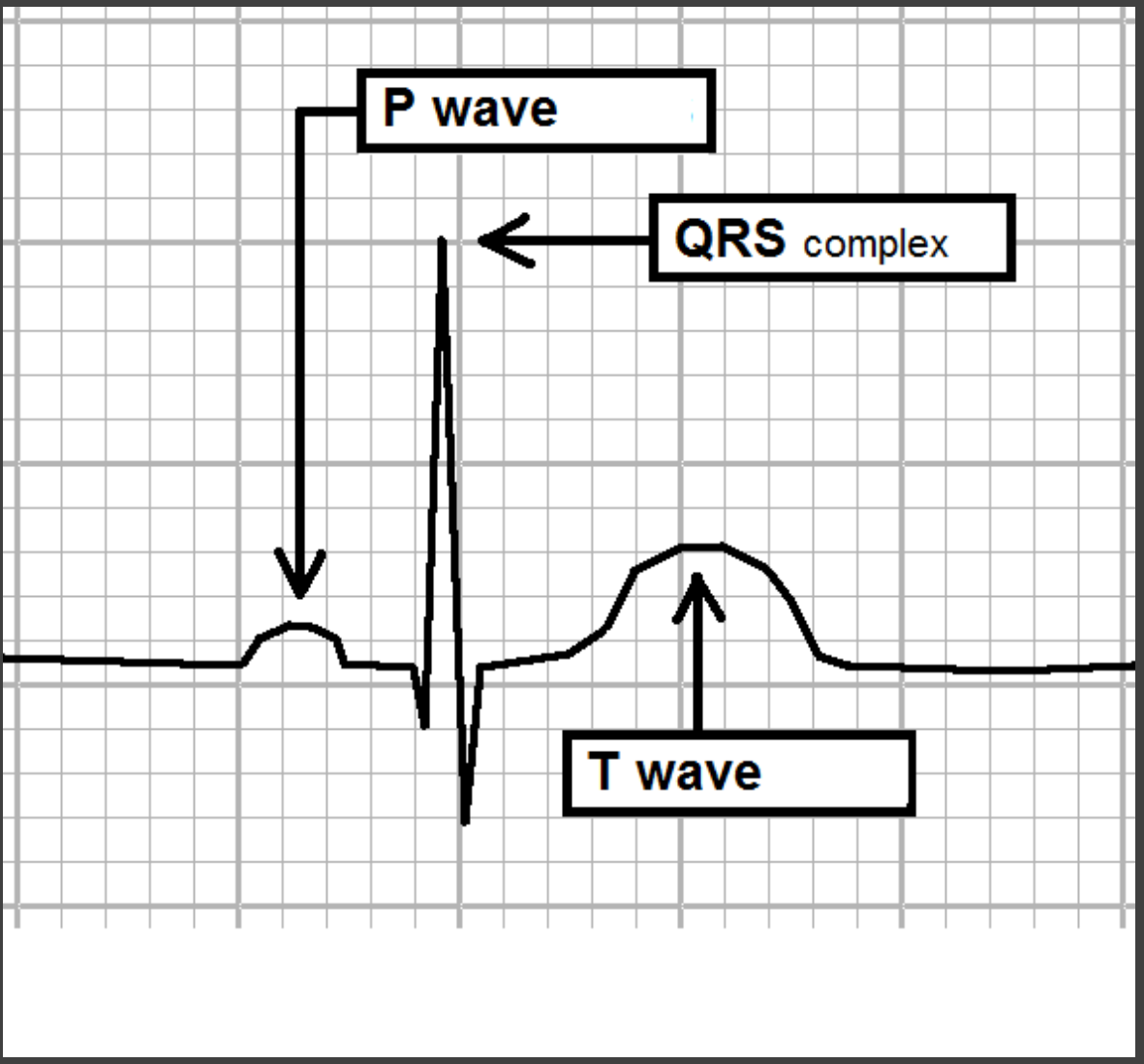
The QUADRAD of ACS

- ☐ PRESENTING SYMPTOMS
- ☐ RISK FACTOR PROFILE
- ☐ ECG ABNORMALITIES
- ☐ CARDIAC MARKERS

A POSITIVE finding in TWO or MORE of the above categories indicates it is EXTREMELY LIKELY that ACS is present . . . . steps must be AGGRESSIVELY TAKEN to definitively RULE OUT the PRESENCE of ACS !

Myocardial Electrophysiology

REVIEW of NORMAL ECG Waveforms:



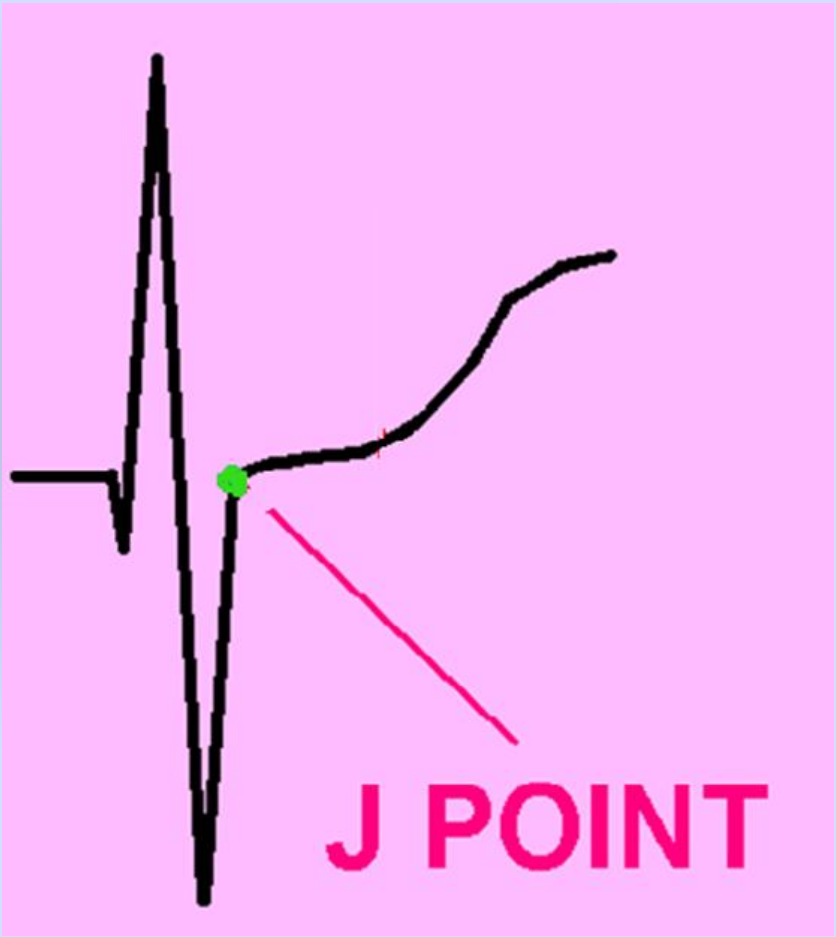
P WAVE =
ATRIAL DEPOLARIZATION

QRS COMPLEX =
VENTRICULAR DEPOLARIZATION (contracting)

T WAVE =
VENTRICULAR REPOLARIZATION (recharging)

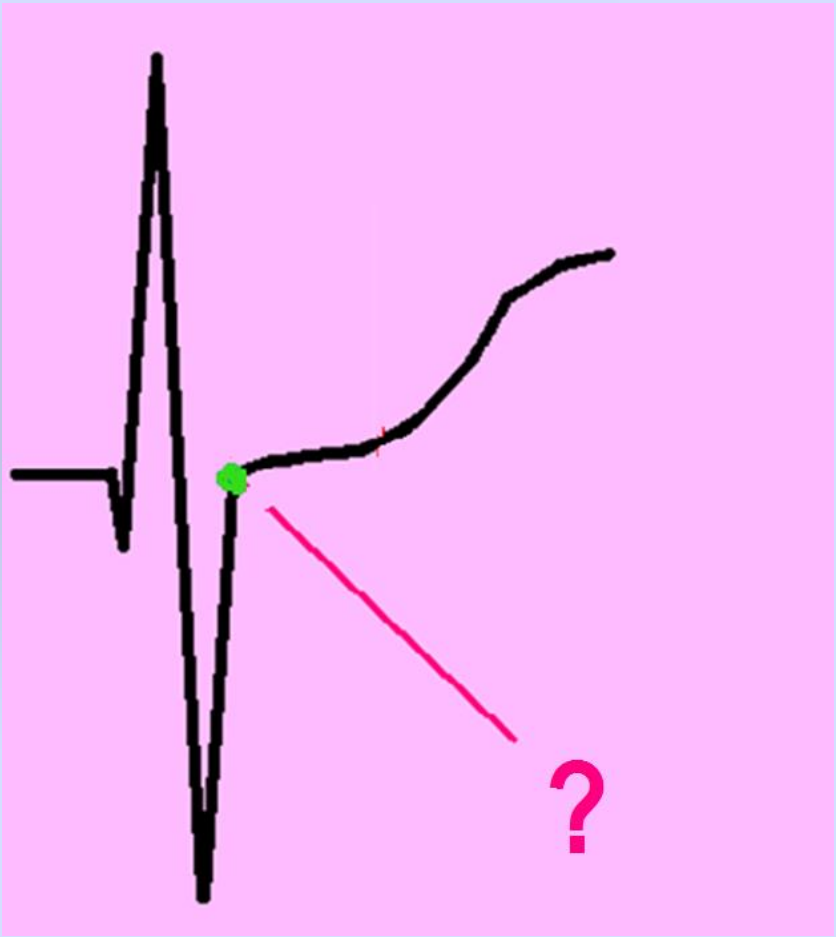
The J Point

- The **J Point** is where the **QRS ends** and the **ST Segment Begins**.

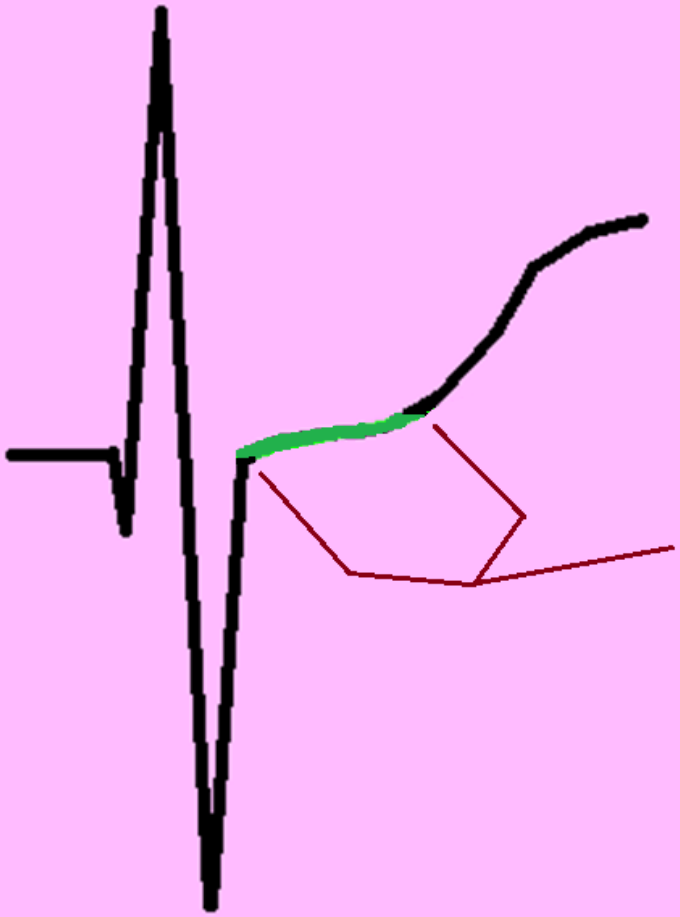


The ___?___

- The _____is where the **QRS ends** and the **ST Segment Begins**.

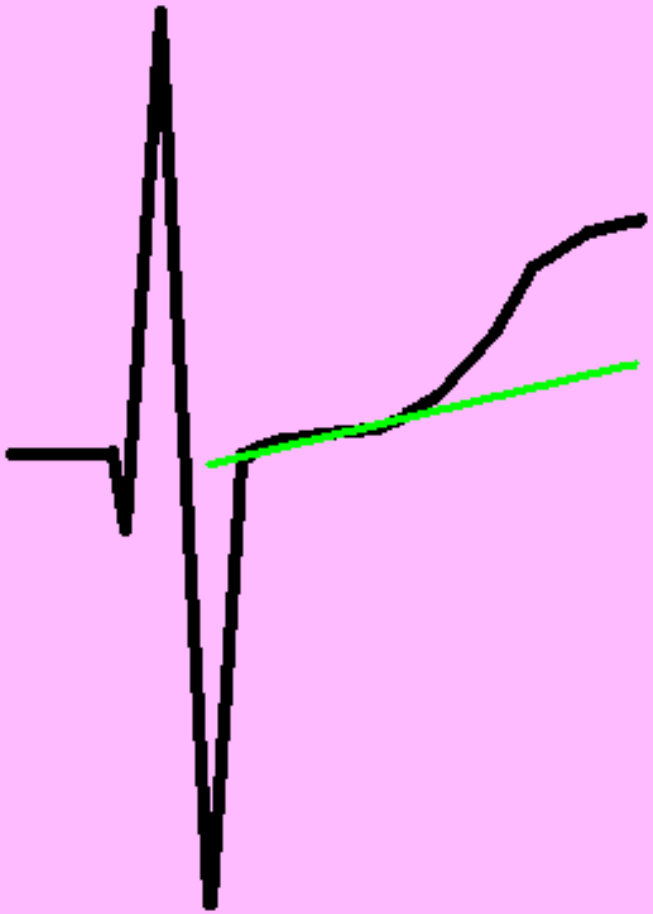


THE S-T SEGMENT



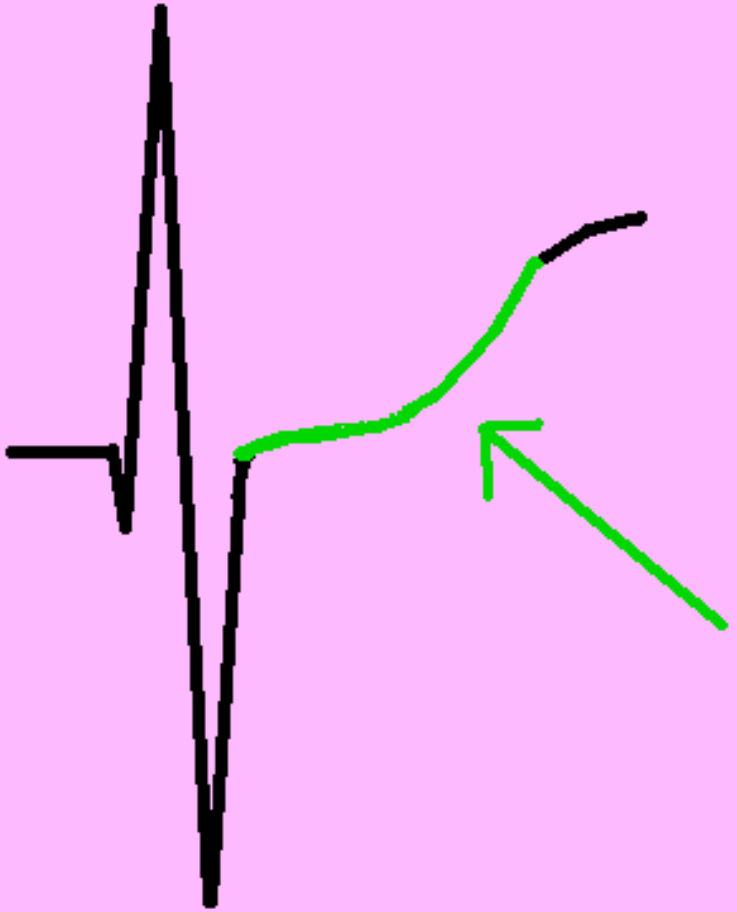
Extends from the J POINT to the T Wave

THE S-T SEGMENT



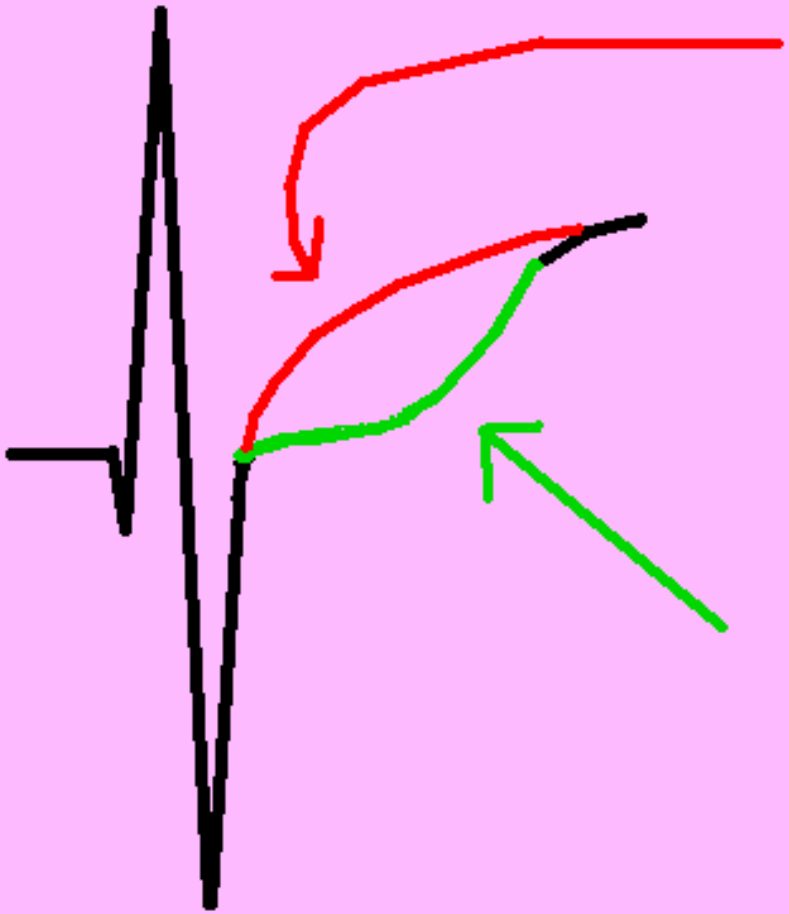
SHOULD HAVE
A "SLIGHT POSITIVE"
INCLINATION

THE S-T SEGMENT



SHOULD BE "CONCAVE" IN SHAPE . . .

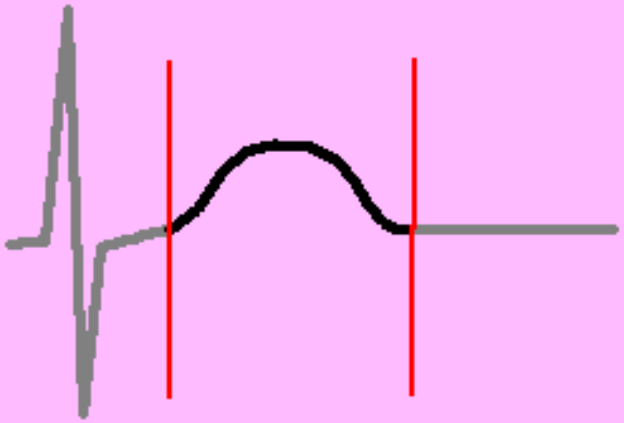
THE S-T SEGMENT



AS OPPOSED TO "CONVEX" IN SHAPE

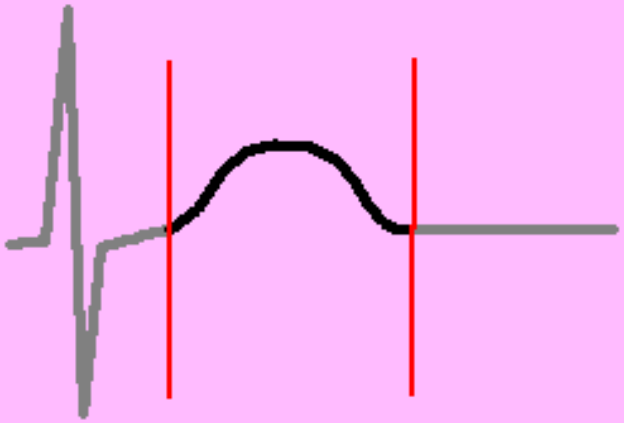
SHOULD BE "CONCAVE" IN SHAPE . . .

THE T WAVE



- SHOULD BE A "NICE," ROUNDED, CONVEX SHAPE
- SHOULD BE SYMMETRICAL

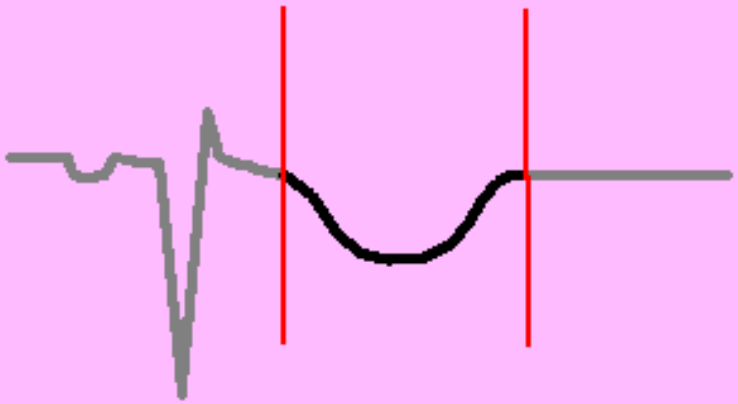
THE T WAVE



- SHOULD BE A "NICE," ROUNDED, CONVEX SHAPE

- SHOULD BE SYMMETRICAL
- SHOULD BE UPRIGHT IN ALL LEADS, EXCEPT AVR

THE T WAVE

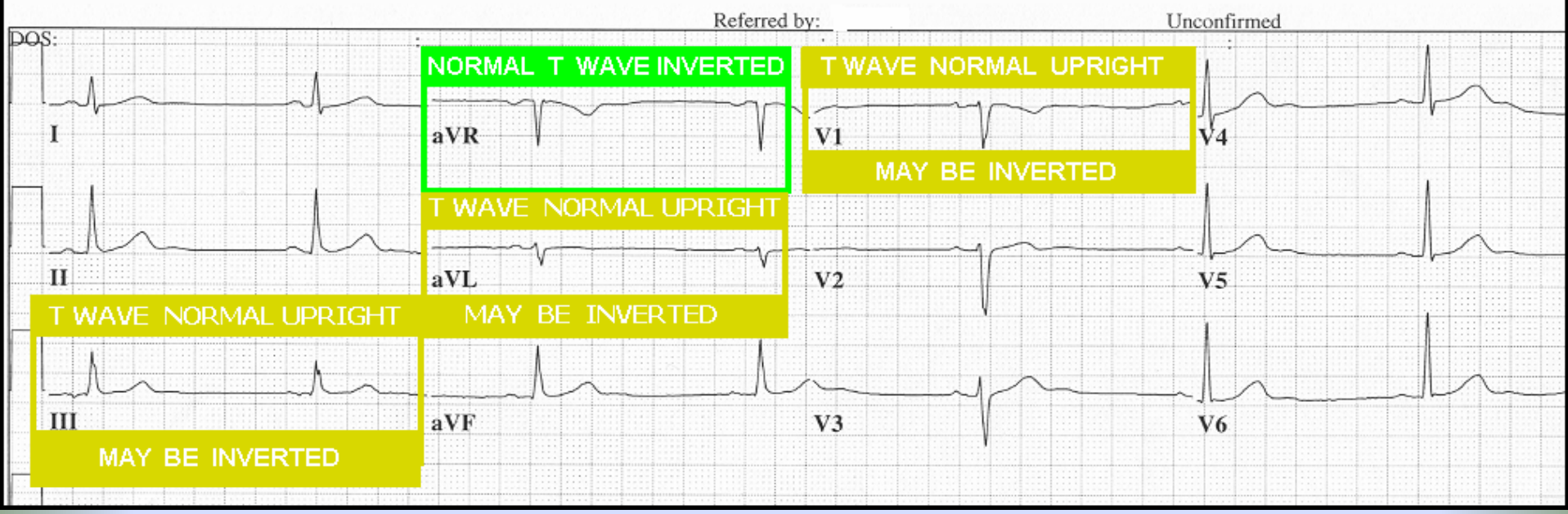


LEAD AVR

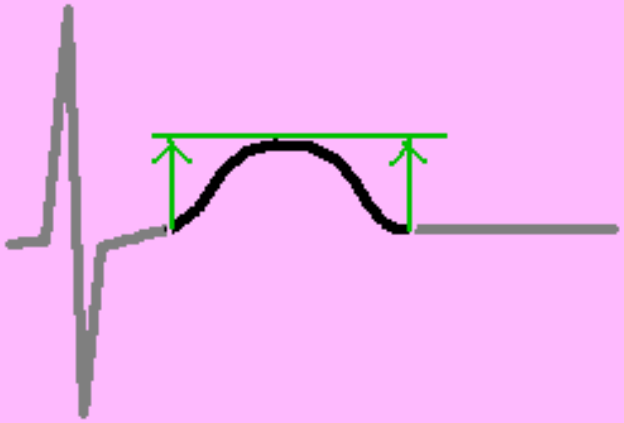
- REMEMBER, IN LEAD AVR *EVERYTHING* IS "UPSIDE-DOWN"

Normal Variants:
T Wave Inversion

Leads where the T WAVE may be INVERTED:



THE T WAVE



AMPLITUDE GUIDELINES:

- IN THE LIMB LEADS, SHOULD BE LESS THAN 1.0 mv (10 mm)
- IN THE PRECORDIAL LEADS, SHOULD BE LESS THAN 0.5 mv (5 mm)
- SHOULD NOT BE TALLER THAN R WAVE IN 2 OR MORE LEADS.

The T Wave SHOULD NOT be:

- Inverted in TWO or more CONTIGUOUS LEADS
- Hyperacute ("Pointy" tipped)
- BiPhasic (half above and half below isoelectric line)

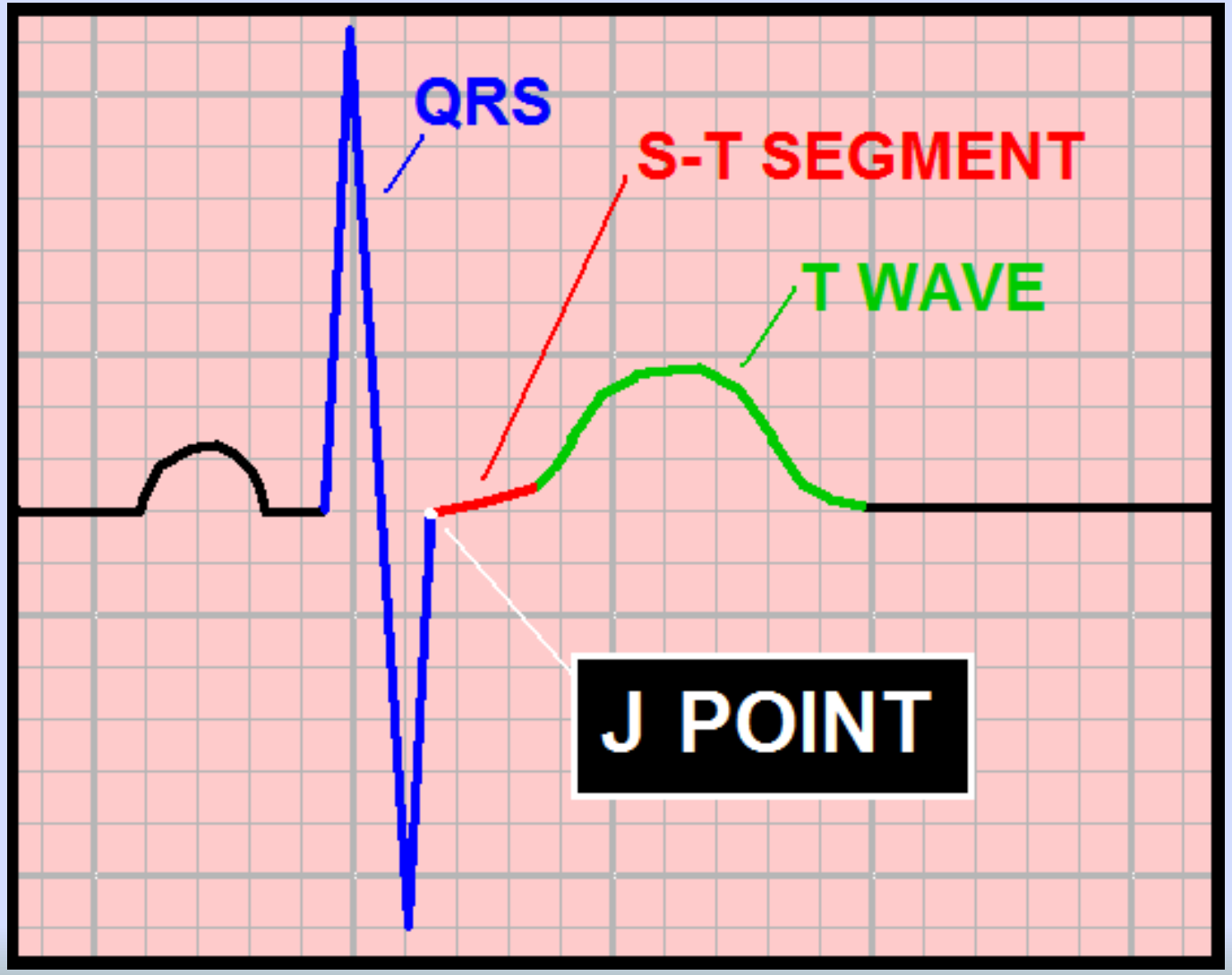
The T Wave SHOULD NOT be:

- Inverted in _____CONTIGUOUS LEADS
- _____ (“Pointy” tipped)
- _____ (half above and half below isoelectric line)

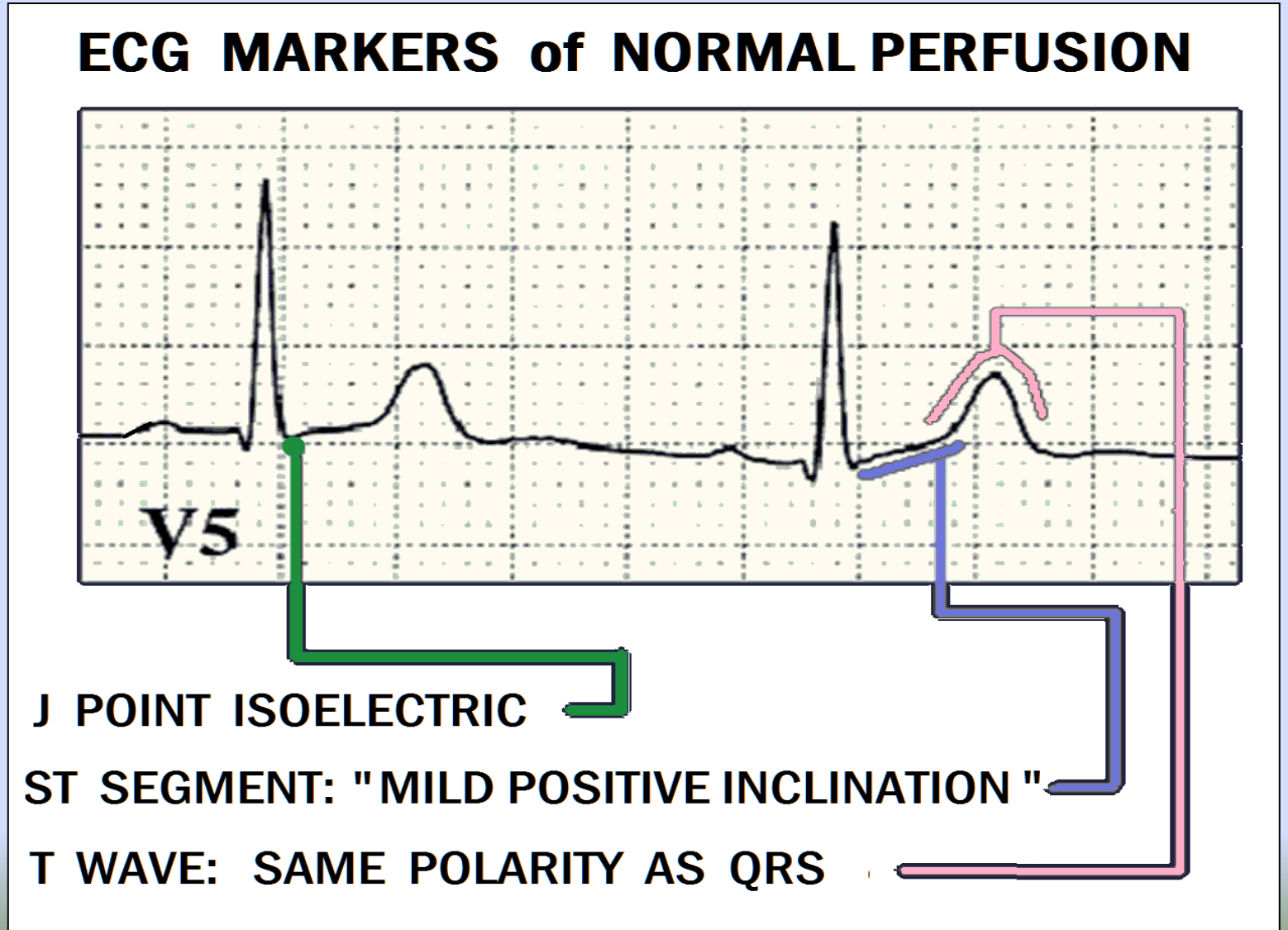
The next slide shows an ECG waveform with ***normal*** J Points, ST Segments and T waves……

THINK OF THIS AS YOUR "MEASURING STICK" of what a NORMAL ECG should look like !!!

The NORMAL ECG



Patients with normal QRS duration (QRS < 120 ms) :



ECG Indicators of NORMAL myocardial perfusion include:

- J Point isoelectric, or within 1mm of the ISOELECTRIC LINE
- ST Segment has a slight positive inclination where ST Segment and T Wave merge, the shape is CONCAVE (bowed downward).
- The T Wave is UPRIGHT (in all leads except for AVR), is not taller than the QRS, and is gently rounded (NOT “pointy”).

ECG Indicators of NORMAL myocardial perfusion include:

- J Point isoelectric, or within_____of the ISOELECTRIC LINE
- ST Segment has a slight_____inclination where ST Segment and T Wave merge, the shape is _____ (bowed downward).
- The T Wave is _____ (in all leads except for AVR), is not taller than _____, and is _____(NOT “pointy”).

Q: If the previous slide showed what *normal* J Points, ST Segments and T waves look like, what is ABNORMAL ?

Q: If the previous slide showed what *normal* J Points, ST Segments and T waves look like, what is ABNORMAL ?

A: *EVERYTHING ELSE !!!*

(we get into many abnormal examples in Part 2, after lunch!)

Digging a Little Deeper . . .

- The cellular level: Ventricular Myocardial Cells

CARDIAC ANATOMY and PHYSIOLOGY "101"

CARDIAC CELLS AT REST have POSITIVE charged IONS on the OUTSIDE of the cell membrane, and NEGATIVE charged IONS on the INSIDE

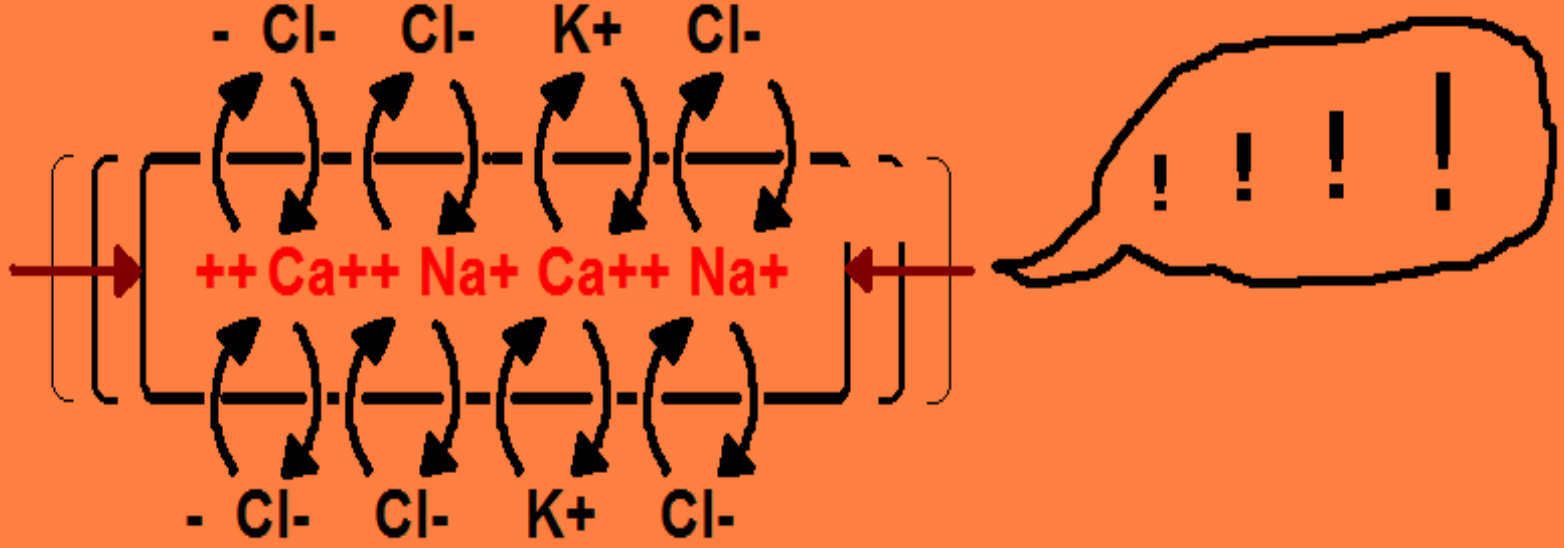
Ca++ Na+ Ca++ Na+ Ca++

Cl- Cl- K+ Cl- K+ Cl- K+ Cl-

Ca++ Na+ Ca++ Na+ Ca++

CARDIAC ANATOMY and PHYSIOLOGY "101"

. . . when the IONS shift . . . that is, the POSITIVE IONS that were on the outside TRADE PLACES with the NEGATIVE IONS that were on the INSIDE . . . .



. . . THE CELL CONTRACTS!

CARDIAC ANATOMY and PHYSIOLOGY "101"

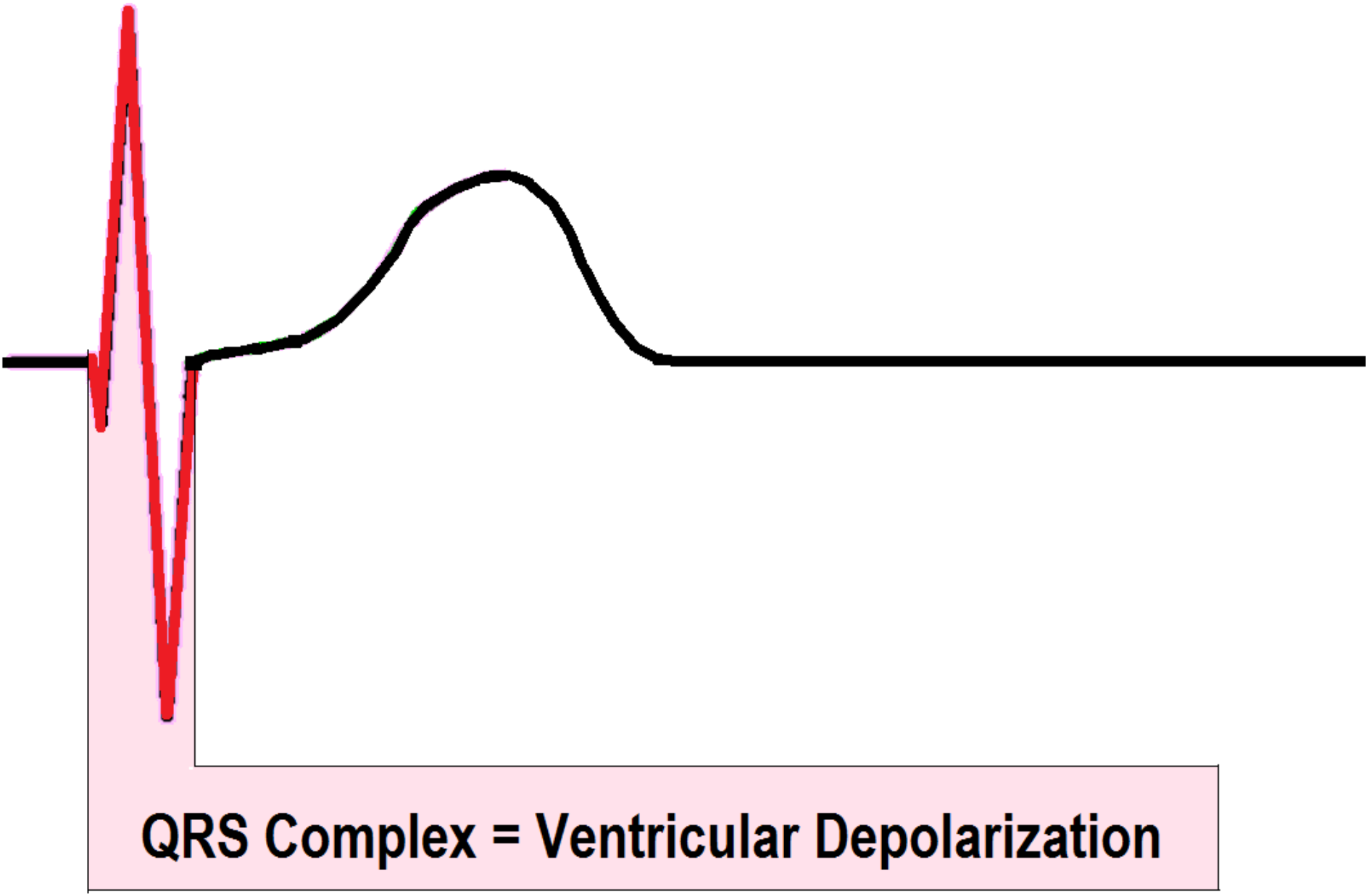
THIS (OF COURSE) IS KNOW AS . . .

DEPOLARIZATION

WHEN EVERYTHING IS WORKING PROPERLY, THE WAVE OF DEPOLARIZING CELLS CAUSES THE HEART TO CONTRACT, AND PUMP BLOOD TO THE LUNGS AND THE SYSTEMIC CIRCULATION

Depolarization on the ECG:

- Is represented by the **QRS Complex**

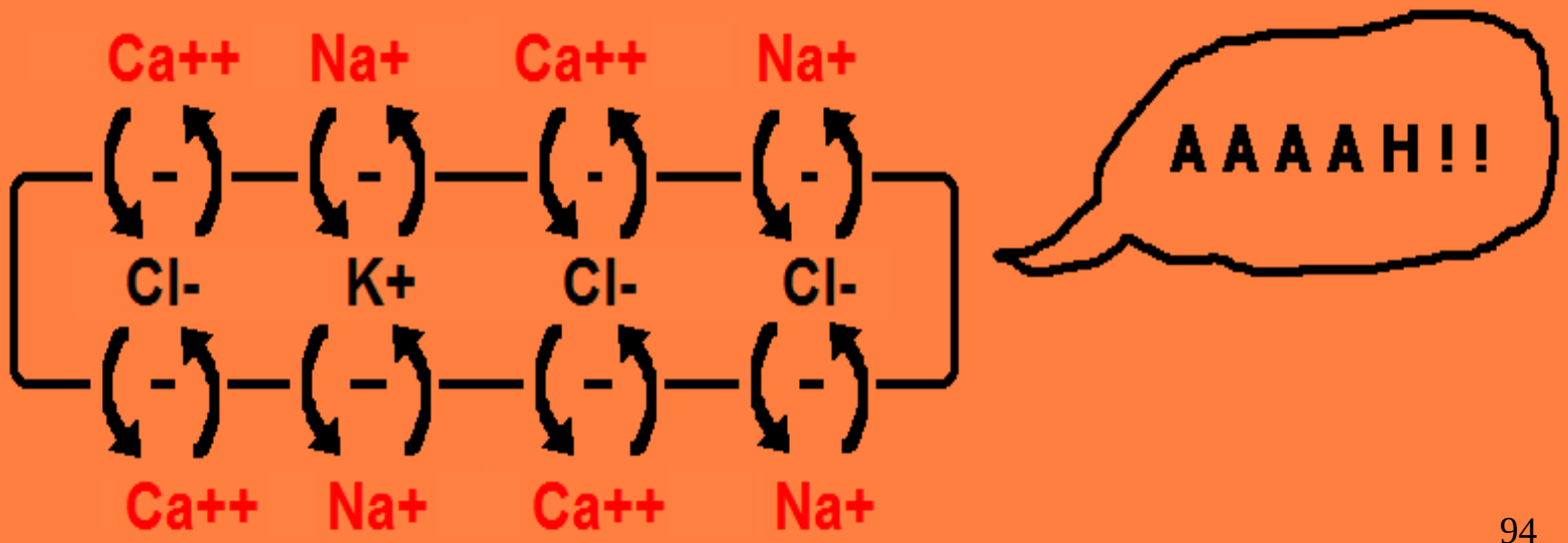

QRS Complex = Ventricular Depolarization

CARDIAC ANATOMY and PHYSIOLOGY "101"

AFTER DEPOLARIZATION, THE CELLS RELAX.

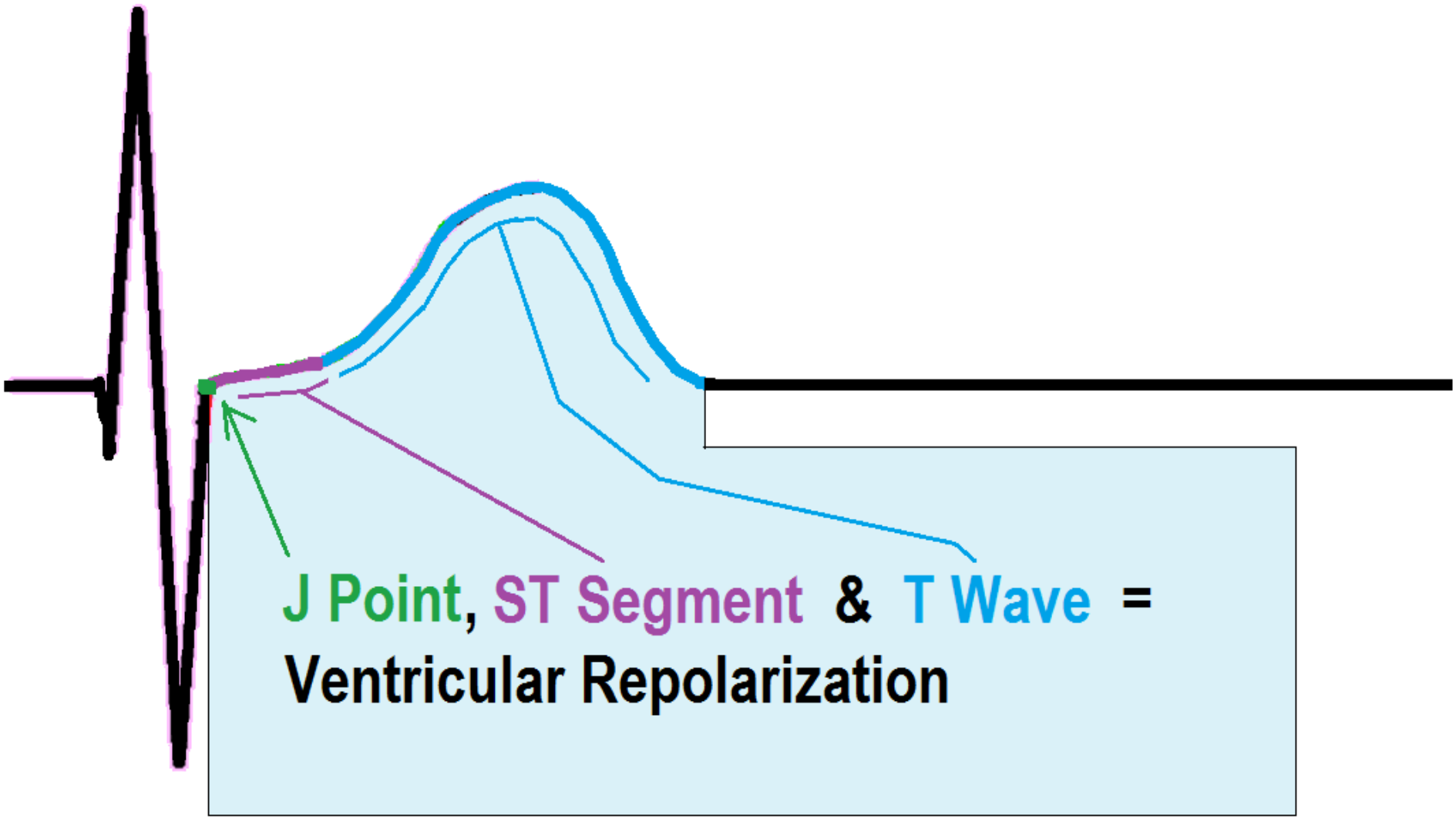
THE IONS RETURN TO THEIR ORIGINAL POSITIONS --

THIS PROCESS IS KNOWN AS REPOLARIZATION

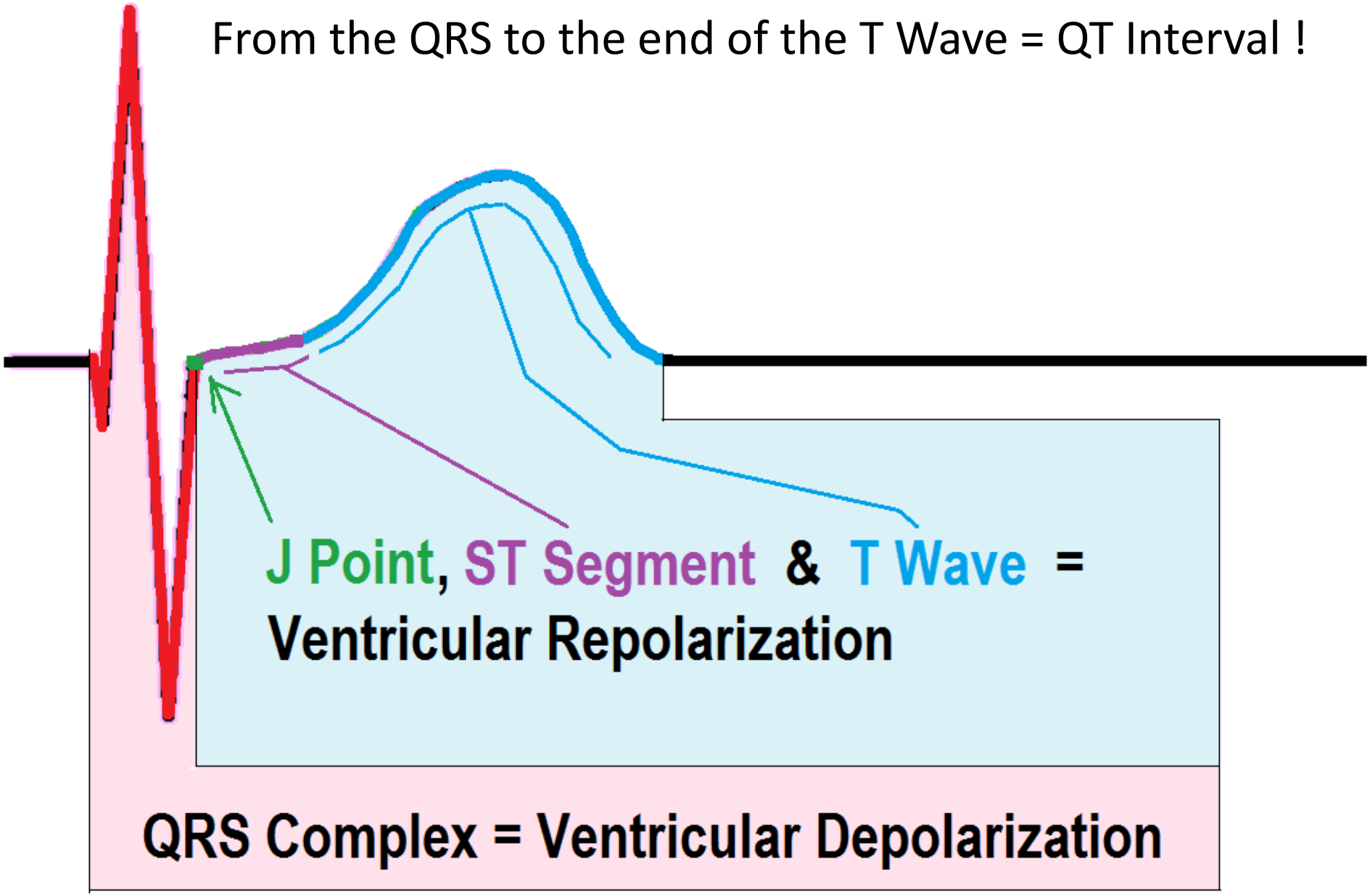


Repolarization on the ECG:

- Is represented by the:
  - **J Point**
  - **ST Segment**
  - **T Wave**


J Point, ST Segment & T Wave =
Ventricular Repolarization

From the QRS to the end of the T Wave = QT Interval !



ECG Intervals:

P-R Interval

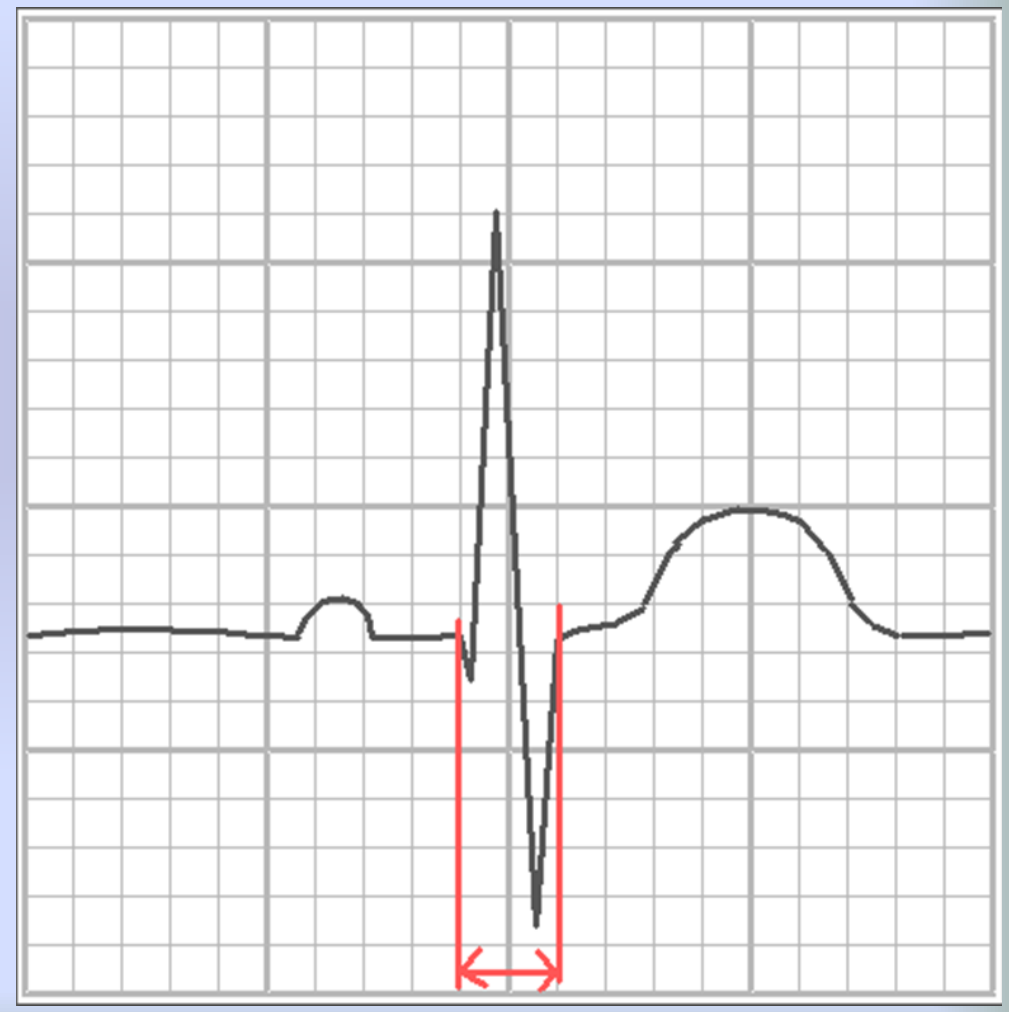
- The P-R Interval should be between **120-200ms,** (which is 3 – 5 little squares).

P-R Interval

- The P-R Interval should be between ___-___**ms,** (which is 3 – 5 little squares).

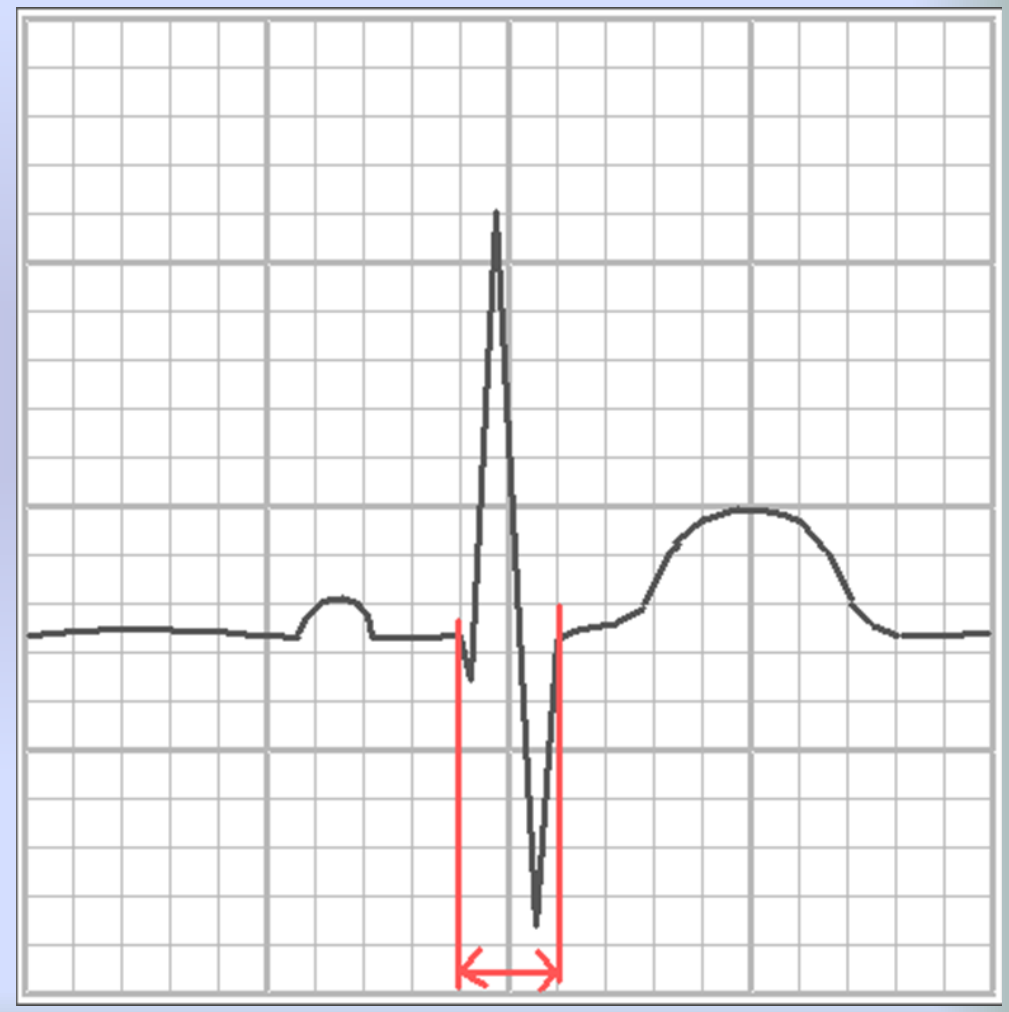
QRS Duration (width):

- The Normal QRS should be NO WIDER than **120ms** (3 little squares).



QRS Duration (width):

- The Normal QRS should be NO WIDER than **___ms** (3 little squares).



QRS Duration (width):

- If the QRS is WIDER than 120ms, it indicates the VENTRICLES are **DEPOLARIZING ABNORMALLY**.
- If the Ventricles are DEPOLARIZING ABNORMALLY, it causes them to **REPOLARIZE ABNORMALLY.**

QRS Duration (width):

- If the QRS is WIDER than 120ms, it indicates the VENTRICLES are _____ _____.
- If the Ventricles are DEPOLARIZING ABNORMALLY, it causes them to _____.

QRS Duration (width):

- When the **VENTRICLES REPOLARIZE ABNORMALLY** due to the QRS being TOO WIDE, it often causes **CHANGES to the:**
  - **J Point**
  - **ST Segment**
  - **T Wave**
- These changes are known as Secondary Repolarization Abnormalities.

QRS Duration (width):

- When the **VENTRICLES REPOLARIZE ABNORMALLY** due to the QRS being TOO WIDE, it often causes **CHANGES to the:**
  - _____
  - _____
  - _____
- These changes are known as Secondary Repolarization Abnormalities.

In other words……

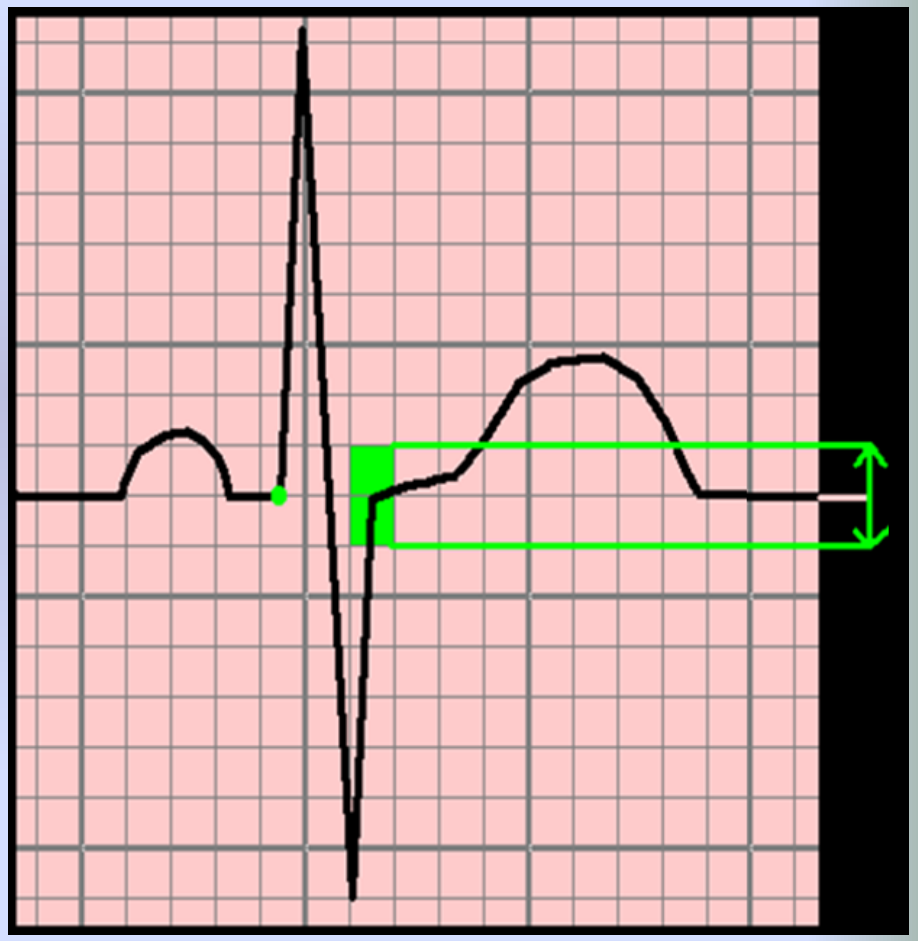
An abnormally wide QRS (greater that 3mm) means it ALTERS the patient's J Point, ST Segment and T wave – IT CAN MIMIC ischemia and STEMI. Therefore when the QRS is TOO WIDE (>120ms) we have some EXTRA RULES that must be applied when reading an EKG for Ischemia or MI. MORE ON THIS in SESSION TWO.

The J Point

The **J Point** should be

WITHIN 1mm

of the **ISOELECTRIC LINE (**in *most, **but not all*** Leads**).**



The J Point

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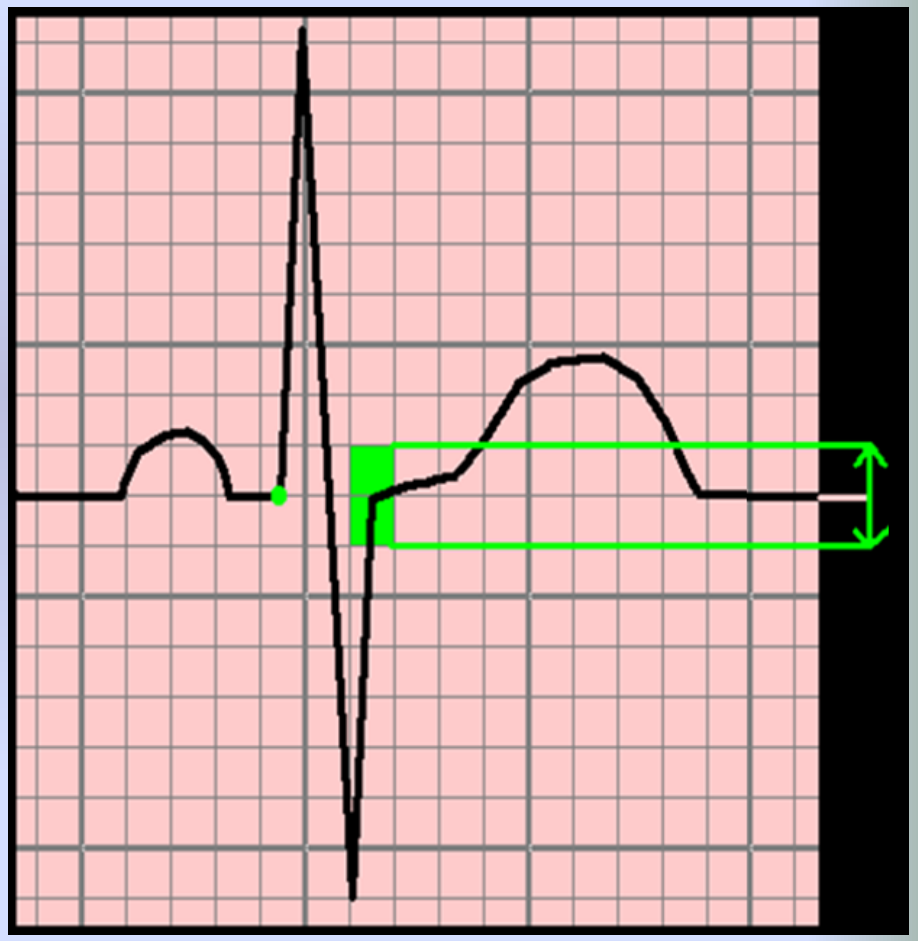


The QT Interval

- When it's TOO LONG it can cause SUDDEN CARDIAC DEATH (SCD).
- Often patients with LONG QT SYNDROME experience ***"syncope of unknown etiology."***
- During the episodes of syncope, they are actually experiencing a run of Torsades de Pointes, a deadly rhythm that sometimes deteriorates into Ventricular Fibrillation.

The QT Interval

- Long QT syndrome (LQTS) is often a CONGENITAL disorder. Therefore there is often a “family history of Long QT Syndrome” or simply a “family history of sudden death.”
- Incidence of LQTS is approximately 1/2500 people.
- The last one at BHSR was……..

BEWARE
of the
QTc
GREATER THAN 600 !!!

Rate	58	Sinus rhythm
PR	185	IVCD, consider atypical RBBB
QRSd	126	Baseline wander in lead(s) V2,V3,V4,V6
QT	668	COMPARED TO ECG 07/22/2020 16:56:59
QTc	657	SINUS RHYTHM NOW PRESENT
--Axis--		
P	107	
QRS	61	
T	45	

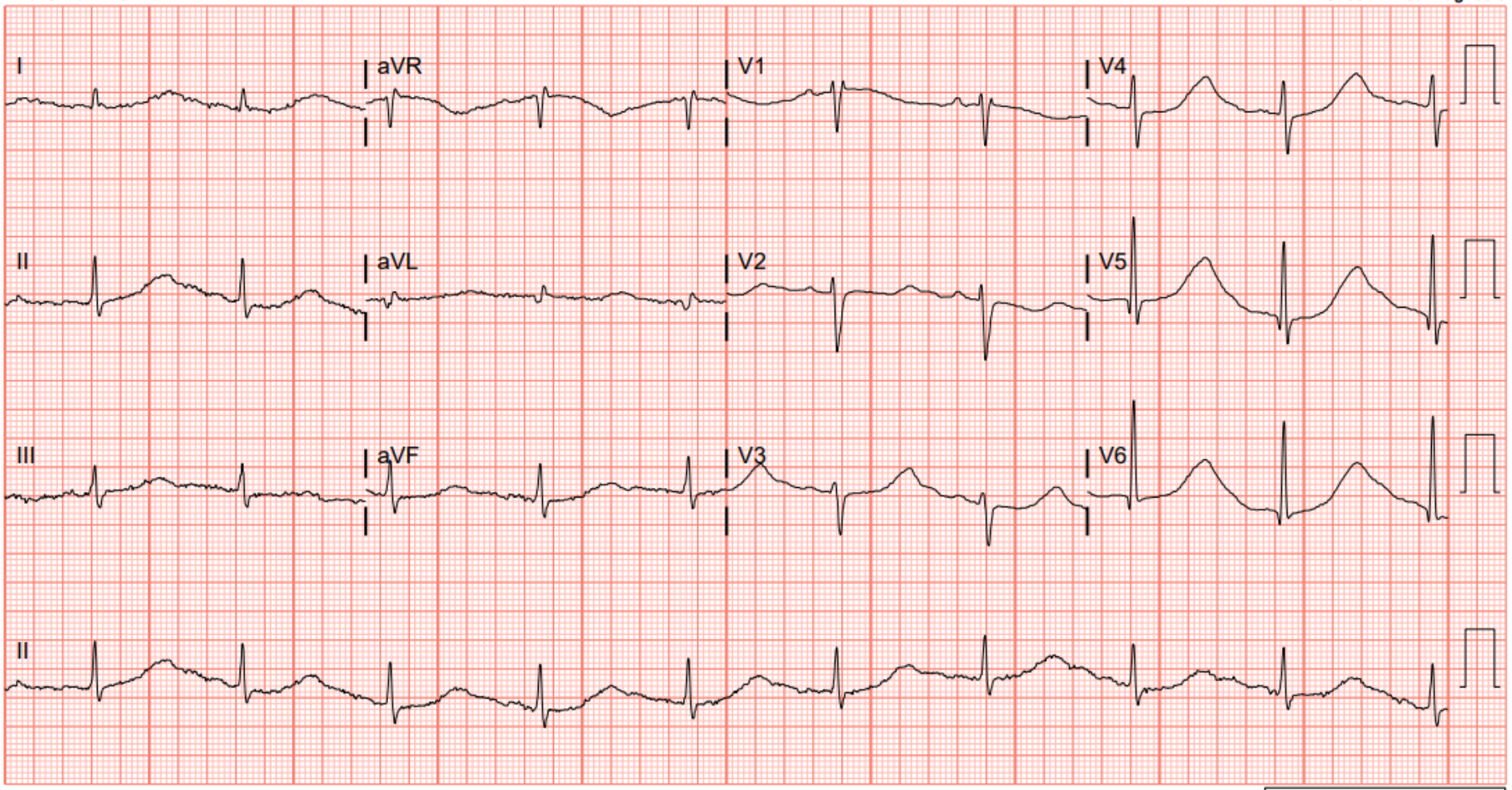
07/22/2020 16:59:39
09/17/1956 63 yrs

Bayfront Health Seven Rivers ED
Dept ED
Room ED02
Tech jb

Req Provider: Rafael Santiago-Aponte

- Abnormal ECG -

Unconfirmed Diagnosis



Philips PageWriter TC | 25 mm/sec | 10.00 mm/mV | F 60~ 0.15 - 100 Hz

Rate	58
PR	185
QRSd	126
QT	668
QTc	657
--Axis--	
P	107
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Sinus rhythm
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SINUS RHYTHM NOW PRESENT

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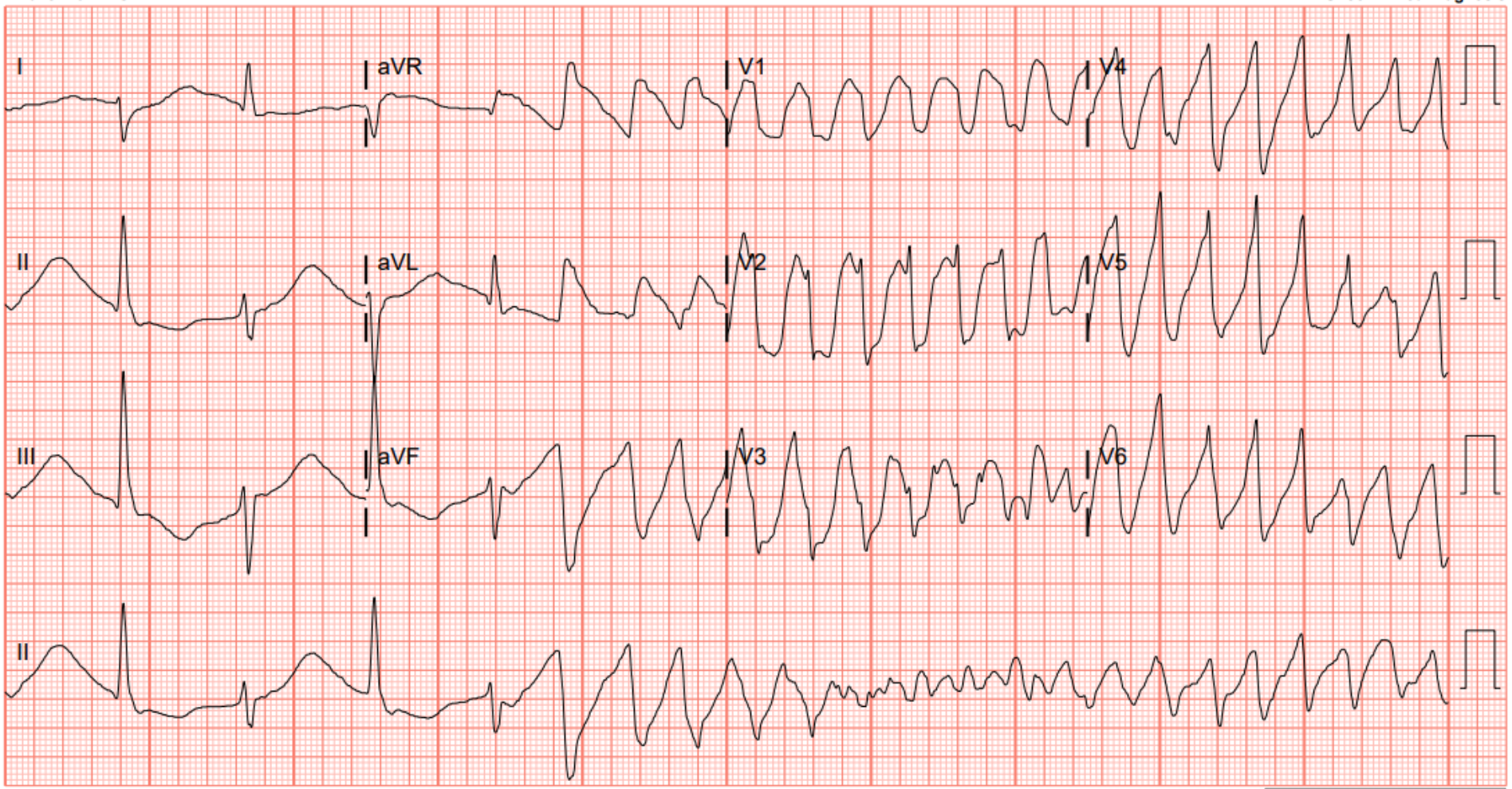


Philips PageWriter TC | 25 mm/sec | 10.00 mm/mV | F 60~ 0.15 - 100 Hz

Q - T INTERVAL

- VARIES BASED ON HEART RATE AND SEX

THE *QTc INTERVAL

*QTc = Q-T interval, *corrected* for heart rate

HEART RATE	MALE	FEMALE
150	0.25	0.28
125	0.26	0.29
100	0.31	0.34
93	0.32	0.35
83	0.34	0.37
71	0.37	0.40
60	0.40	0.44
50	0.44	0.48
43	0.47	0.51

Annals of Internal Medicine, 1988 109:905.

Determining the QTc

Manual calculation:

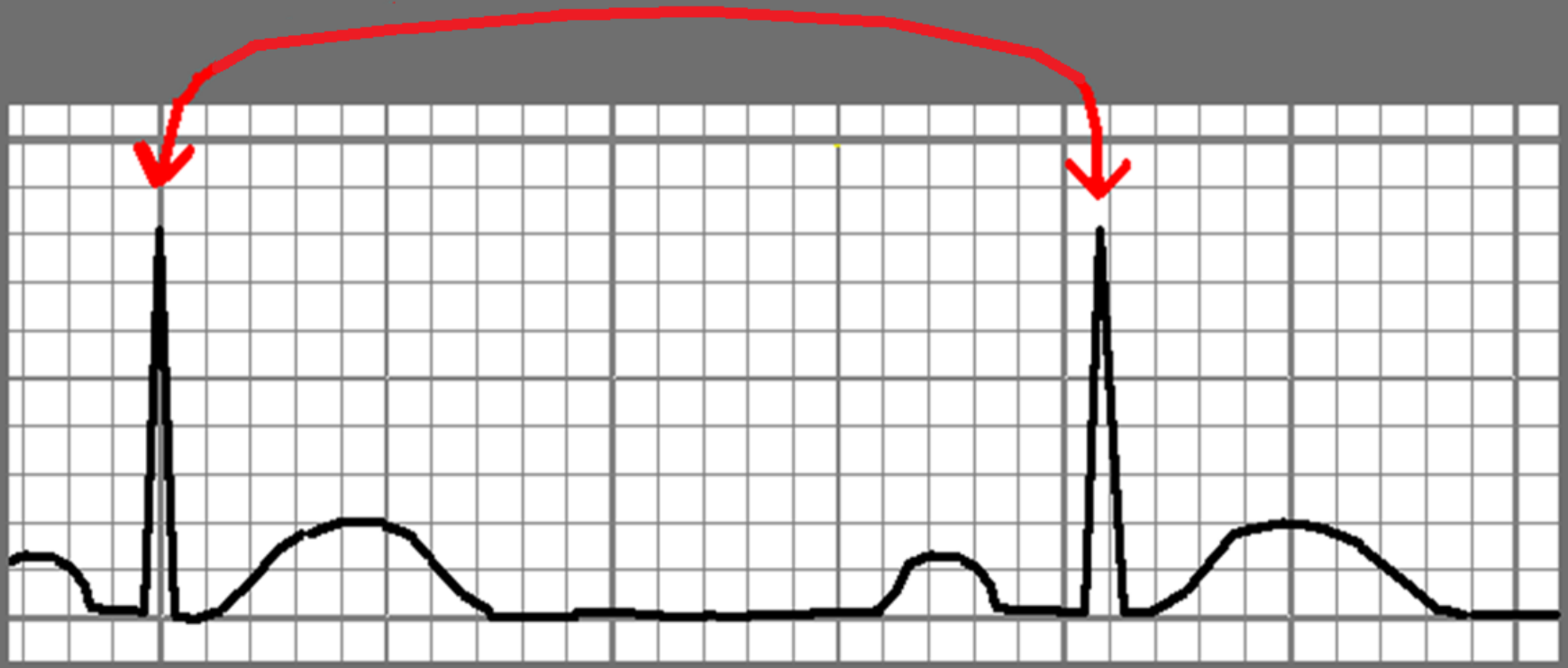
QT CORRECTION FORMULAS:

Bazett's	$QTc=QT/\sqrt{RR}$
Fredericia	$QTc=QT/(RR)1/3$
Framingham	$QTc=QT+0.154(1-RR)$
Rautaharju	$QTp=656/(1+HR/100)$

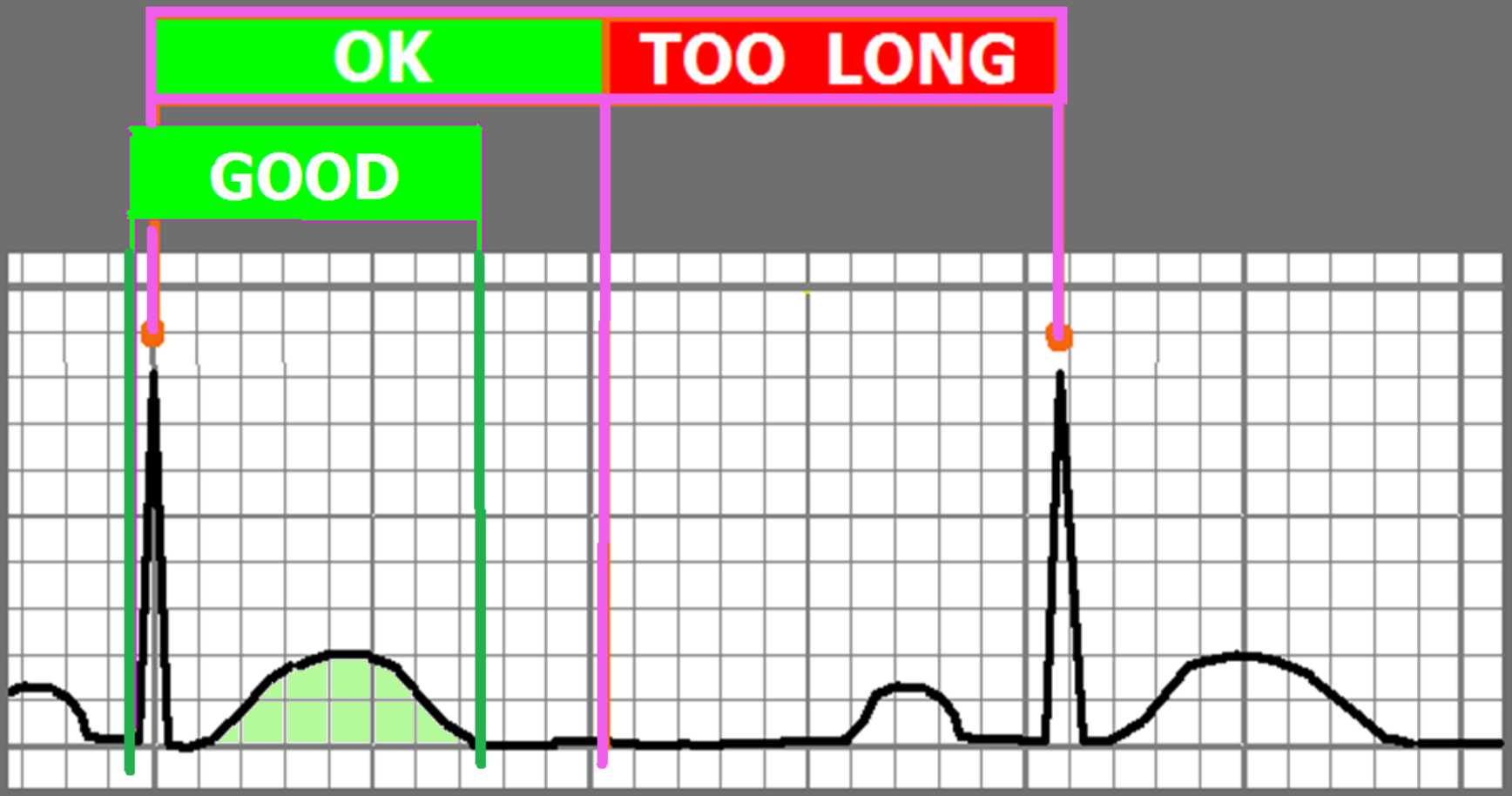
DETERMINING Q-T INTERVAL LIMITS

THE "QUICK PEEK" METHOD

- Relatively accurate method to quickly identify patients with abnormal QT Intervals.
  - Applies to patients with normal heart rates (60-100) and narrow QRS (QRSd <120ms)



The Q - T Interval should be LESS THAN 1/2 the R - R Interval



The Q - T Interval should be LESS THAN 1/2 the R - R Interval

Determining the QT / QTc

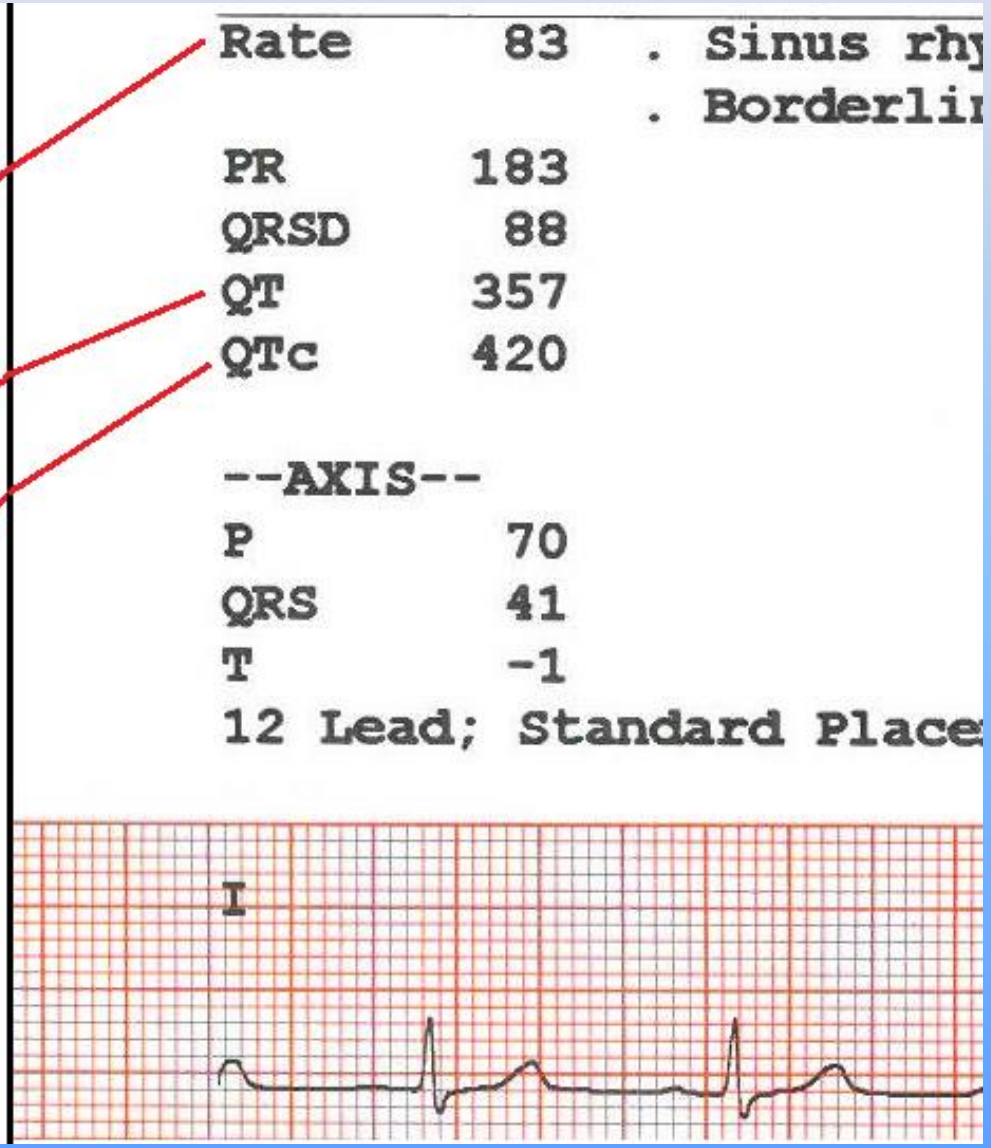
Method 1 – 12 Lead ECG Report:

Standard 12 Lead ECG printout . . .

Heart Rate = 83

QT Interval = 357

QTc = 420

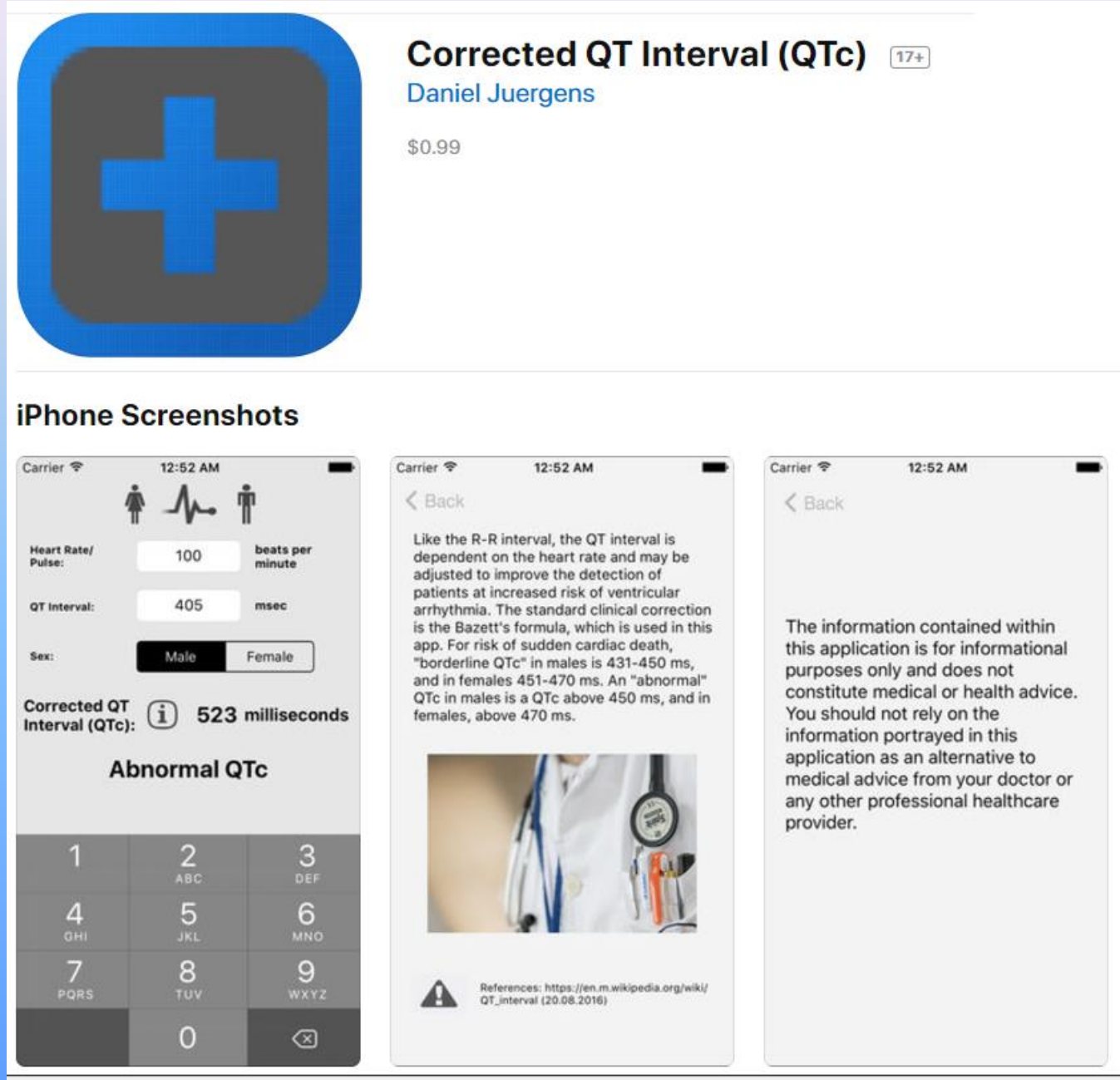


Determining the QTc

Method 4, Use a Smartphone App:

- **iPhone**
  - https://itunes.apple.com/us/app/corrected-qt-interval-qtc/id1146177765?mt=8
- **Android**
  - https://play.google.com/store/apps/details?id=com.medsam.qtccalculator&hl=en

“There’s an APP for that!”



QTc Values:

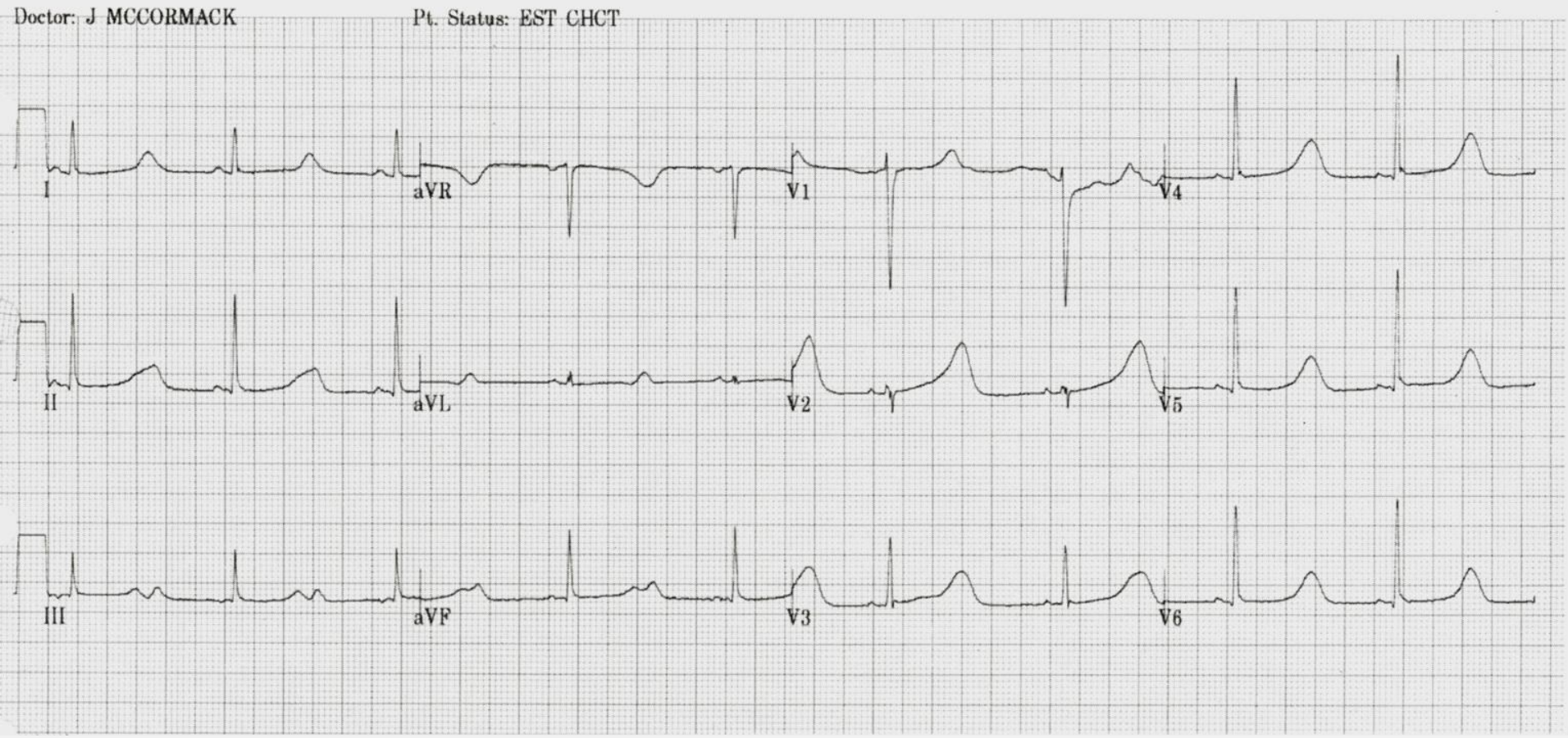
Too Short:	**< 390 ms**
Normal	
-Males:	**390 - 450 ms**
-Females:	**390 - 460 ms**
Borderline High	
-Males:	**450 - 500 ms**
-Females:	**460 - 500 ms**
High (All Genders):	**500 - 600 ms**
Critical High (associated with TdP):	**600 + ms**

SOURCE: "ACC/AHA/HRS Recommendations for Standardization and Interpretation of the ECG, Part IV: The ST Segment, T and U Waves, and the QT Interval" Rautaharju et al 2009

22 y/o FEMALE

Vent. rate	53 bpm
PR interval	110 ms
QRS duration	84 ms
QT/QTc	678/636 ms
P-R-T axes	25 60 48

PEDIATRIC CARDIOLOGY ASSOCIATES



WHEN THE “QUICK PEEK” METHOD for QT INTERAL EVALUATION IS APPLIED TO THE ABOVE ECG, WHAT IS THE RESULT?

Dysrhythmia Associated with Mortality, Triggered by LQTS: *Torsades de Pointes*

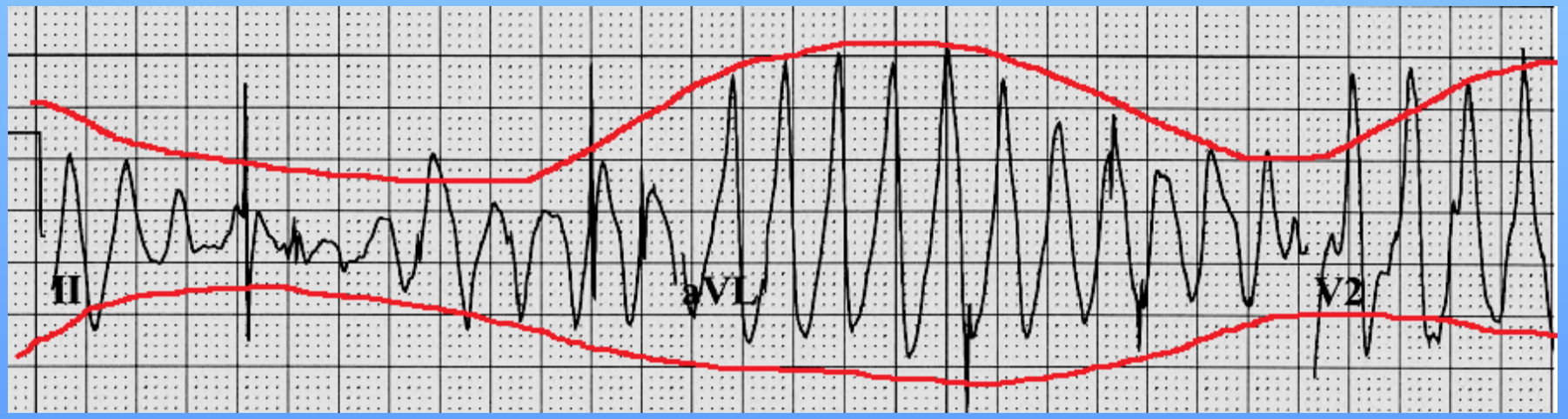
Torsades de Pointes (TdP) – HEMODYNAMICS:

- **Decreased – to – NO Cardiac Output**
- **Often patient PULSELESS during episode**
- **Patients often report SYNCOPE when TdP self-terminates.**
- **May DETERIORATE into VENTRICULAR FIBRILLATION and CARDIAC ARREST. ("Sudden Death")**

ECG Characteristics of TdP: The QRS Pattern of *Torsades de Pointes*

resembles . . . . .

a piece of Twisted Ribbon !



Etiology of Long QT Syndromes:

Congenital (14 known subtypes)

Genetic mutation results in abnormalities of cellular ion channels

Acquired

- Drug Induced
- Metabolic/electrolyte induced
- Very low energy diets / anorexia
- CNS & Autonomic nervous system disorders

Miscellaneous

- Coronary Artery Disease
- Mitral Valve Prolapse

QT Prolongation -- *STAT Intervention:*

- **Evaluate patient's meds list for meds that prolong the QT Interval.**
- **Discontinue any medication(s) known to prolong the QT Interval**
- **Consult pharmacist and the patient's physician to determine alternate medications that do not prolong the QT interval.**
- **Obtain a thorough patient history, to rule out incidence of syncope, seizures (**of unknown etiology**), and family history of sudden death/ near sudden death.**
- **Rule out hypothermia**
- **Rule out CVA / intracranial bleed**
- **Evaluate the patient's electrolyte levels**
- **Continuously *MONITOR PATIENT'S ECG FOR RUNS OF TORSADES***
- **Consider "expert consult" (electrophysiologist) to rule out LQTS**

PROLONGED Q-T INTERVAL

THINK:

- CHECK K+ AND MAG LEVELS
- POSSIBILITY OF TORSADES

If the patient is single…….

If the patient is single…….CALL THE CLERGY

STAT !

IN THE JOURNALS

Prolonged QT interval more likely in unmarried vs. married adults

Ahmad MI, et al. *Am J Cardiol*. 2019;doi:10.1016/j.amjcard.2019.04.020.

July 9, 2019

Compared with married people, unmarried people were more likely to have a prolonged QT interval, according to findings published in *The American Journal of Cardiology*.

PROLONGED Q-T INTERVAL

THINK:

- CHECK K+ AND MAG LEVELS
- POSSIBILITY OF TORSADES

- QUESTION MEDS THAT PROLONG Q-T

QT Prolongation -- *STAT Intervention:*

☞ ***Avoidance of Meds that are known to prolong the QT Interval. Click here for current list from CREDIBLEMEDS.ORG***

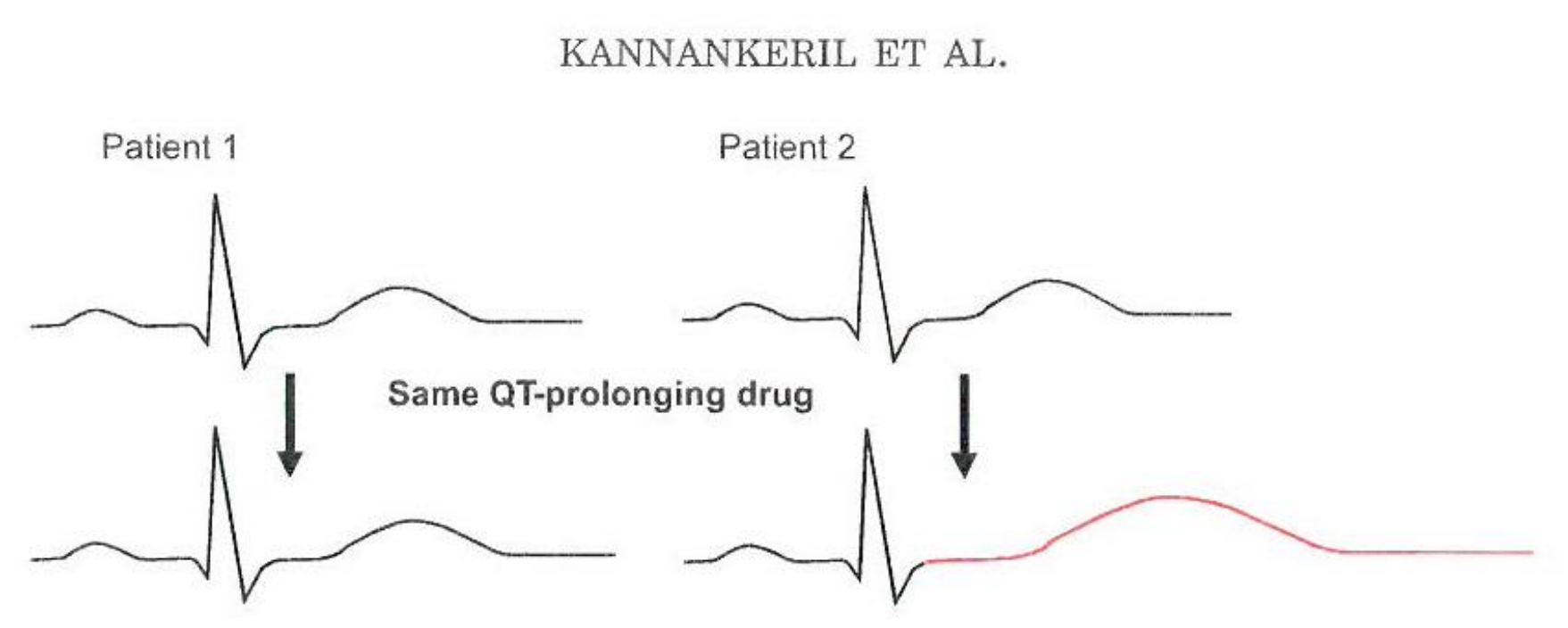
Commonly used QT prolonging meds include:

-Amiodarone
-Procainamide
-Levaquin
-Erythromycin
-Norpace
-Tequin
-Benadryl
-Ritalin
-Pseudophedrine
-Haloperidol
-Thorazine
-Propulcid
-Zofran
-Ilbutilide

and MANY more!

PATIENT 1: NORMAL

PATIENT 2: Genetic susceptibility; sensitivity to QT prolonging drugs:



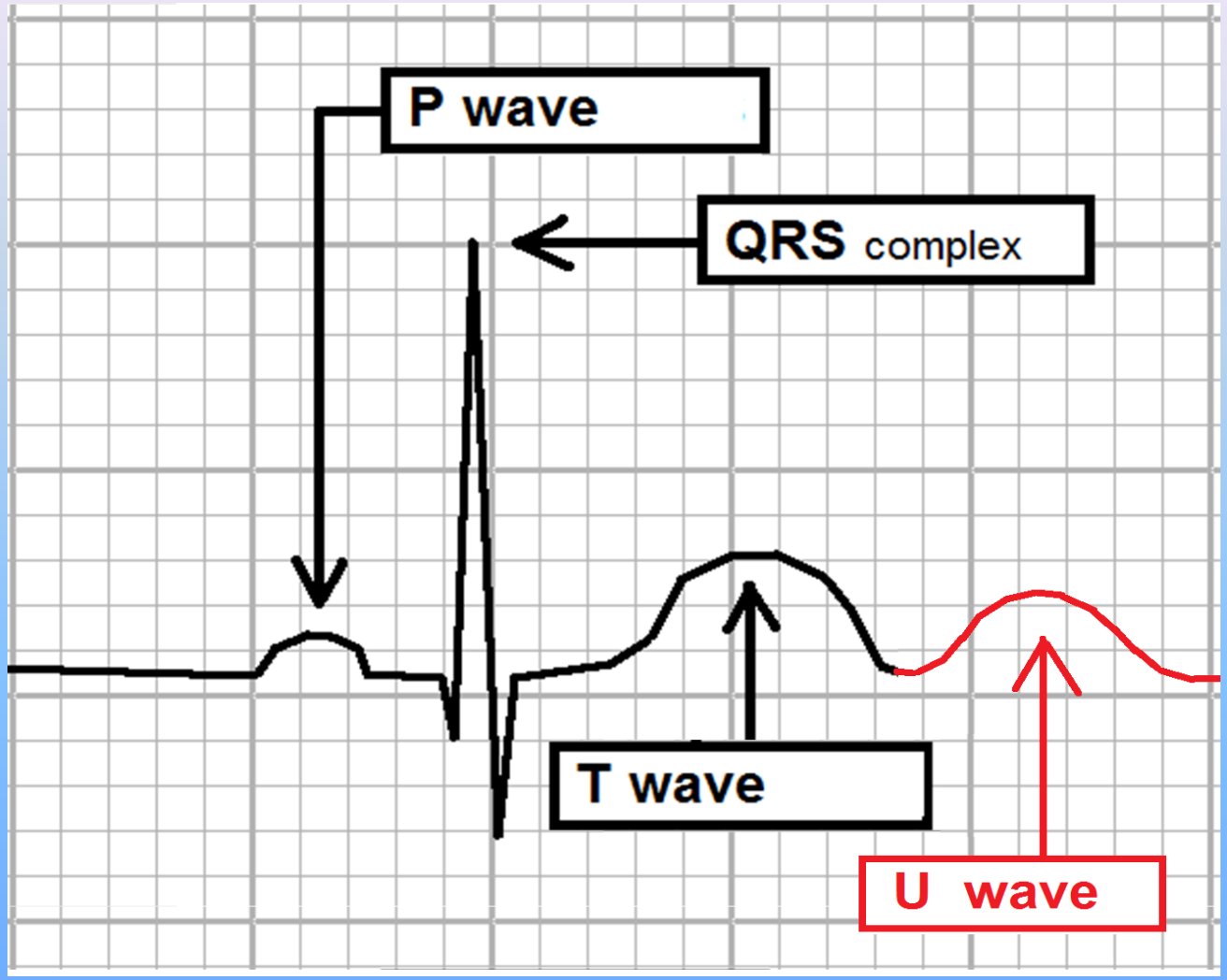
Click here for link to paper by Kannankeril et al (2010 Pharmacological Reviews) that describes genetic susceptibility described above.

U Waves

Occasionally an extra wave is noted after each T wave.

It typically resembles

"a secondary T wave."



When present on the ECG, this "extra" waveform is referred to as a " U Wave."

U Waves . . .

- Common U wave Etiology:
  - **Hypomagnesemia***
  - **Hyperkalemia***
  - **Hypocalcemia***
  - **QT prolonging medications***
  - **Increased intracranial pressure***
  - **Hypothermia***
  - **Digitalis** (usually *shortens* the QT Interval)

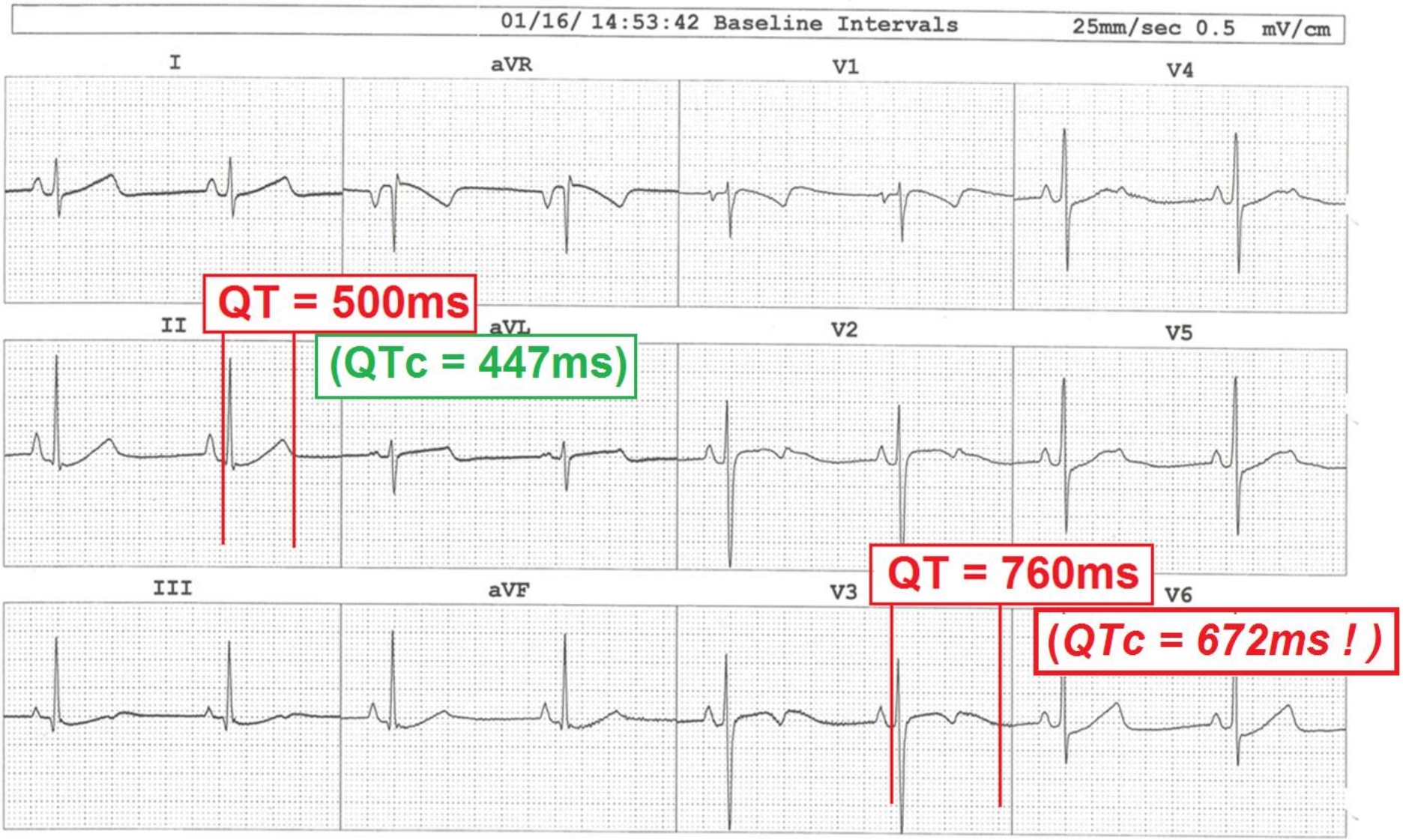
**** These are also causes of QT interval prolongation.***

Abnormal U Waves

INCLUDE the U Wave in the QT Interval measurement **when any one or more criteria are present:**

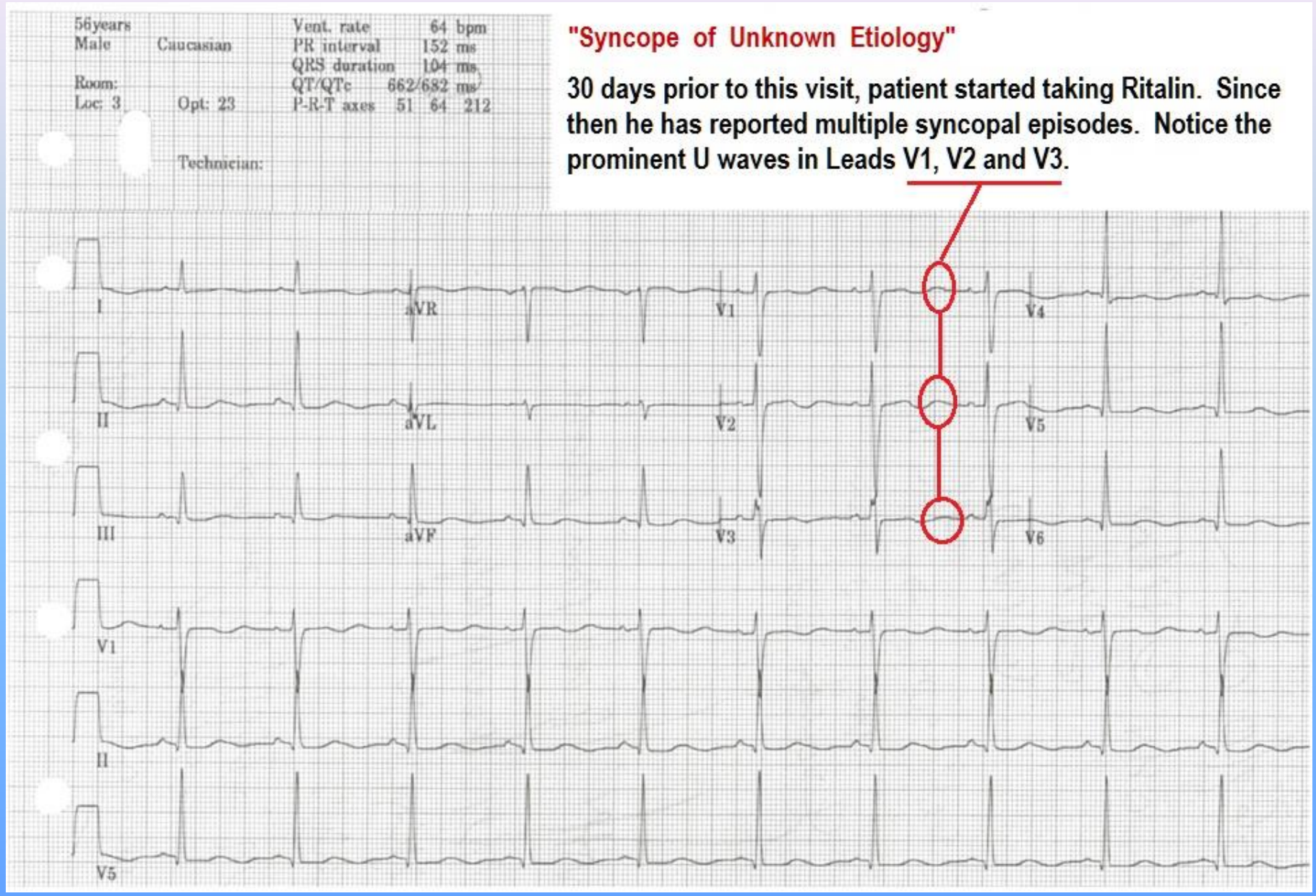
- **U wave 100% (or more) the size of the T wave.**
- **U wave is INVERTED (opposite polarity of T wave)**
- **U wave merged with the T wave**

EVIDENCE SOURCE:
ACC/AHA/HRS Recommendations for the Standardization and Interpretation of the Electrocardiogram Part IV: The ST Segment, T and U Waves, and the QT Interval.

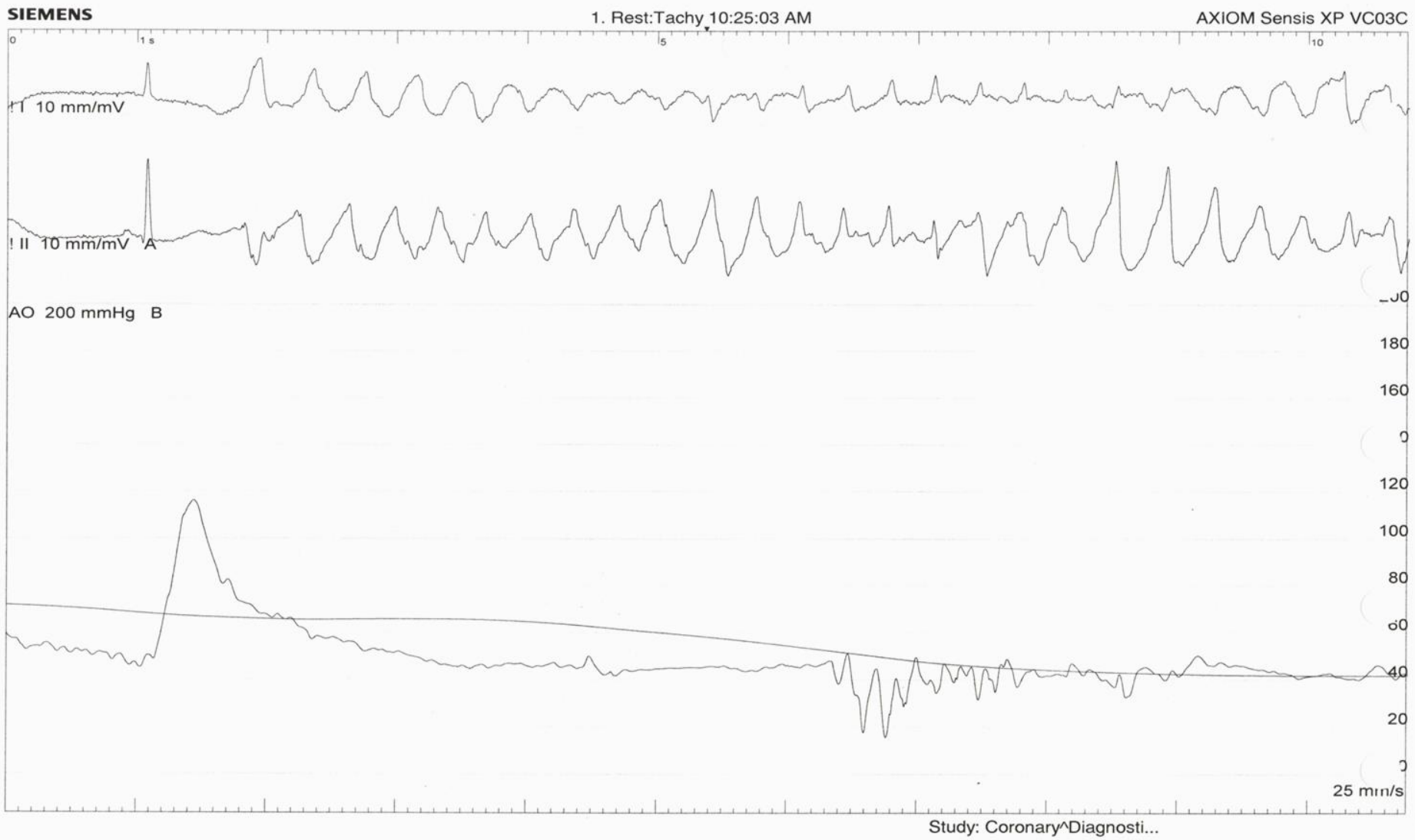


This ECG illustrates the degree of variation that can be noted between different leads on the 12 Lead ECG. ALWAY measure the QT Interval in the lead with the GREATEST value.

Medication induced LQTS with TdP and Cardiac Arrest - Case Study: 56 year old male

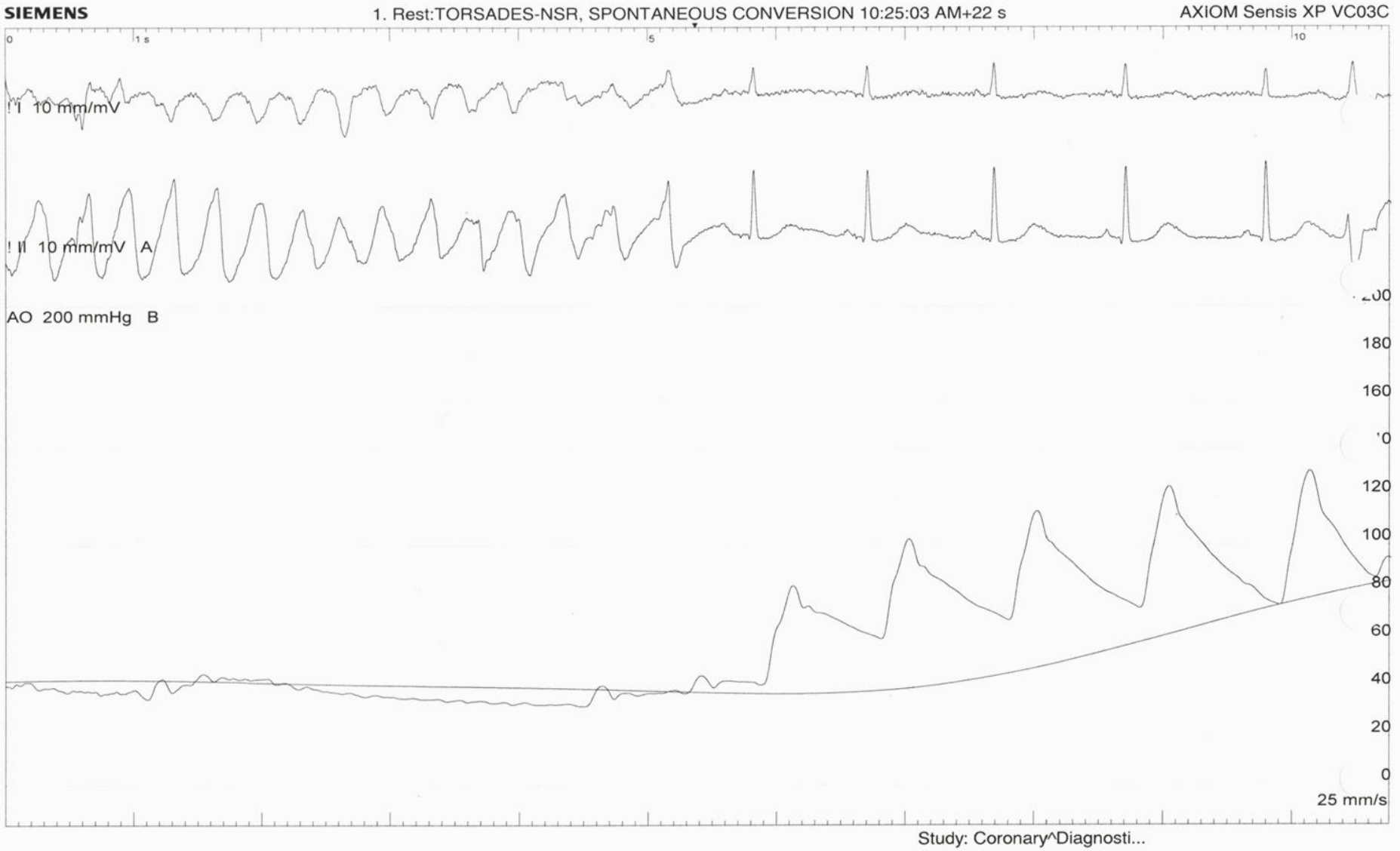


Medication induced LQTS with TdP and Cardiac Arrest - Case Study: 56 year old male



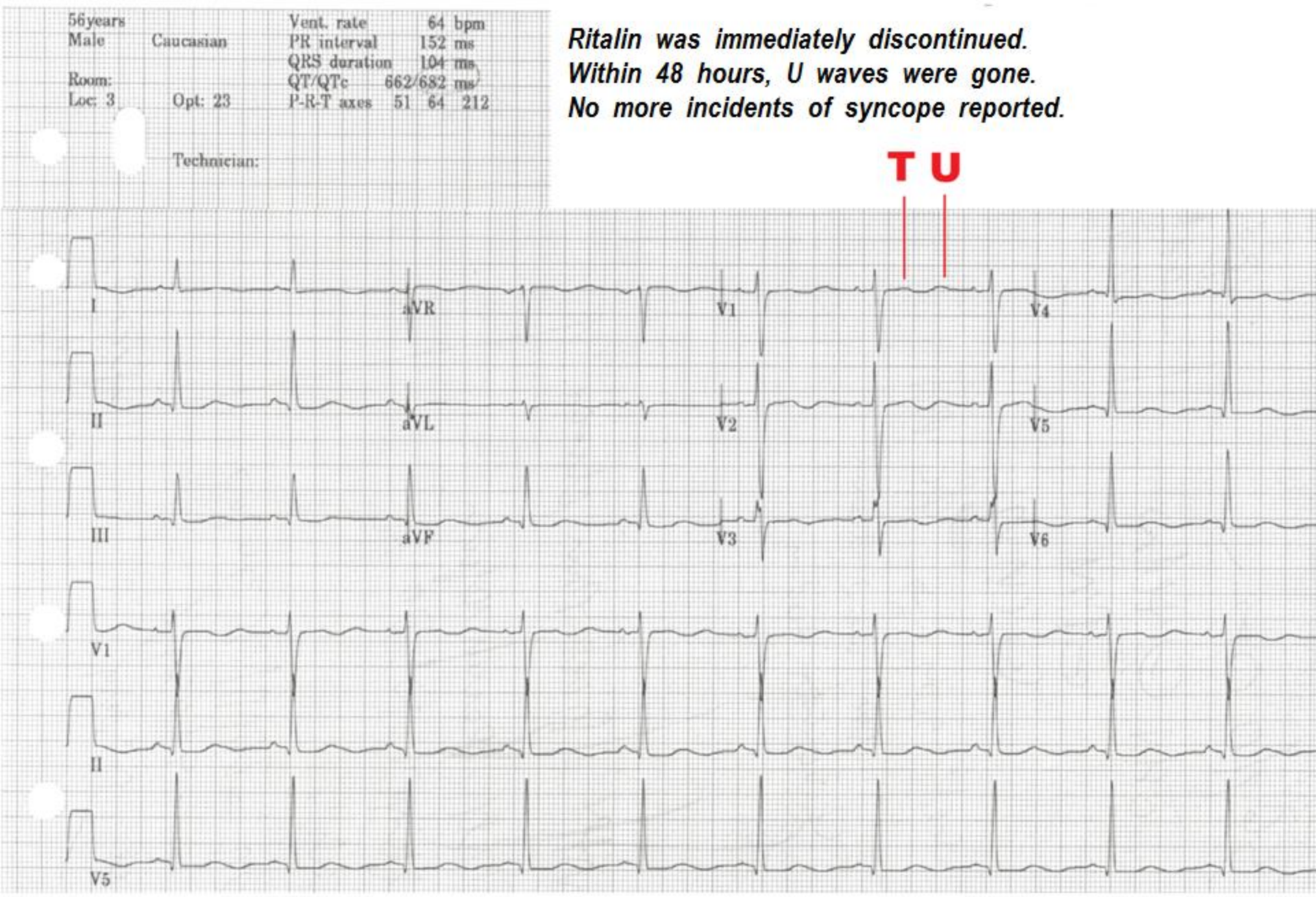
Run of Torsades de Pointes occurred during Cardiac Catheterization . . .

Medication induced LQTS with TdP and Cardiac Arrest - Case Study: 56 year old male



Torsades de Pointes self-terminates just before aborted Defibrillation

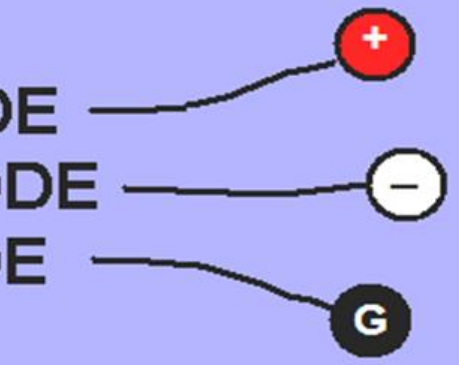
Medication induced LQTS with TdP and Cardiac Arrest - Case Study: 56 year old male



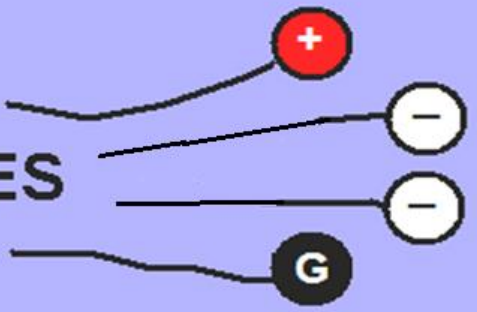
THE ECG MACHINE

STANDARD 12 LEADS - USES 10 WIRES
(6 CHEST and 4 LIMB)

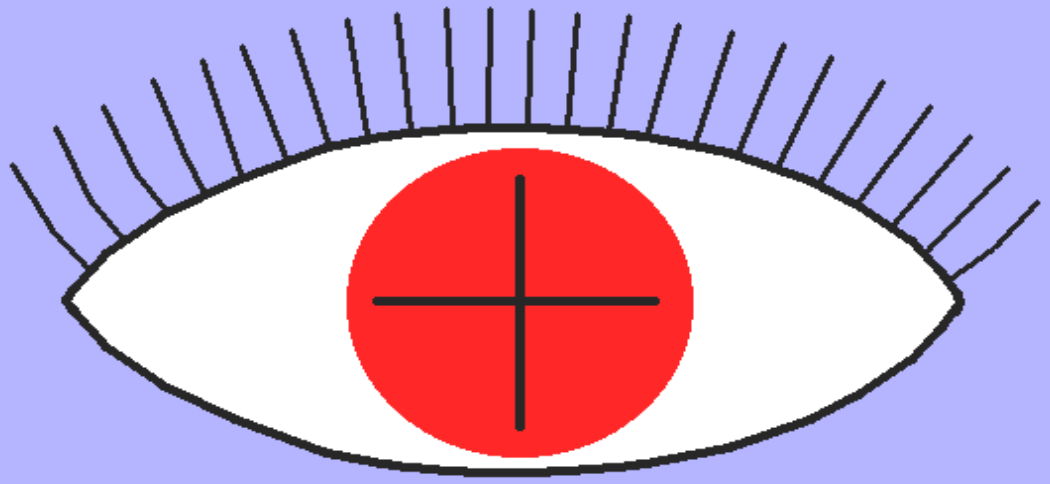
- LEADS I, II, III, and V1, V2, V3, V4, V5, V6



- LEADS AVR, AVL, and AVF



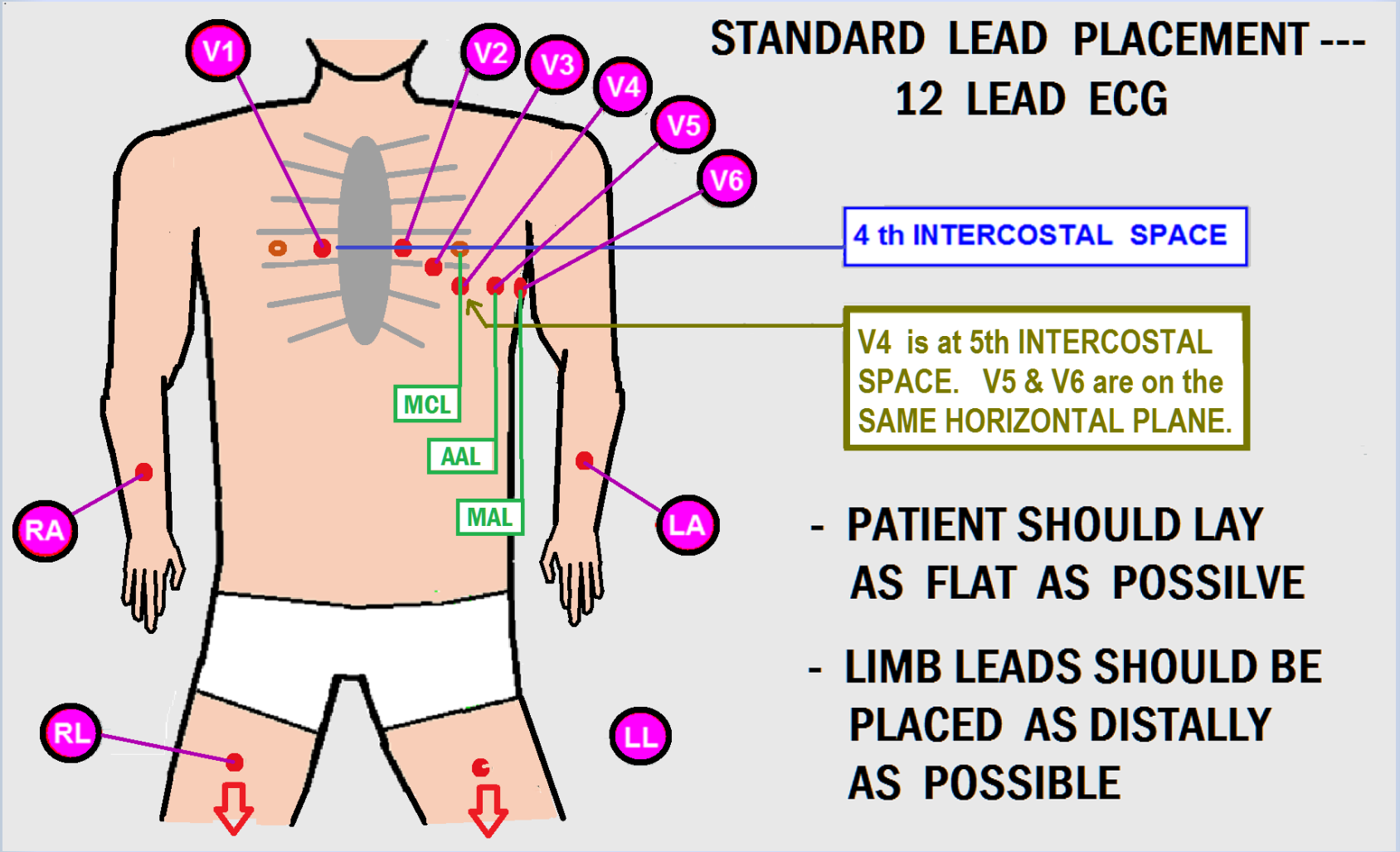
THE POSITIVE ELECTRODE



IS THE "EYE" . . .

Wherever it's positioned on the body, that's the perspective of the heart it's seeing . . . .

Obtaining the 12 Lead ECG



Obtaining the 12 Lead ECG

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

Obtaining the 12 Lead ECG

- **Limb leads should be on the limbs.**
  - **To minimize muscular artifact, place leads over bone (e.g. Tibia) or places with minimal muscle (palmar aspect [underside] of wrist)**

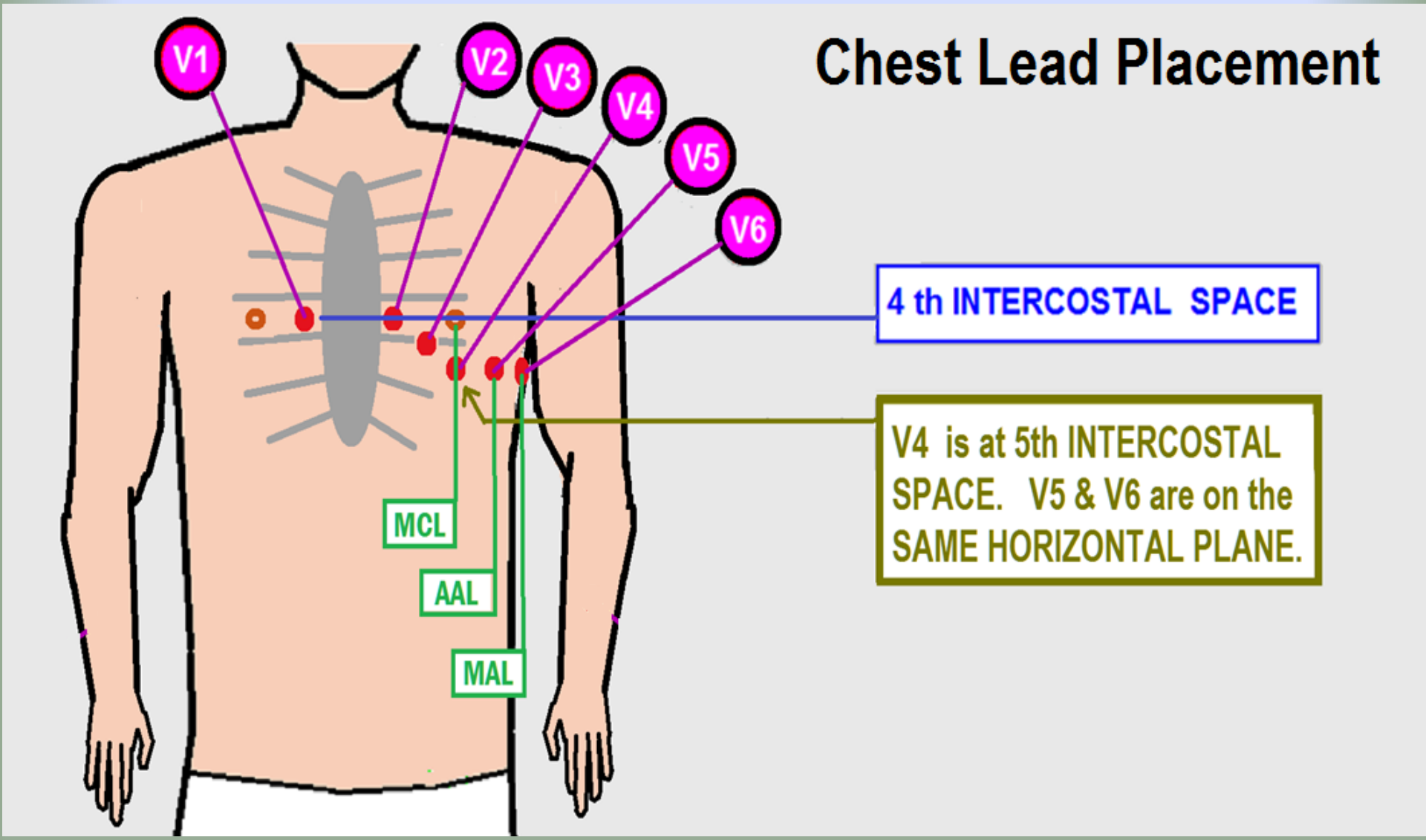
Obtaining the 12 Lead ECG

- **Limb leads should be placed 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.**

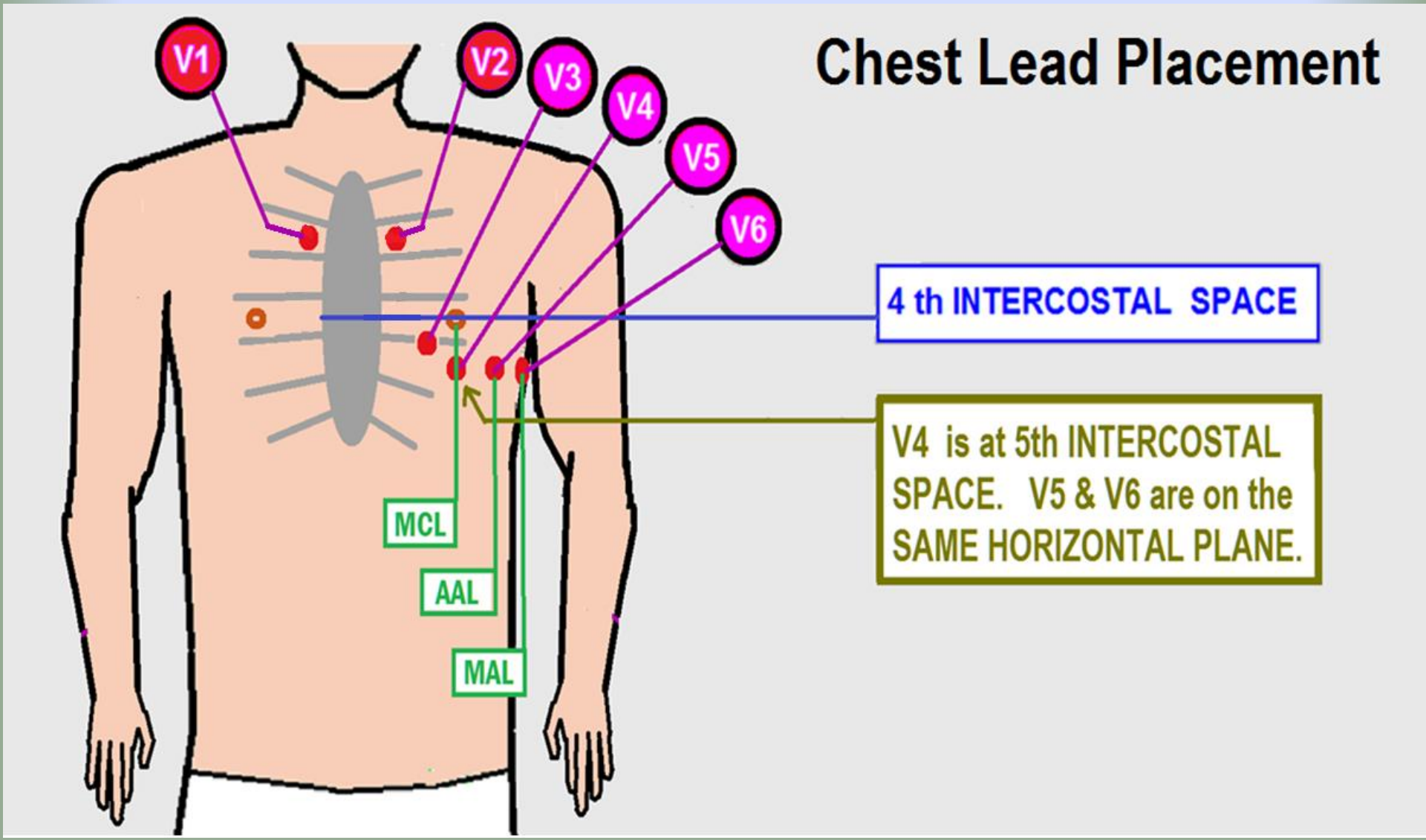
Obtaining the 12 Lead ECG

- **Limb leads should be placed _____.**
- **When emergency circumstances dictate that limb leads be placed on patient's torso, the words "_____" should be noted on the ECG.**

CORRECT Lead placement:



INCORRECT Lead placement:



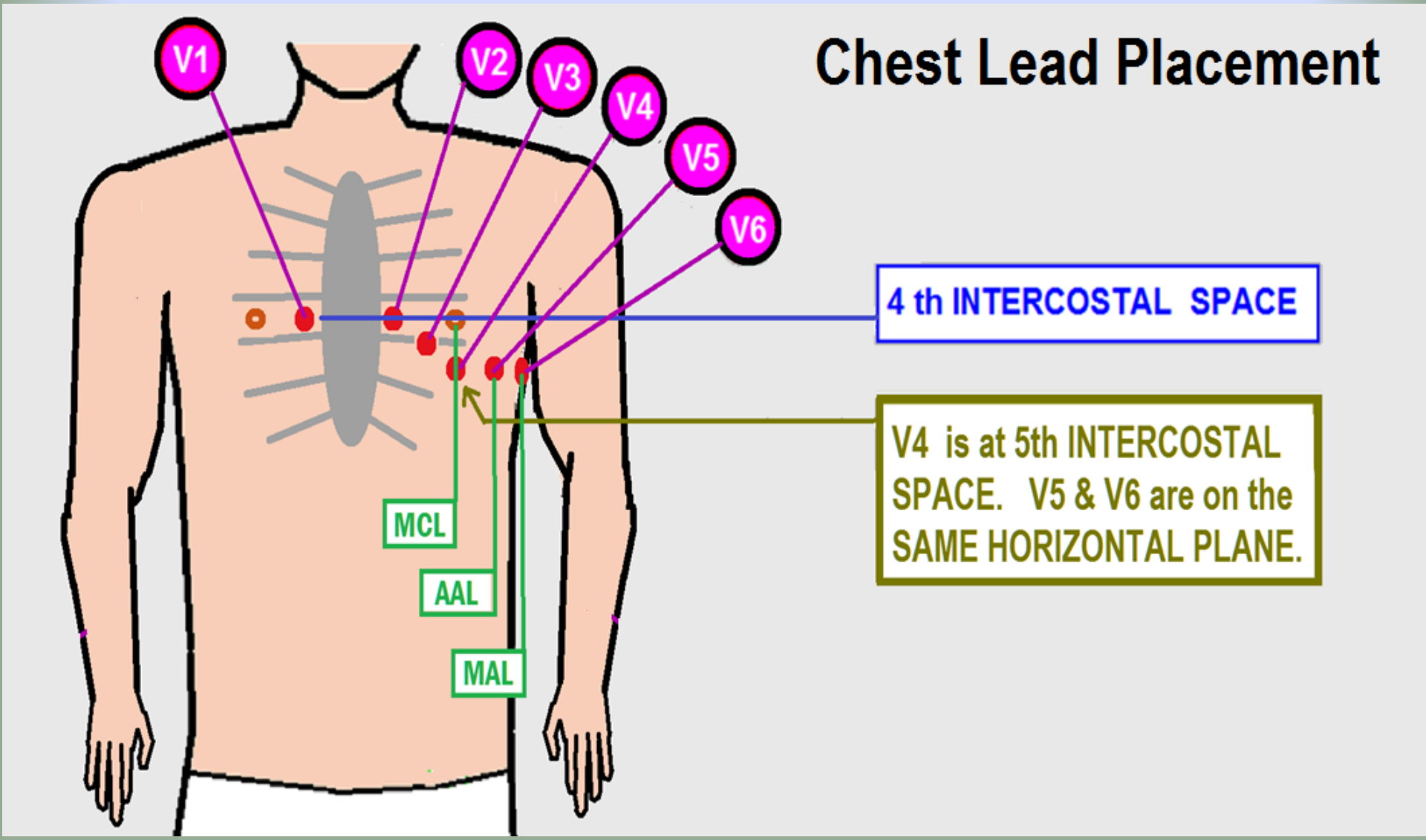
AHA/ACC/HRS Scientific Statement

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]

CORRECT Lead placement:



[redacted] [redacted] [redacted]

DOB [redacted] 75 Years Female (2)

Rate 76 . Sinus rhythm.....normal P axis, V-rate 50- 99

PR 161
QRSD 90
QT 350
QTc 394

--AXIS--
P 50
QRS 51
T 44

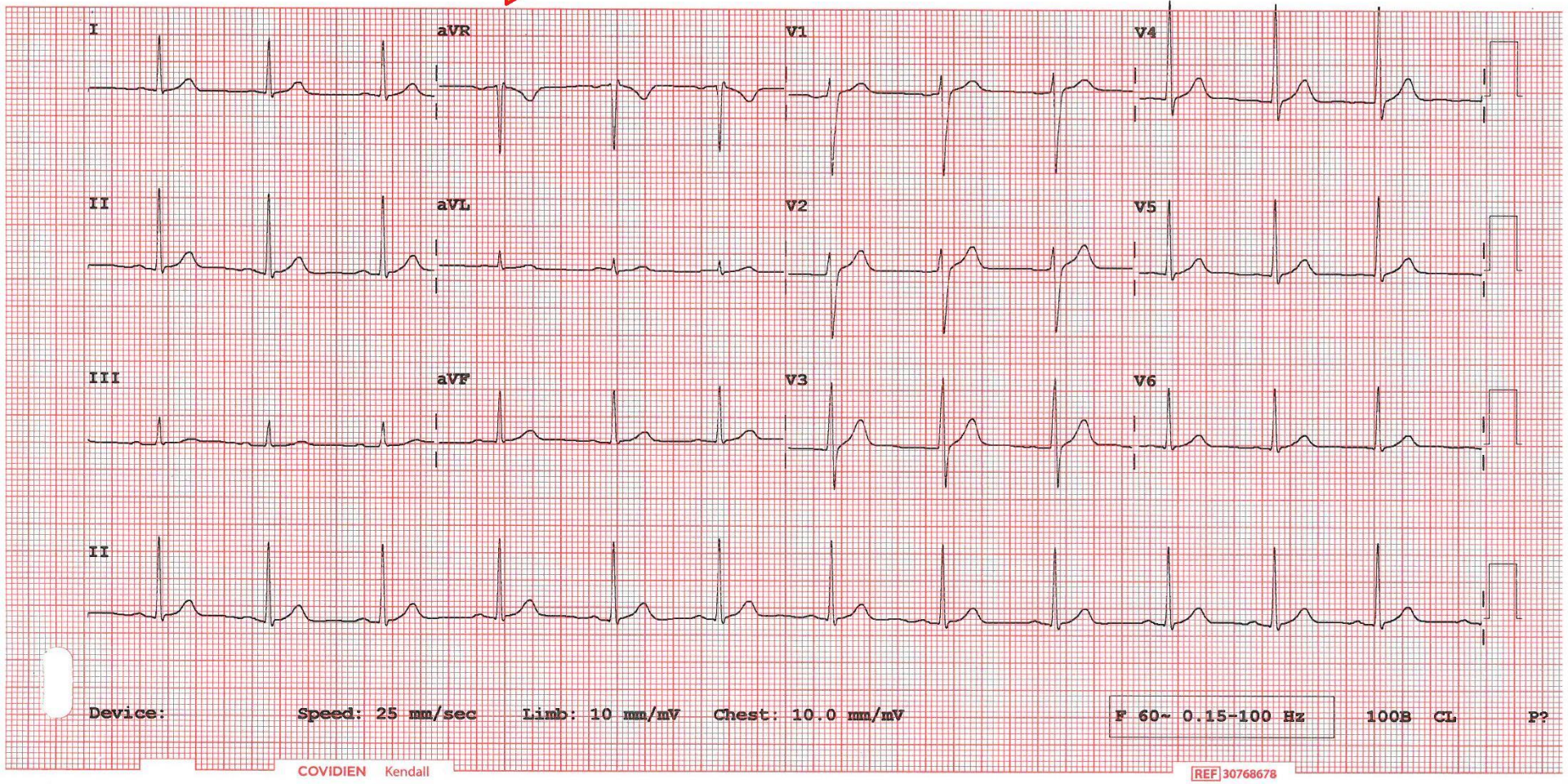
12 Lead; Standard Placement

[redacted] TECH SD

[redacted]

- NORMAL ECG -

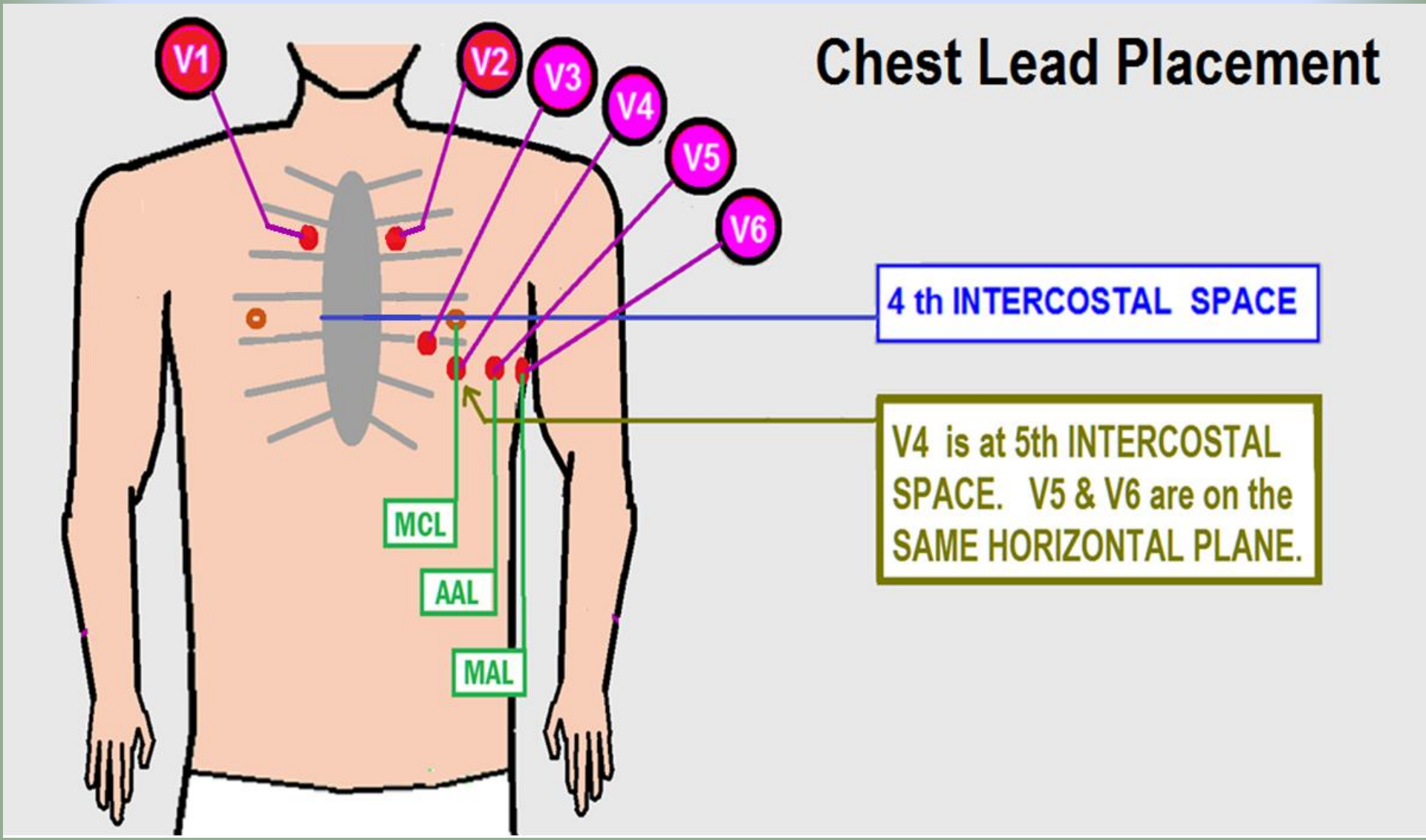
Unconfirmed Diagnosi



Device: Speed: 25 mm/sec Limb: 10 mm/mV Chest: 10.0 mm/mV F 60~ 0.15-100 Hz 100B CL P?

COVIDIEN Kendall REF 30768678

INCORRECT Lead placement:



[redacted] [redacted] [redacted] 5:20:58 AM

DOB [redacted]1988 30 Years Female (1)

3NE

Rate 89 . Sinus rhythm.....normal P axis, V-rate 50- 99

. Anteroseptal infarct, age indeterminate.....Q >35mS

PR 157
QRSD 96
QT 365
QTc 445

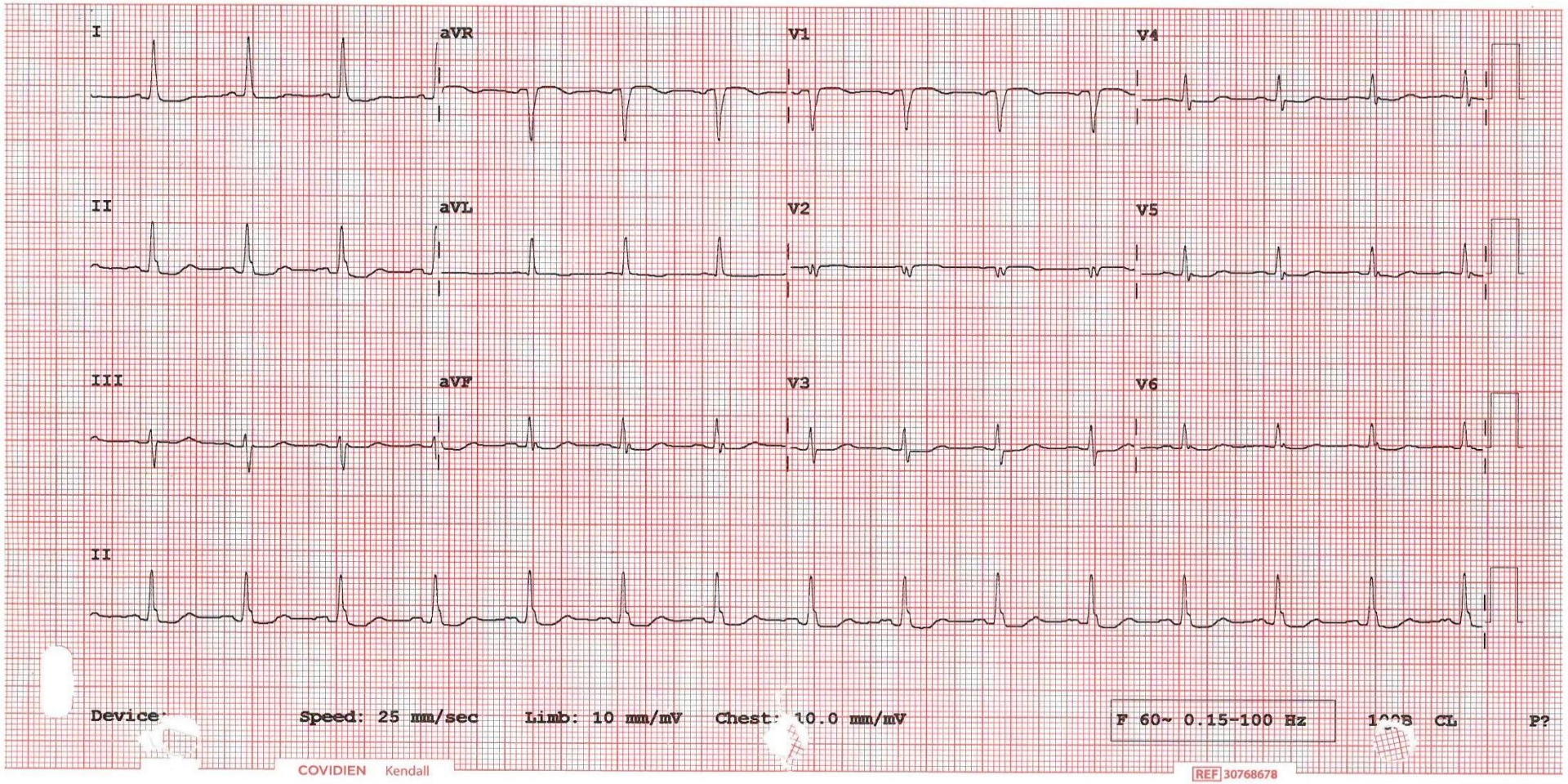
--AXIS--
P 46
QRS 24
T 86

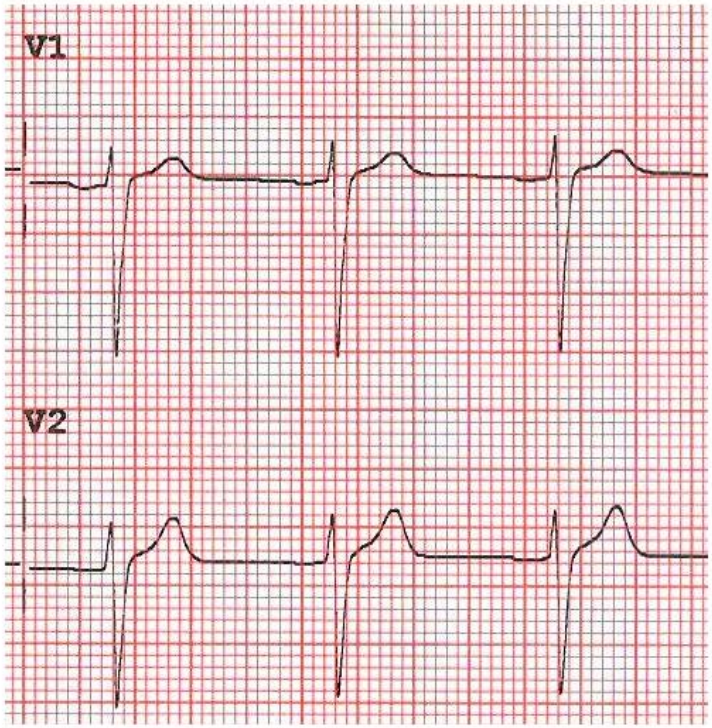
12 Lead; Standard Placement

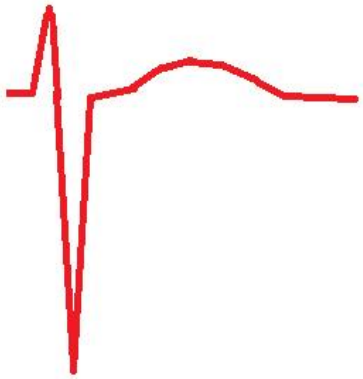
- ABNORMAL ECG -

Unconfirmed Diagnosis

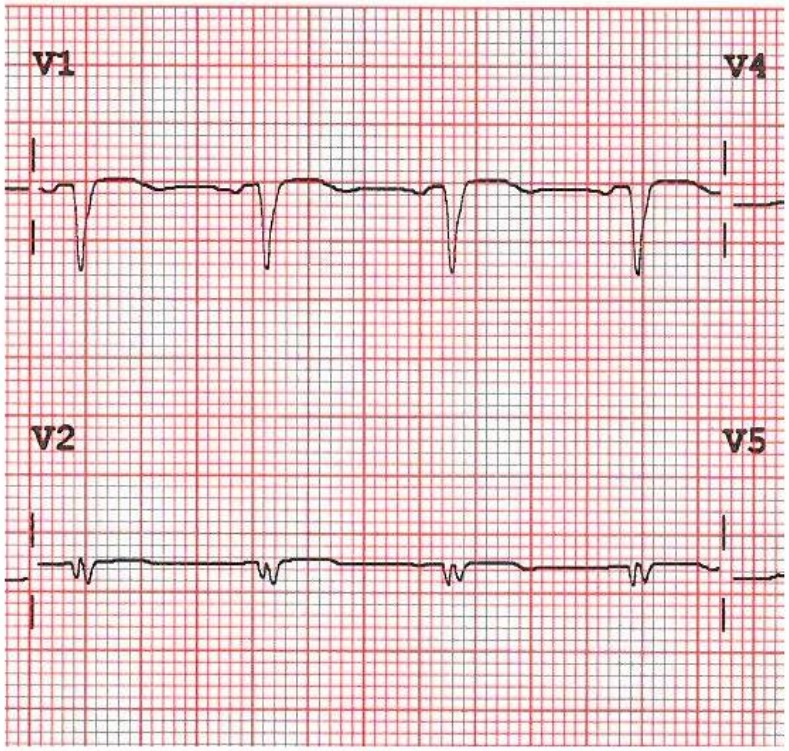
[redacted]

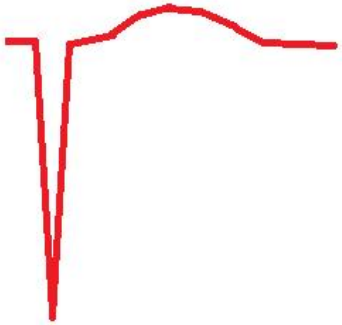






RS = NO old MI





QS = old MI

Leads V1 & V2 on 12 Lead ECG:

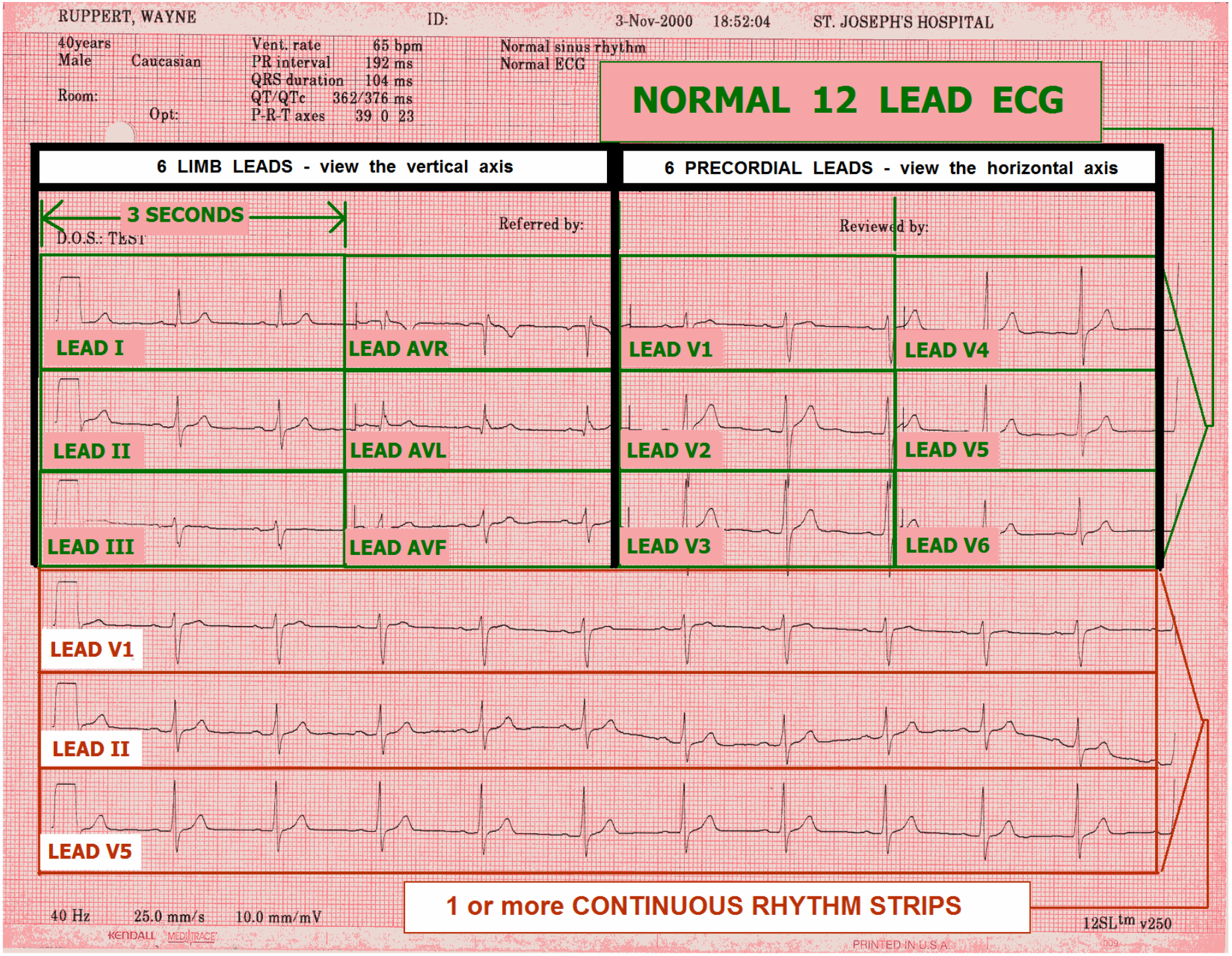
- **Proper lead placement of precordial Leads V1 and V2 are 4th intercostal space on opposite sides of the sternum.**
- **Incorrect placement of Leads V1 and V2 will result in *the presence of Q Waves* (indicator of necrosis) leading to misdiagnosis of previous anterior / septal infarction.**

Leads V1 & V2 on 12 Lead ECG:

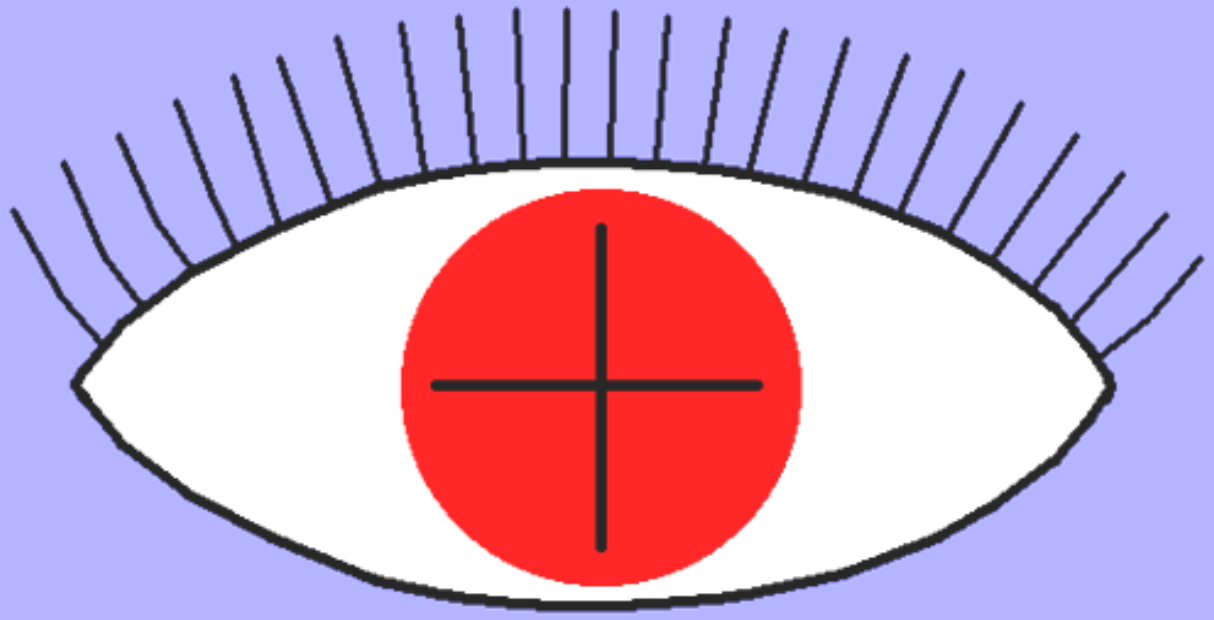
- **Proper lead placement of precordial Leads V1 and V2 are _____on opposite sides of the sternum.**
- **Incorrect placement of Leads V1 and V2 will result in *the presence of Q Waves* (indicator of necrosis) leading to misdiagnosis of _____.**

The New England Medical Journal

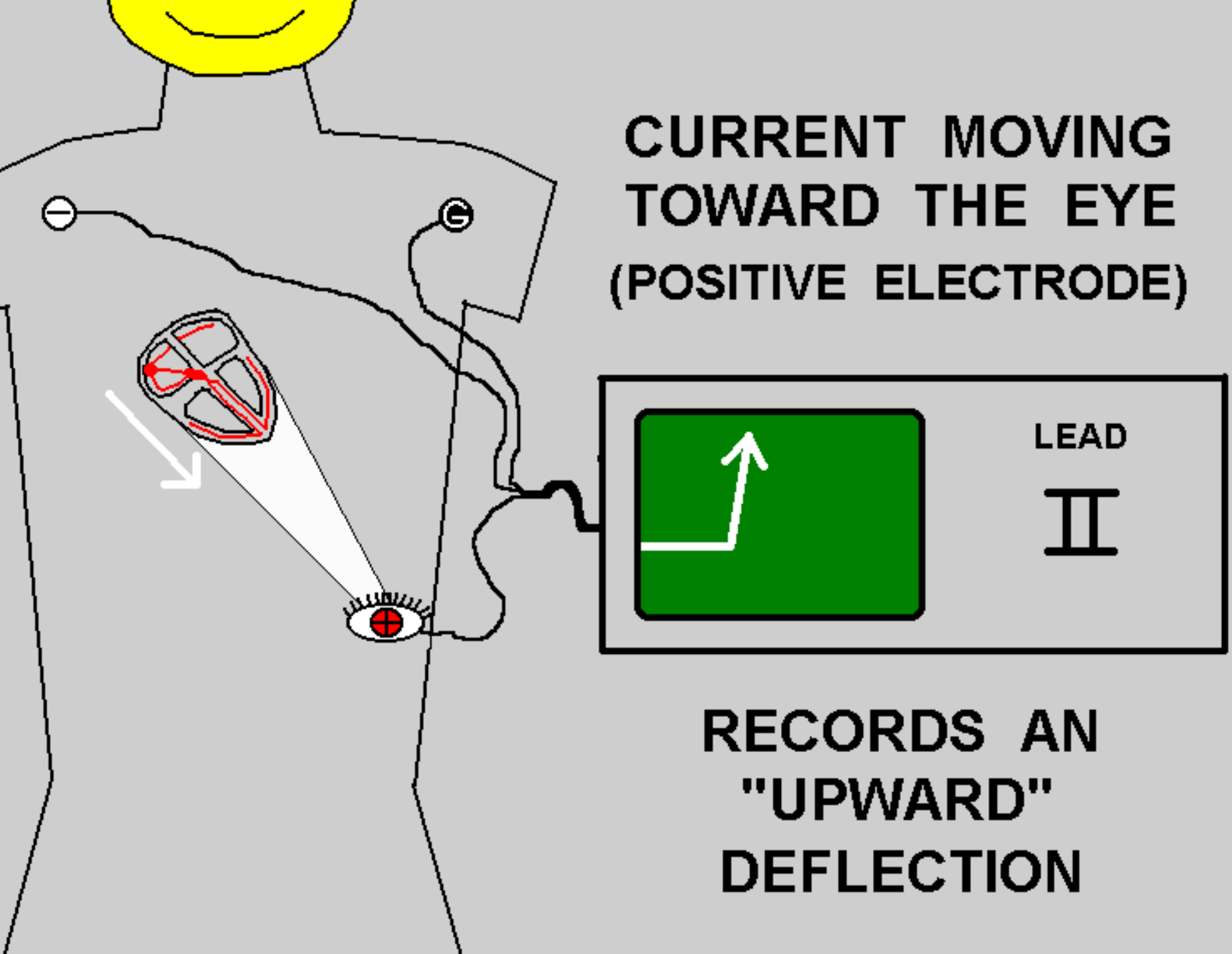
The 12 Lead ECG . . .

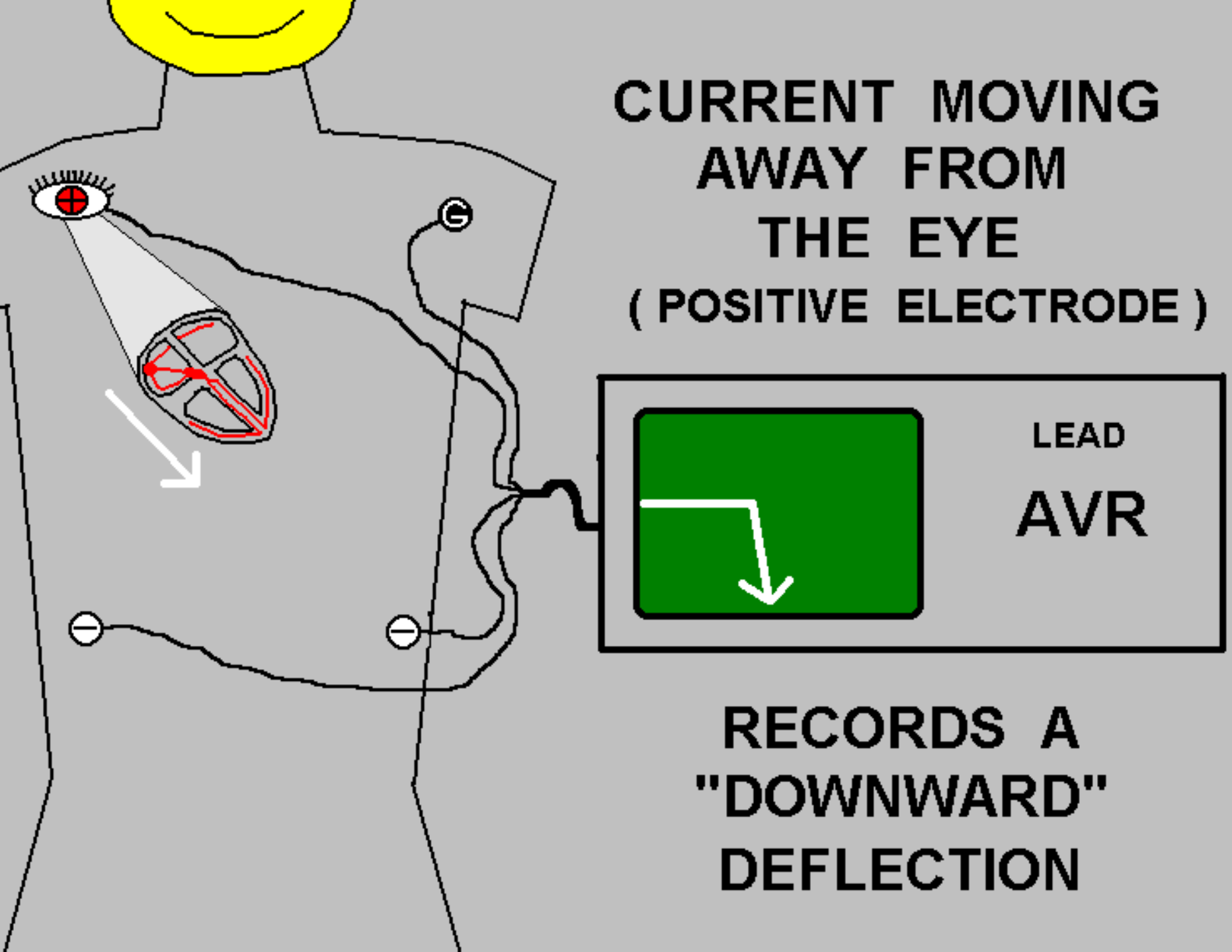

RUPPERT, WAYNE
ID:
3-Nov-2000 18:52:04
ST. JOSEPH'S HOSPITAL
40years
Male Caucasian
Room:
Opt:
Vent. rate 65 bpm
PR interval 192 ms
QRS duration 104 ms
QT/QTc 362/376 ms
P-R-T axes 39 0 23
Normal sinus rhythm
Normal ECG
NORMAL 12 LEAD ECG
6 LIMB LEADS - view the vertical axis
6 PRECORDIAL LEADS - view the horizontal axis
3 SECONDS
D.O.S.: TEST
Referred by:
Reviewed by:
LEAD I
LEAD AVR
LEAD V1
LEAD V4
LEAD II
LEAD AVL
LEAD V2
LEAD V5
LEAD III
LEAD AVF
LEAD V3
LEAD V6
LEAD V1
LEAD II
LEAD V5
1 or more CONTINUOUS RHYTHM STRIPS
40 Hz
25.0 mm/s
10.0 mm/mV
12SL tm v250
KENDALL MEDITRACE
PRINTED IN U.S.A.

THE POSITIVE ELECTRODE



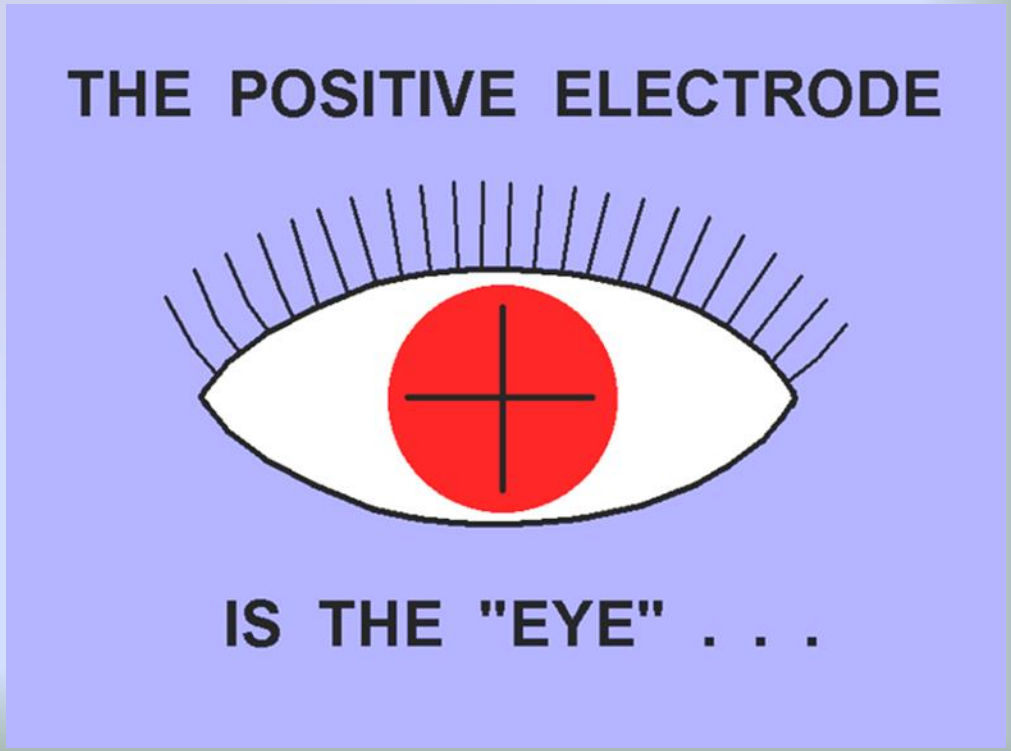
IS THE "EYE" . . .


CURRENT MOVING
TOWARD THE EYE
(POSITIVE ELECTRODE)
LEAD
II
RECORDS AN
"UPWARD"
DEFLECTION


CURRENT MOVING AWAY FROM THE EYE
(POSITIVE ELECTRODE)
LEAD
AVR
RECORDS A "DOWNWARD" DEFLECTION

Imagine a body made of clear glass, with only a HEART inside. We dip this body in liquid chocolate, and then scratch holes in each spot where we normally place the ECG leads . . . . .

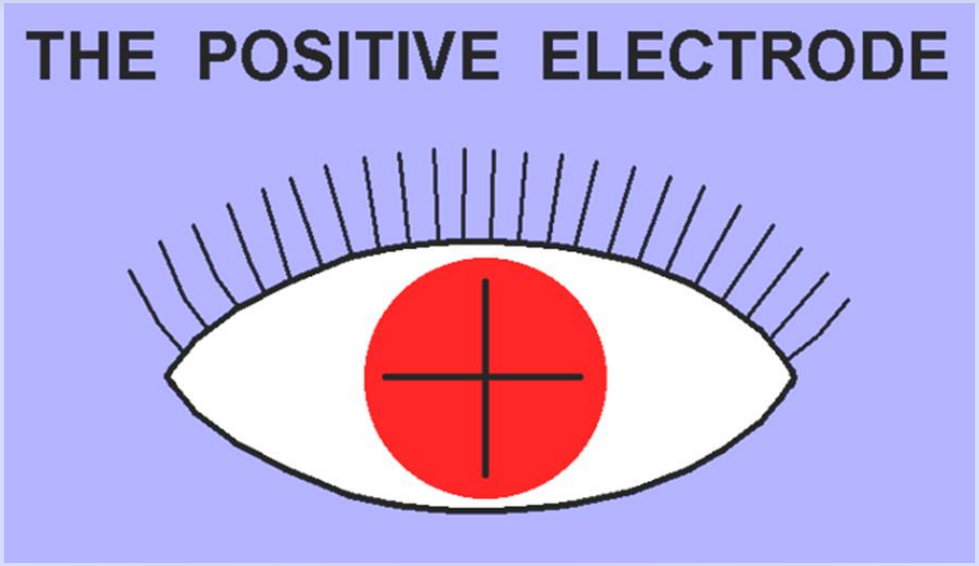
What part of the HEART would each lead SEE ?



AREAS VIEWED by 12 LEAD ECG

AVR
AVL, I
V1, V2
V3, V4
V5, V6
II, III, AVF

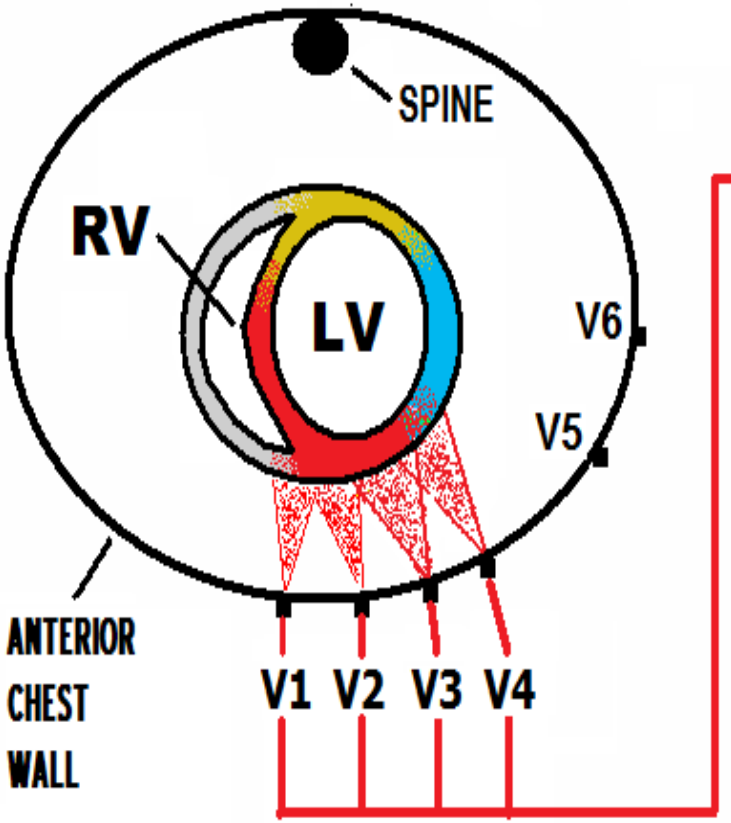
Fill in the blanks as we proceed!



What each of the 12 Leads “see,” in more detail . . . .

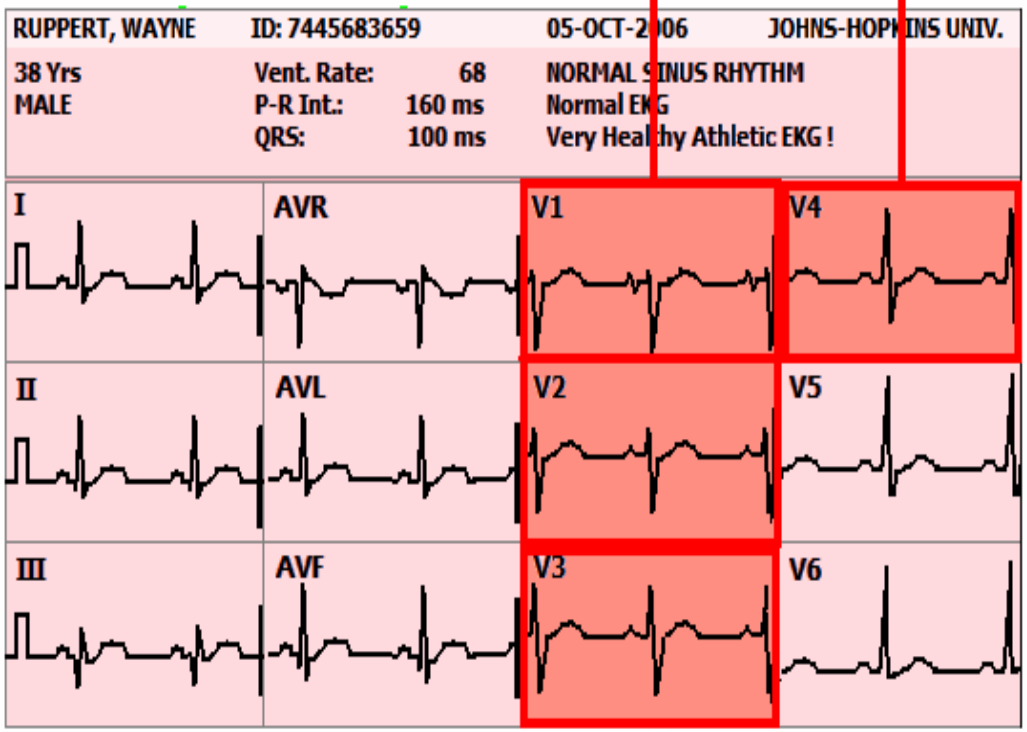
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE



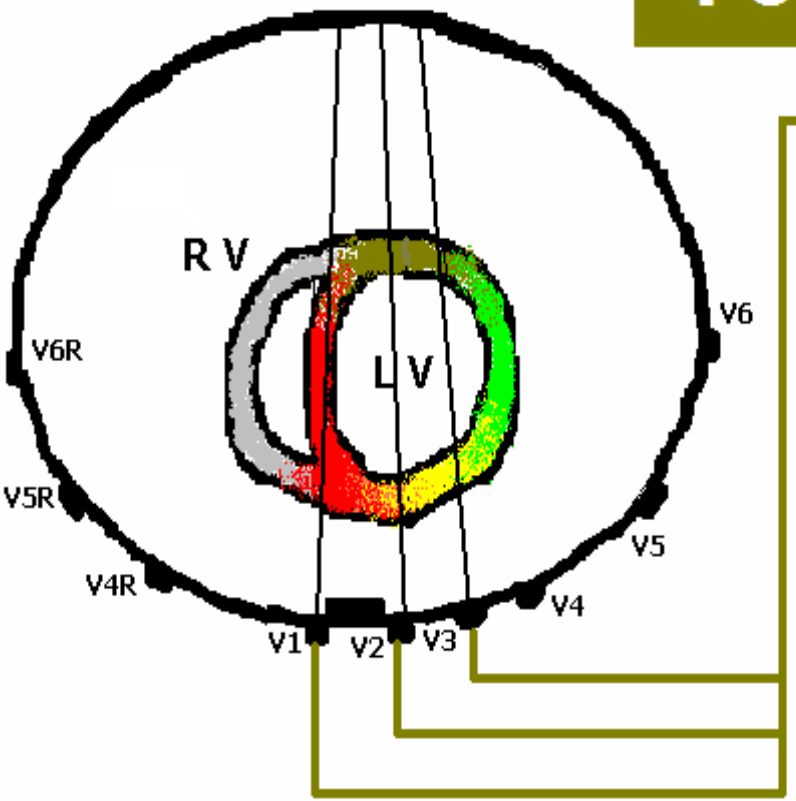
V1, V2 - ANTERIOR / SEPTAL

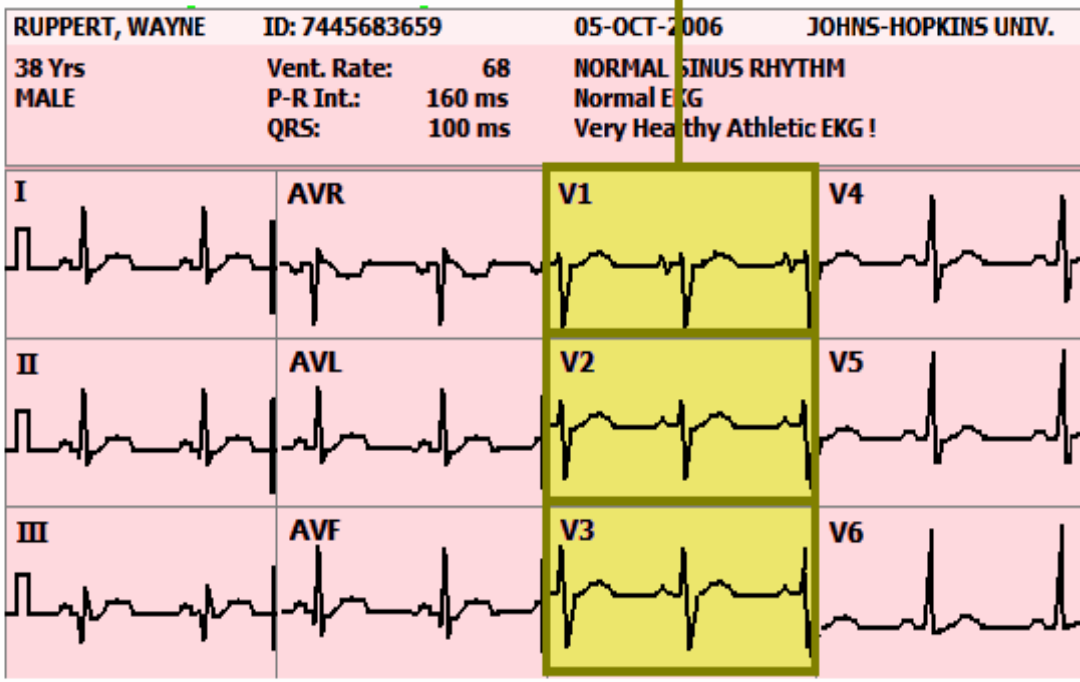
V3, V4 - ANTERIOR



LEADS V1 - V3 *view the*

POSTERIOR WALL



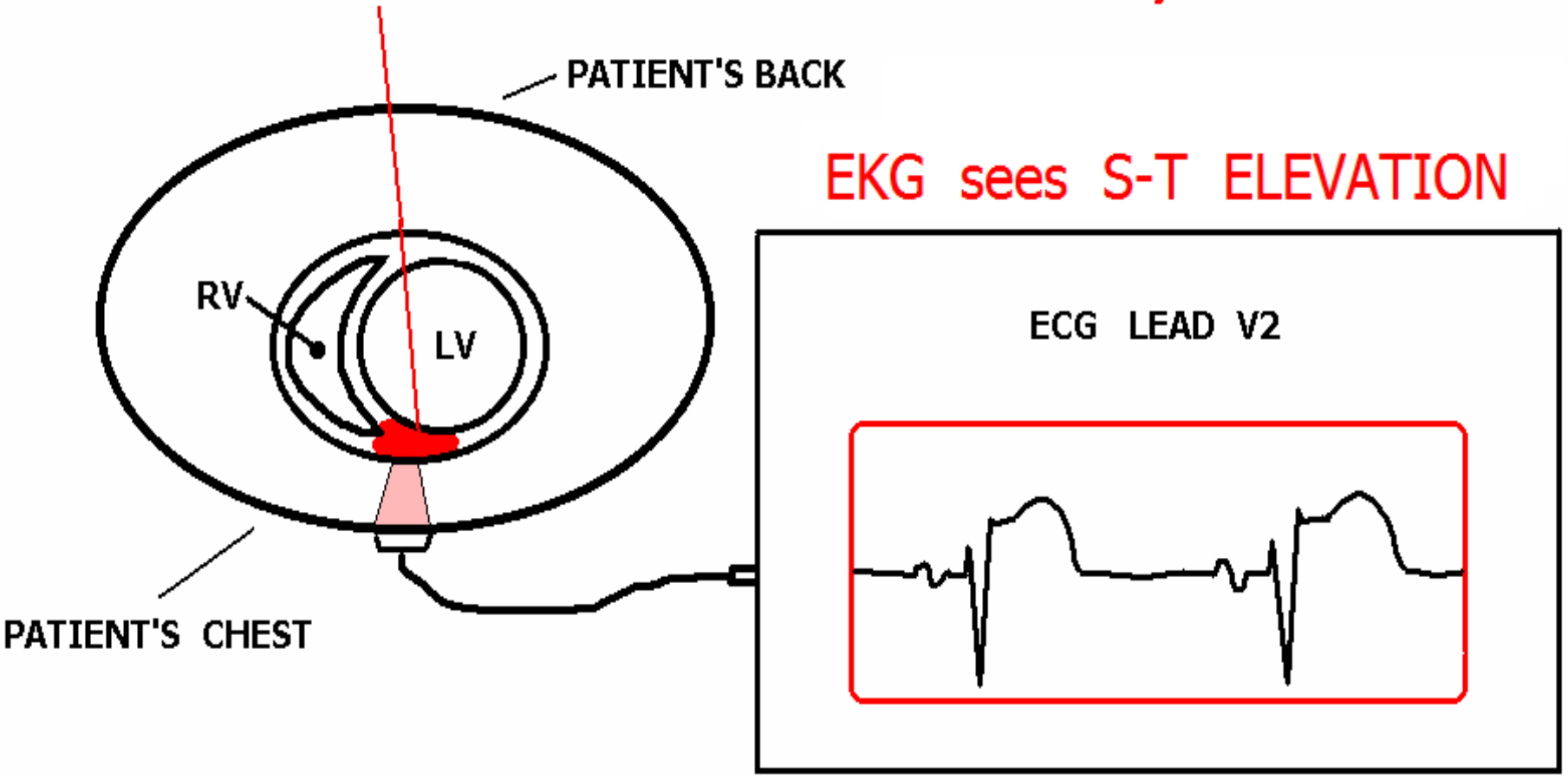


via RECIPROCAL CHANGES.

HOW EKG VIEWS INDICATIVE CHANGES

EXAMPLE:

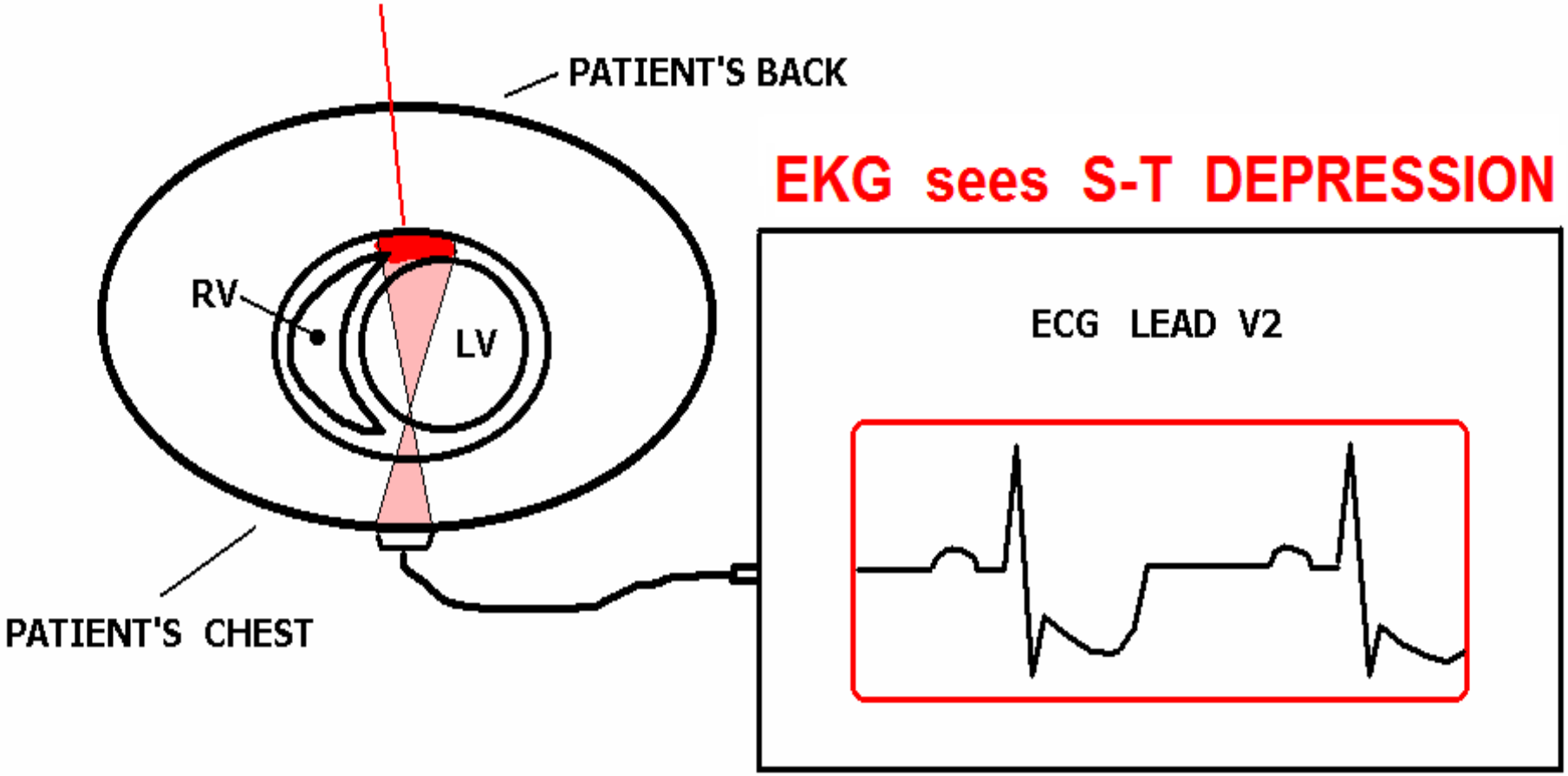
AREA OF ACUTE INFARCTION - ANTERIOR/SEPTAL



HOW EKG VIEWS RECIPROCAL CHANGES

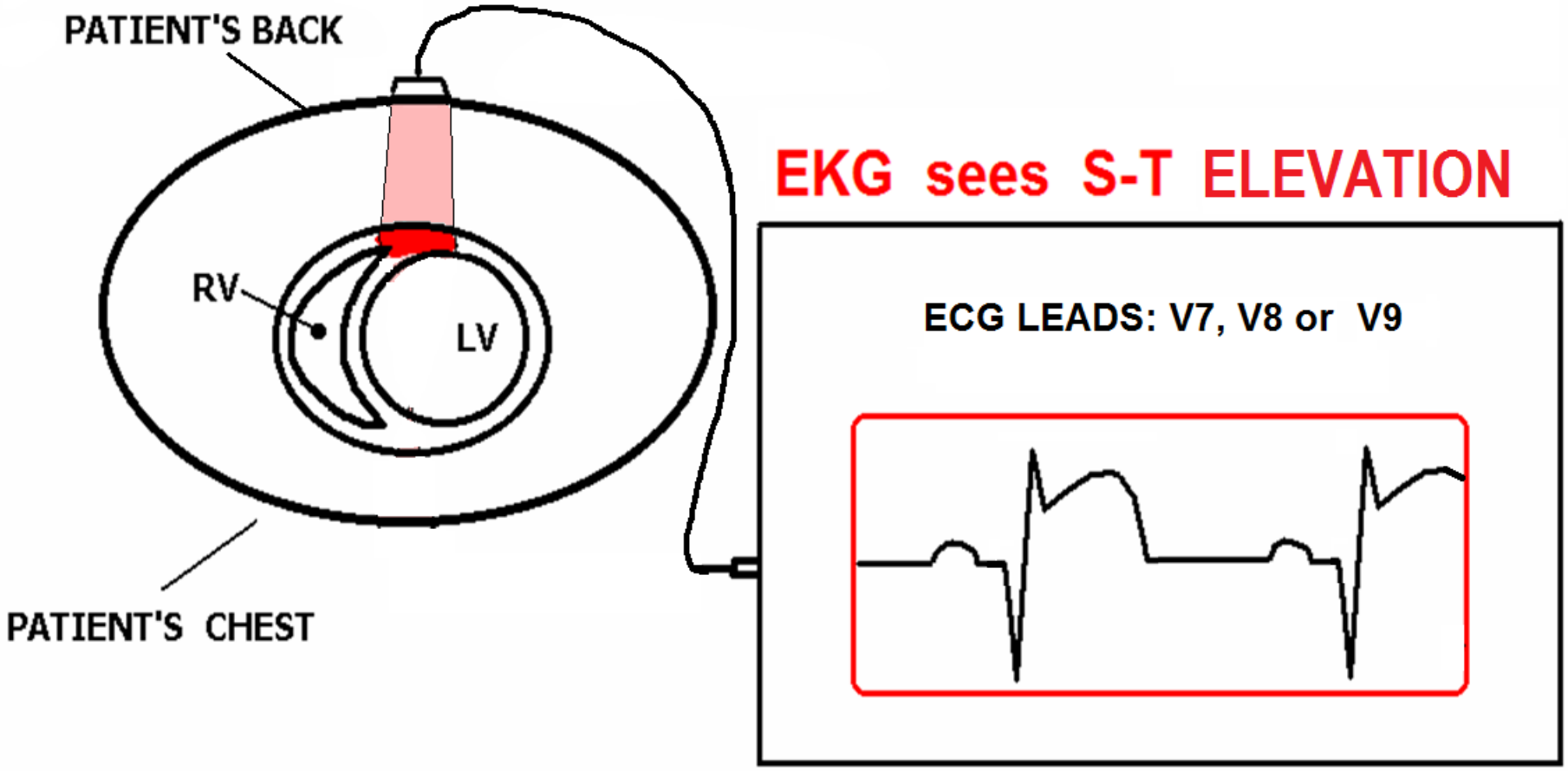
EXAMPLE:

AREA OF ACUTE INFARCTION - POSTERIOR WALL



If we put ECG leads on the BACK of a PATIENT who is having an

ACUTE POSTERIOR WALL MI . . . . .



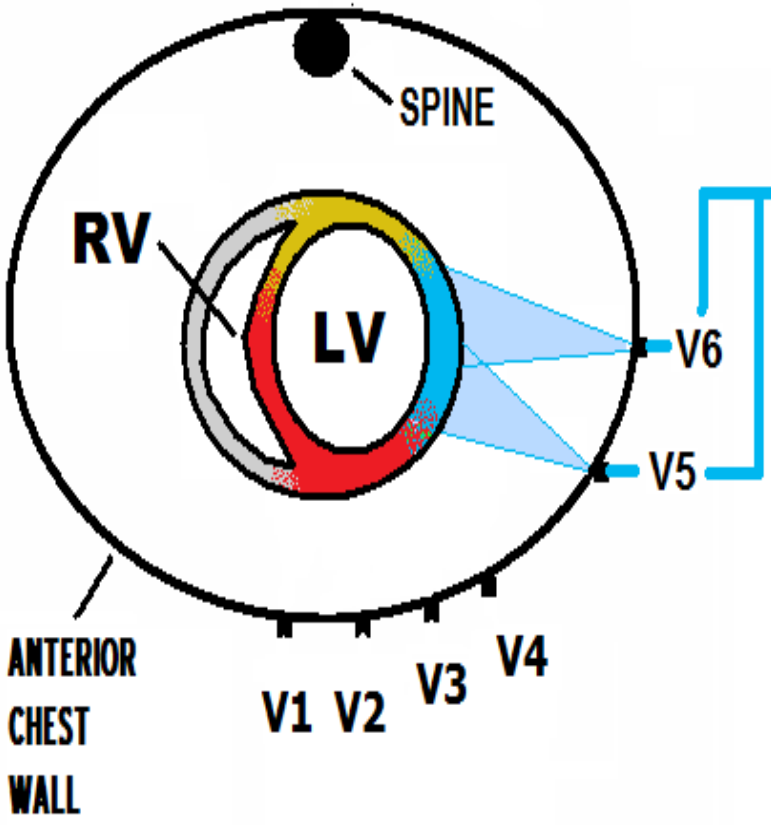
Leads V1-V4:

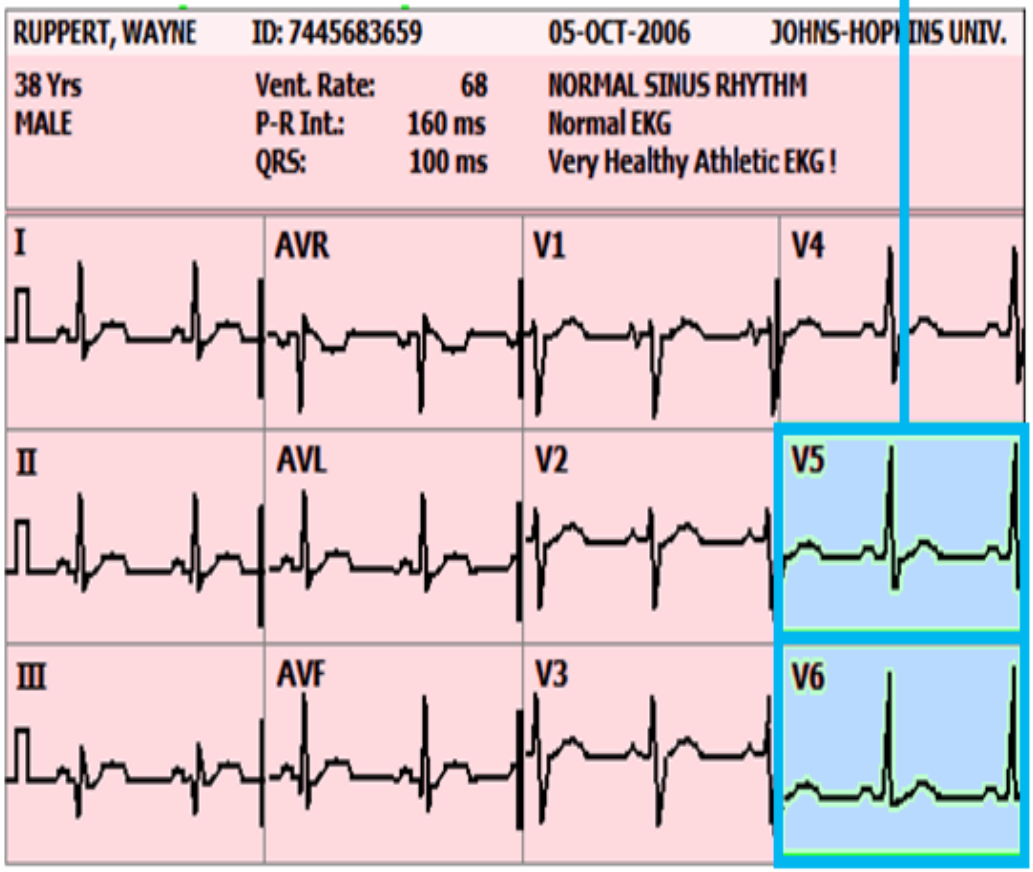
- V1 – V4 view the **ANTERIOR WALL** of the Left Ventricle.
- V1 and V2 also view the **SEPTAL WALL**
- V1 – V3 view the **POSTERIOR WALL** via Reciprocal Changes.

Leads V1-V4:

- V1 – V4 view the _____of the Left Ventricle.
- V1 and V2 also view the _____
- V1 – V3 view the _____via Reciprocal Changes.

V5 - V6 VIEW THE LATERAL WALL
of the LEFT VENTRICLE





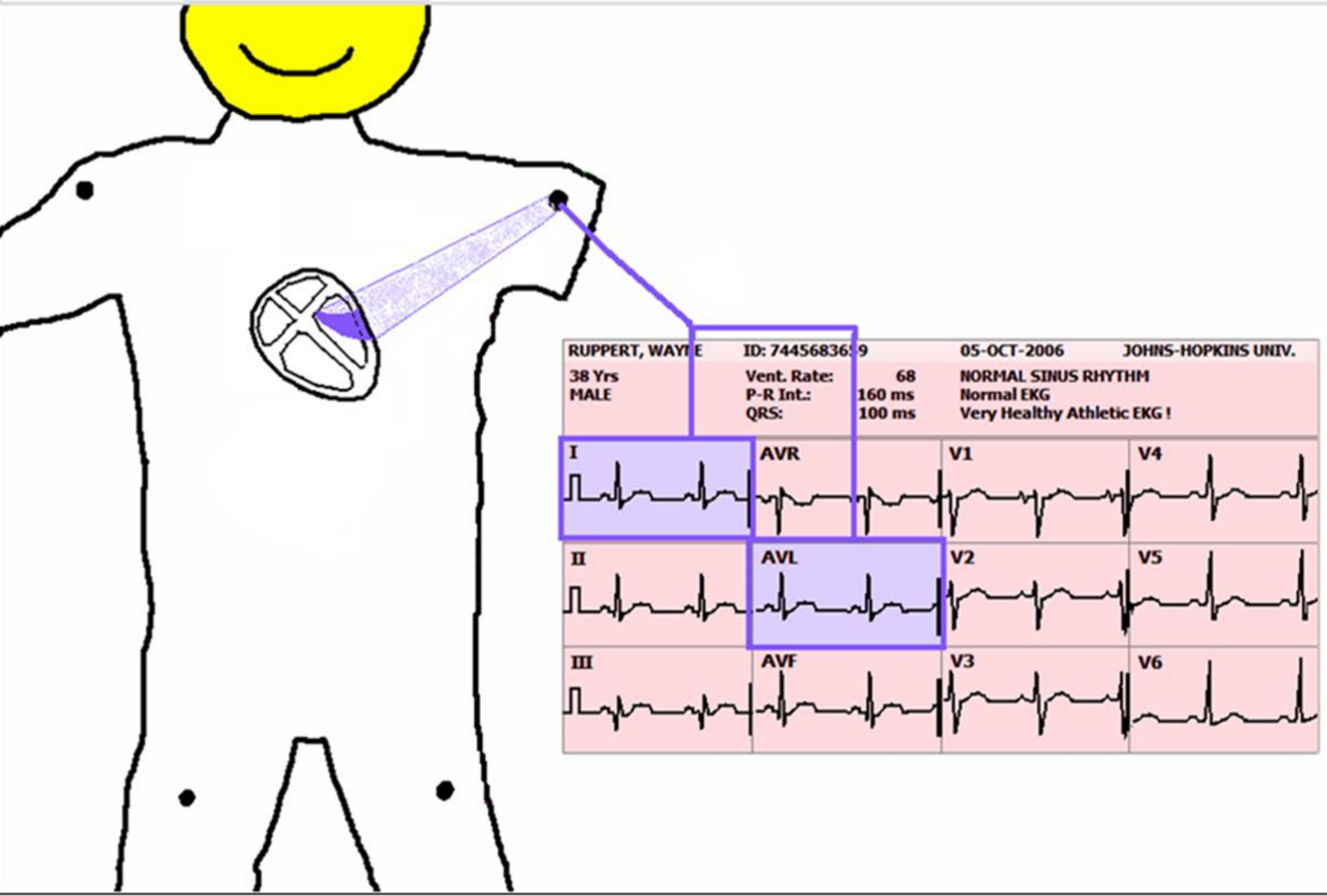
Leads V5 & V6:

- V5 & V6 view the **LATERAL WALL** of the Left Ventricle.

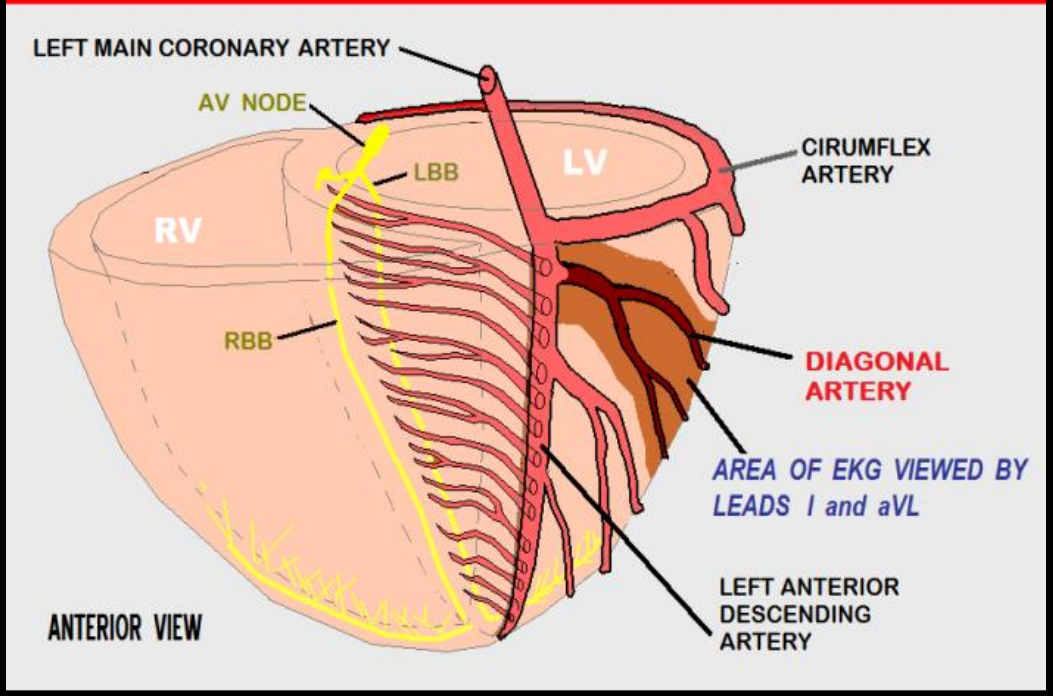
Leads V5 & V6:

- V5 & V6 view the _____of the Left Ventricle.

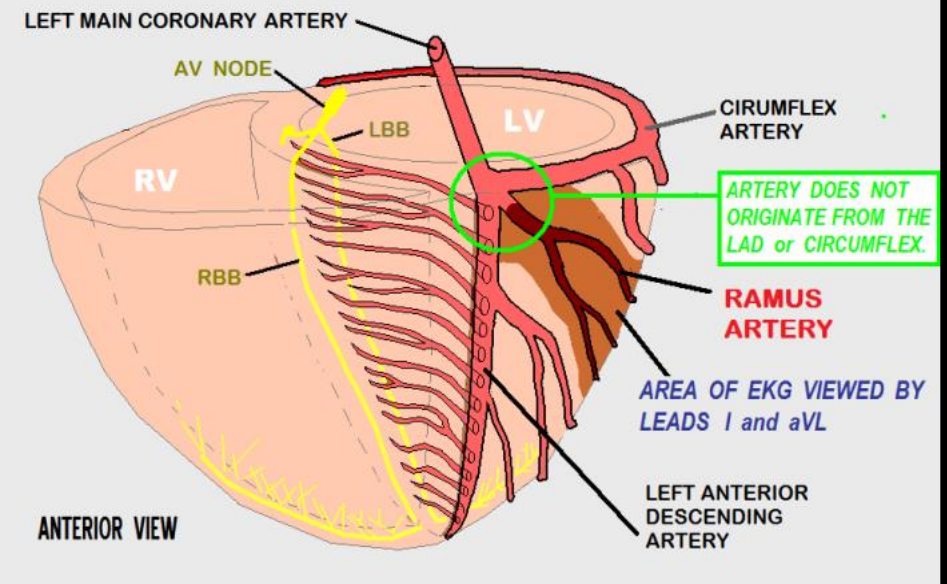
Leads I & AVL View: Proximal Lateral / Anterior Wall



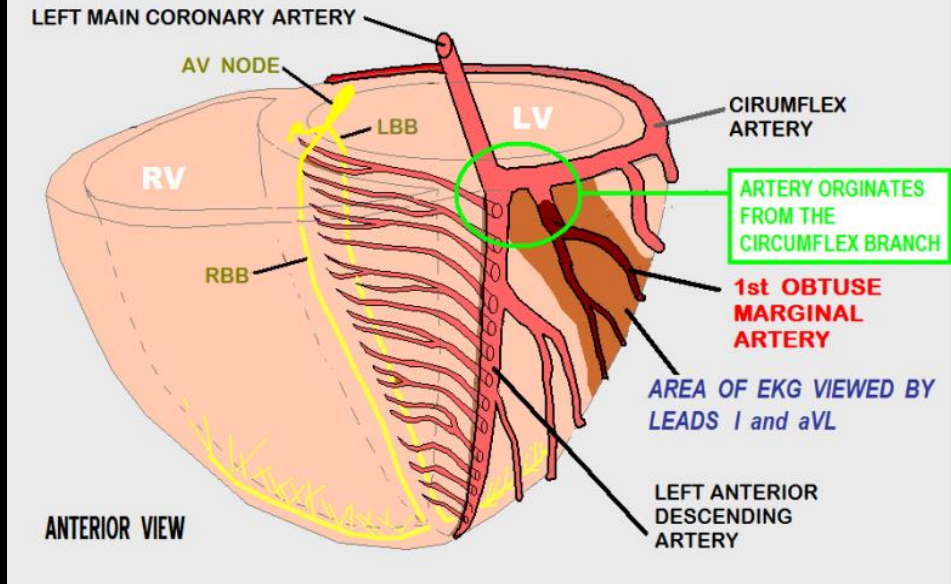
OCCLUSION of DIAGONAL ARTERY



OCCLUSION of RAMUS ARTERY



OCCLUSION of OBTUSE MARGINAL ARTERY



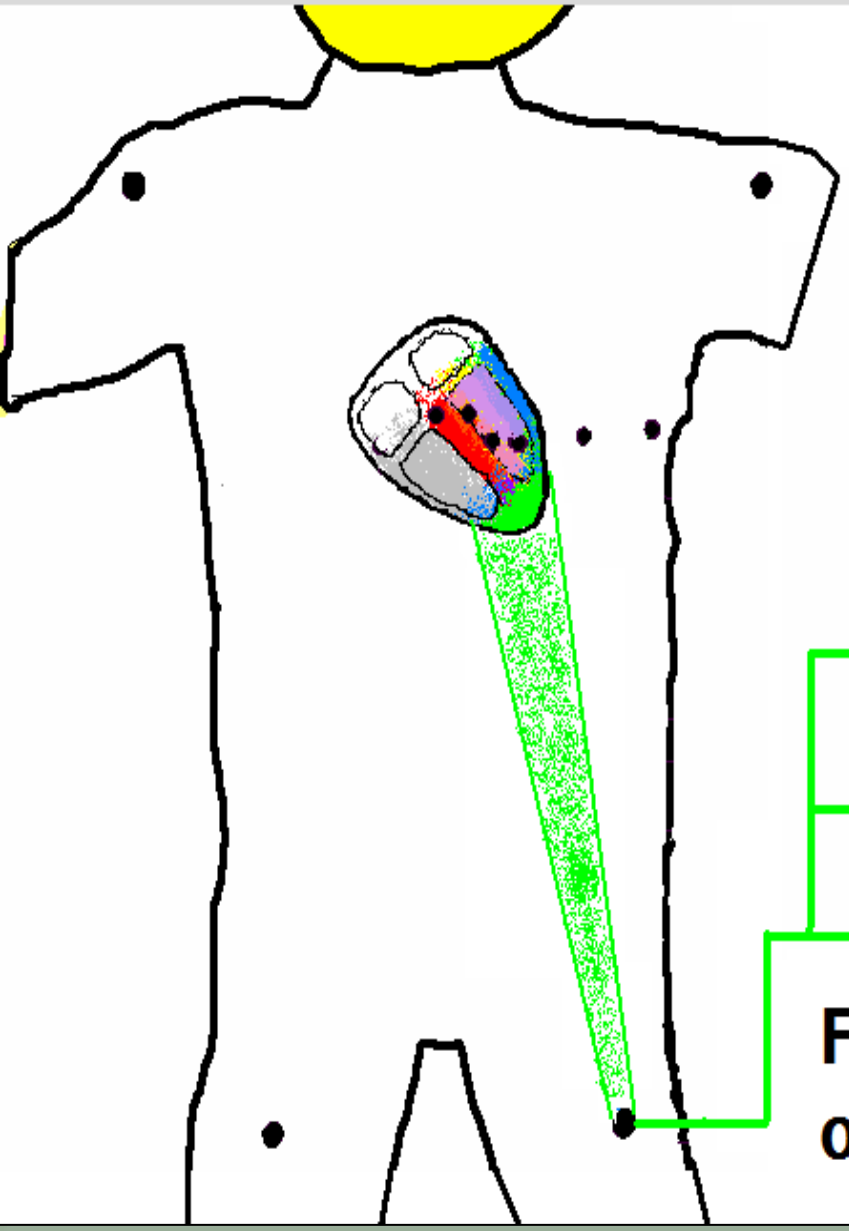
Leads I and AVL:

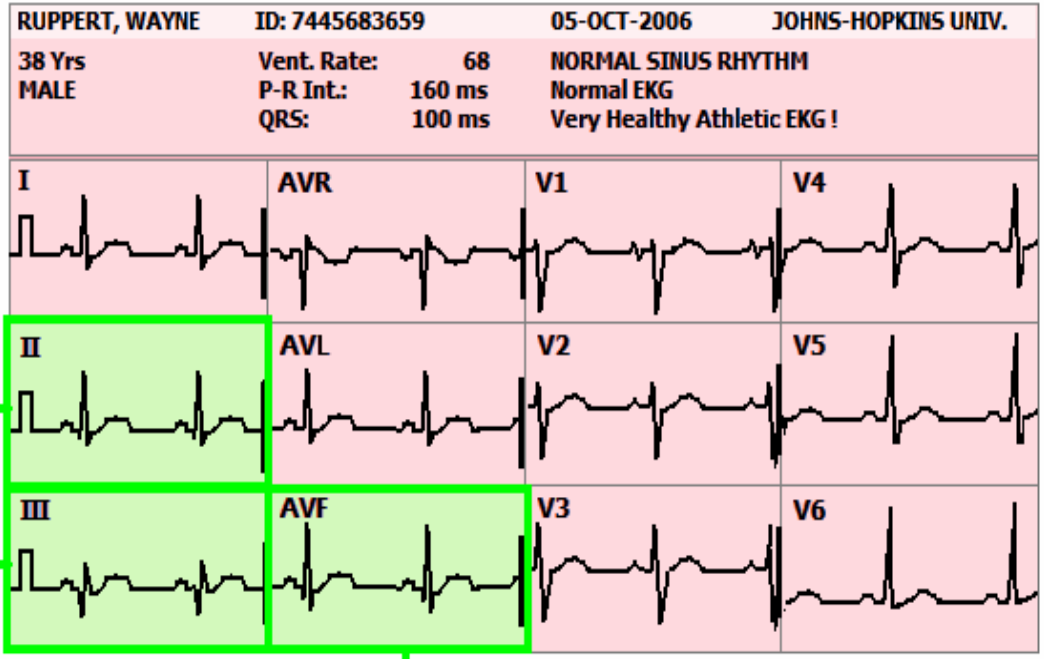
- Leads I and AVL view the **PROXIMAL aspect** of the **LATERAL** and **ANTERIOR WALLS**
- I and AVL can be associated with EITHER the **LATERAL WALL**, the **ANTERIOR WALL**, or BOTH the **LATERAL and ANTERIOR WALLS.**

Leads I and AVL:

- Leads I and AVL view the **PROXIMAL aspect** of the _____ and _____ **WALLS**
- I and AVL can be associated with EITHER the _____, the _____, or BOTH the _____ **and** _____.

LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE





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

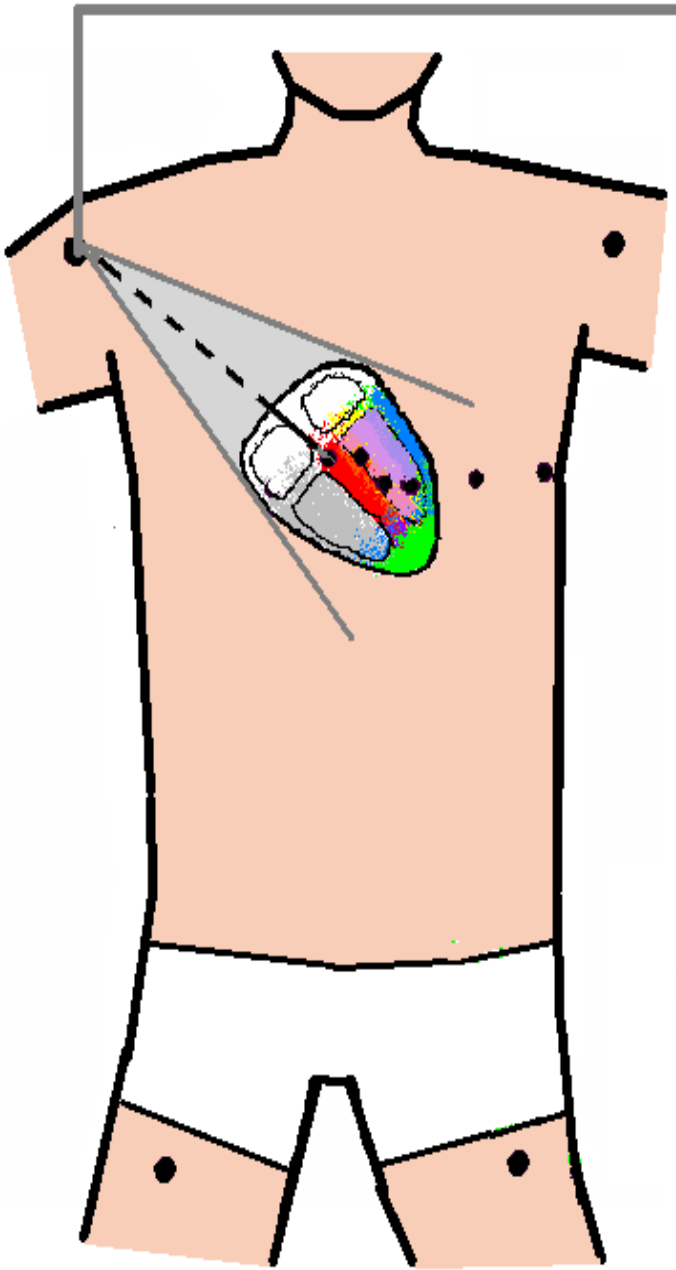
Leads II, III, and AVF:

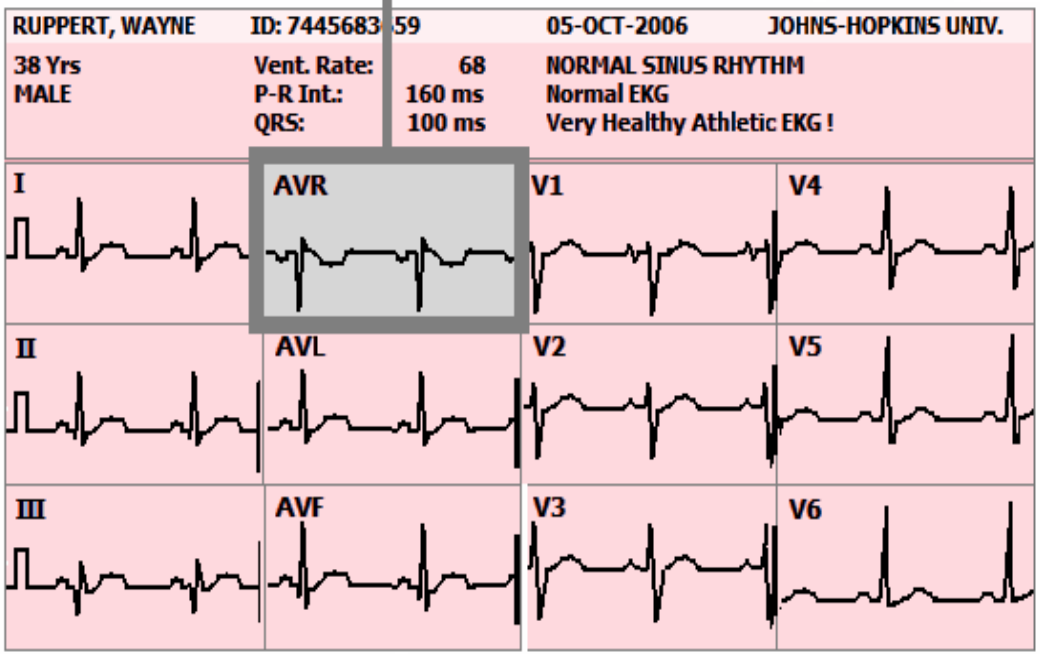
- Leads, II, III, and AVF view the **INFERIOR WALL** of the Left Ventricle.

Leads II, III, and AVF:

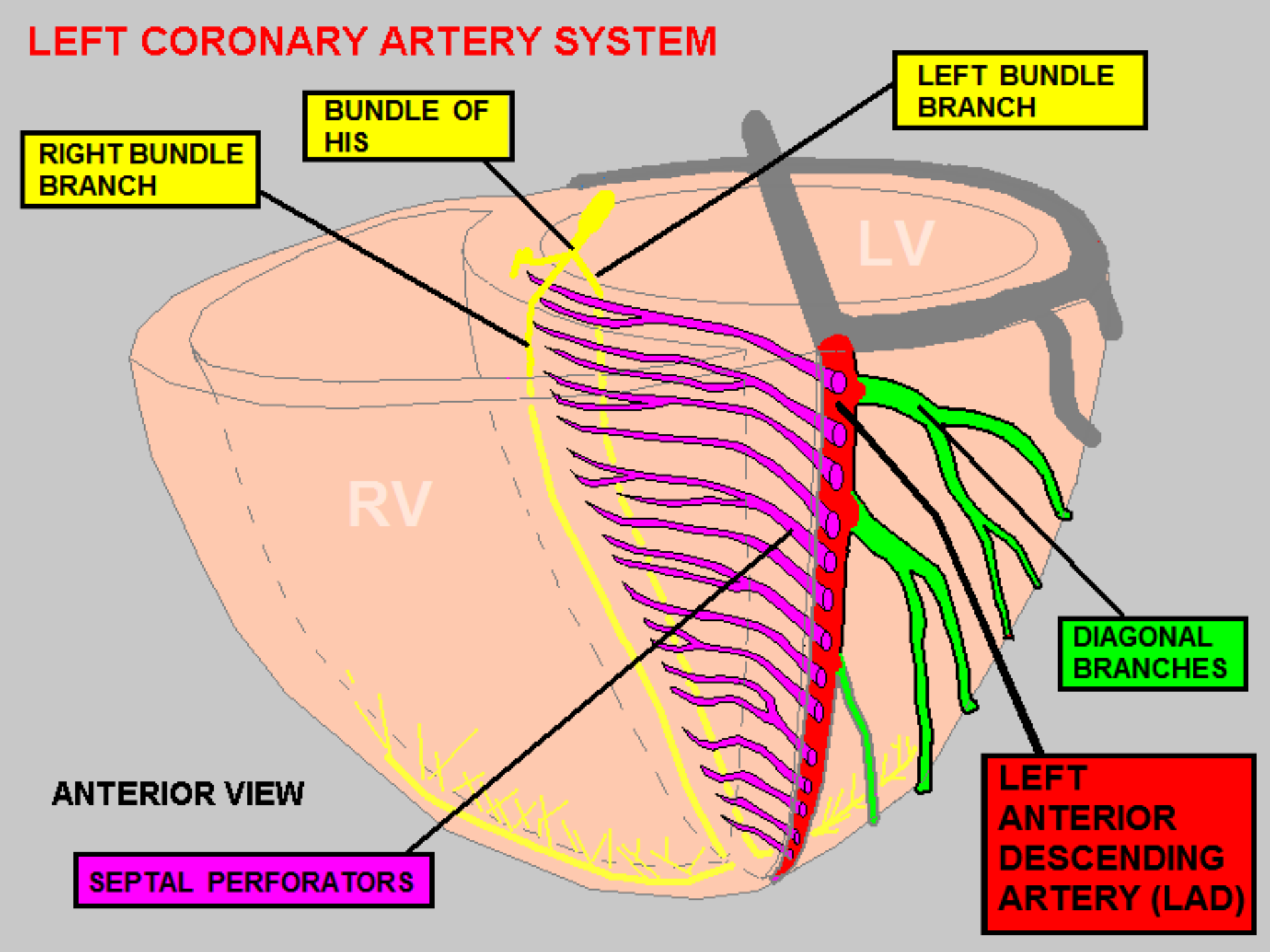
- Leads, II, III, and AVF view the _____ of the Left Ventricle.

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





LEFT CORONARY ARTERY SYSTEM



Lead AVR:

- Lead AVR views the **BASILAR SEPTUM.**
- The **BASILAR SEPTUM** is the area where the **BUNDLE of HIS** is typically located.

Lead AVR:

- Lead AVR views the _____.
- The _____is the area where the _____ is typically located.

Lead AVR:

- **ST Elevation in Lead AVR during Acute STEMI is associated with LEFT MAIN CORONARY ARTERY obstruction, which has a 75% mortality Rate.**
- **ST Elevation of Lead AVR when STEMI is NOT present is often associated with CRITICAL TRIPLE VESSEL disease, and/or CRITICAL OCCLUSION of the LEFT MAIN CORONARY ARTERY: both require Coronary Artery Bypass Graft (CABG) Surgery!!**

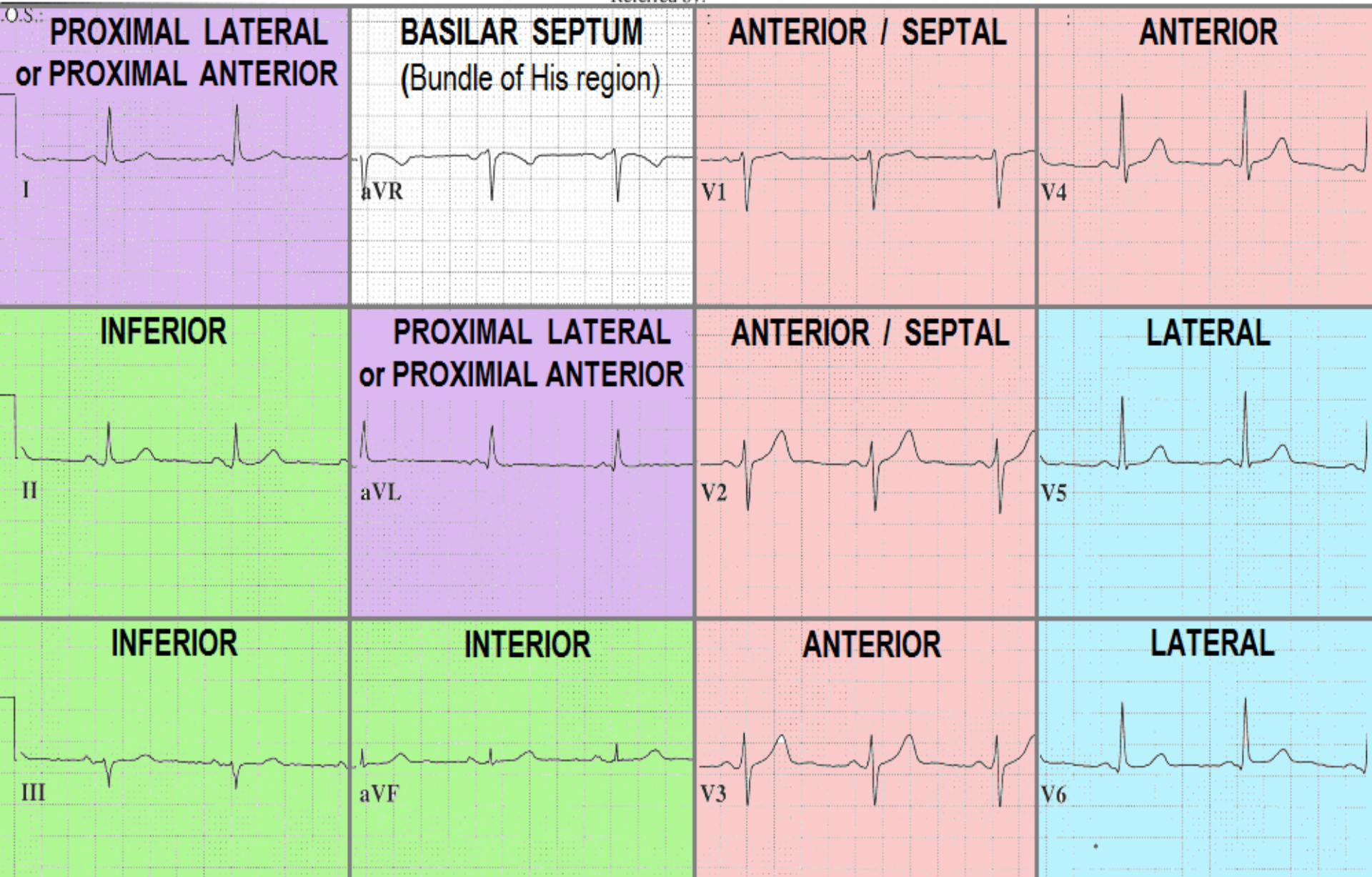
Lead AVR:

- ST Elevation in Lead AVR during Acute STEMI is associated with _____ _____ obstruction, which has a __% mortality Rate.
- ST Elevation of Lead AVR when STEMI is NOT present is often associated with _____ _____ disease, and/or CRITICAL OCCLUSION of the _____ _____: both require Coronary Artery Bypass Graft (CABG) Surgery!!

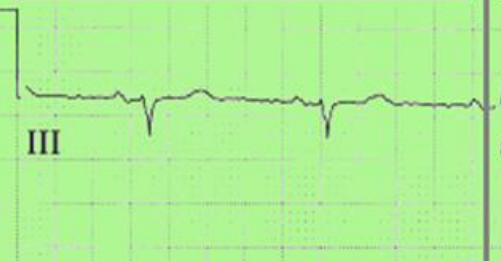
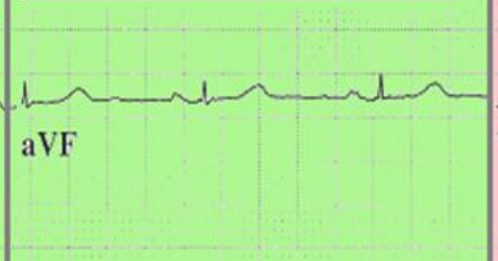
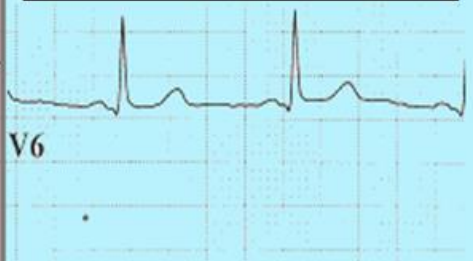
Vent. rate	64	BPM
PR interval	130	ms
QRS duration	96	ms
QT/QTc	396/408	ms
P–R–T axes	40 11	61

Normal sinus rhythm
Normal ECG
No previous ECGs available

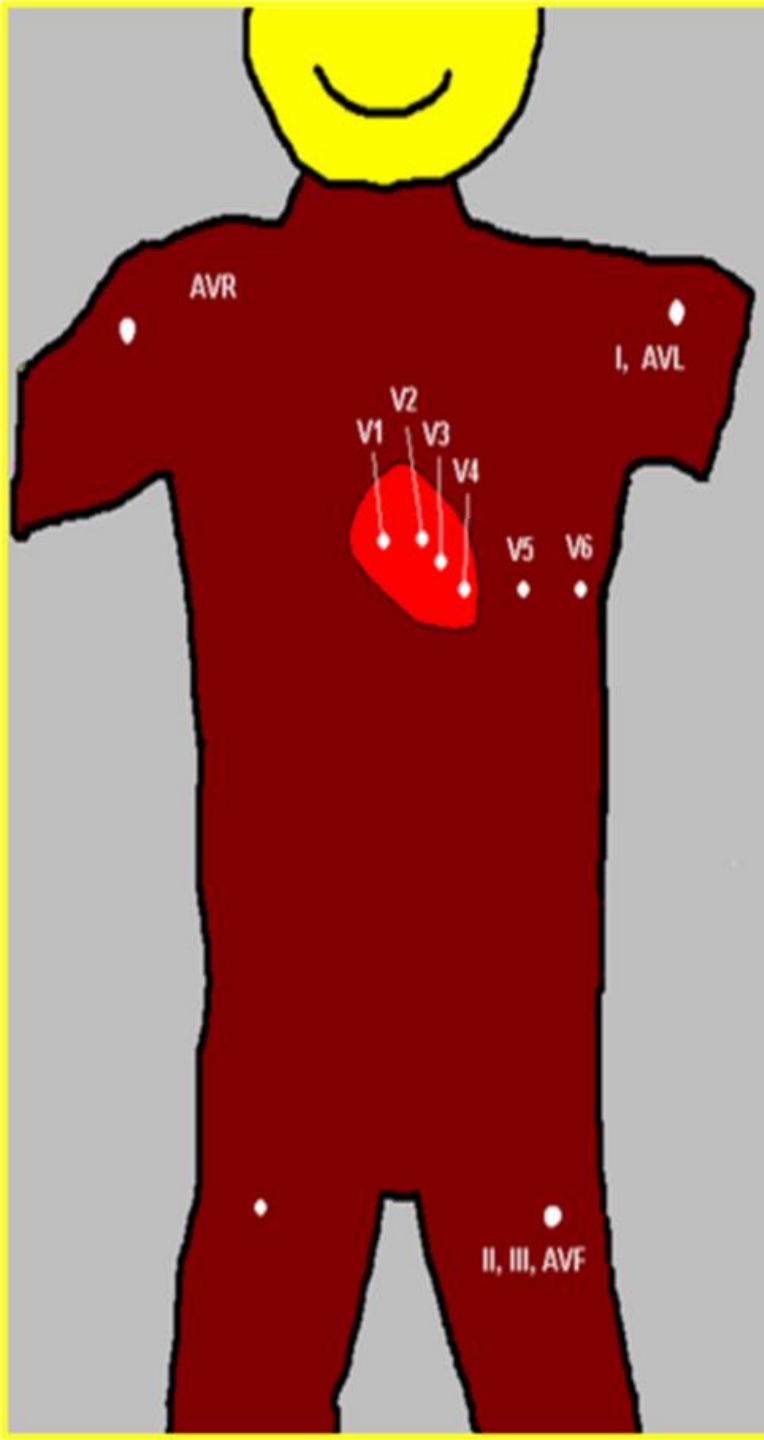
Referred by:



What REGION of the HEART does EACH LEAD VIEW ? ?

Lead I views: _____ 	Lead AVR views: _____ 	Lead V1 views: _____ 	Lead V4 views: _____ 
Lead II views: _____ 	Lead AVL views: _____ 	Lead V2 views: _____ 	Lead V5 views: _____ 
Lead III view: _____ 	Lead AVF views: _____ 	Lead V3 views: _____ 	Lead V6 views: _____ 

AREAS VIEWED by 12 LEAD ECG



AVR	*BASILAR SEPTAL*
AVL, I	*PROXIMAL* LATERAL-ANTERIOR
V1, V2	ANTERIOR
	SEPTAL
	POSTERIOR (recip.)
V3, V4	ANTERIOR
V5, V6	LATERAL
II, III, AVF	INFERIOR

AREAS VIEWED by 12 LEAD ECG

AVR

AVL, I

V1, V2

V3, V4

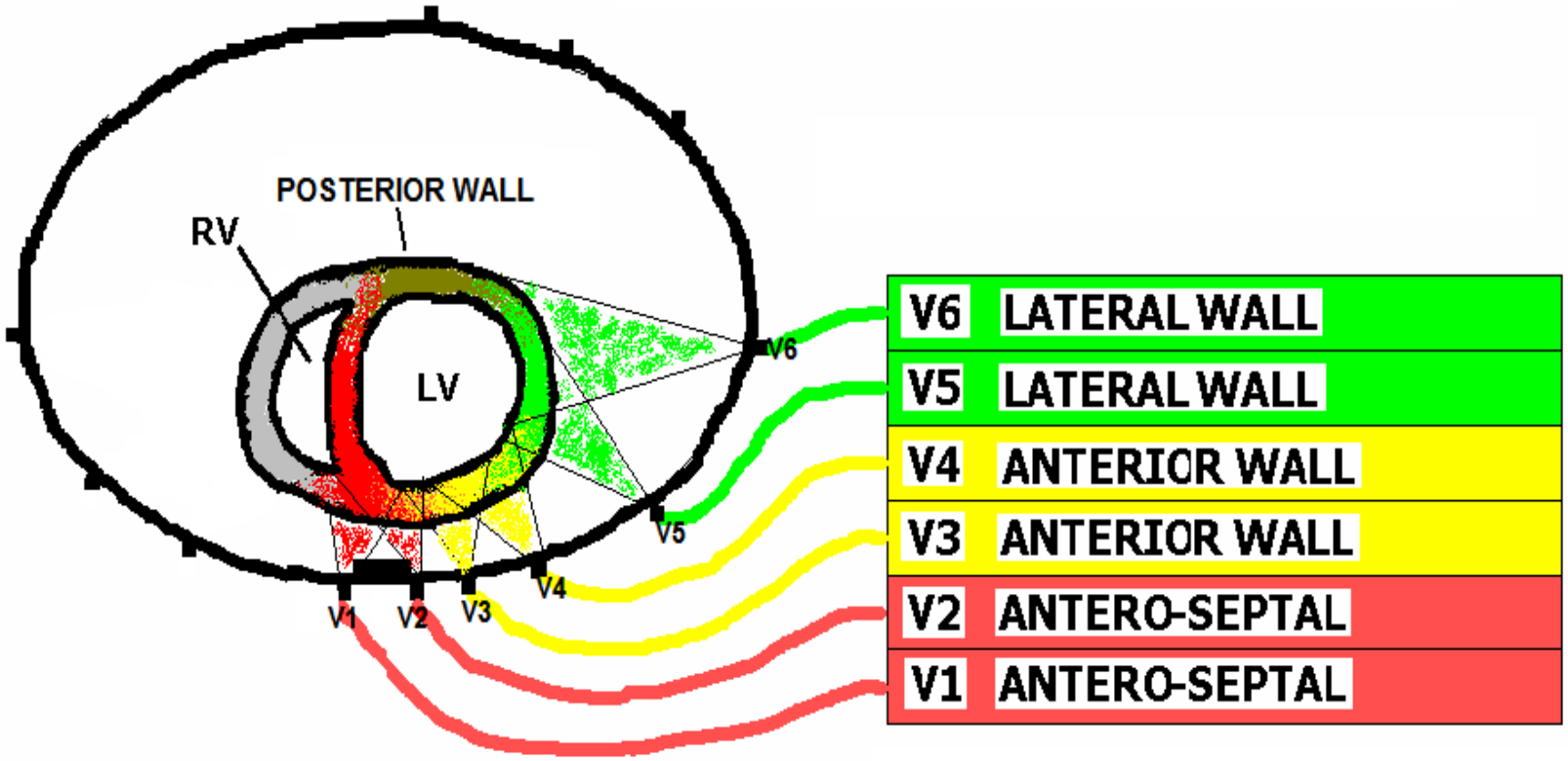
V5, V6

II, III, AVF

THE 12 LEAD ECG HAS TWO MAJOR BLIND SPOTS . .

CHEST LEADS V1 - V6

WHAT EACH LEAD "SEES" . . .



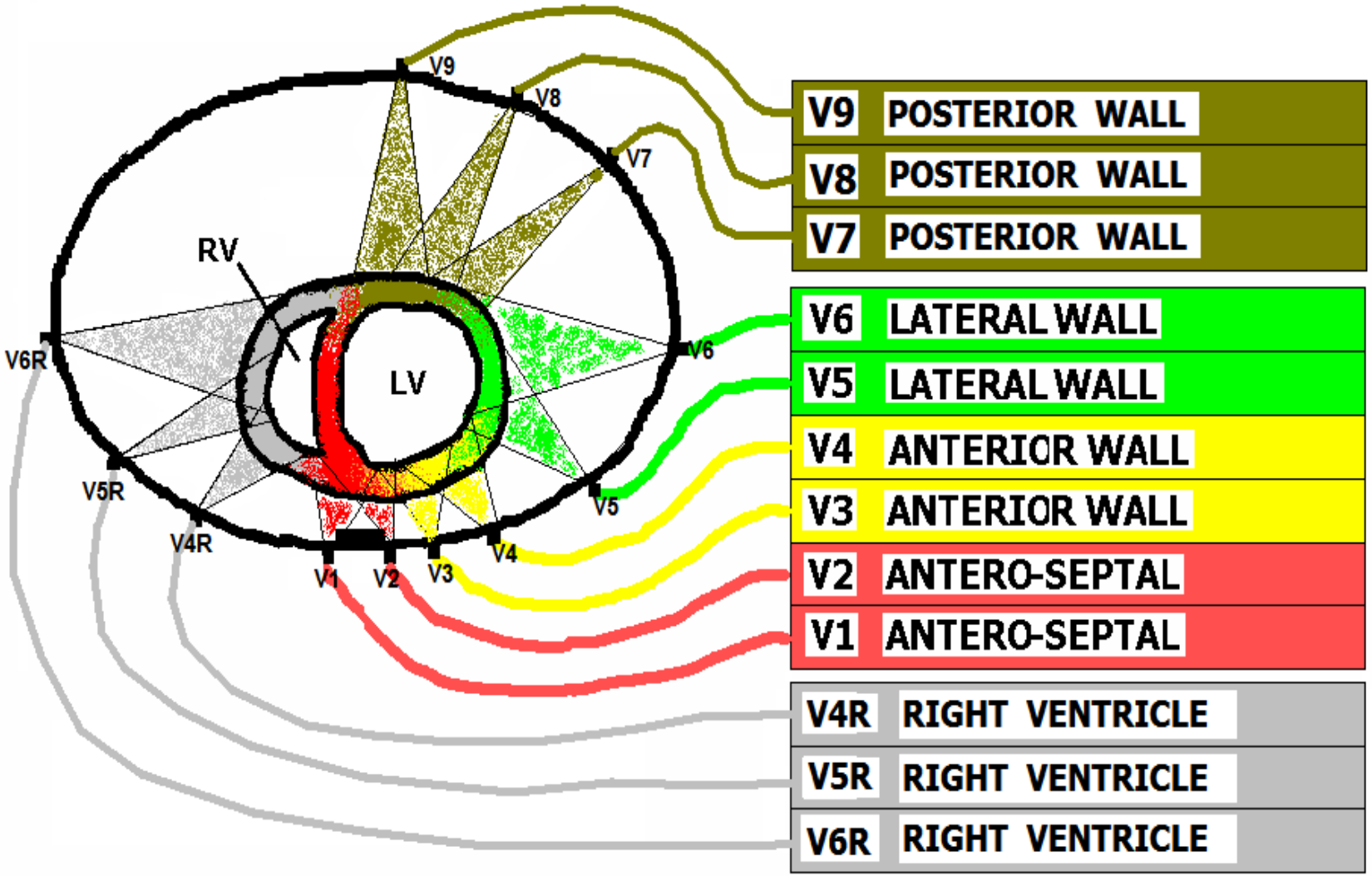
The TWO major BLIND SPOTS of the 12 Lead ECG are the POSTERIOR WALL and the RIGHT VENTRICLE.

The TWO major BLIND SPOTS of the 12 Lead ECG are the _____and the _____.

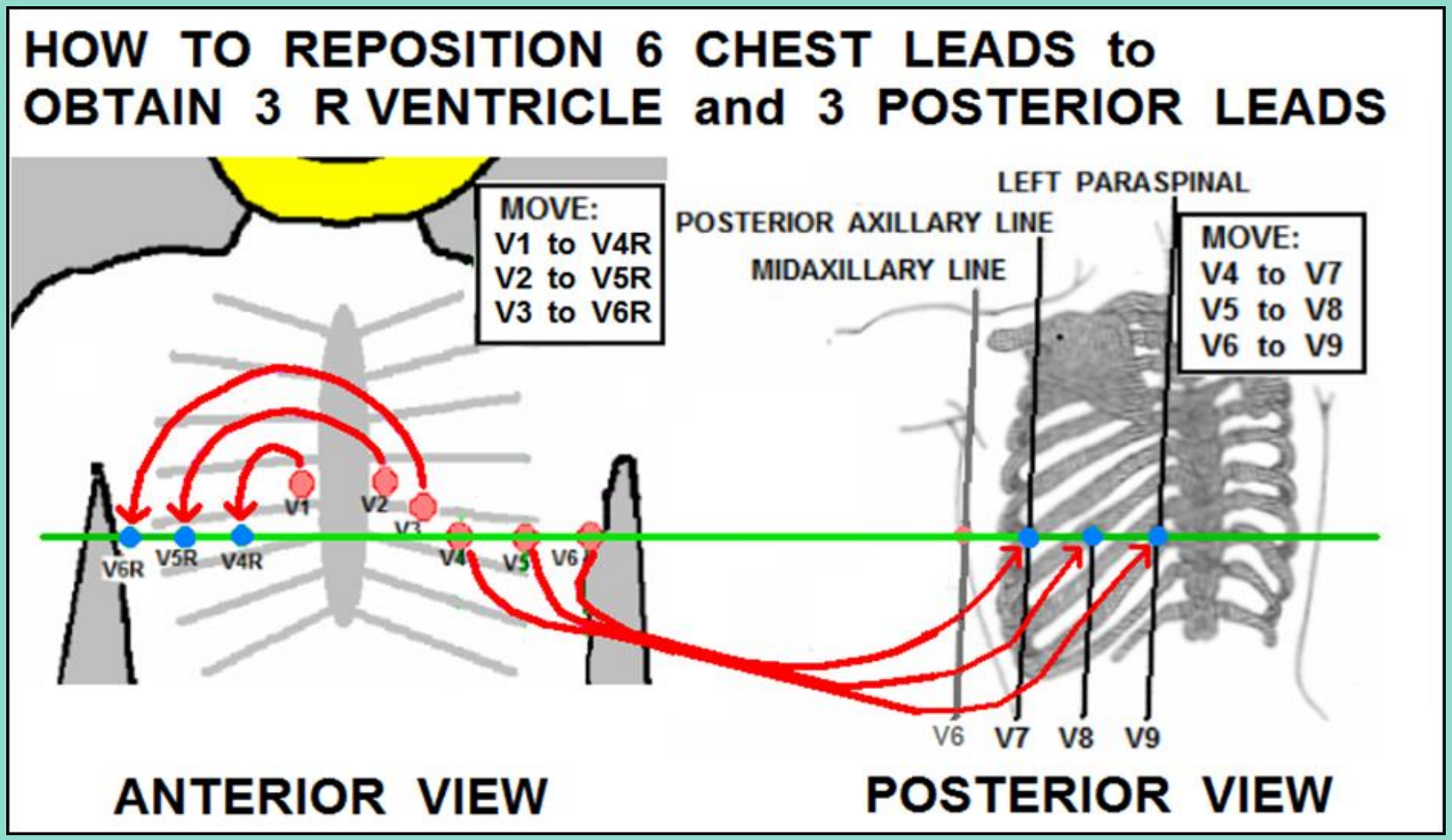
THE 18 LEAD ECG COVERS THE ENTIRE HEART . .

CHEST LEADS V1 - V6 *PLUS* V4R, V5R, V6R, and V7, V8, V9

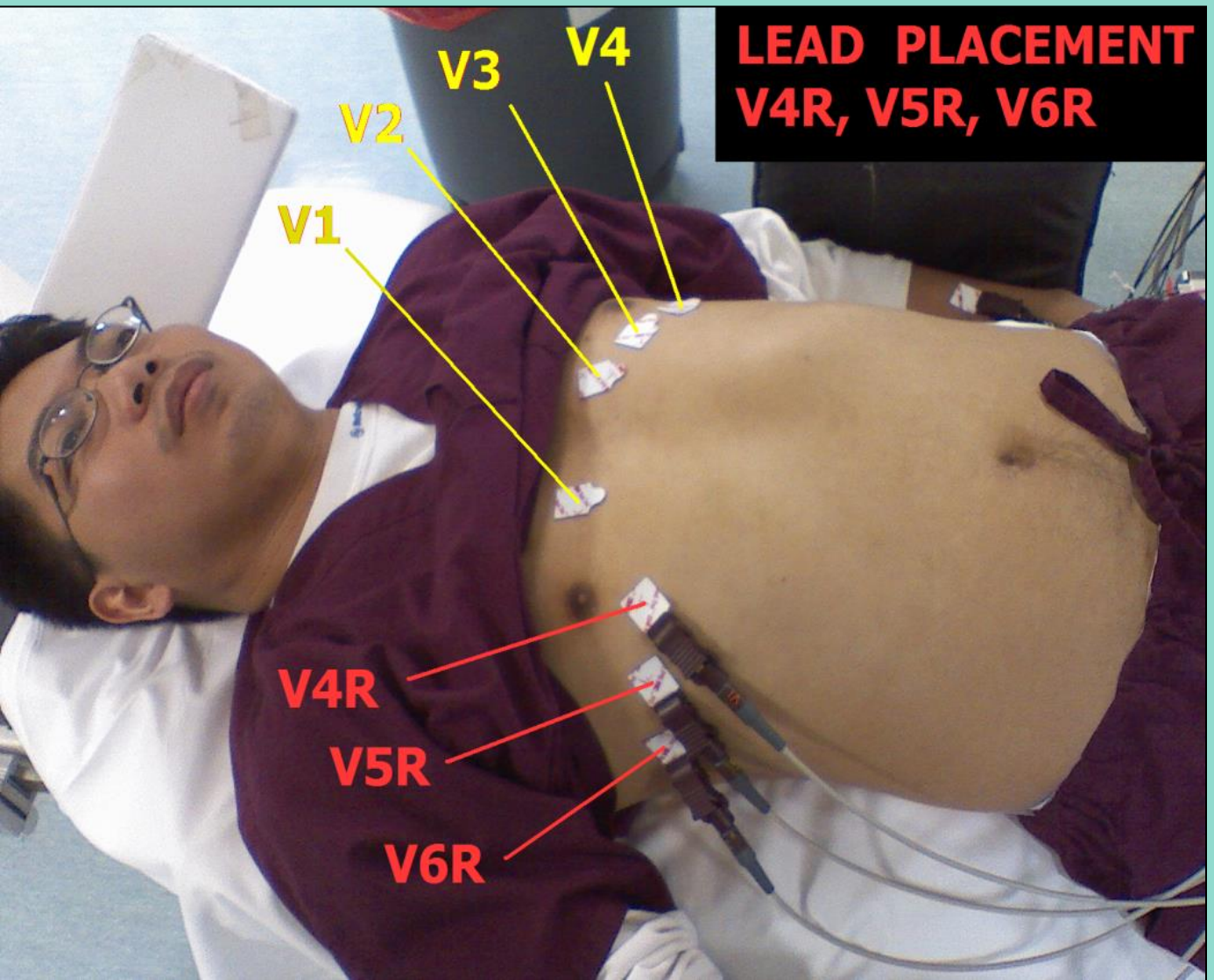
WHAT EACH LEAD "SEES" . . .



To do 18 Lead ECG with 12 Lead machine – after you obtain 12 Lead, reposition CHEST LEADS to this configuration, then print !



LEAD PLACEMENT for obtaining RIGHT VENTRICULAR ECG:



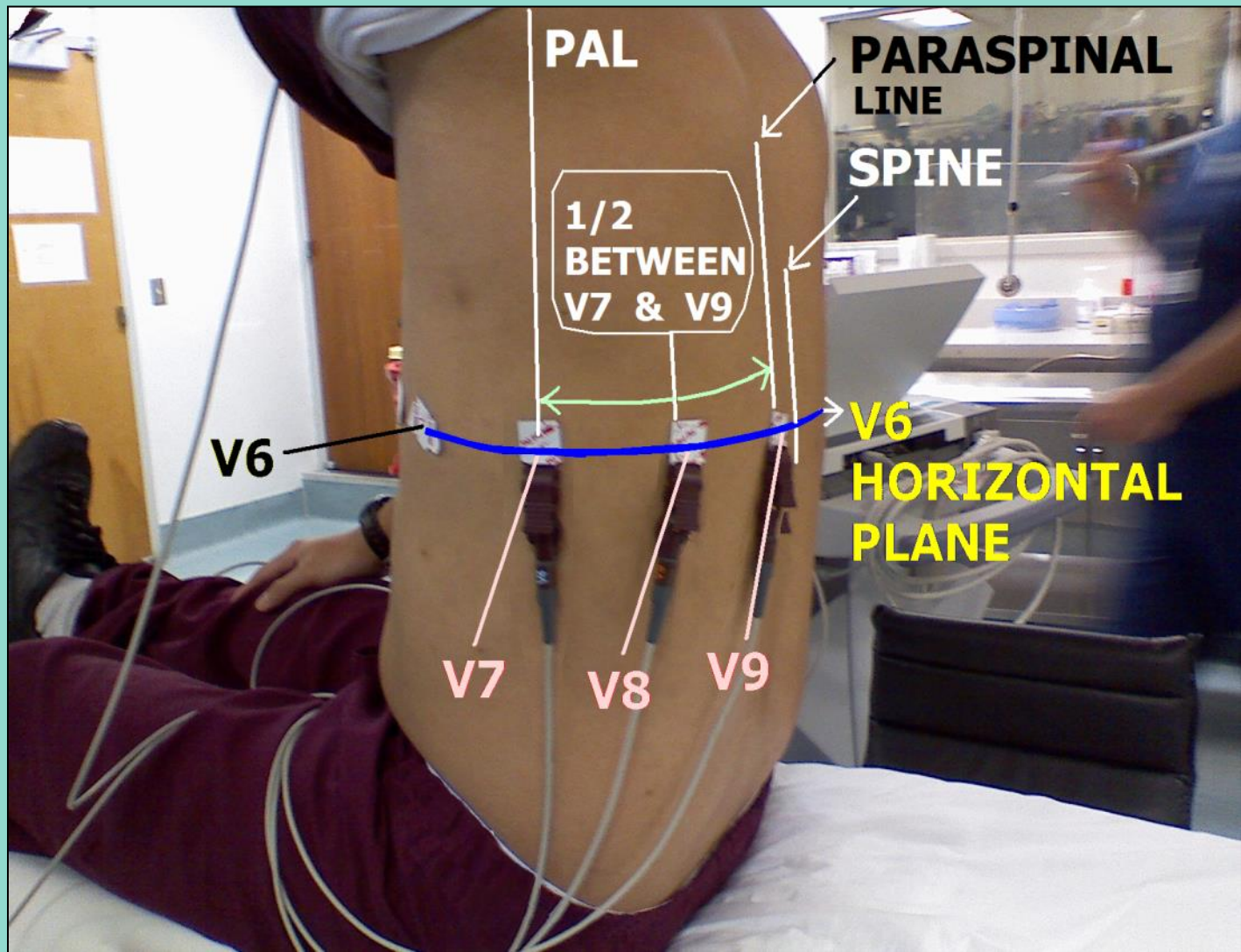
V4R – V6R

The INDICATION for obtaining a RIGHT VENTRICULAR ECG is INFERIOR WALL STEMI.

The INDICATION for obtaining a RIGHT VENTRICULAR ECG is _____.

LEAD PLACEMENT for obtaining a POSTERIOR ECG.

Leads
V7 – V9



The INDICATION for obtaining a POSTERIOR LEAD ECG is ST Depression in Leads V1-V4.

The INDICATION for obtaining a POSTERIOR LEAD ECG is

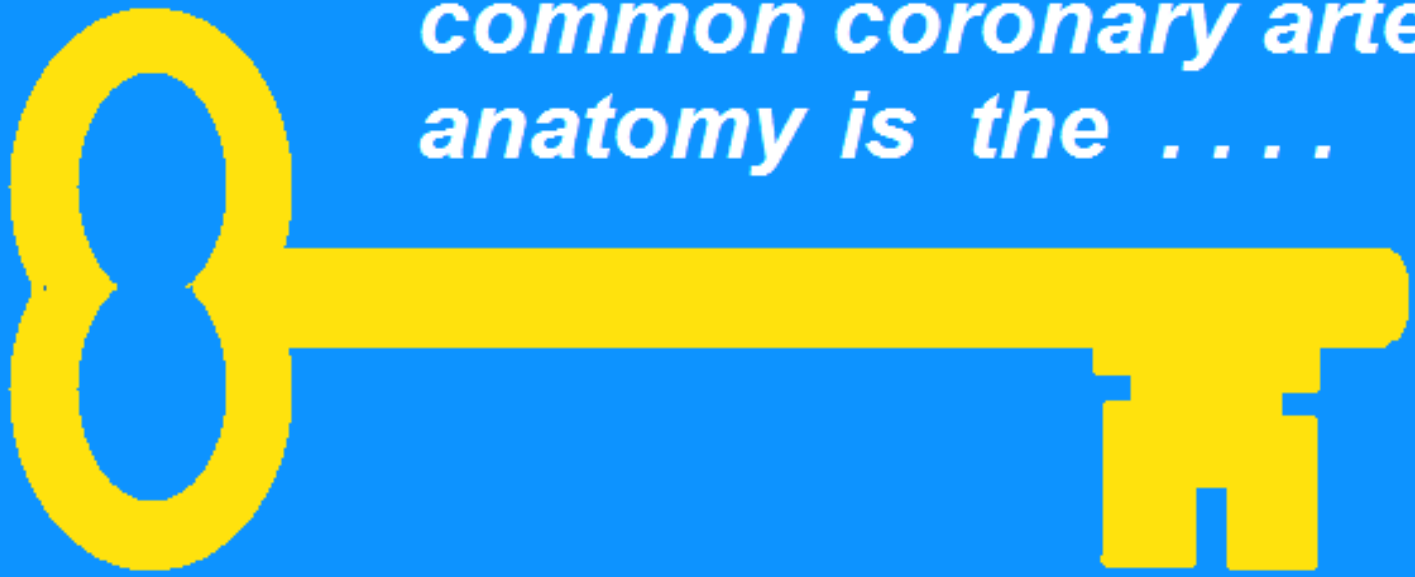
_____.

Coronary Artery Anatomy

THE CORONARY

ARTERIES

"Having knowledge of common coronary artery anatomy is the . . . .



to understanding the PHYSIOLOGICAL CHANGES that occur during ACUTE MI."

"INVALUABLE ASSET for ALL MEDICAL PROFESSIONALS who provide direct care to STEMI patients !"

The 12 Lead ECG becomes your "crystal ball !!"

INTERPRET THE EKG, THEN:

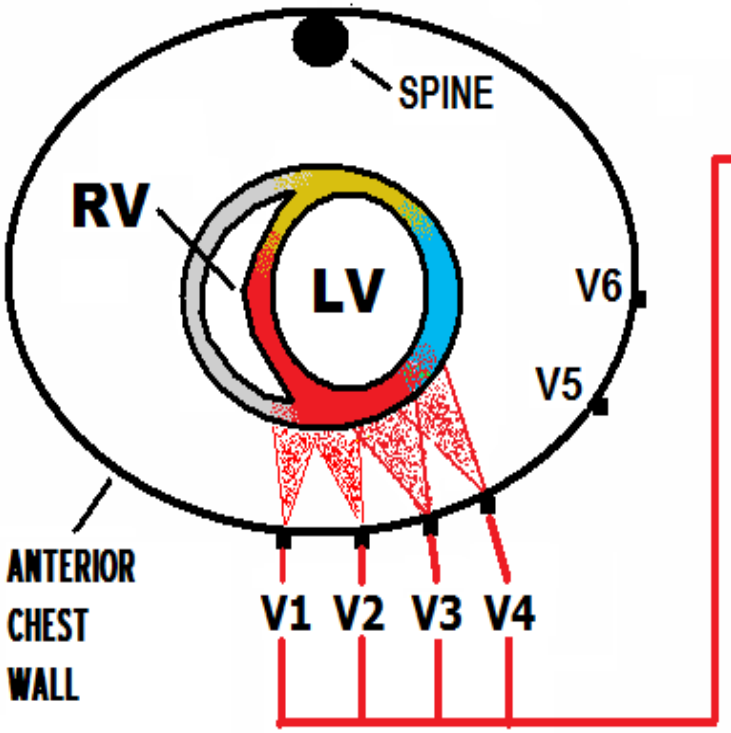
- IDENTIFY THE AREA OF THE HEART WITH A PROBLEM . . .
- RECALL THE ARTERY WHICH SERVES THAT REGION . . .
- RECALL OTHER STRUCTURES SERVED BY THAT ARTERY . . .
- ANTICIPATE FAILURE OF THOSE STRUCTURES . . .
- ***INTERVENE APPROPRIATELY !***

There are MUTLITPLE anatomic variations in Coronary Artery Anatomy.

This curriculum reviews the TWO most common, which account for approximately 90% of the population.

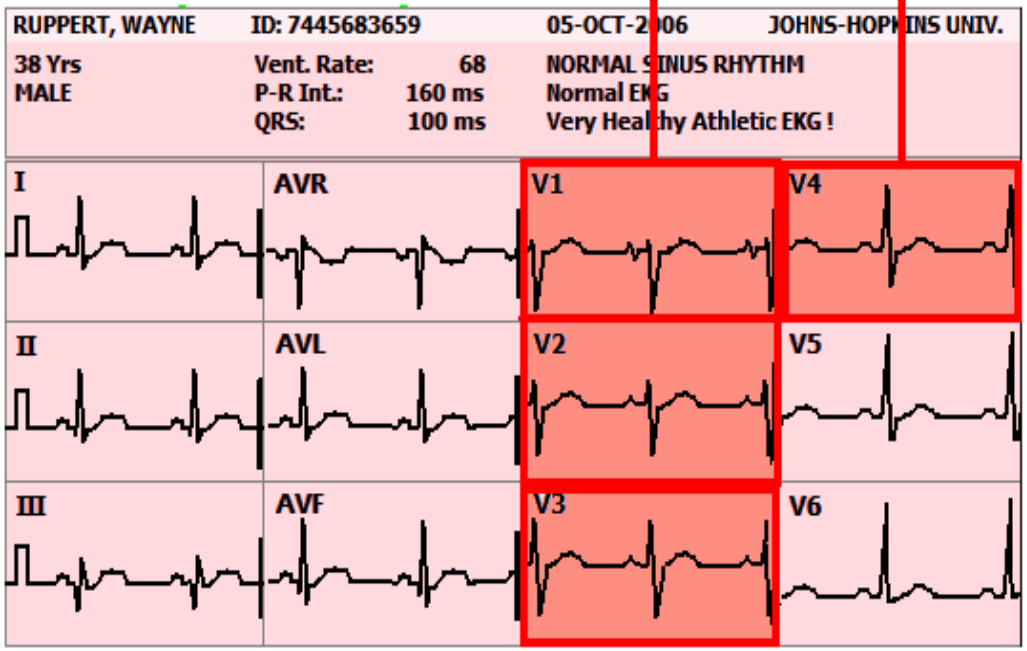
V1 - V4 VIEW THE ANTERIOR-SEPTAL WALL

of the LEFT VENTRICLE



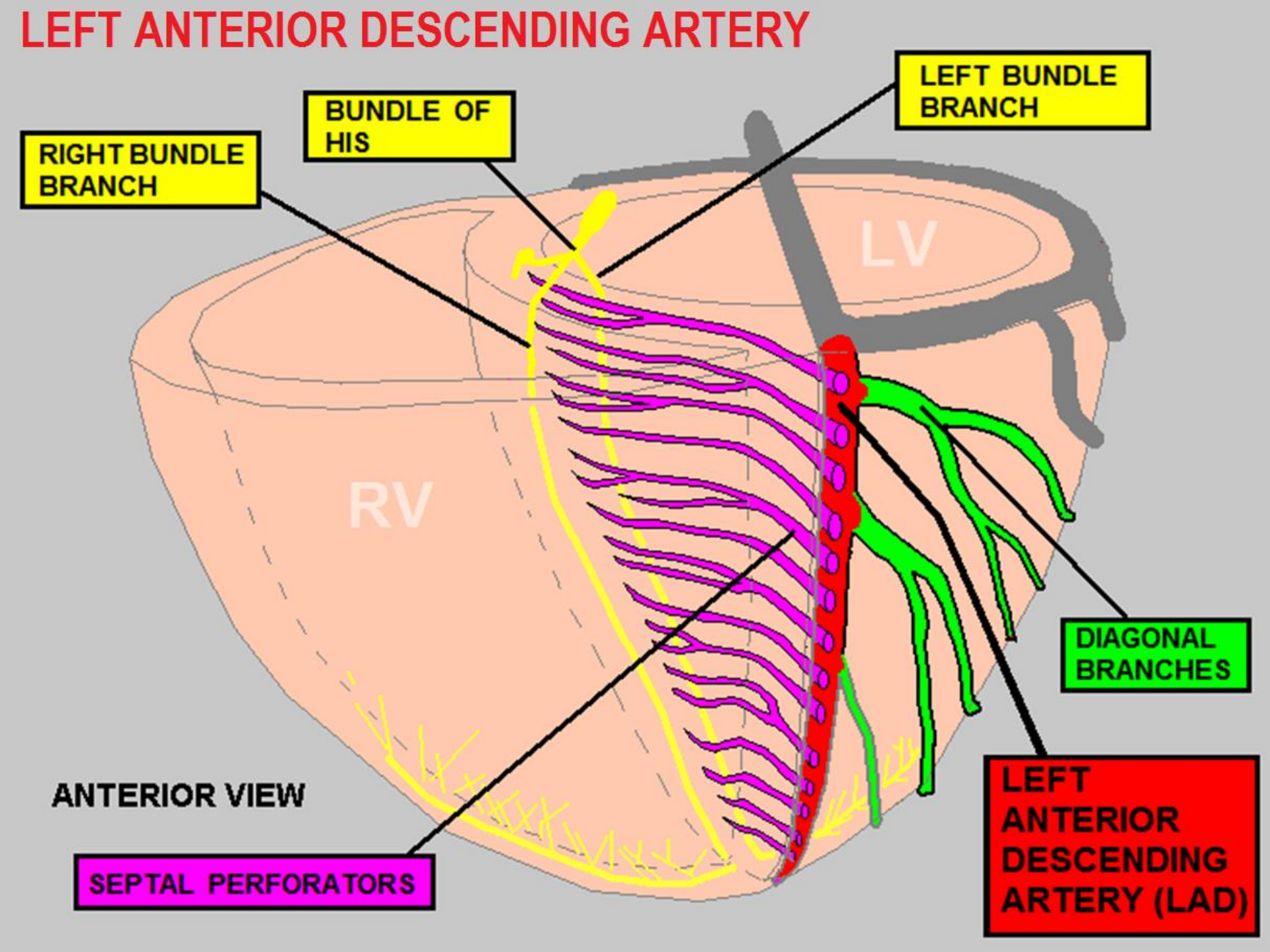
V1, V2 - ANTERIOR / SEPTAL

V3, V4 - ANTERIOR



Leads V1 – V4 are associated with the Left Anterior Descending Artery

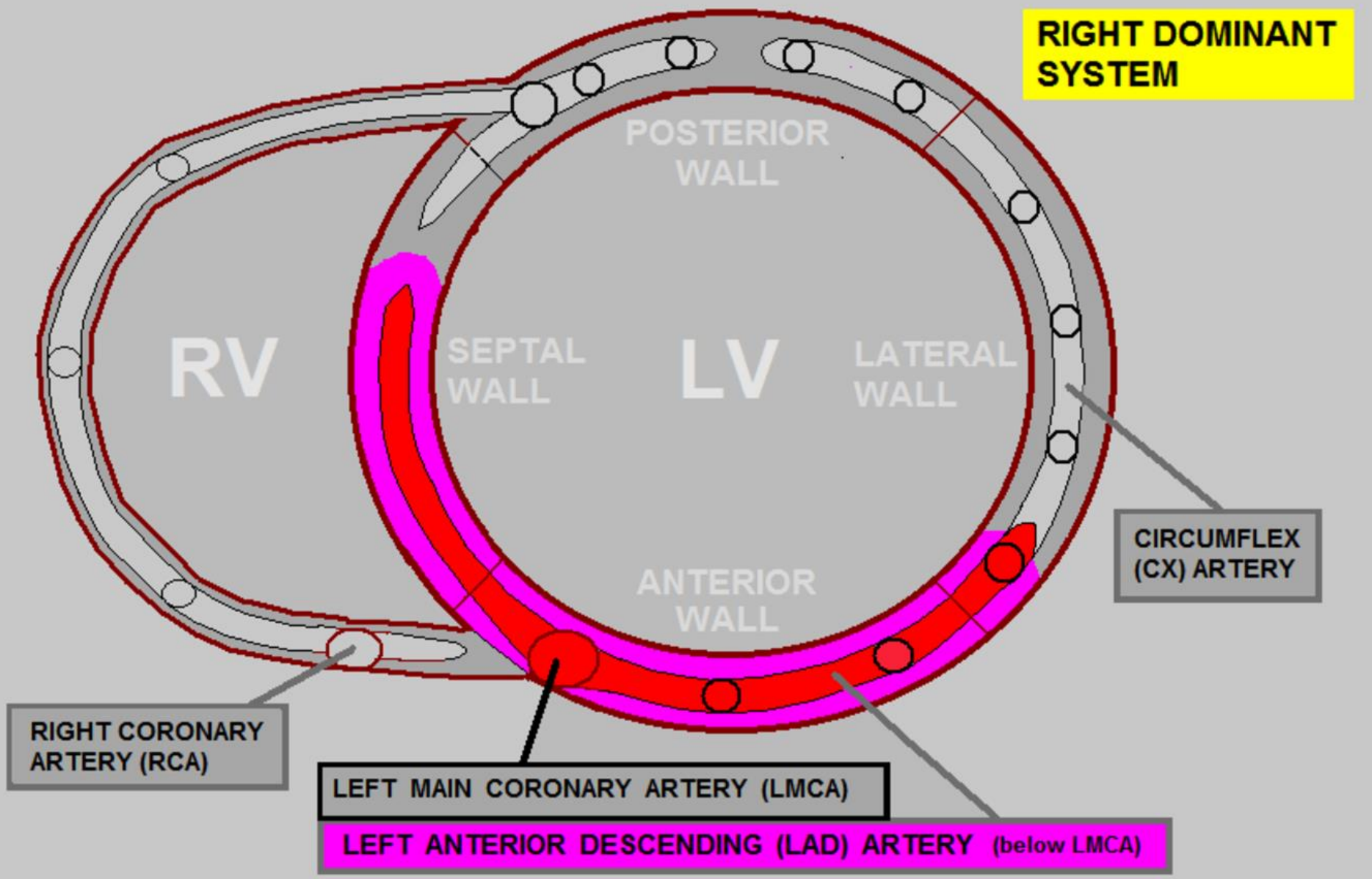
LEFT ANTERIOR DESCENDING ARTERY



cutaway view of the

LEFT ANTERIOR DESCENDING ARTERY (LAD)

SUPPLIES APPROX. 45% of the LV MUSCLE MASS



Left Anterior Descending Artery

The LAD supplies blood to the ANTERIOR and SEPTAL walls, and includes the following CRITICAL STRUCTURES:

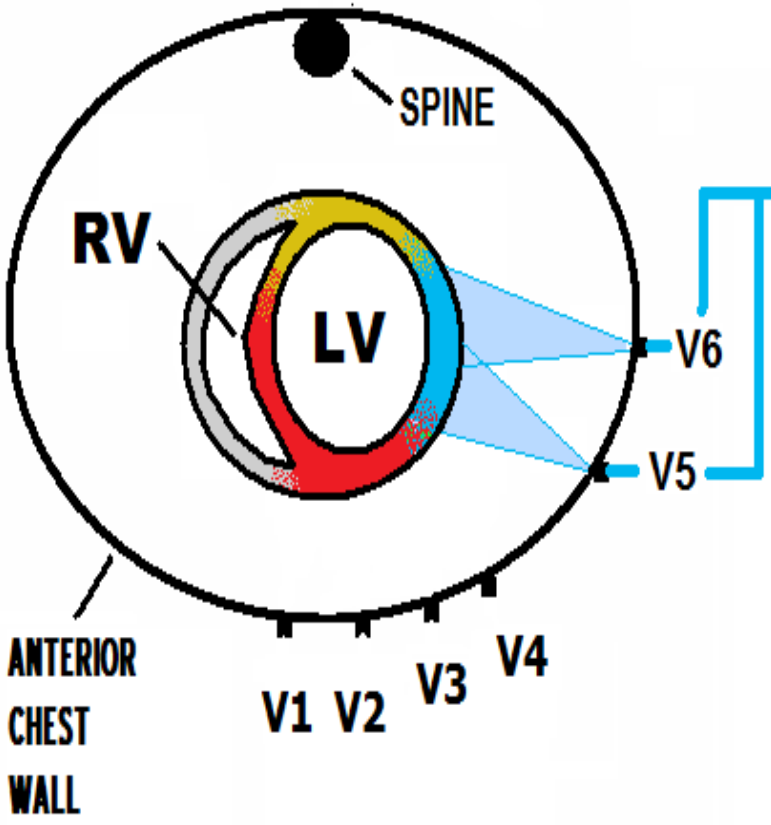
- **Approximately 45% of the Left Ventricle**
- **Bundle of His**
- **Bundle Branches**

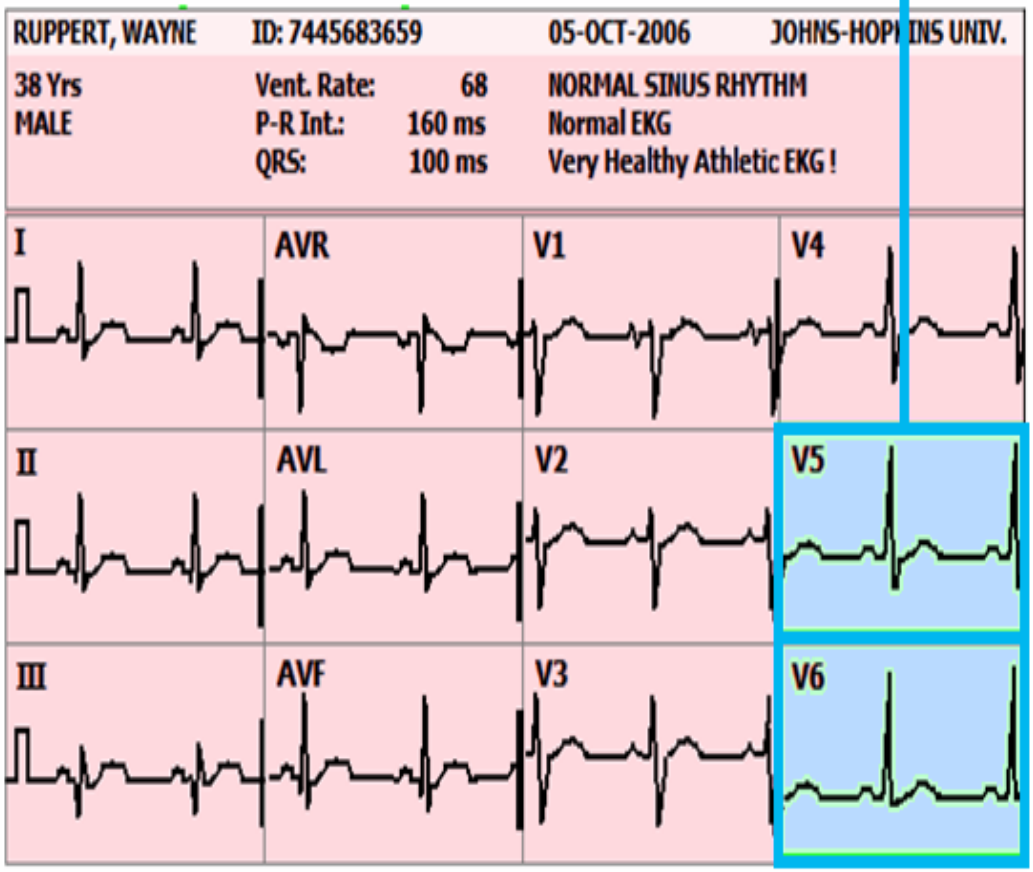
Left Anterior Descending Artery

The LAD supplies blood to the ANTERIOR and SEPTAL walls, and includes the following CRITICAL STRUCTURES:

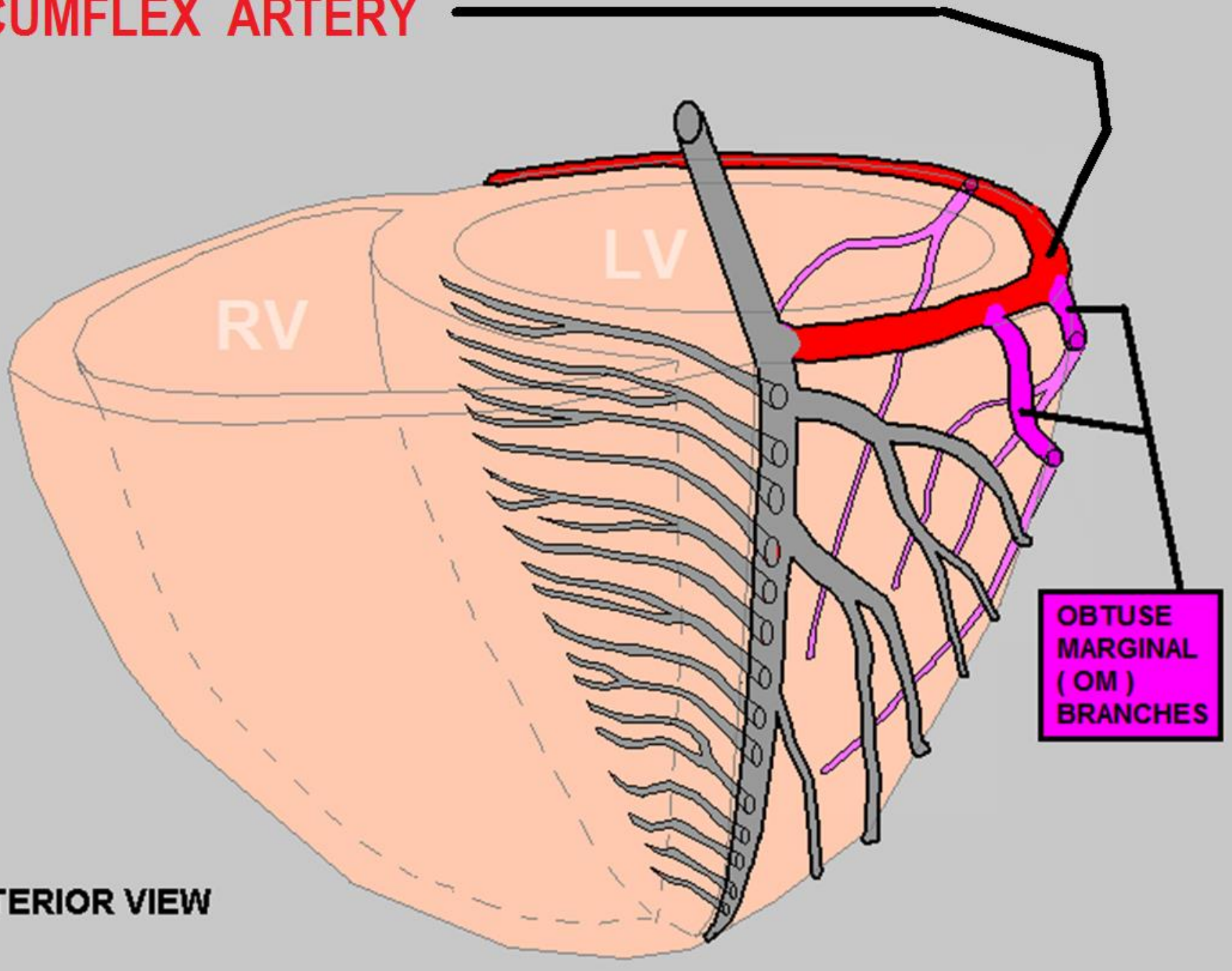
- **Approximately ____of the Left Ventricle**
- **_____**
- **_____**

V5 - V6 VIEW THE LATERAL WALL
of the LEFT VENTRICLE





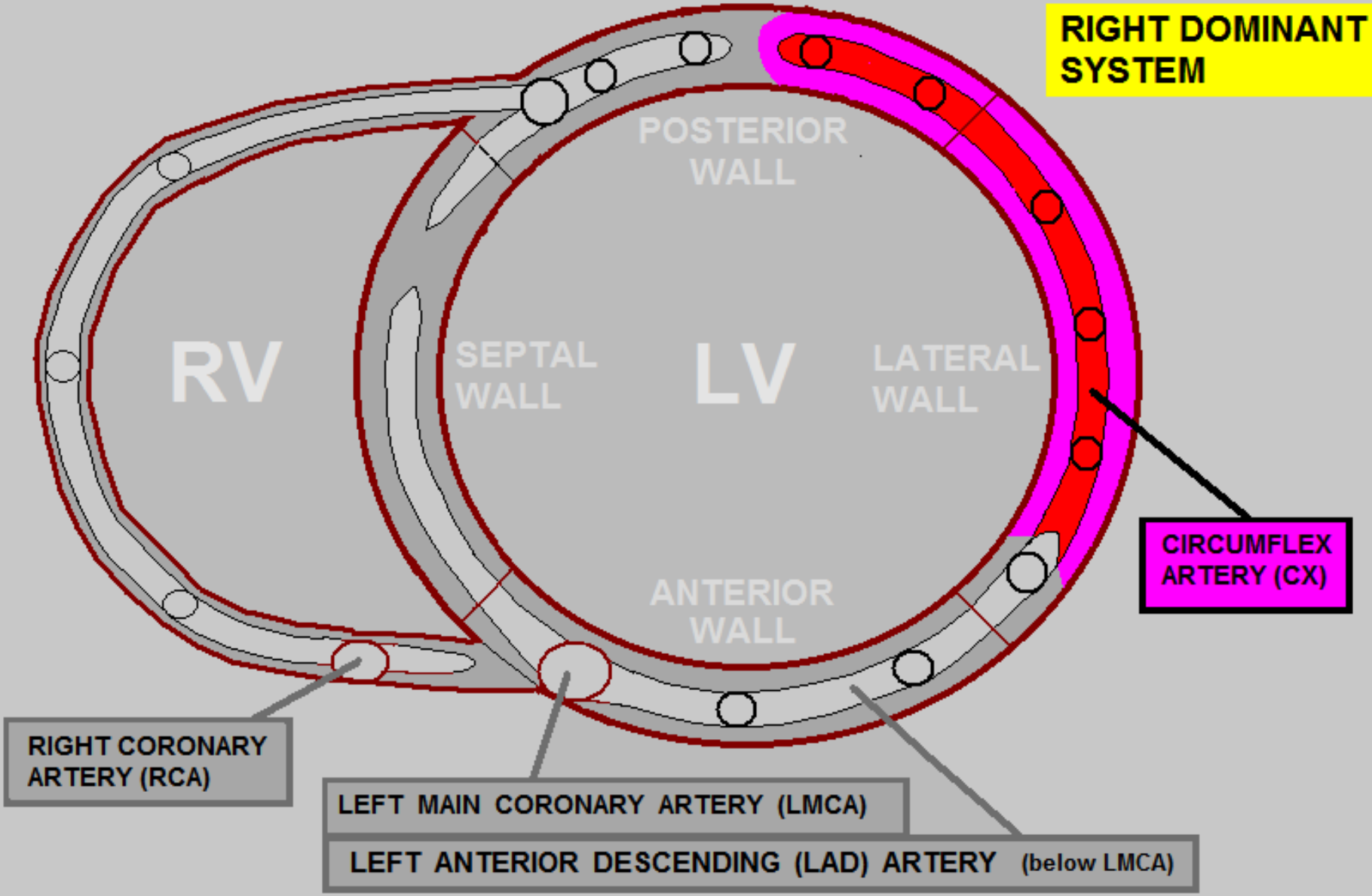
CIRCUMFLEX ARTERY



cutaway view of the

CIRCUMFLEX ARTERY (CX) DISTRIBUTION

SUPPLIES 20 - 30 % of the LV MUSCLE MASS



Circumflex (Cx) Artery

In patients with a Right Dominant coronary artery system, the Circumflex supplies blood to:

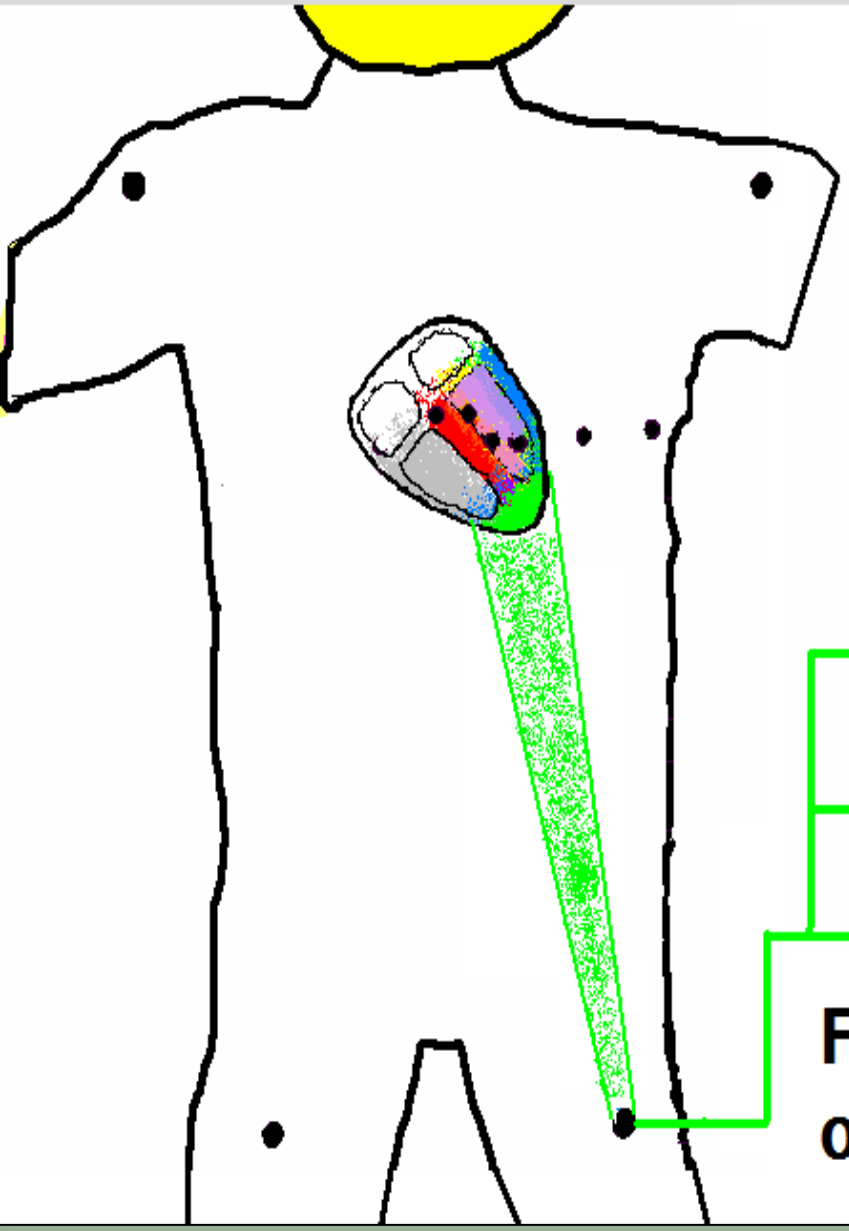
- **Approximately 20-30% of the Left Ventricle, which includes:**
  - **Lateral Wall of Left Ventricle**
  - **Approx ½ of Posterior Wall**
- **On rare occasion, the SINUS NODE**

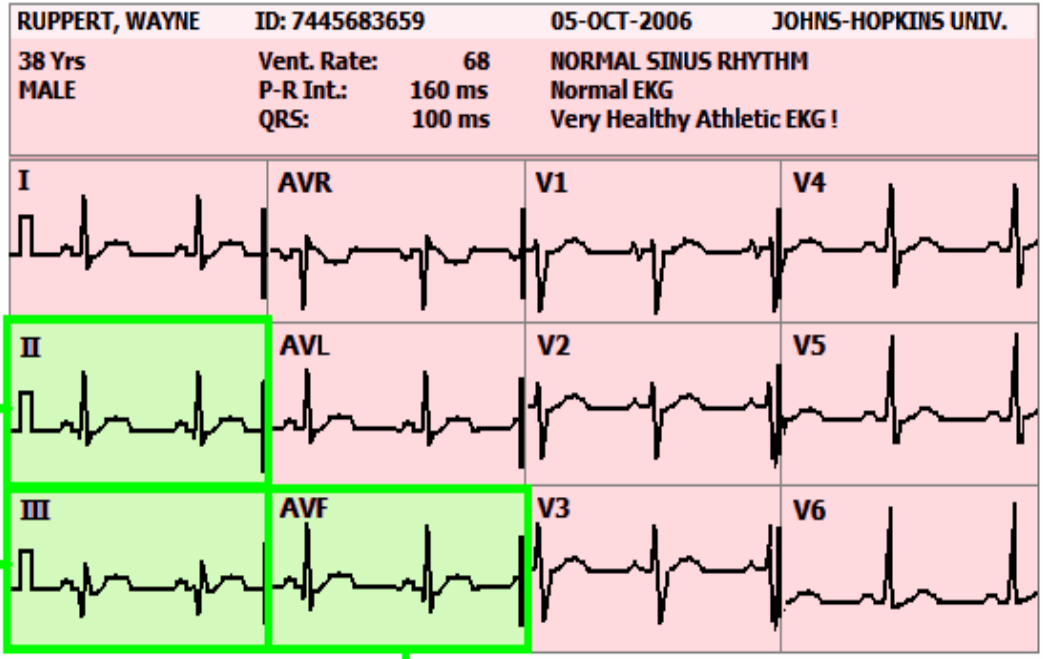
Circumflex (Cx) Artery

In patients with a Right Dominant coronary artery system, the Circumflex supplies blood to:

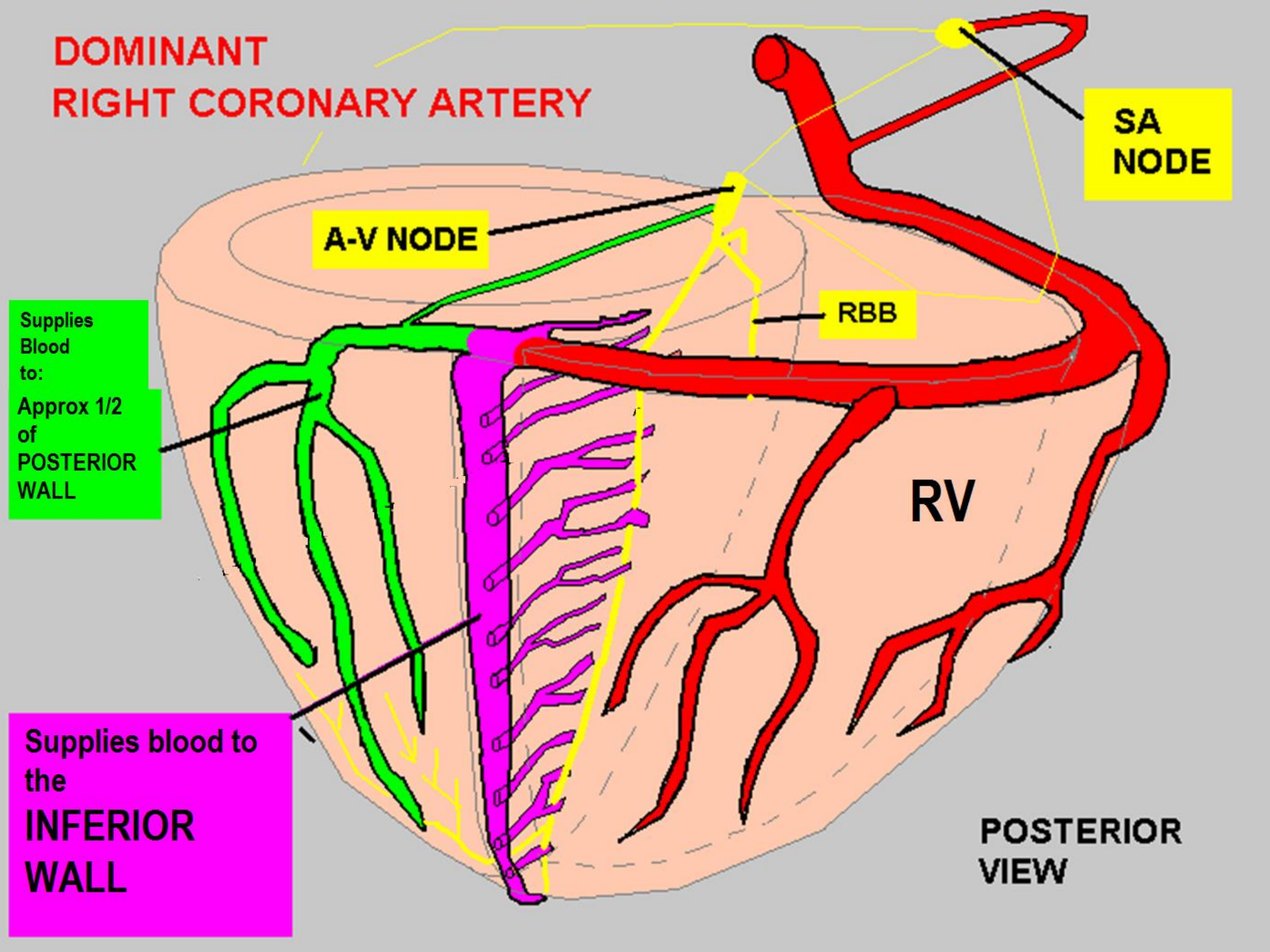
- **Approximately 20-30% of the Left Ventricle, which includes:**
  - **_____of Left Ventricle**
  - **_____**
- **On rare occasion, the _____**

LEADS II, III, and aVF VIEW
INFERIOR WALL of the LEFT VENTRICLE





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


DOMINANT
RIGHT CORONARY ARTERY
SA NODE
A-V NODE
RBB
Supplies Blood to:
Approx 1/2 of POSTERIOR WALL
RV
Supplies blood to the INFERIOR WALL
POSTERIOR VIEW

Right Coronary Artery (RCA)

In patients with a RIGHT DOMINANT system, the RCA supplies blood to the following cardiac structures:

- **Sinus Node**
- **Right Ventricle**
- **AV Node**
- **Approximately 15-25% of the Left Ventricle**
  - **INFERIOR Wall**
  - **½ POSTERIOR WALL**

Right Coronary Artery (RCA)

In patients with a RIGHT DOMINANT system, the RCA supplies blood to the following cardiac structures:

- _____
- _____
- _____
- **Approximately _____%of the Left Ventricle**
  - **INFERIOR Wall**
  - **½ POSTERIOR WALL**

MOM and DAD at Lee's Diner, York, PA 2006