STEMItators

Objectives

- Review Basics
- Imitators
- Axis, QTc
- Rhythms
- Putting it all together

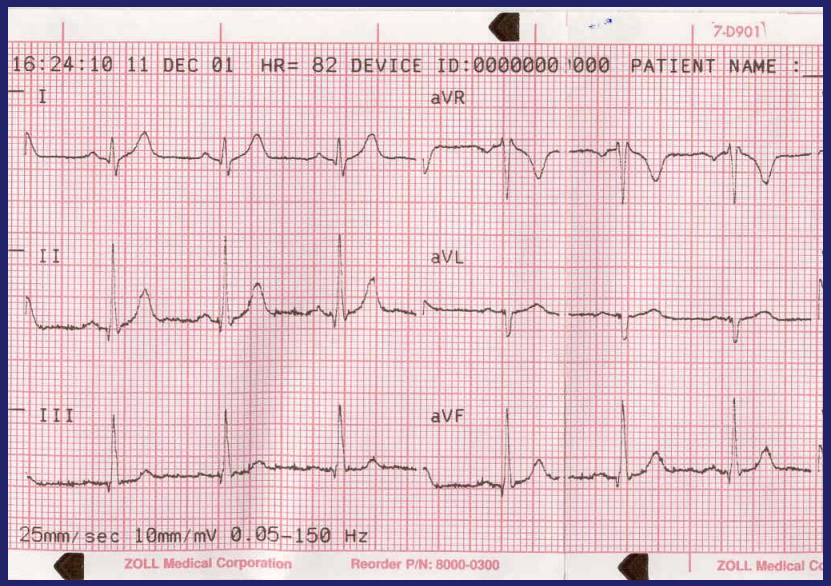
Lead Groups

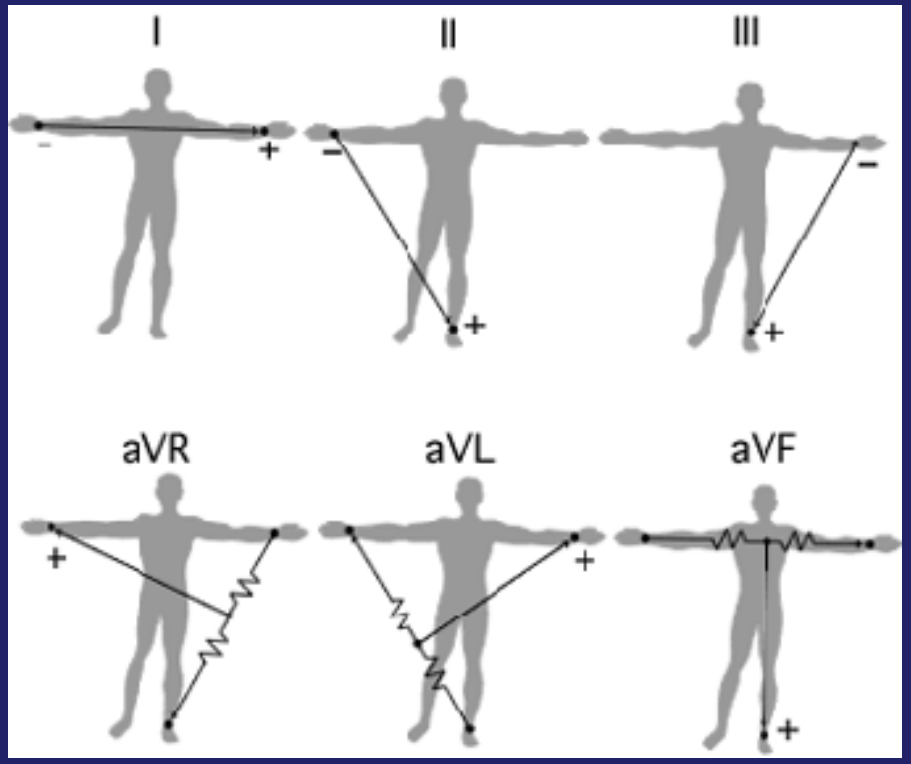
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

Limb Leads

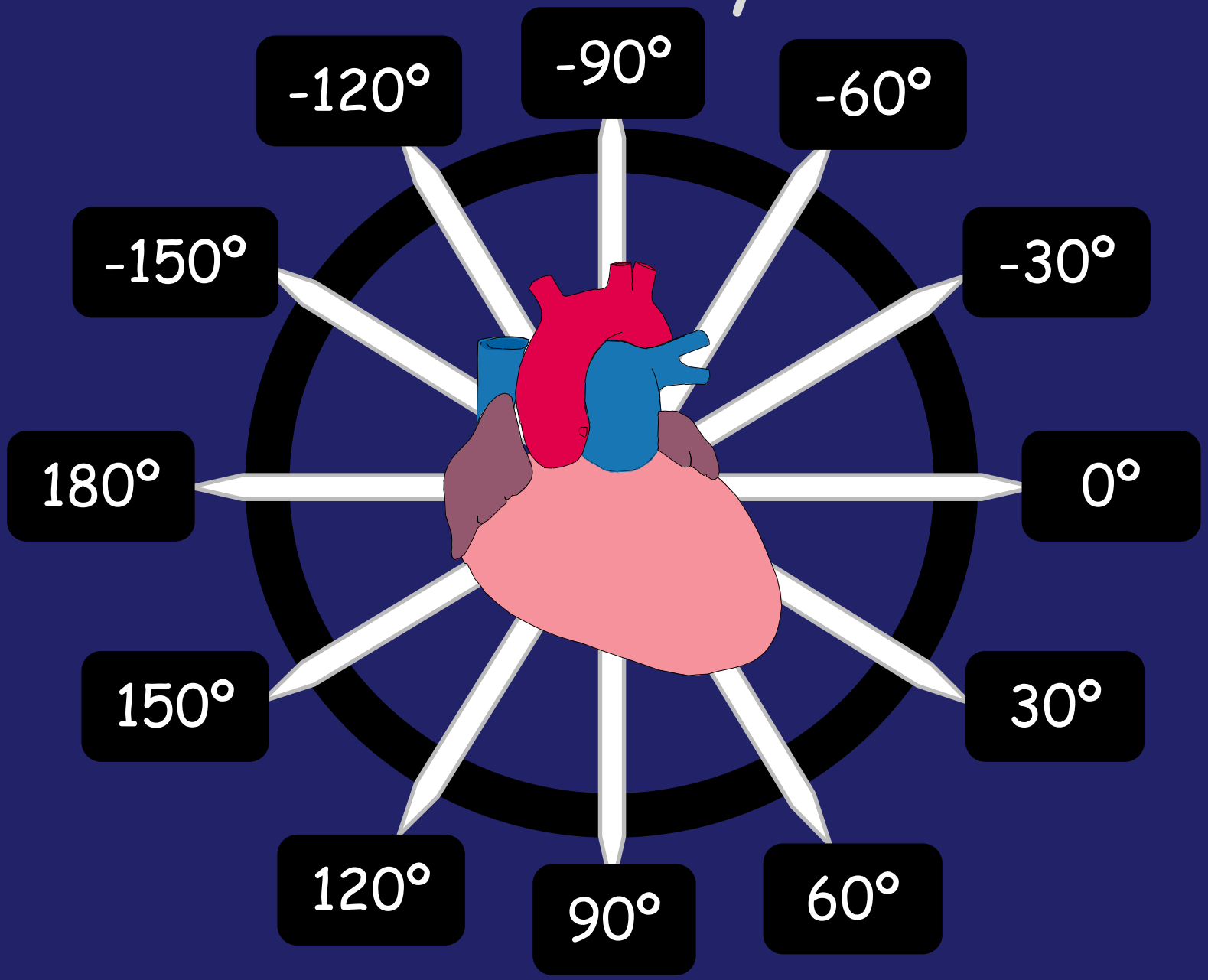
Chest Leads

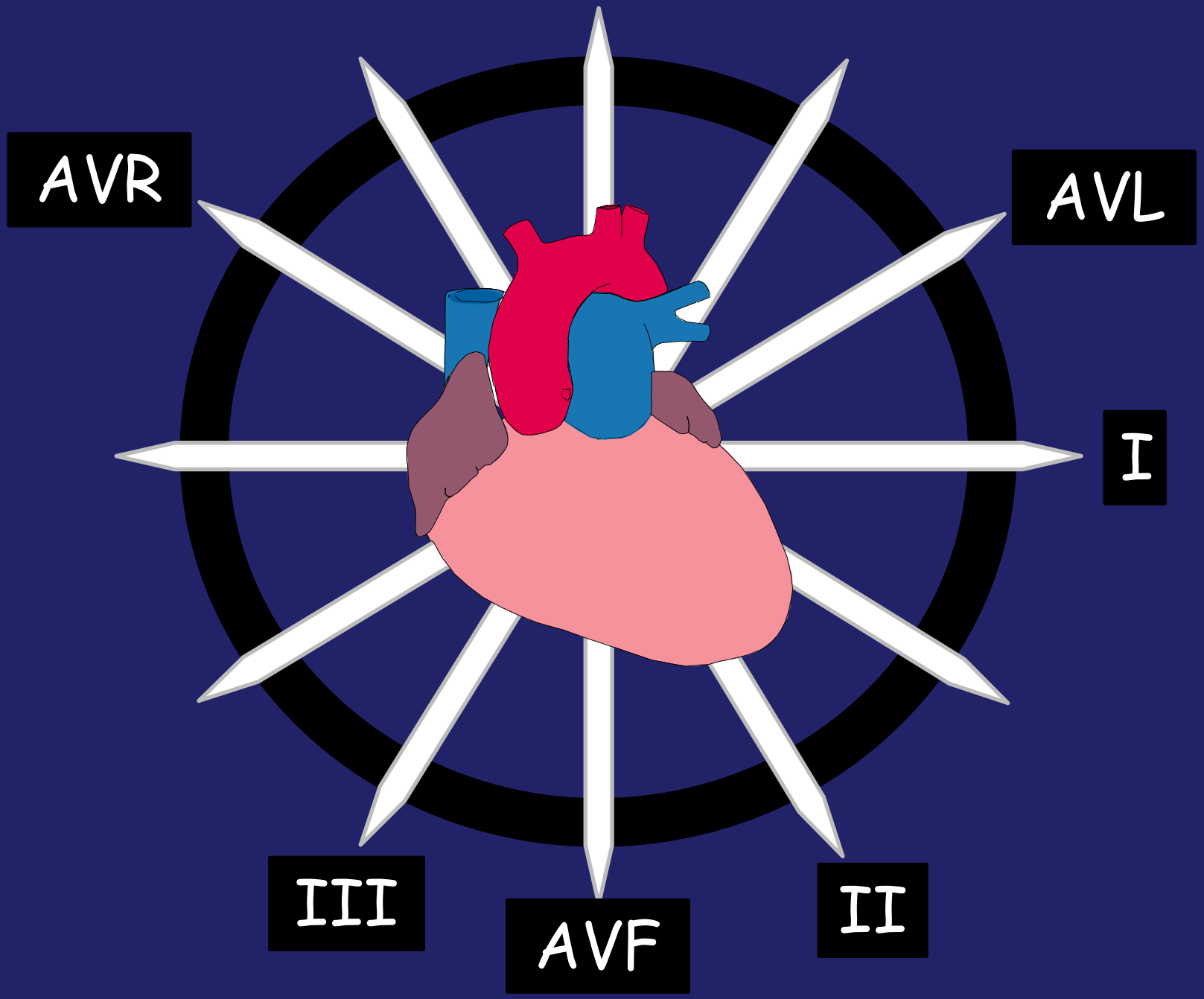
The Limb Leads



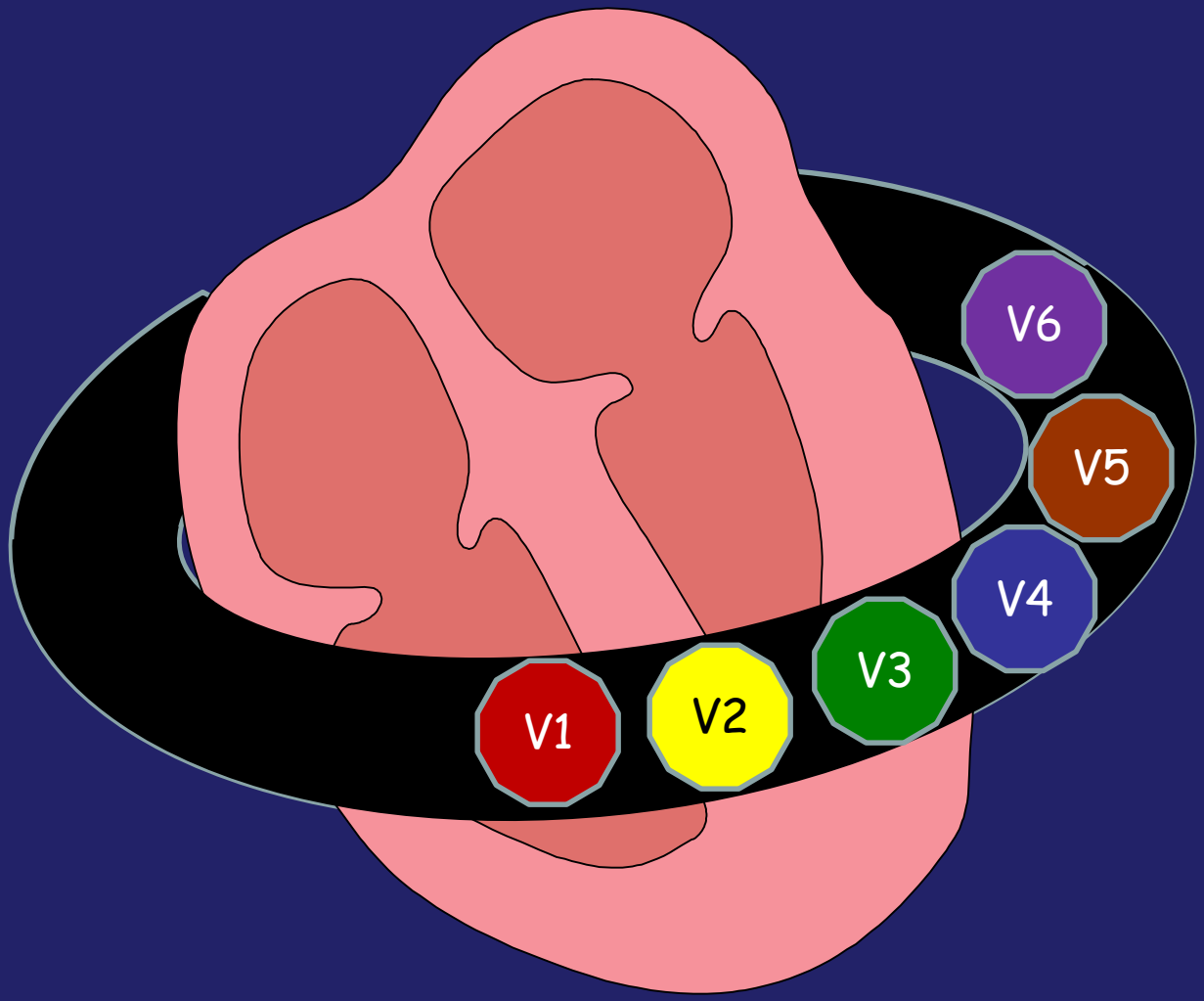


Hexaxial System

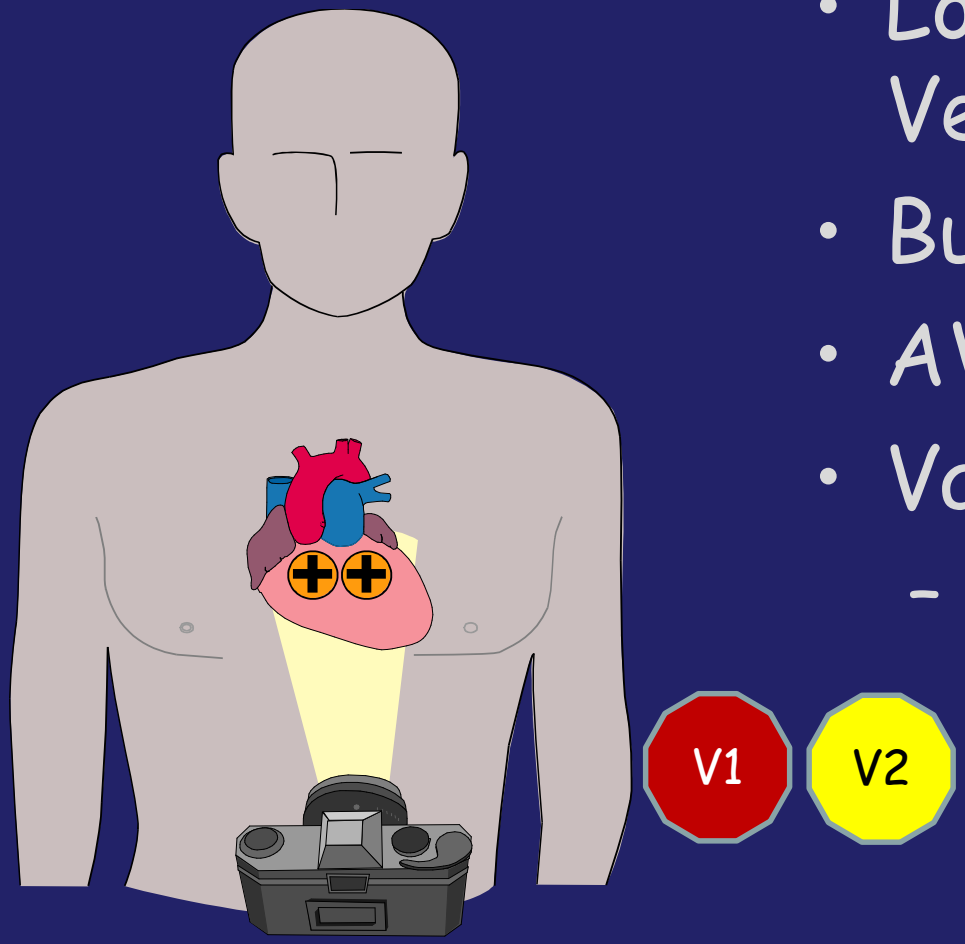



AVR
AVL
I
III
AVF
II

Unipolar Precordial Leads

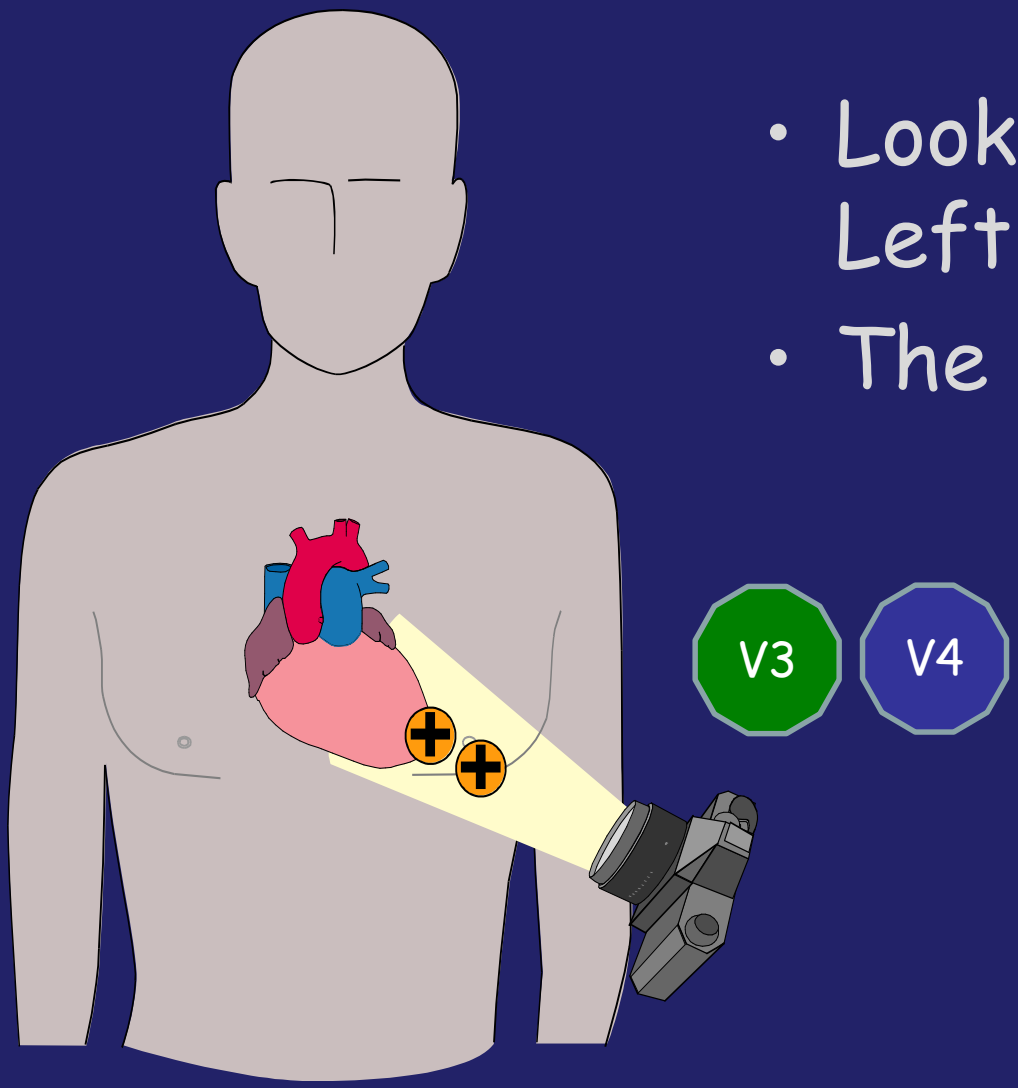


The Septal Leads



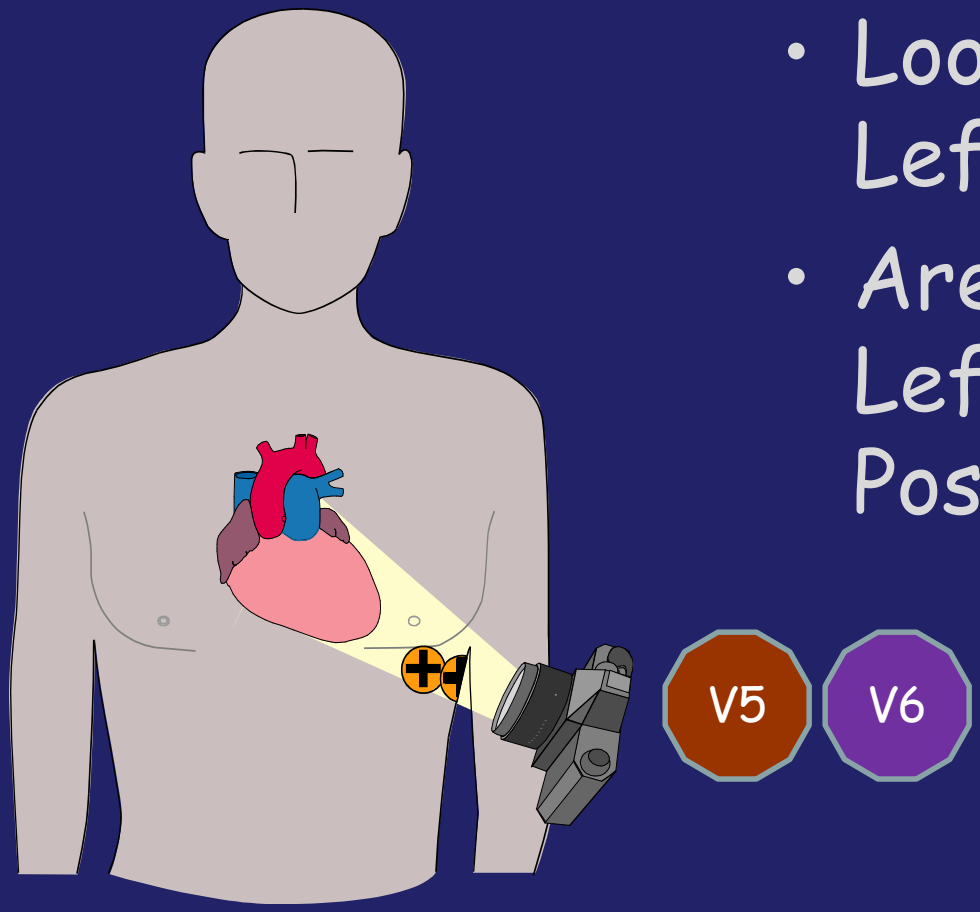
- Look Directly at Ventricular Septum
- Bundle Branches
- AV Node
- Valves
  - Cordae Tendonae

The Anterior Leads



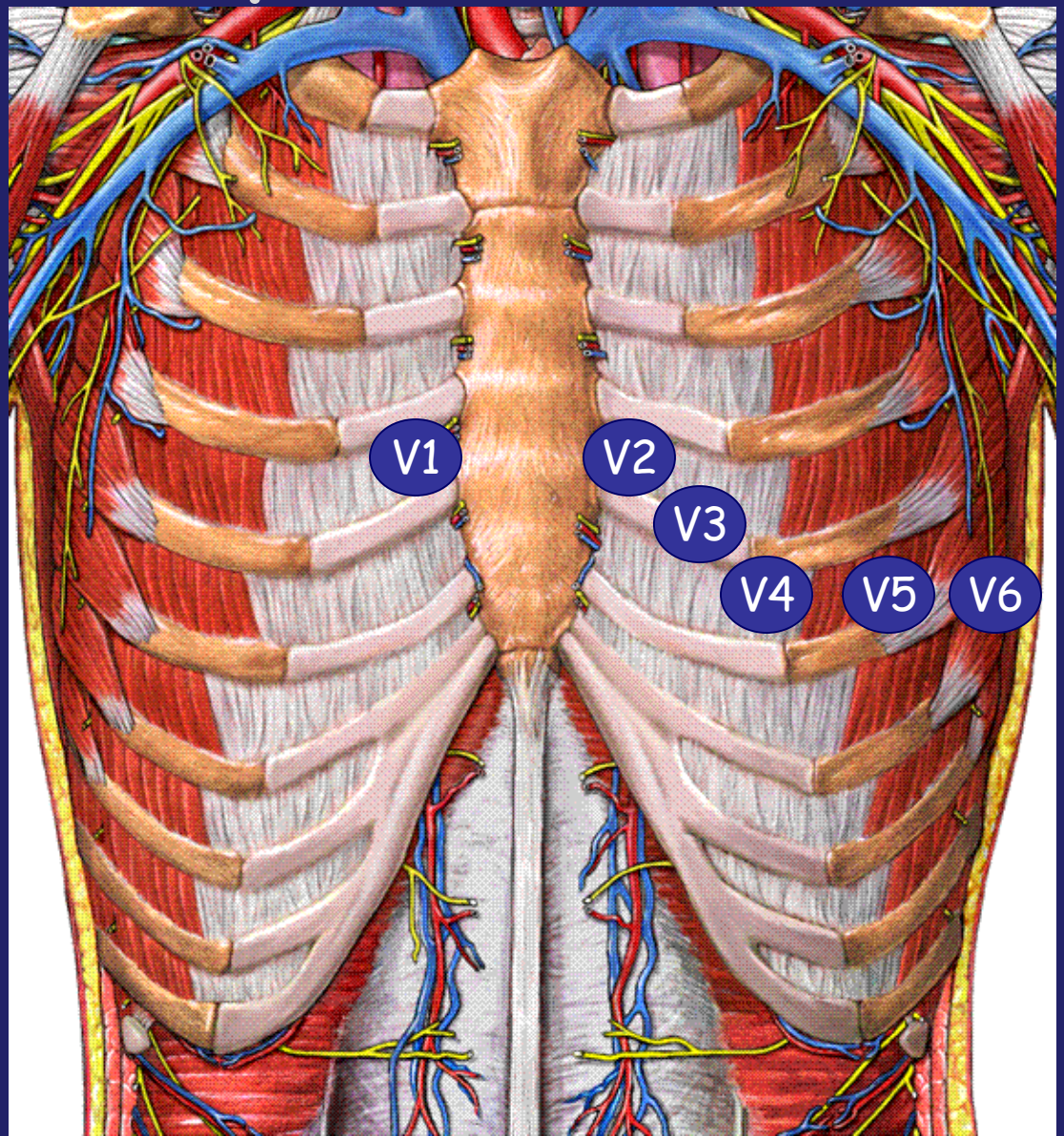
- Look Directly at Left Ventricle
- The pump

The Lateral Leads

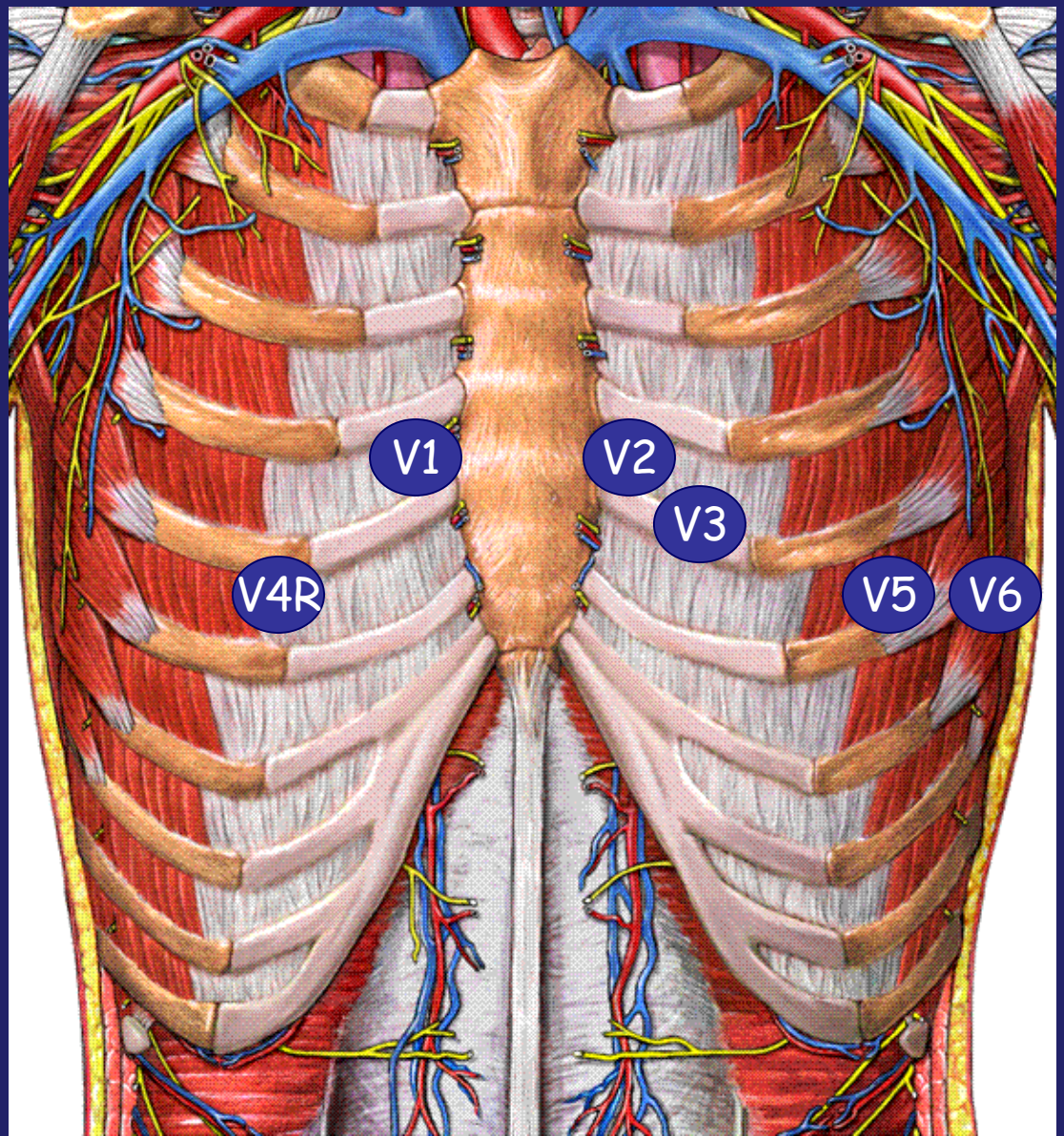


- Look Directly at Left Side of Heart
- Area Involved is Left Ventricle and Posterior Muscles

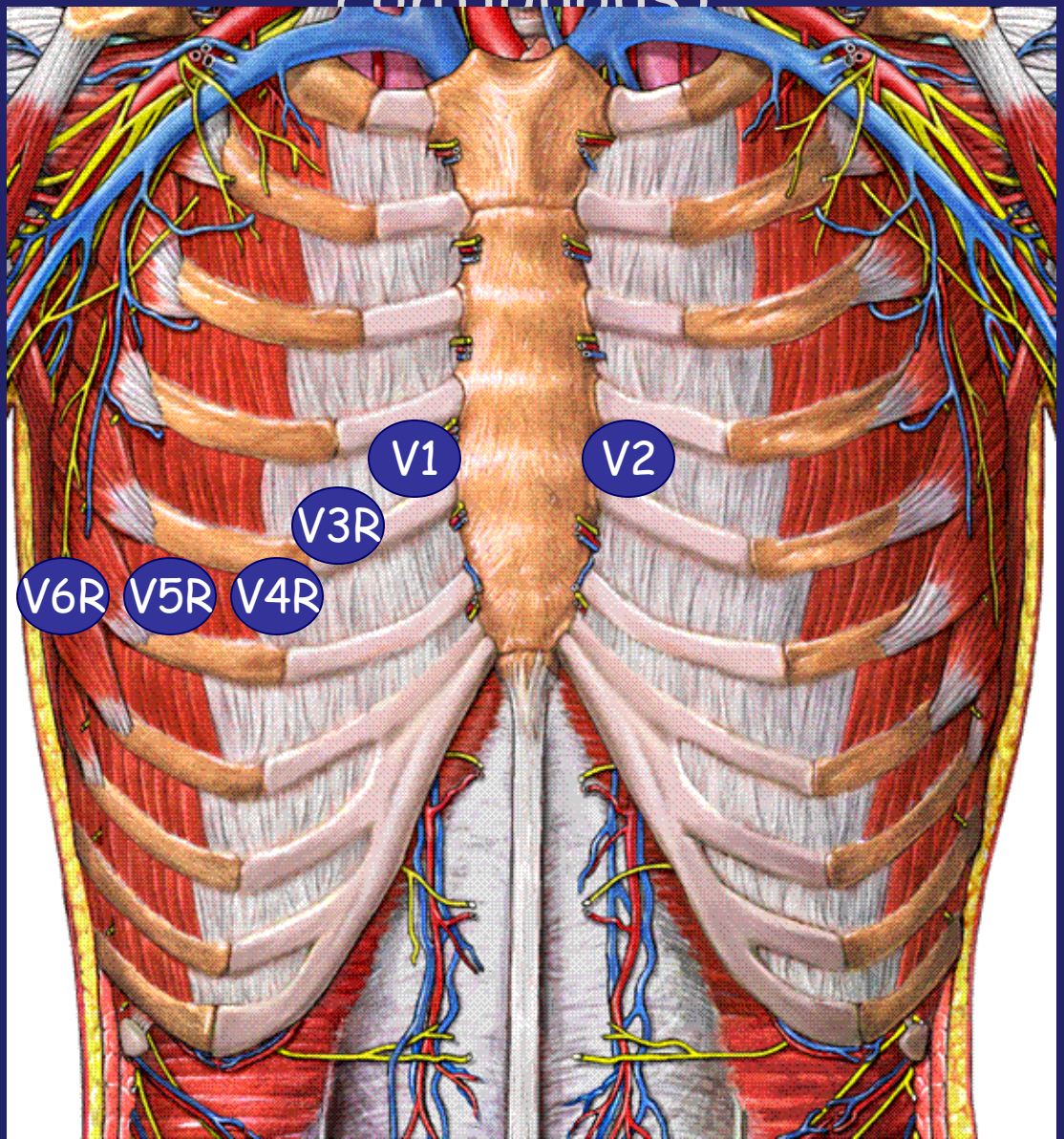
Proper Placement



"Quick Look" (83% diagnostic accuracy)



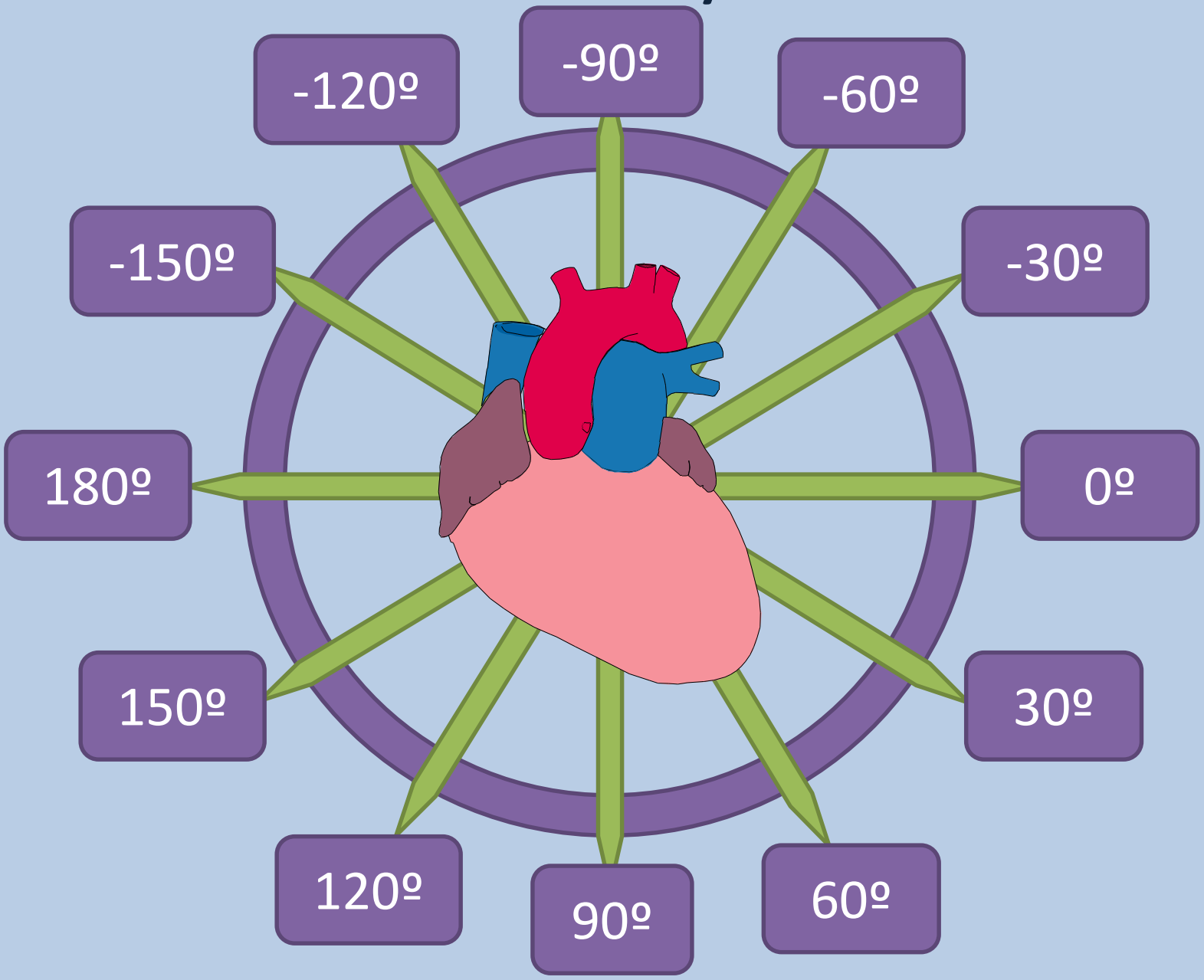
Complete RV View (any two are contiguous)

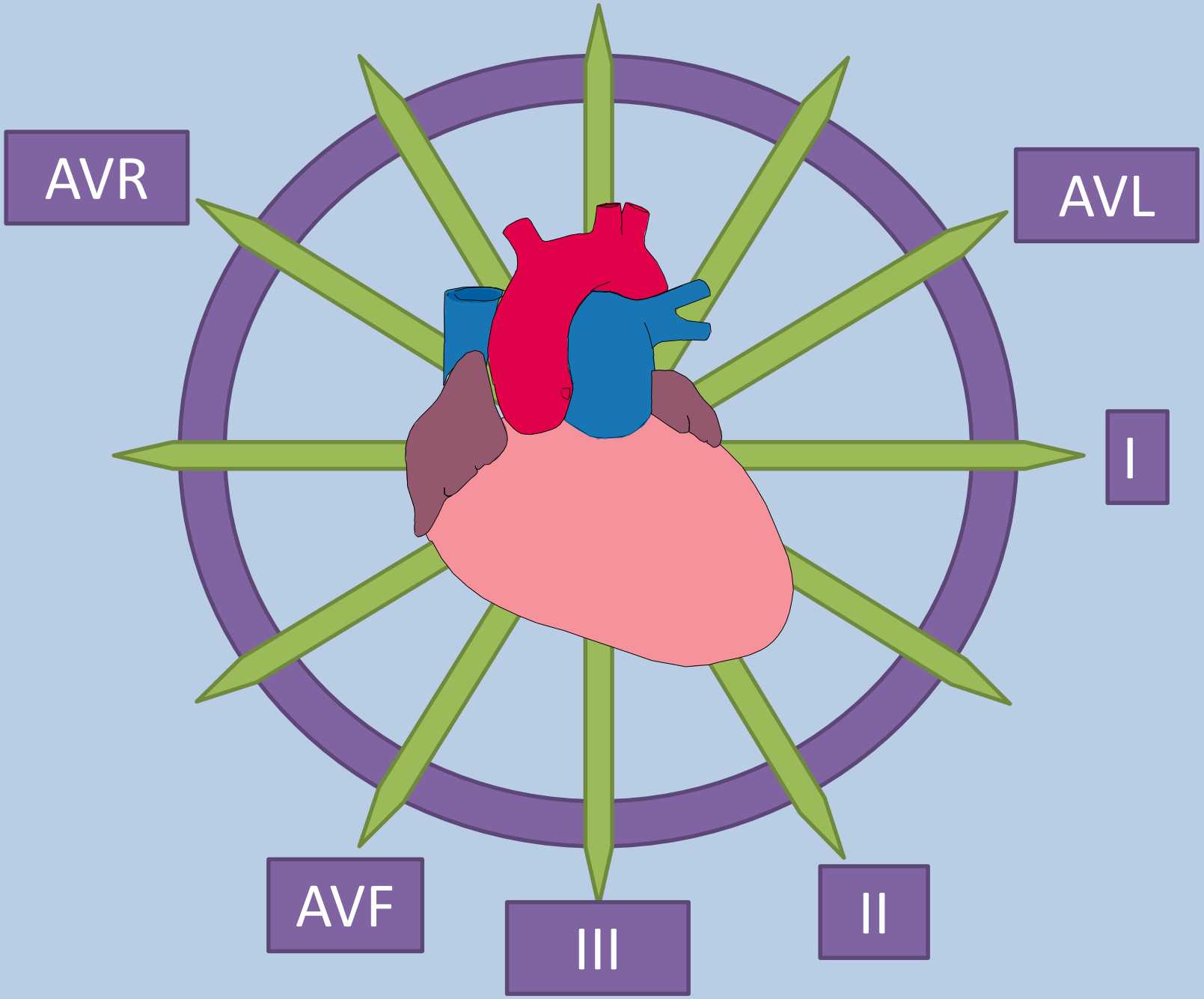


Leads are a Camera Picture taken + to -

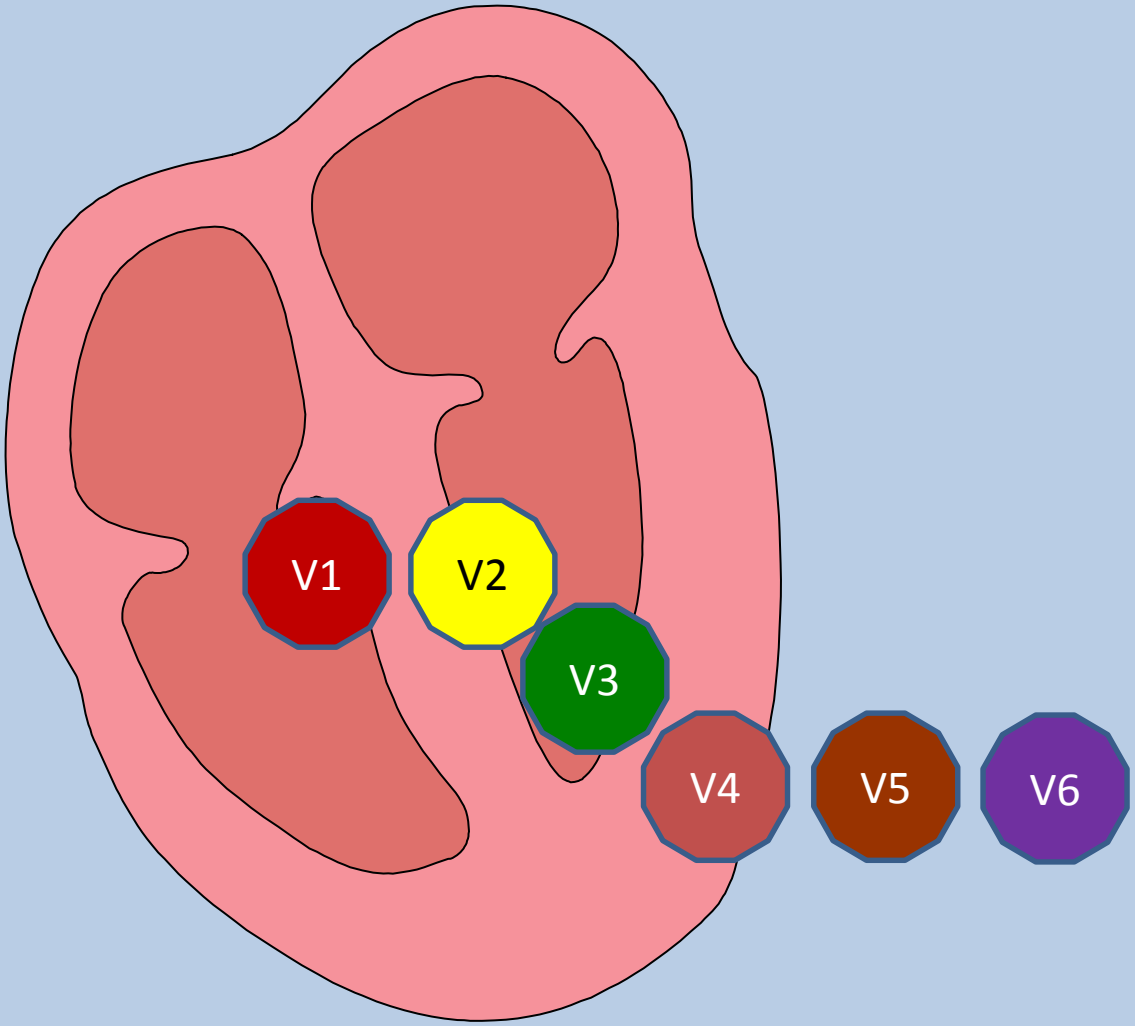
- Bipolar Limb Leads
  - I, II, III
- Augmented Limb Leads
  - aVR, aVL, aVF
- Unipolar Precordial Leads
  - V1, V2, V3, V4, V5, V6

Hexaxial System



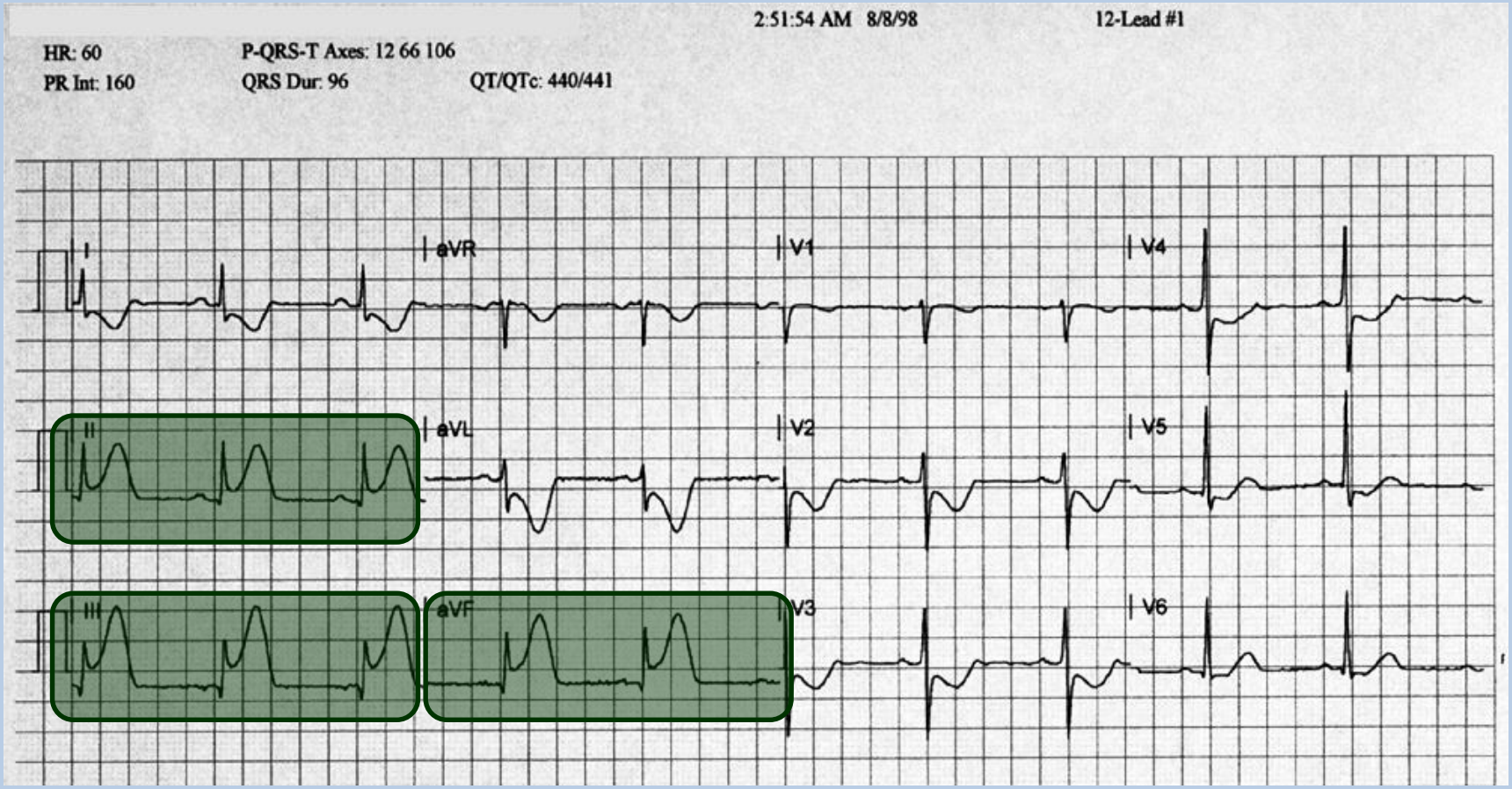

AVR
AVL
I
II
III
AVF

Unipolar Precordial Leads



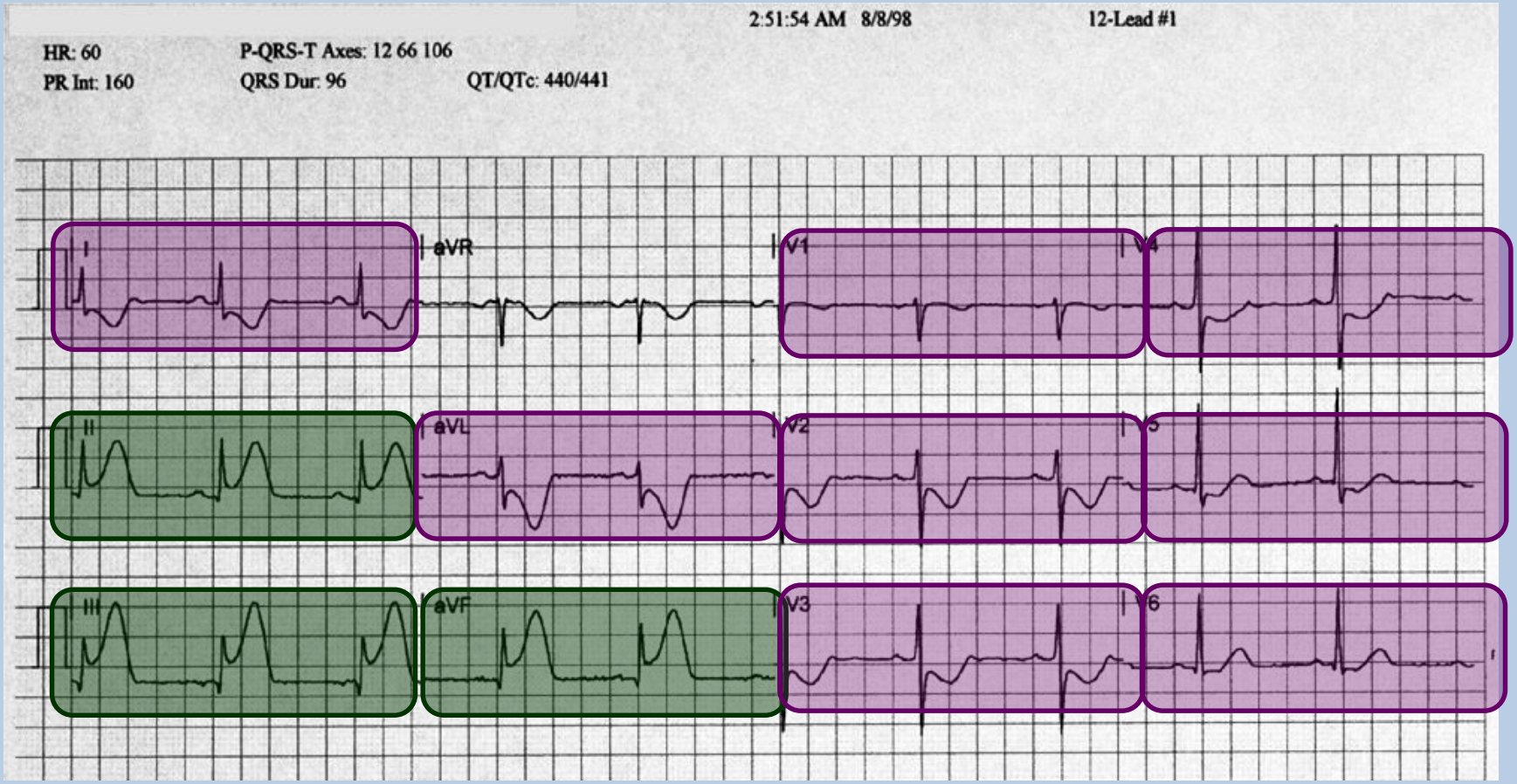
How do you diagnose STEMI?

- Contiguous ST elevation > 1mm

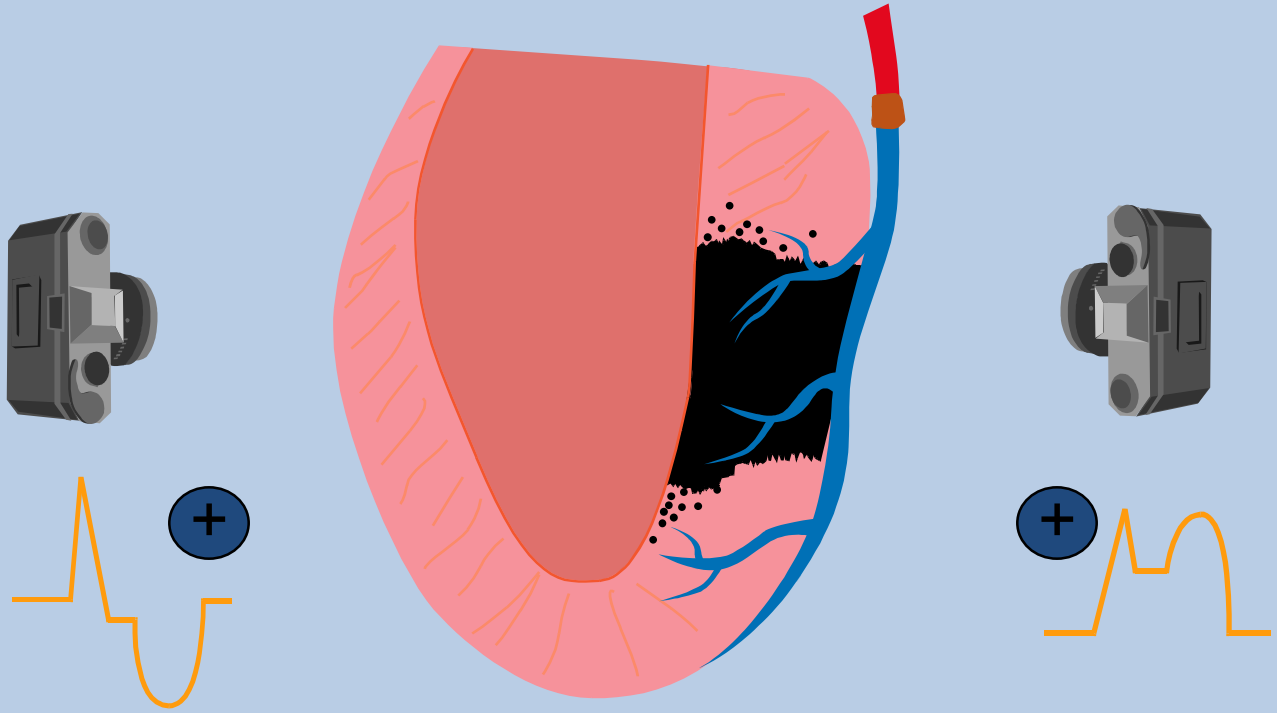


How do you diagnose STEMI?

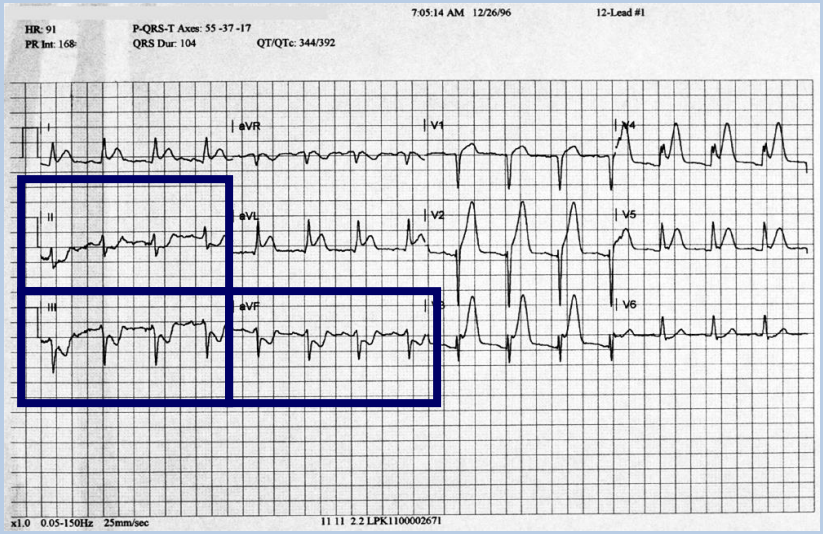
- Reciprocal Changes (strong evidence)

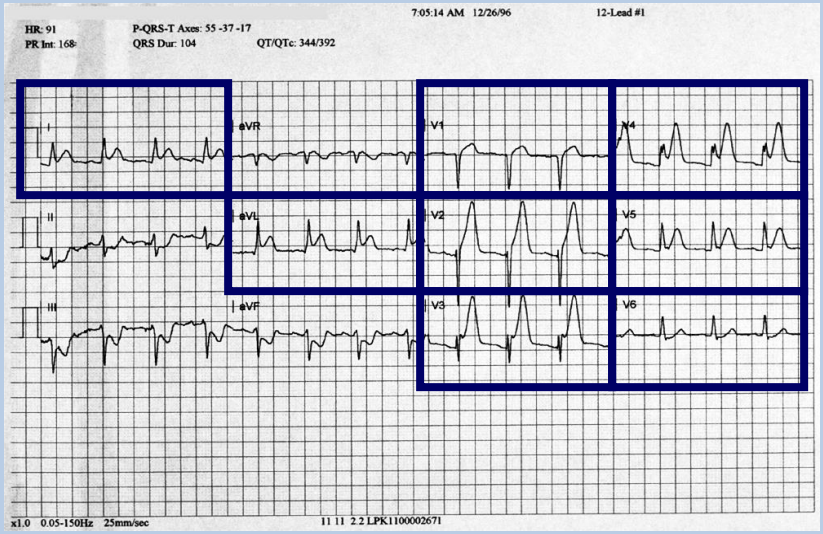


Reciprocal Changes



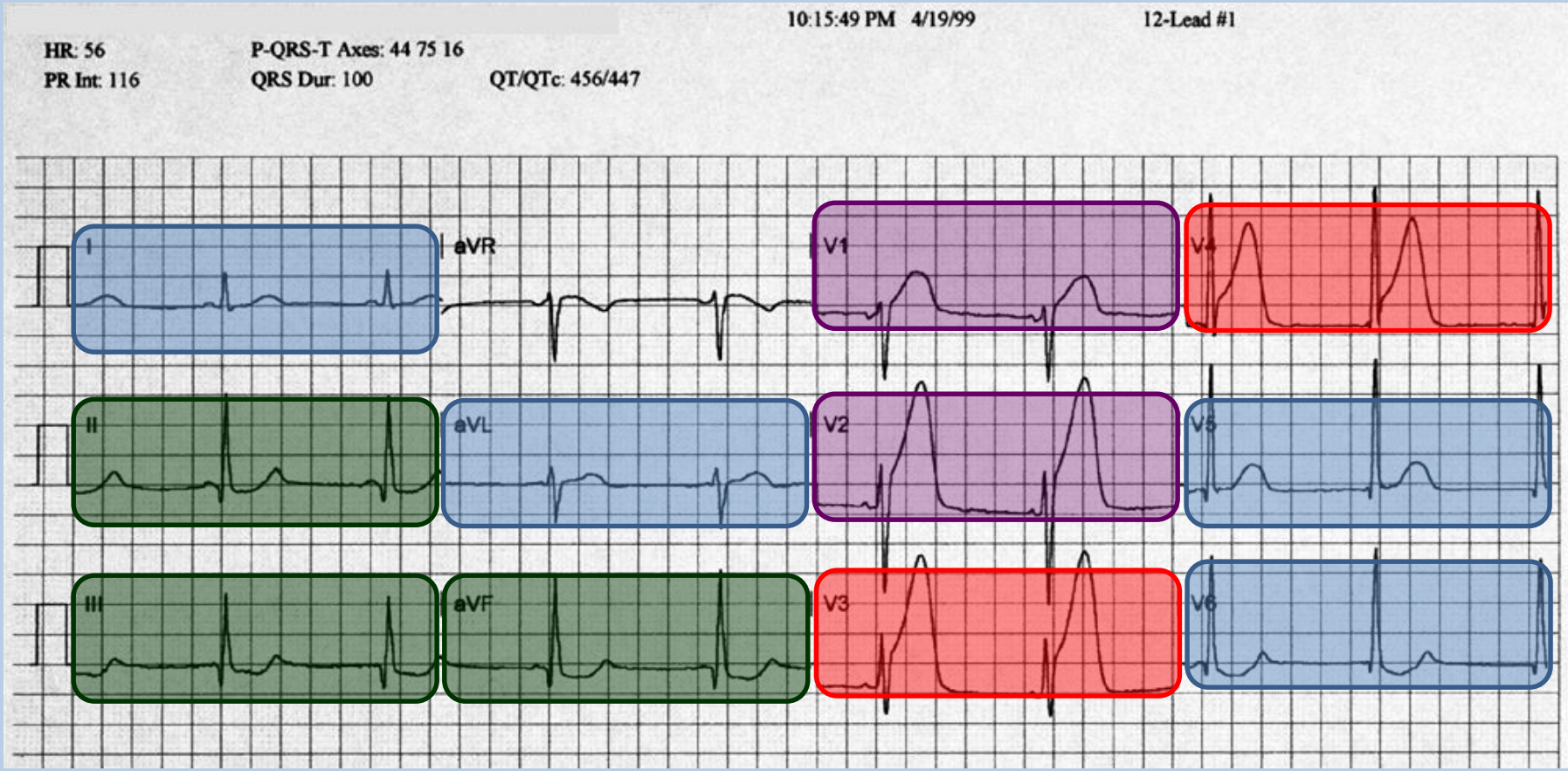
RCA vs LCA



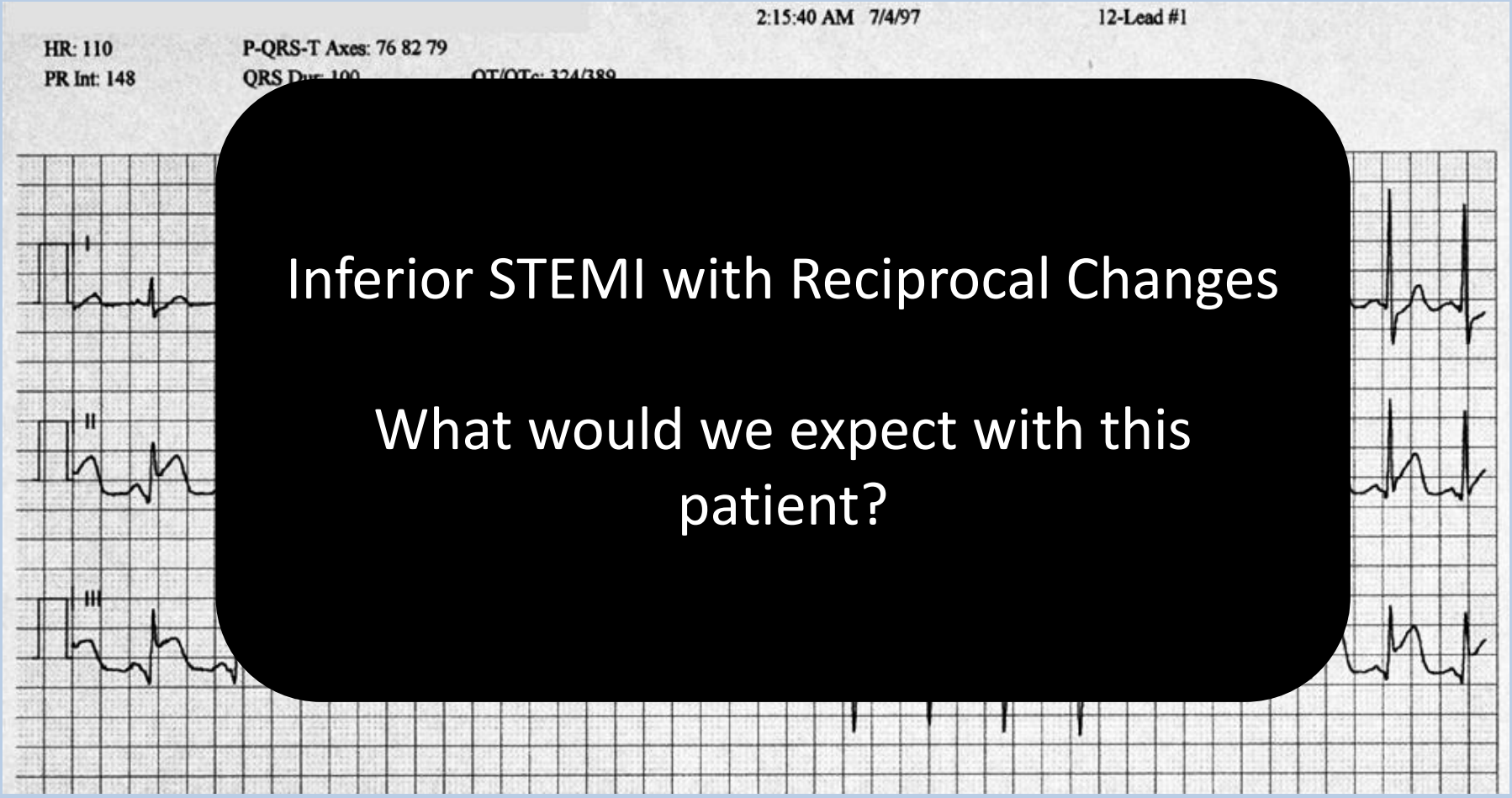


II, III, aVF **I, aVL, V leads**

Location of Infarction

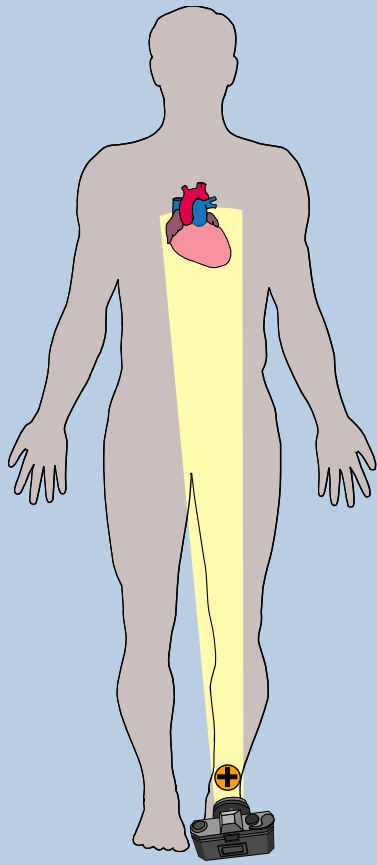


Types of MI

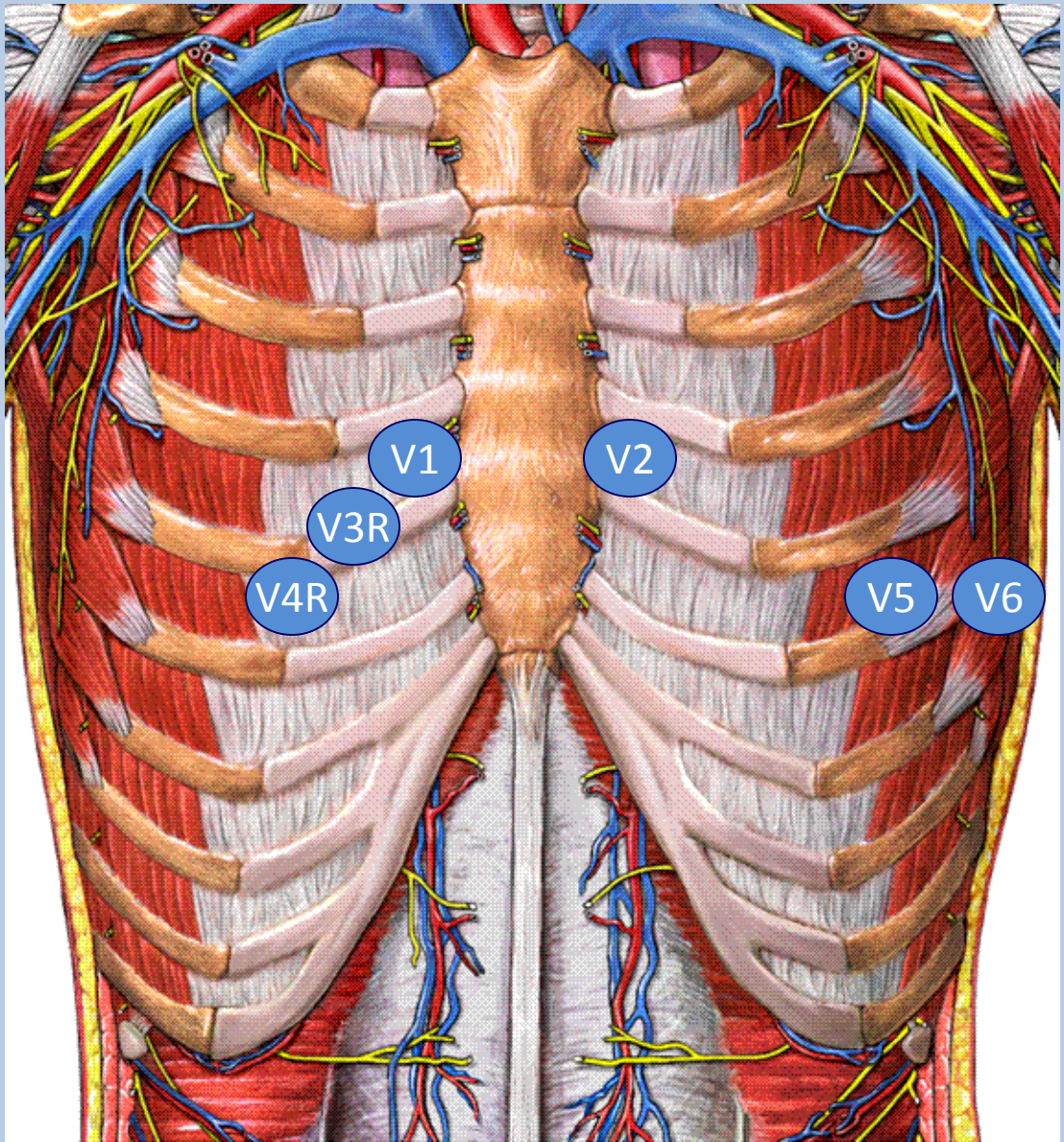

2:15:40 AM 7/4/97
12-Lead #1
HR: 110
PR Int: 148
P-QRS-T Axes: 76 82 79
I
II
III
Inferior STEMI with Reciprocal Changes
What would we expect with this patient?

Inferior

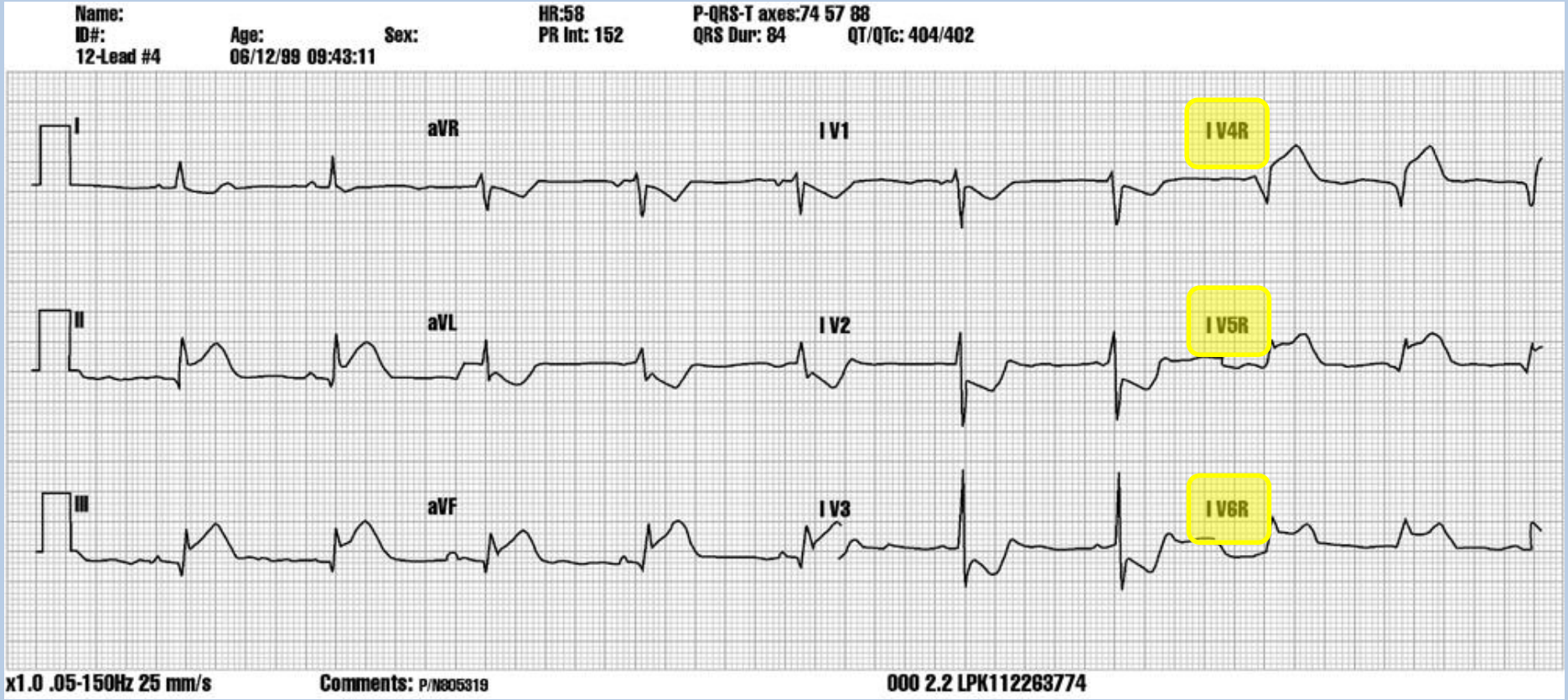
- Lead II, III, AVF
- Transient Conduction Defects
  - 2nd degree type 1
  - Bradycardia
  - 1 degree AVB
- ** 40-60% of these have RV infarct



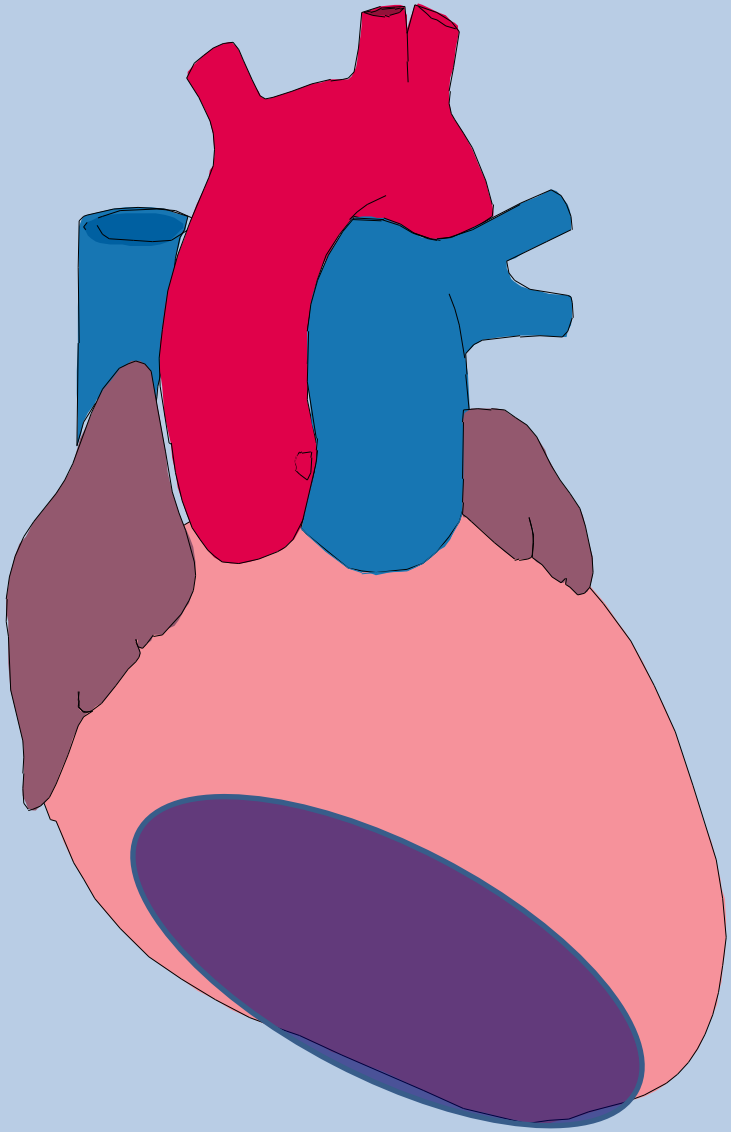
What do we do with all Inferior MI's?



Types of MI

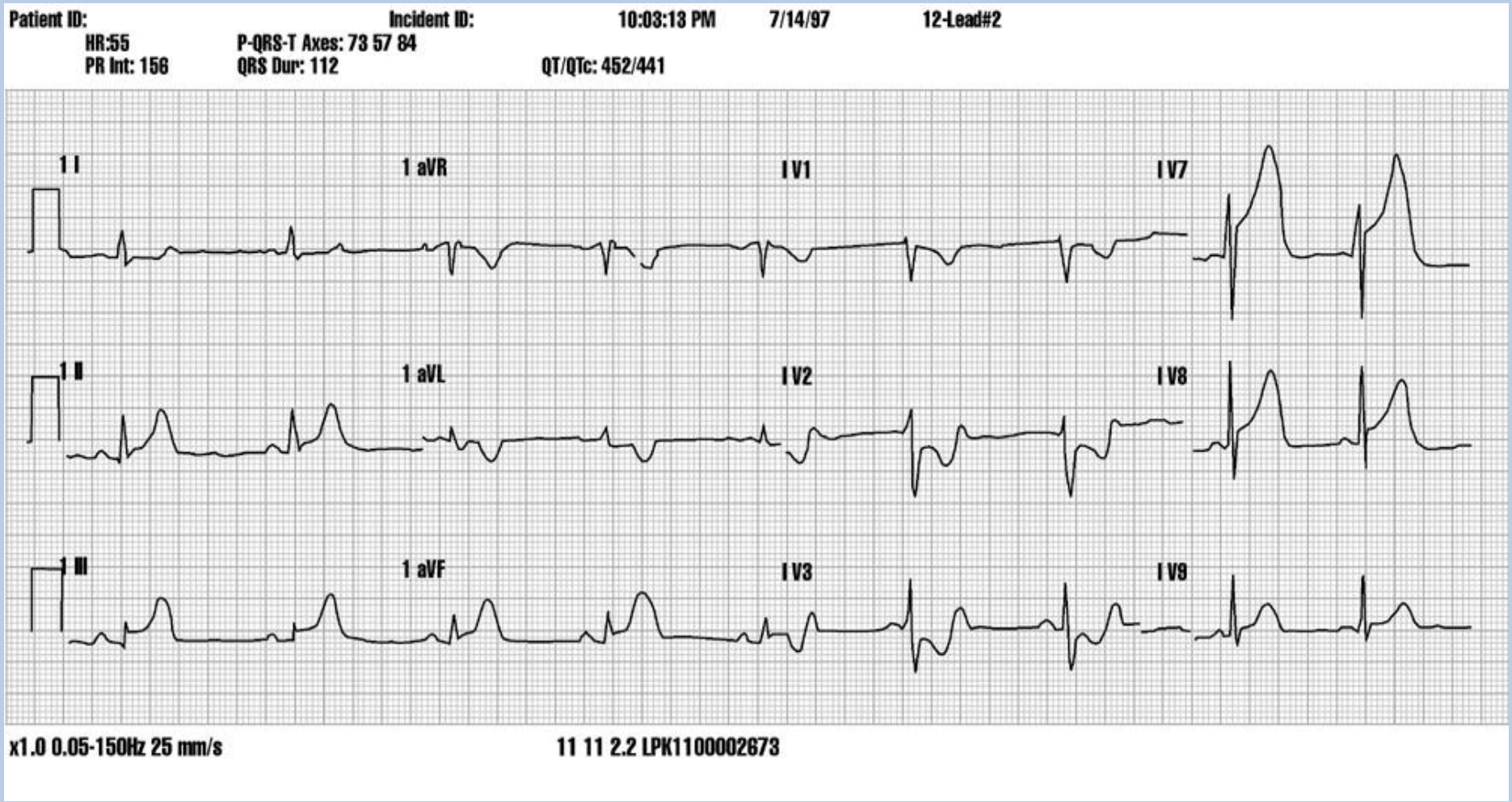

Name:
ID#:
12-Lead #4
Age:
06/12/99 09:43:11
Sex:
HR:58
PR Int: 152
P-QRS-T axes:74 57 88
QRS Dur: 84
QT/QTc: 404/402
I
aVR
I V1
I V4R
II
aVL
I V2
I V5R
III
aVF
I V3
I V6R
x1.0 .05-150Hz 25 mm/s
Comments: P/N805319
000 2.2 LPK112263774

Right Ventricle MI's



- Preload Dependent
- Vasoactive Drugs can have devastating affects
- "Cautious with NTG" vs. NTG by Drip
- Require lots of Fluids

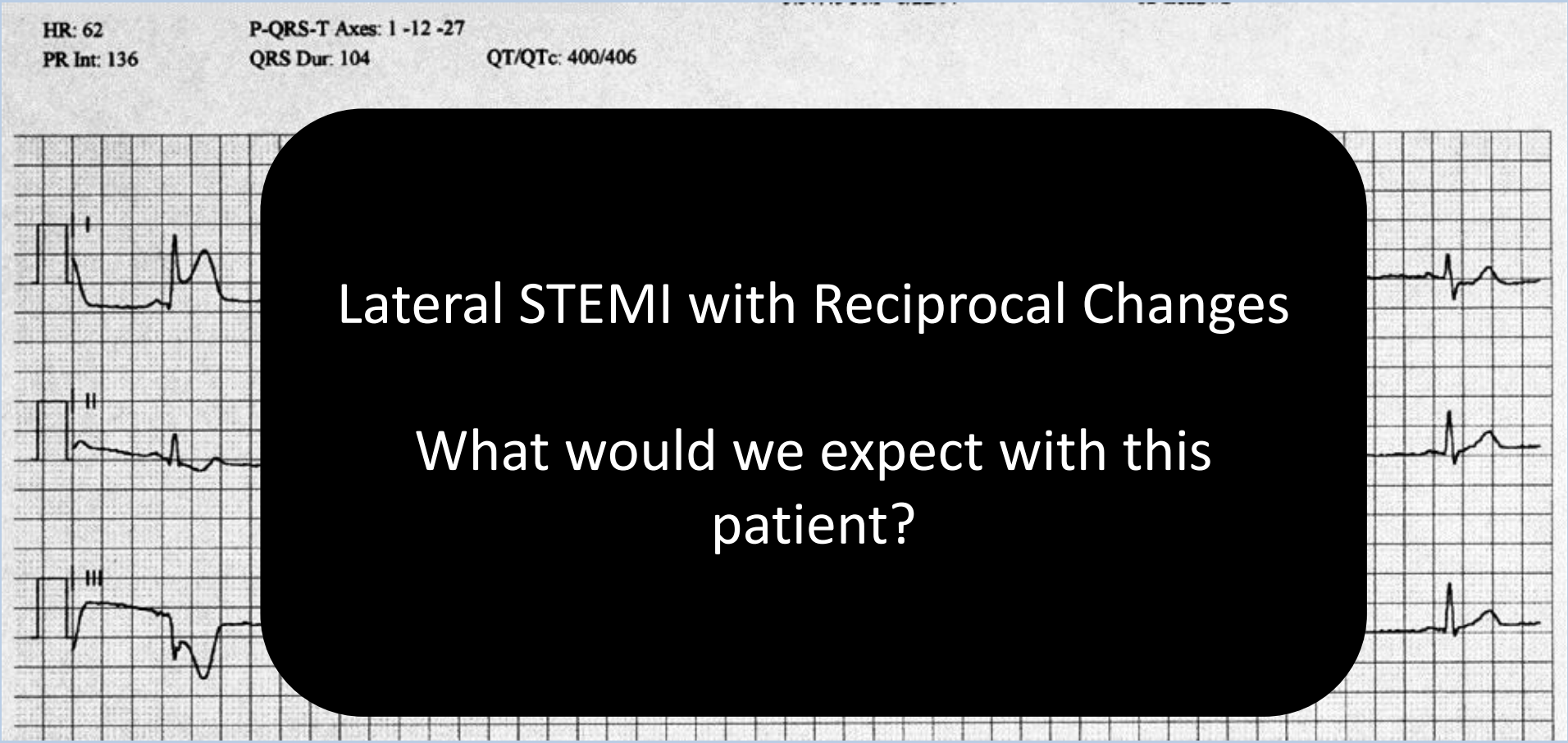
What else gets blood flow from RCA…



Posterior Wall MI (PWMI)

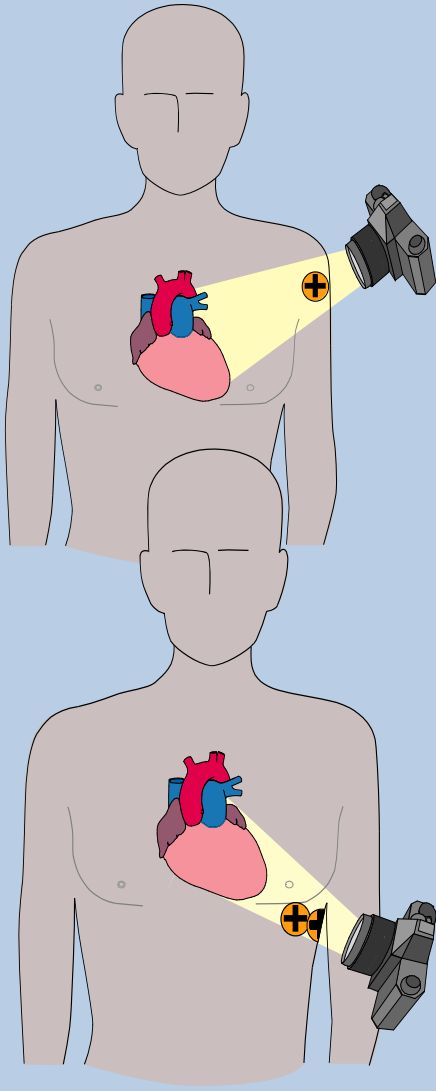
- Usually an extension of an inferior or lateral MI
- Common with proximal RCA occlusions
- Occurs with LCX occlusions
- Big clue is V1-V4 ST Depression

Types of MI

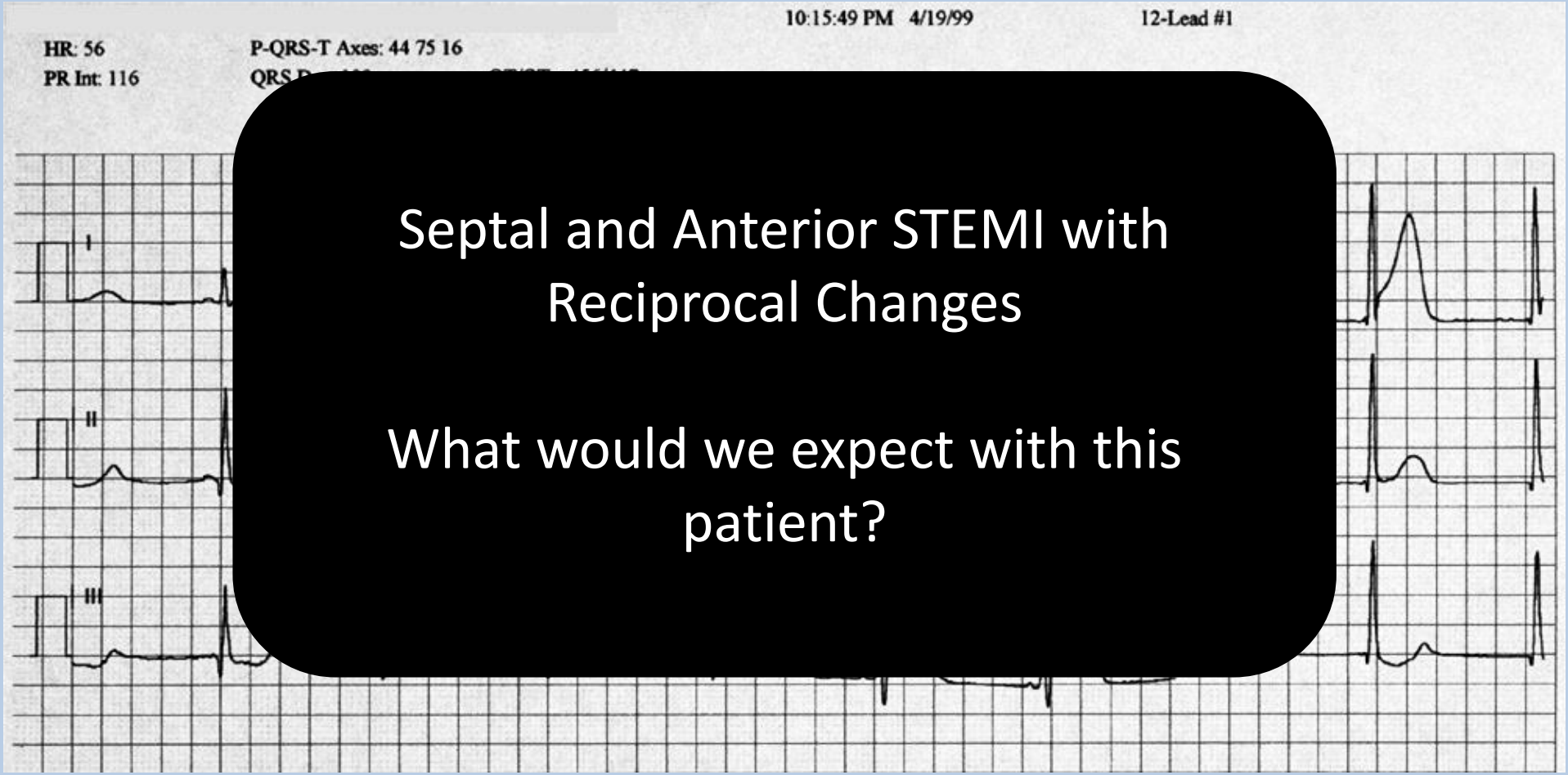

HR: 62
PR Int: 136
P-QRS-T Axes: 1 -12 -27
QRS Dur: 104
QT/QTc: 400/406
I
II
III
Lateral STEMI with Reciprocal Changes
What would we expect with this patient?

Lateral

- Lead I, AVL, V5, V6
- Usually pretty stable



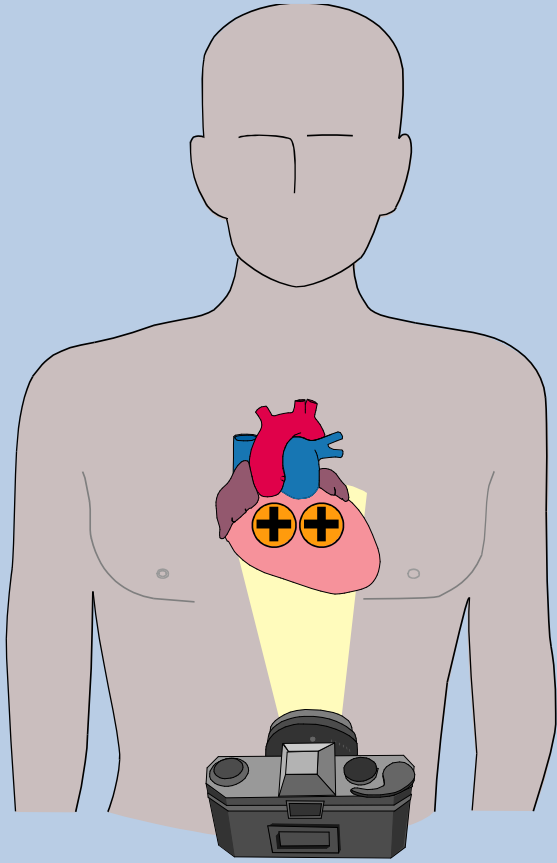
Types of MI


10:15:49 PM 4/19/99
12-Lead #1
HR: 56
P-QRS-T Axes: 44 75 16
PR Int: 116
I
II
III
Septal and Anterior STEMI with Reciprocal Changes
What would we expect with this patient?

Septal

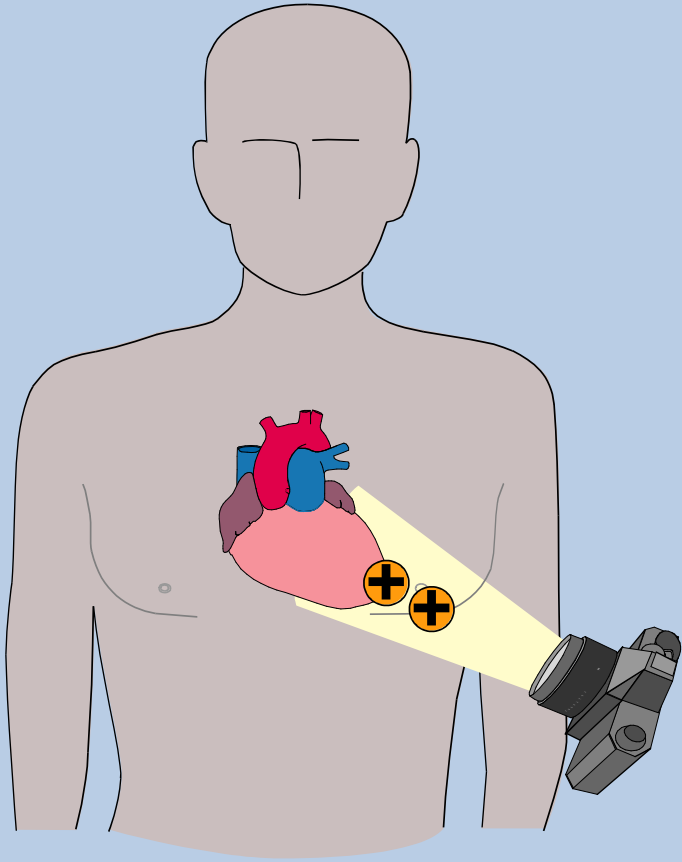
- Lead V1, V2
- Permanent Conduction Defects
- Causes Valve Rupture
  - Cordae Tendonae

- Bundle Branches!

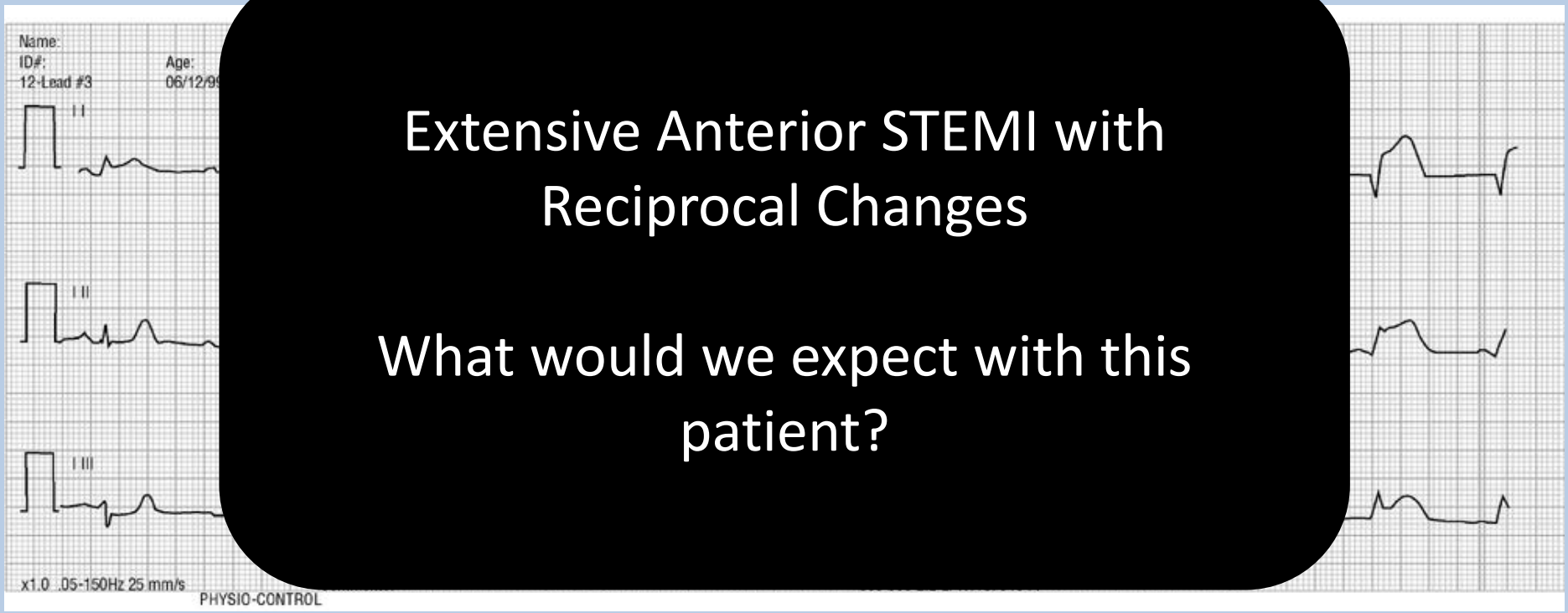


Anterior

- Lead V3, V4
- Permanent Conduction Defects
  - Mobitz 2
  - 3 degree AVB
- Cardiogenic Shock
- VF, VT, SCA



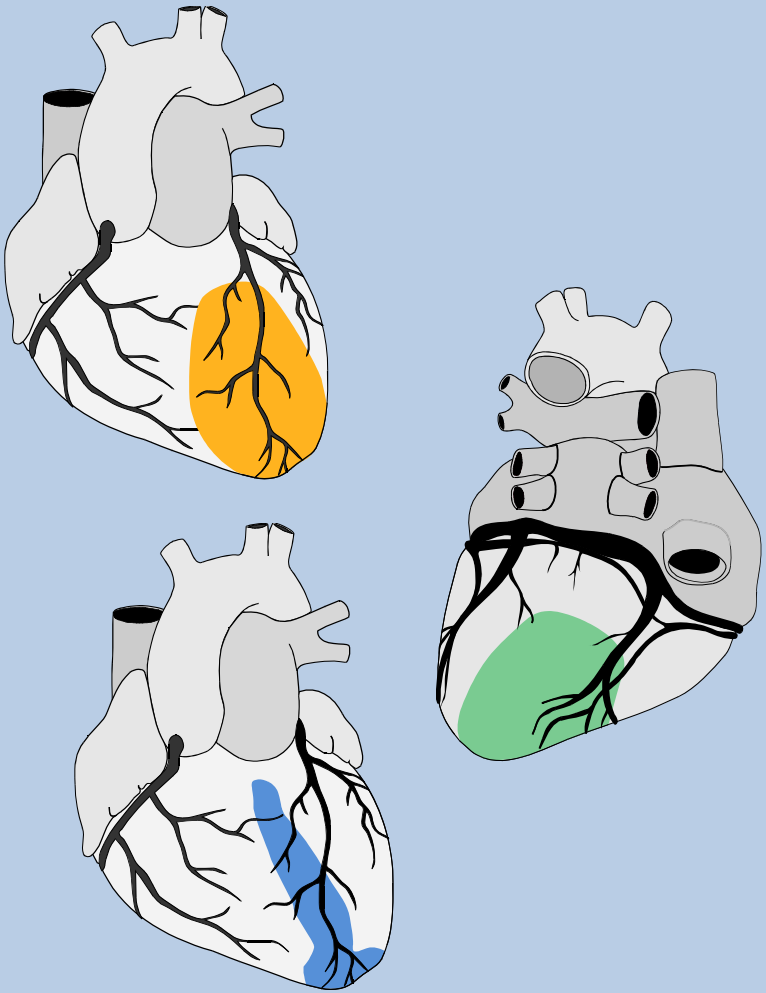
Types of MI



Extensive Anterior STEMI with Reciprocal Changes

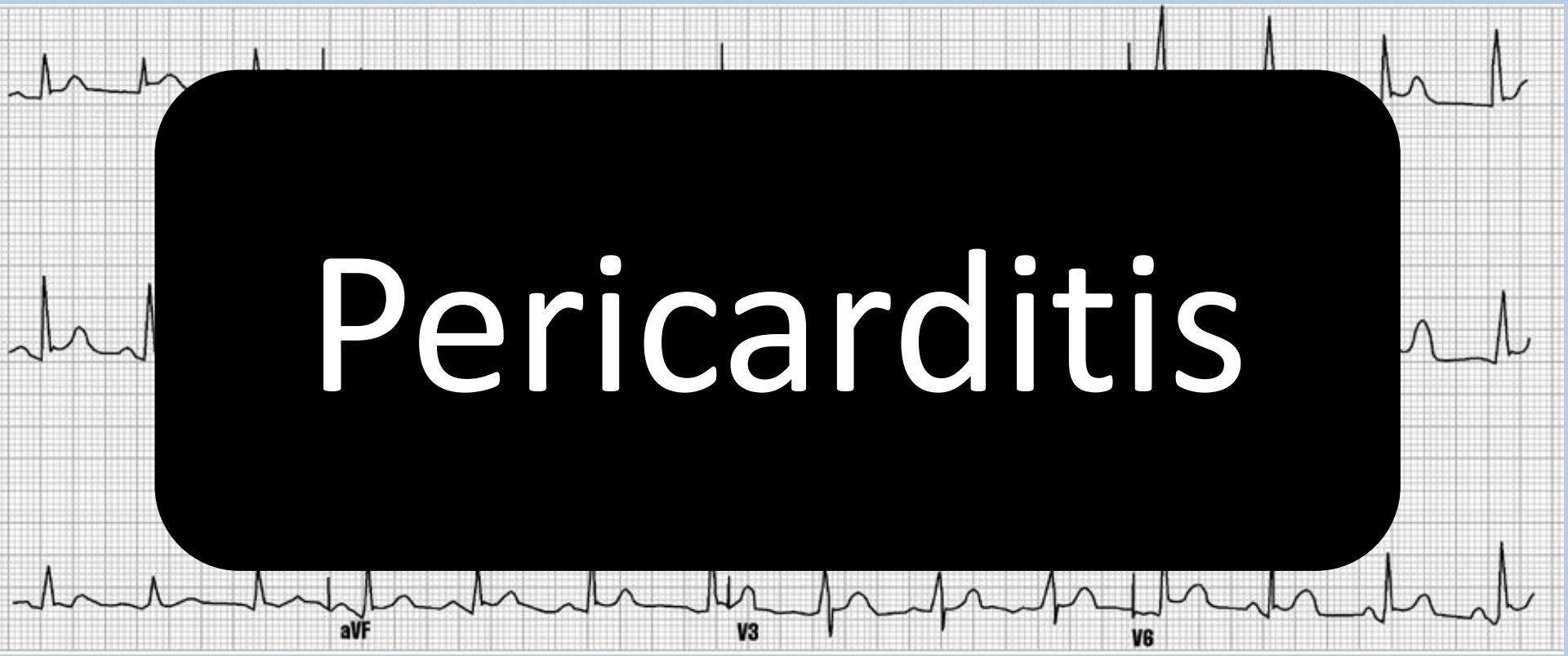
What would we expect with this patient?

Extensive Anterior



- Happens when Left Main occludes
- Involves portions of Septal, Anterior, and Lateral parts of Heart
- “Widowmaker”
- Cardiogenic Shock, CABG, SCA, Death

Types of MI



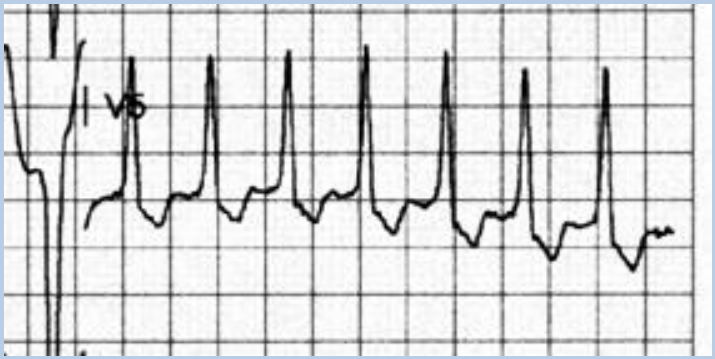
STEMImitators

- BBB
- Ventricular Rhythms
- LVH
- BER
- Vent Aneurism
- Pericarditis
- Medications

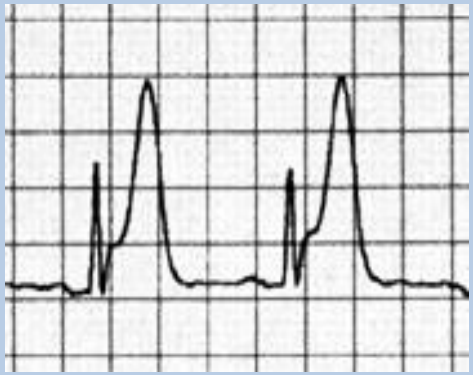
Objectives

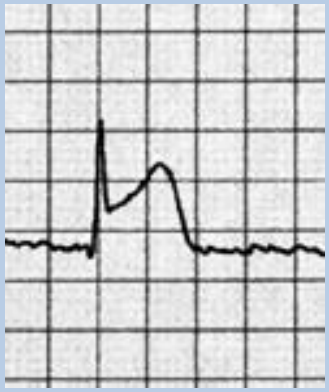
- Can you identify impostors vs. STEMI
- Discordant vs. Concordant
- GUSTO & HERO Trials
- STEMI vs.
  - LVH
  - BBB
  - Paced and Ventricular
  - BER and Pericarditis

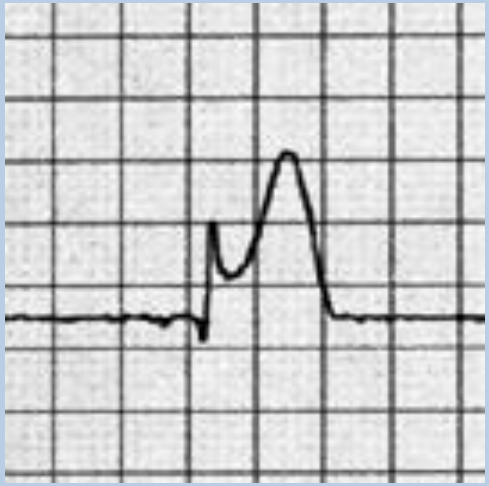
Discordant QRS-ST-T



Concordant QRS-ST-T







Ventricular Rhythms

- Can mask or mimic every ECG change suggestive of ACS

Paced rhythms

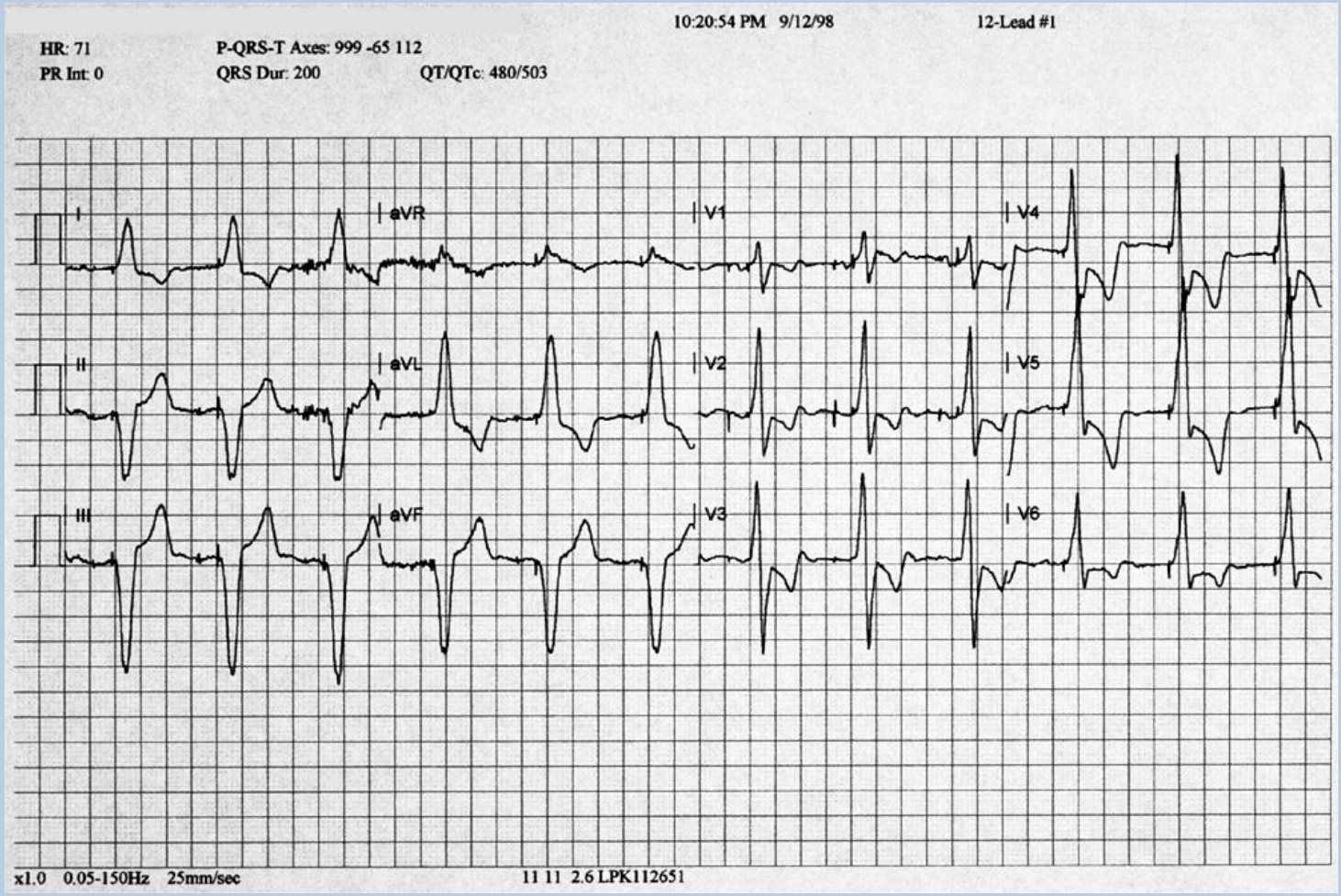
Idioventricular rhythms

AIVR

V-Tach

PVC

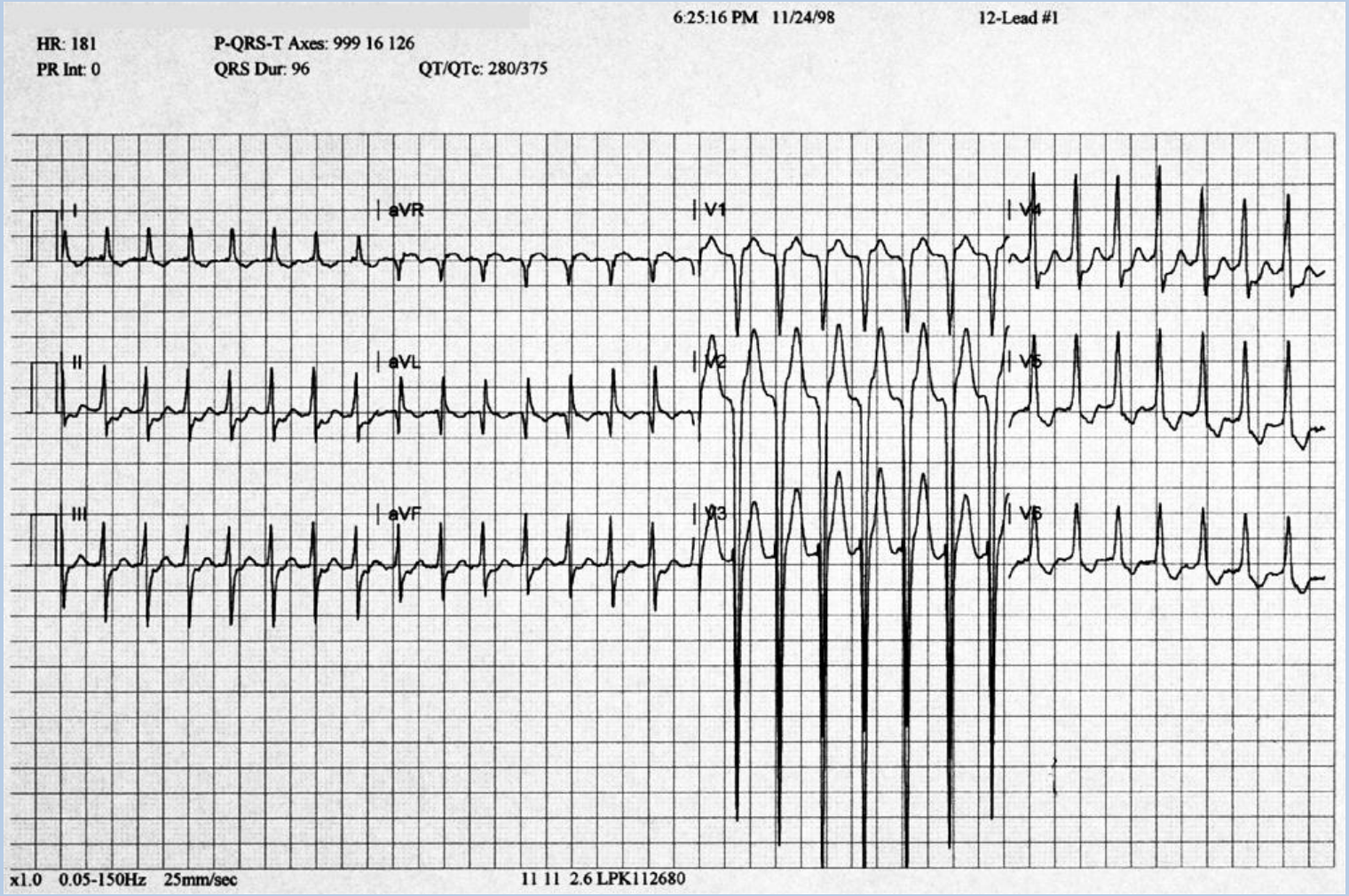
Ventricular Rhythms



Left Ventricular Hypertrophy

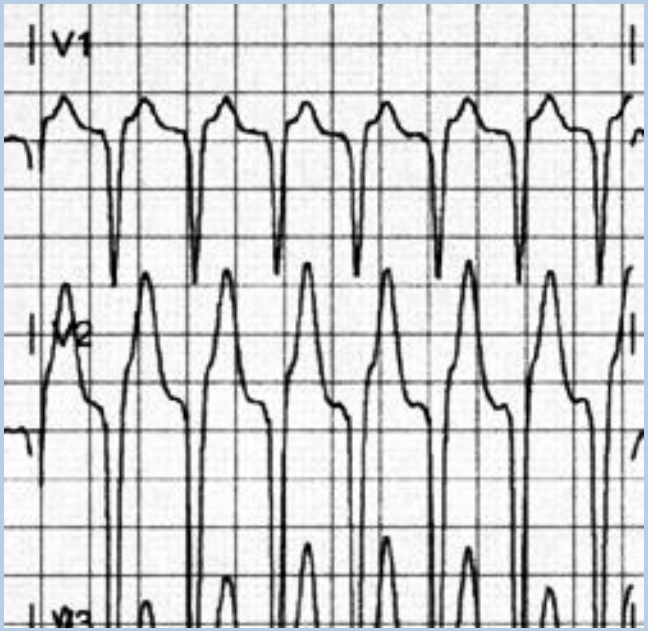
- Can mask or mimic every ECG change suggestive of ACS
- Enlarged left ventricle
  - Pumping against increased resistance
  - Chronic overfilling

LVH


6:25:16 PM 11/24/98
12-Lead #1
HR: 181
P-QRS-T Axes: 999 16 126
PR Int: 0
QRS Dur: 96
QT/QTc: 280/375
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112680

STEMI and LVH

- LVH normally produces discordance



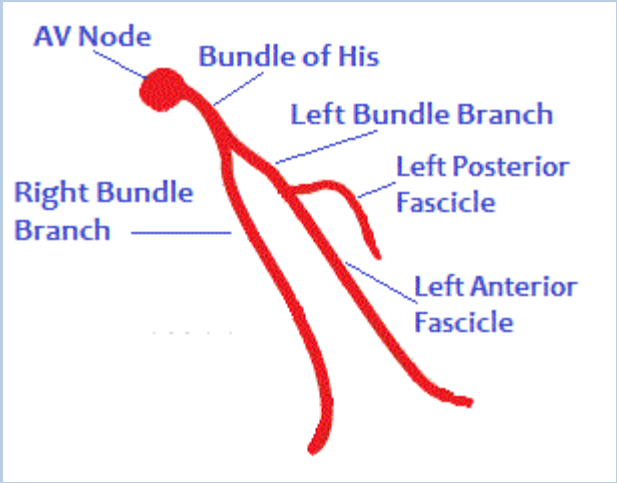
STEMI vs. LVH

- When ST elevation is present in contiguous leads…

- Suspect STEMI if ST elevation is concordant

Bundle Branches

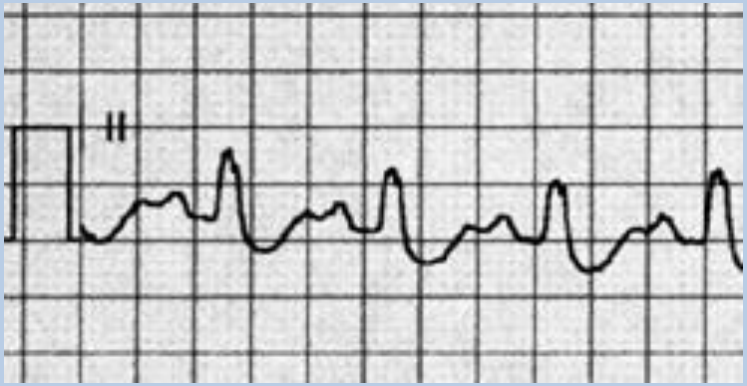
- Right and Left
- Left further divided
  - Anterior Fascicle
  - Posterior Facicle
- Why are Bundle Branch Blocks Bad?



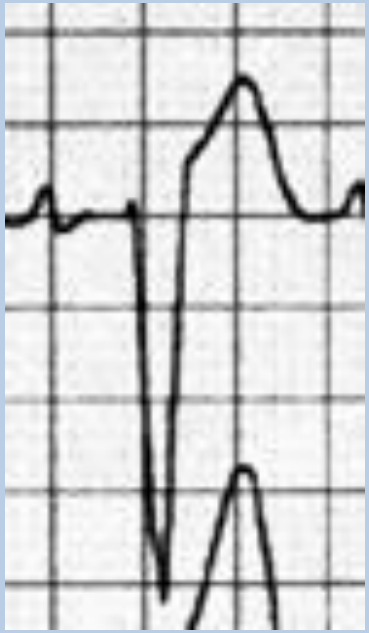
BBB Recognition

- Wide QRS
  - ≥ 120ms
- Supraventricular rhythm

BBB Recognition



BBB Recognition



Sgarbossa GUSTO 1 trial

- Of 26,003 MI patients, 131 had LBBB as well (0.5 %)
- Scoring Scale developed from 0 to 5 for predictability of AMI
- Resulted in high specificity, but low sensitivity

  – Sgarbossa et al NEJM 1996

HERO trial

- Of 297,832 patients 6.7 % had LBBB (n = 19,467)
- Refined criteria for predicting RBBB and LBBB in presence of AMI
- Resulted in high sensitivity and specificity for 2 of 3 criteria

  – Wong et al J Am Coll Cardiol 2005

What's all the fuss about LBBB

- When caused by AMI
  - Causes pump failure and CHF
  - Highest mortality rate of any MI
  - Most Complications
  - Requires extensive Interventional Cardiology and in many cases requires CABG

LBBB vs. STEMI

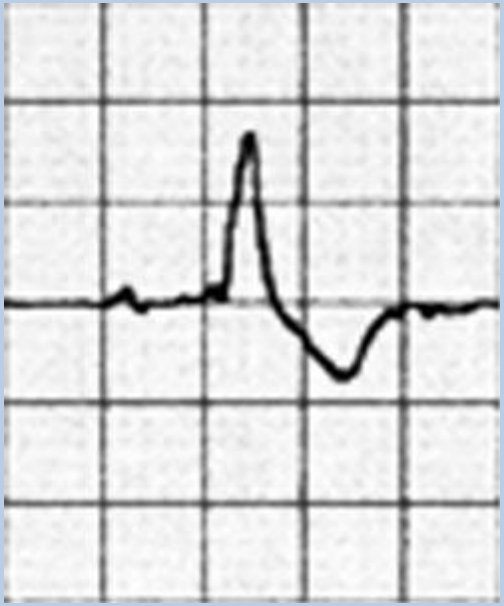
- Concordant ST elevation in any lead
  - 92% probability of STEMI
- Concordant ST depression in V1, V2, or V3
  - 88% probability of STEMI
- Discordant ST elevation > 5mm
  - 50% probability of STEMI

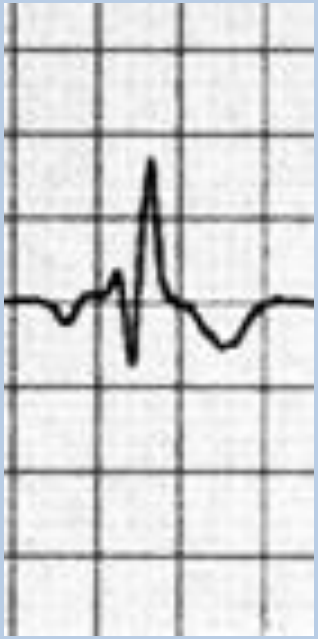
Combinations

- Concordant ST elevation with ST elevation > 5mm
  - 98% probability of STEMI
  - But only 36% of STEMI's had that criteria

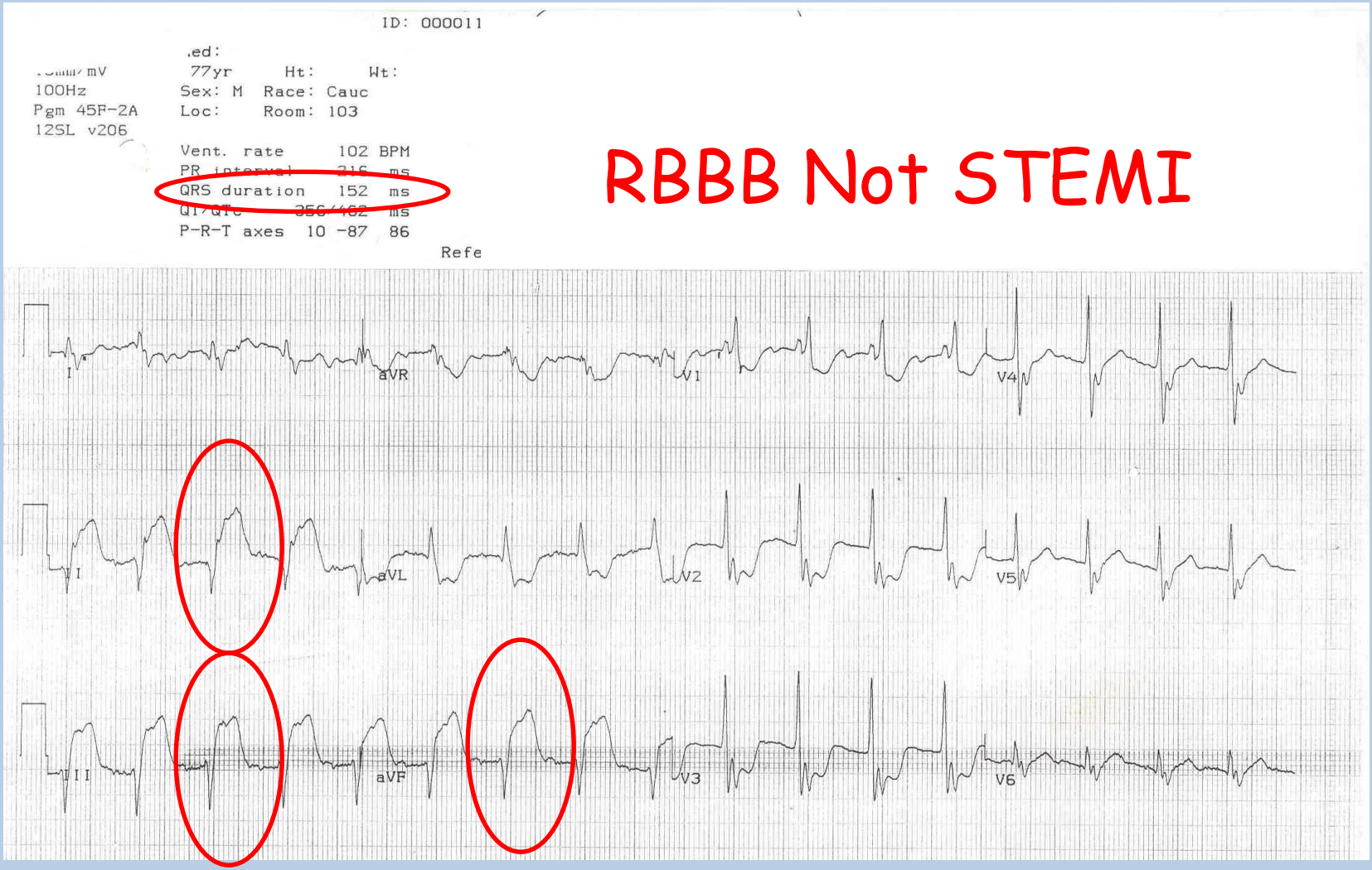
RBBB vs. STEMI

- When pt has RBBB...with ST elevation
- Suspect STEMI if ST elevation is concordant with direction of terminal force of QRS





Discordant ST elevation



LBBB

- Highest Mortality (is a bifascicular block)
- J Hypert 2008 Li et al (compared to Ant MI)
  - 350% increased one hour mortality
  - 360% increased 24 hour mortality
  - 160% increased post AMI discharge death
  - 170% increased future heart failure hospitalizations

RBBB

- RBBB with bifascicular (LPFB) block
  - 8% required pacemaker
  - No fatalities with 6 year followup
  - J Coll Cardiol 2013 Maleil et al
- RBBB with bifascicular (LAFB) block
  - 3 year mortality rate of 25% when compared to anterior MI (J Coll Cardio 1978 Denes et al)
  - 140% increase in complete heart block

BBB

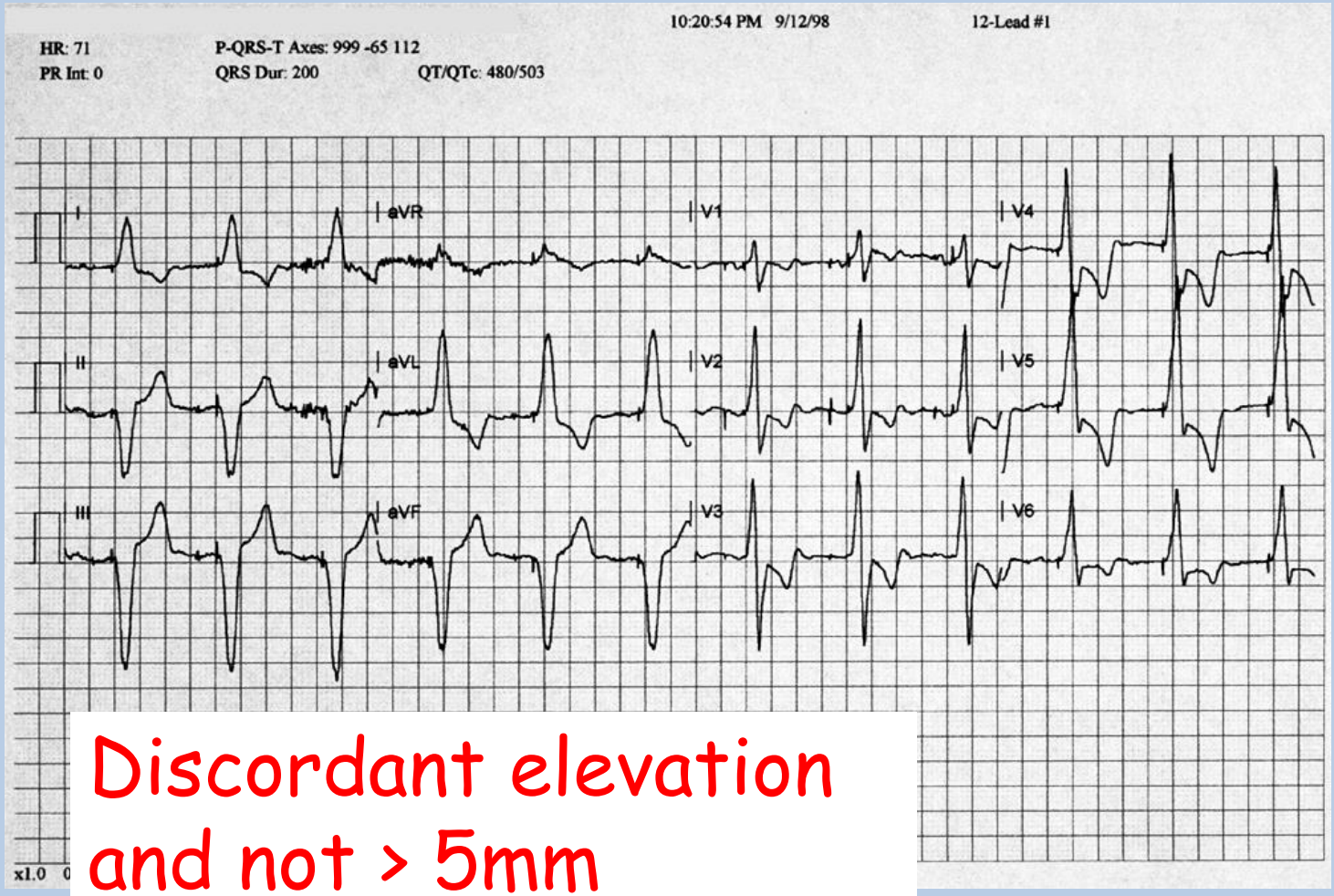
- May be old… may be new
- If not proven to be old, assume it is new
- If story and risk factors suggest MI, treat new or assumed to be new BBB as ST elevation
- If possible…seek most recent ECG

How do you get an old EKG?

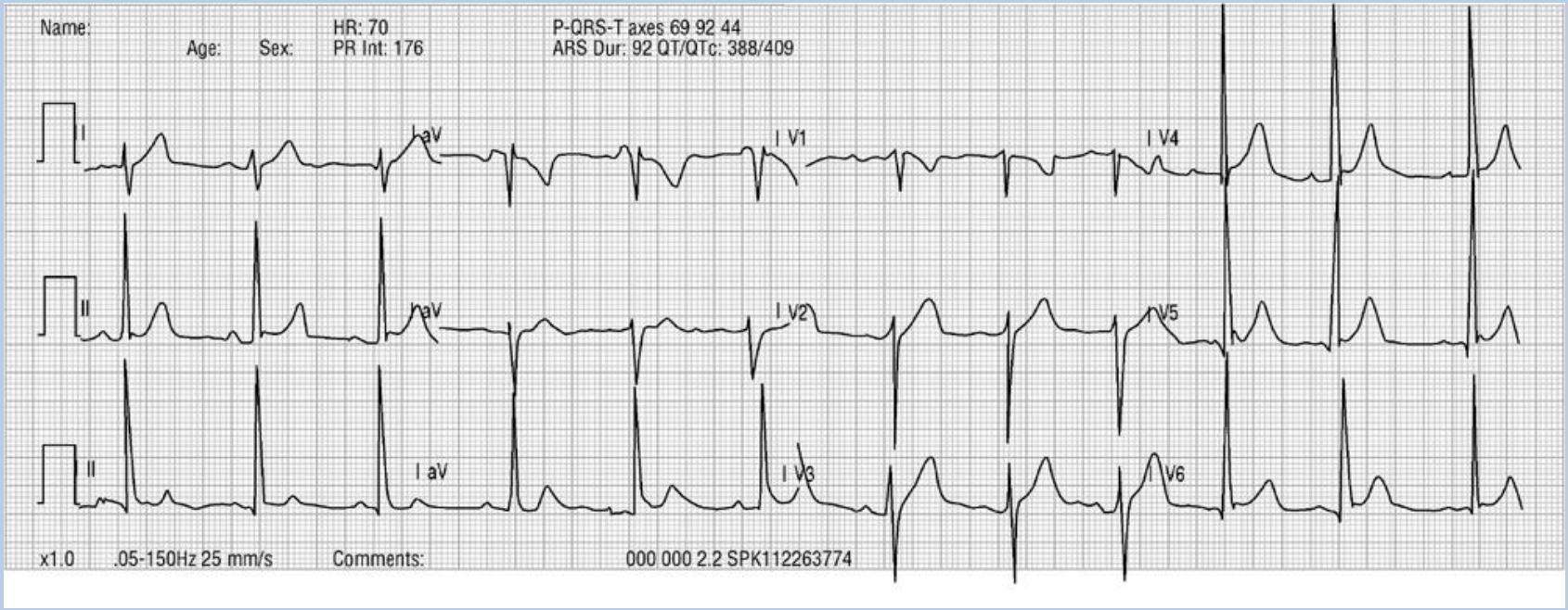
STEMI and Paced Rhythms

- Use HERO criteria but order changes
- Most predictive is ST elevation > 5 mm
- Next most predictive is Concordant ST elevation
- But R-T axis deviation means something…

Paced Rhythms



Benign Early Repolarization

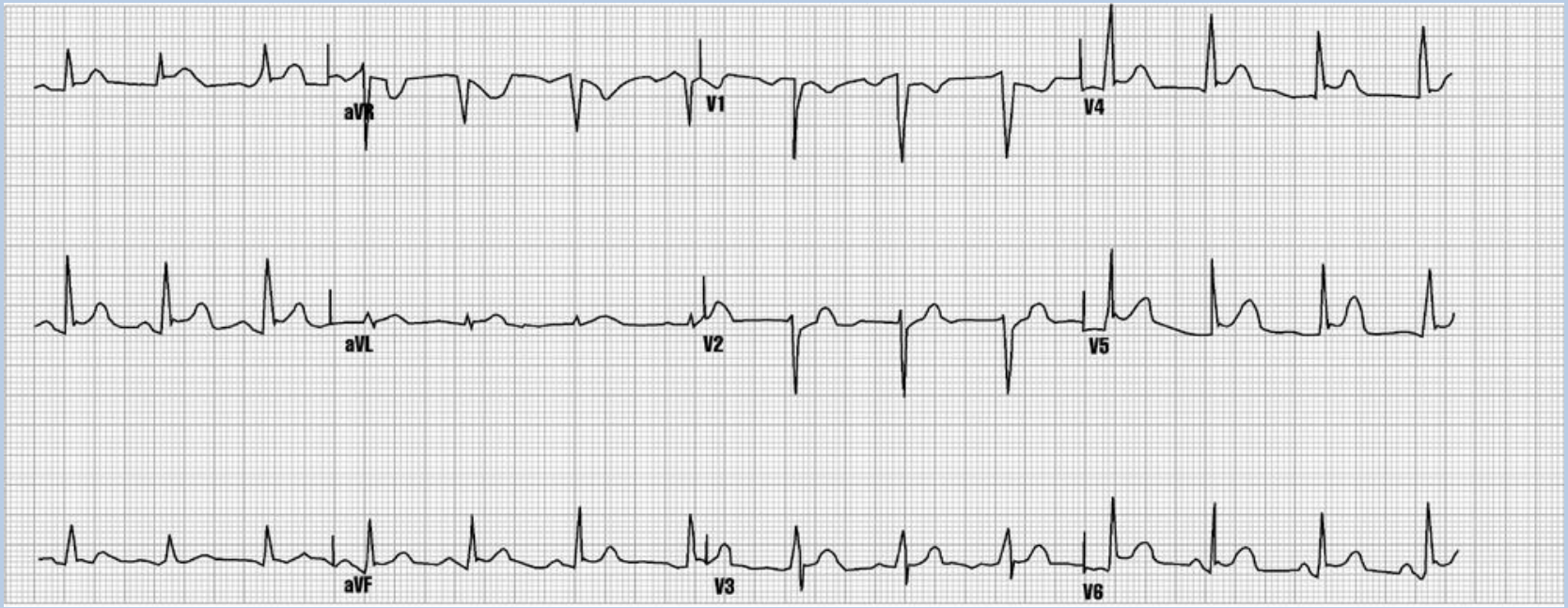


Benign Early Repolarization

- Changes usually seen in anterior and lateral leads
  - ST Elevation
  - Tall T waves
- Most often seen in males ages 20-40
  - African males

Benign Early Repolarization

Pericarditis



Pericarditis

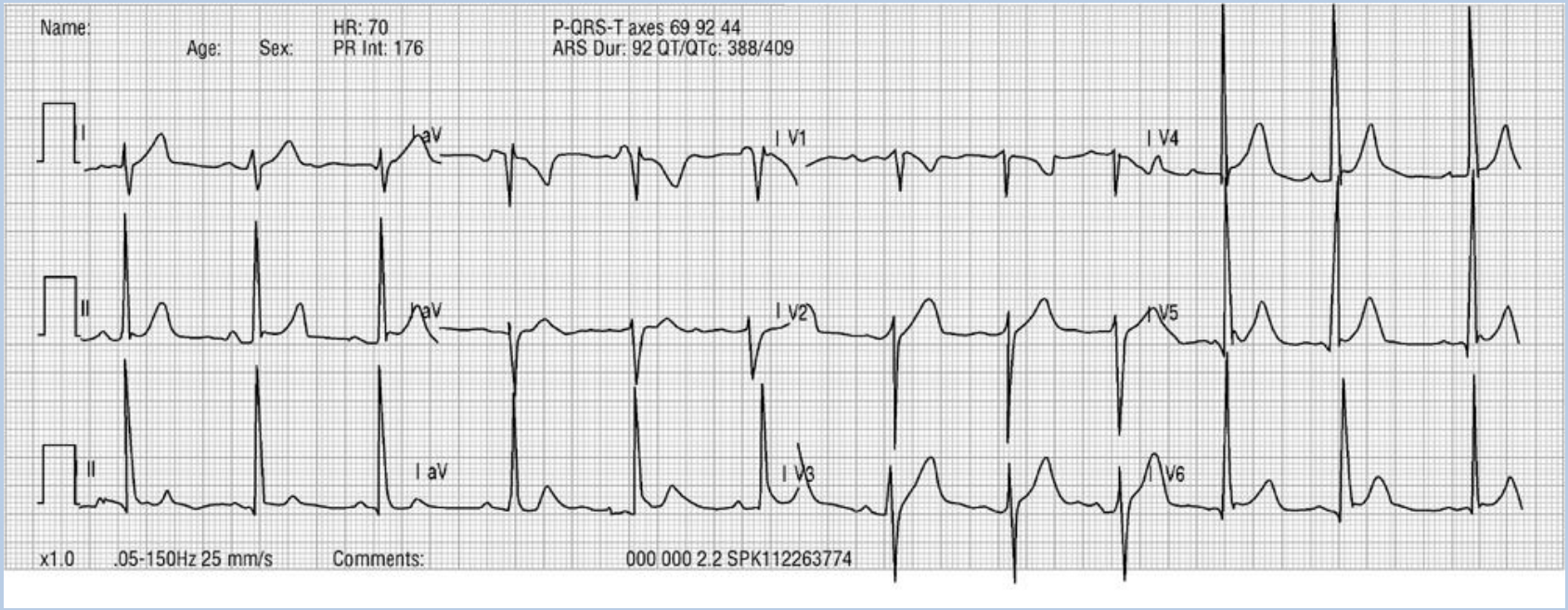
- May be viral, bacterial or metabolic
- Clinical presentation may include chest pain
- Often produces diffuse ST elevation on ECG
- Also has non grouped ST elevation

BER and Pericarditis

- Both produce concordant ST elevation!!
- Both do not produce reciprocal changes

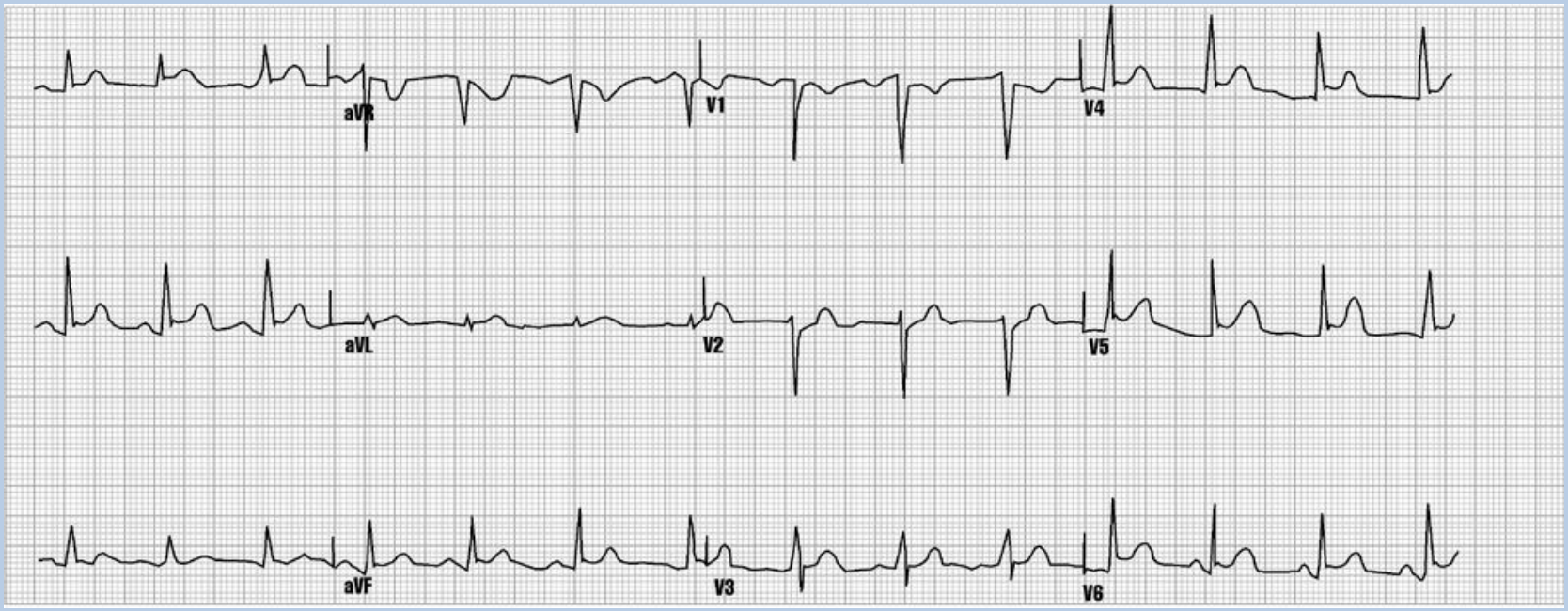
- If reciprocal changes are present, STEMI probability is HIGH

Benign Early Repolarization



Not STEMI, No reciprocal changes

Pericarditis



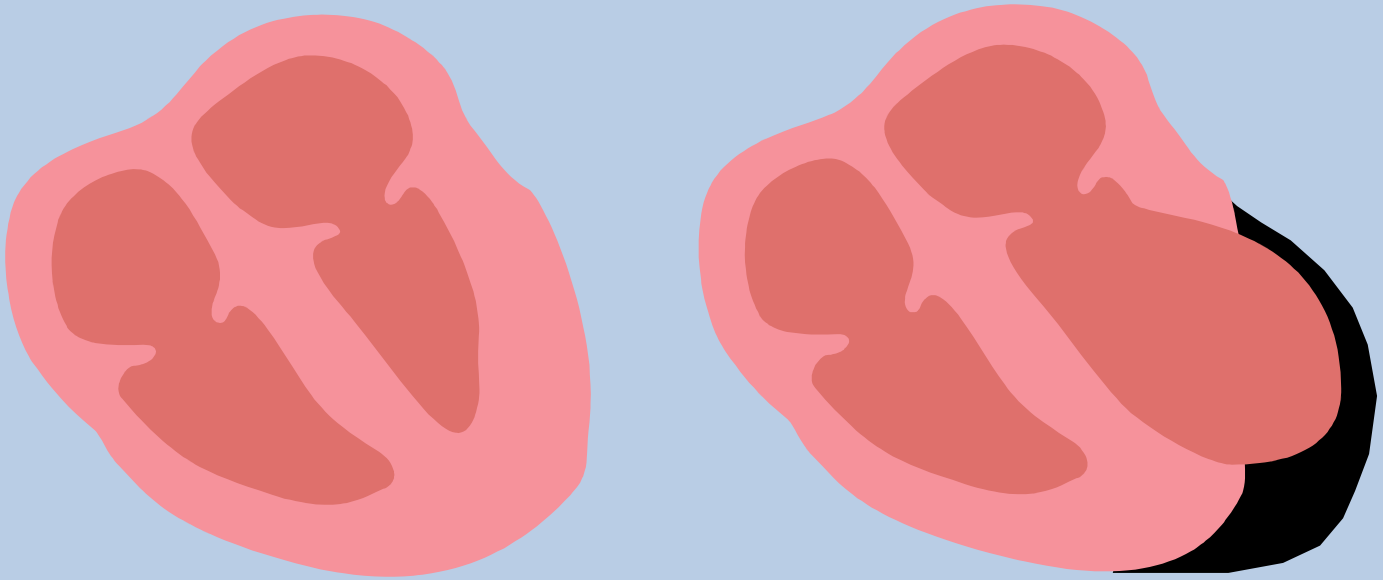
Not STEMI, No reciprocal changes

Ventricular Aneurysm

- Can mask or mimic every ECG change suggestive of ACS

- NOT Aortic Aneurysm
- “Bleb” in ventricle secondary to infarct
  - Bleb is dyskinetic
  - “Pops out” when ventricle contracts

Ventricular Aneurysm



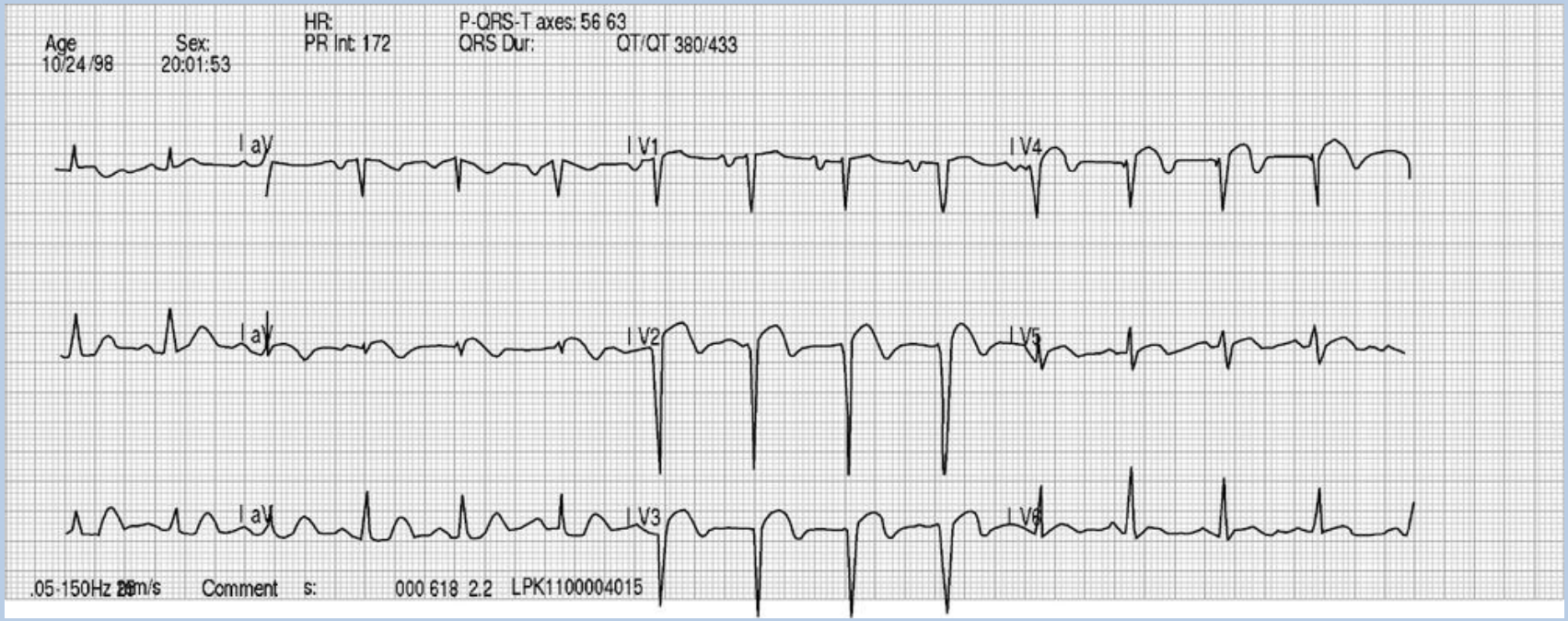
Ventricular Aneurysm

- Associated with persistent ST elevation
  - Often in V1-V4
  - Can occur in any lead

Ventricular Aneurysm

Ventricular aneurysm is difficult to identify with certainty without previous ECG tracings.

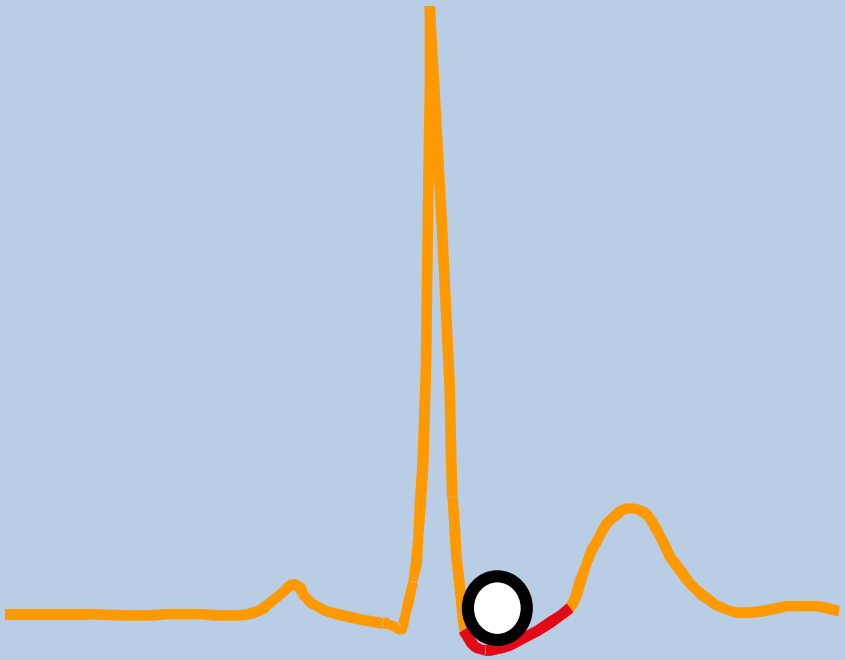
As with the other imitators, when the clinical presentation suggests ACS, treat the patient accordingly.



Medications

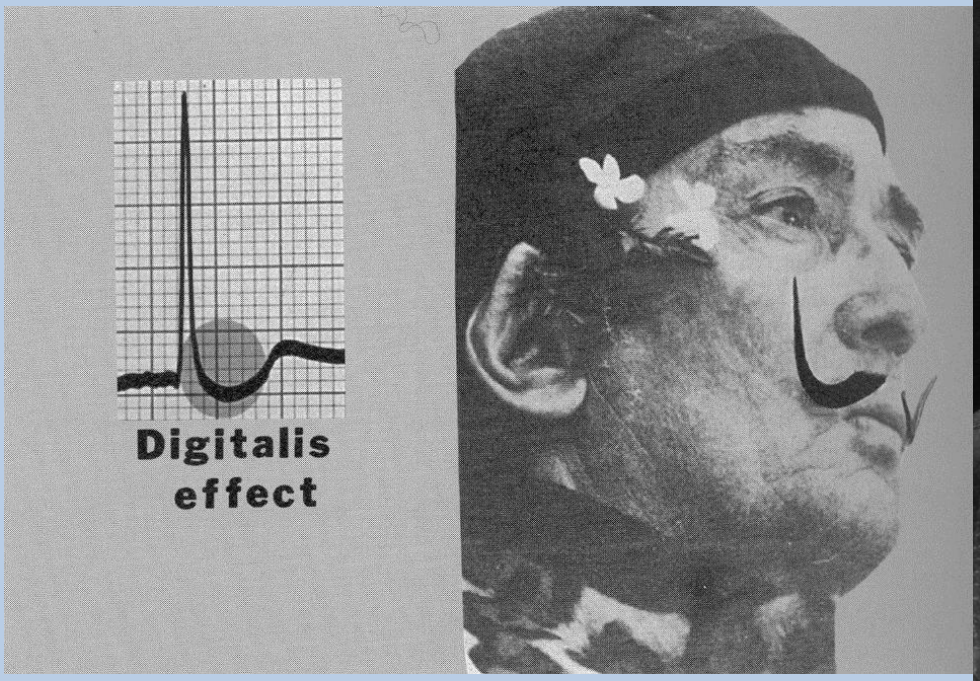
- Some medications affect the ECG
- Digitalis
  - ST depression
  - Characteristic sag

Digitalis Effect



Dig Effect

- Salvador Dali's mustache



Remember…

- Most of this is for predicting interventional cardiology success and appropriate destination
- ACS treatment remains targeted at History, Risk Factors, ECG, and Sx

Summary

- Imitators can incorrectly place an ECG into any of the three categories

ST Elevation BBB	ST Depression T wave inversion	Normal Non-diagnostic

Axis

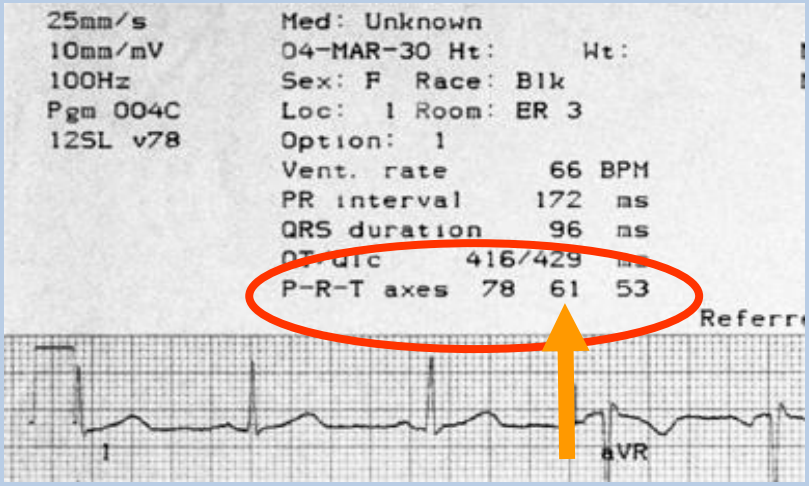
And why it can solve most Imitators

P-R-T Axis Deviation

- Complicated
- Seldom used to its full benefit
- Most people just don’t care about it…

Why do we care?

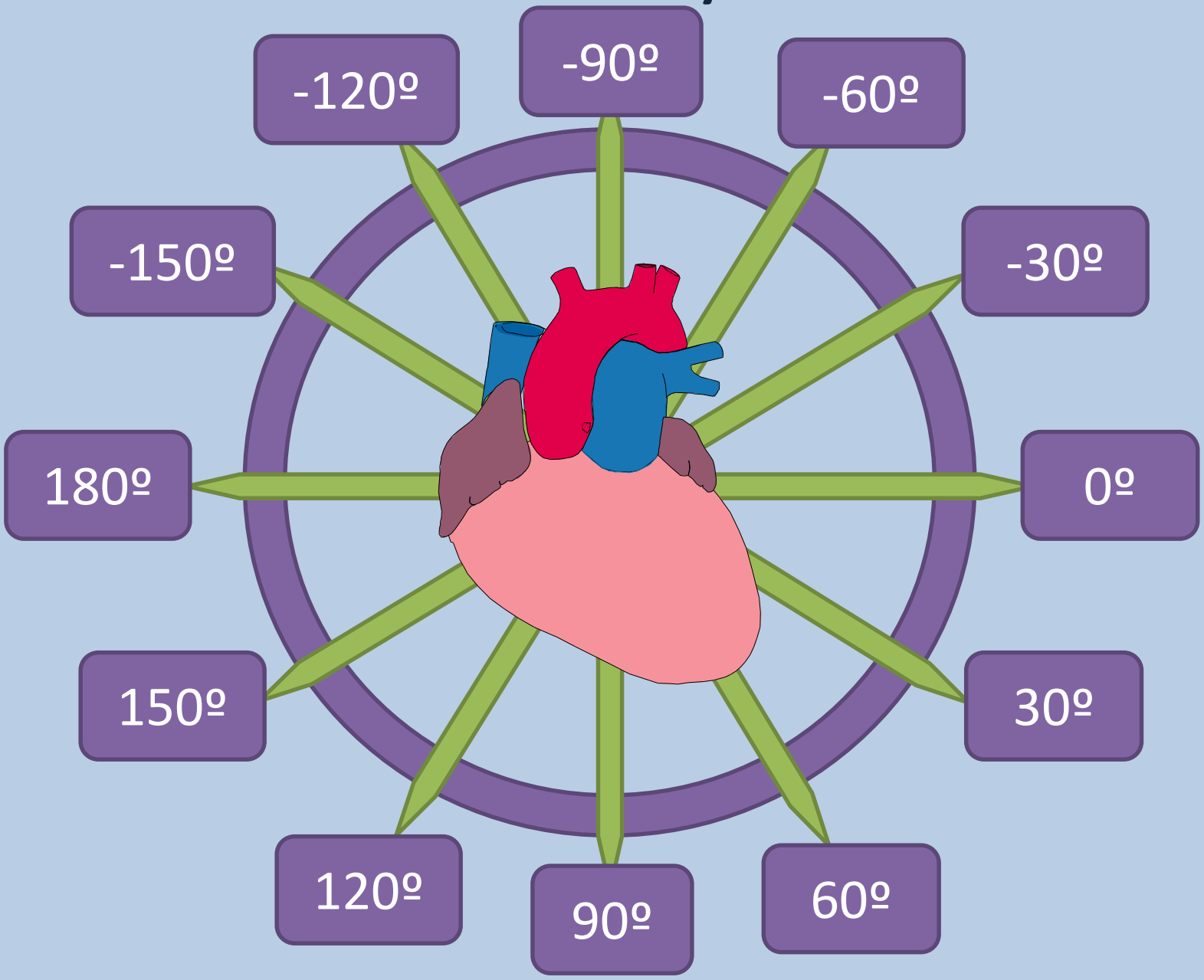
- It can tell you about the pt
  - MI or Hypertrophy
- It can tell you why the waveform is abnormal
- It can tell you where the rhythm came from



What is it?

- Axis refers to the direction of each waveform's electrical conduction
- Three Axis
  - P wave
  - QRS (R)
  - T wave
- We care about QRS Axis…(and P and T)

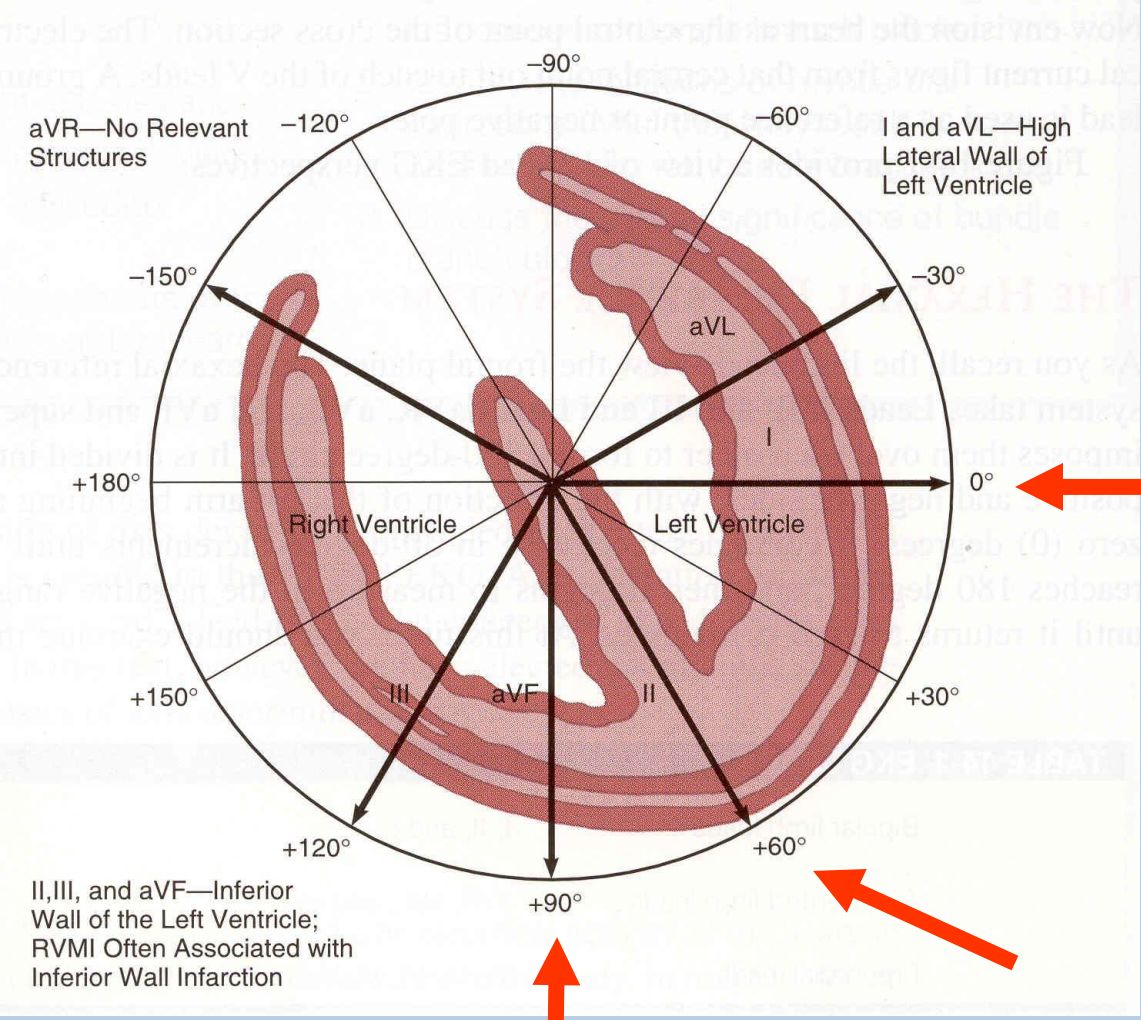
Hexaxial System



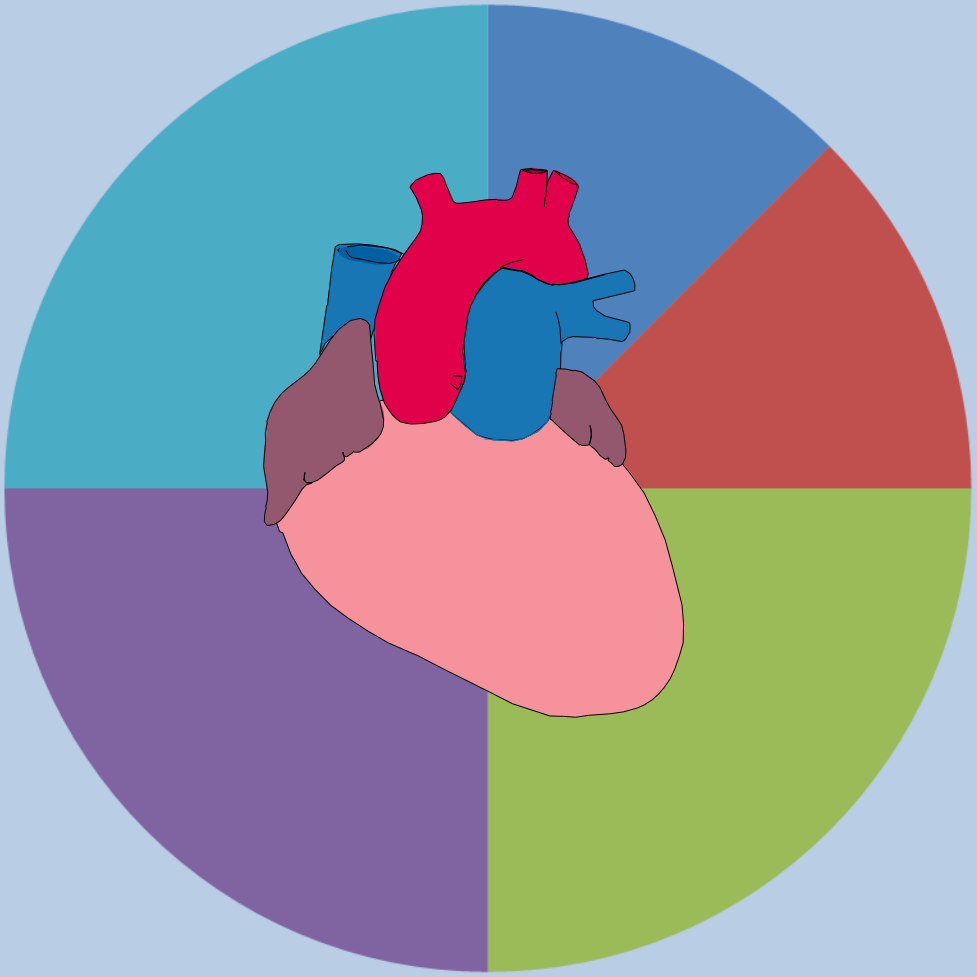
Someone put axis on its side

- The limb leads imposed into a 360º circle
- Divided into positive (0-180) and negative (180-0) sides
- Top is Negative and Bottom is Positive
- Normal is 0 to +90
  - Average norm is +60

Hexaxial Reference System



Axis Deviation Labels



- Pathologic Left Axis -45 to -90
- Physiologic Left Axis -1 to -45
- Normal Axis 0-90
- Right Axis 90-180
- Indefinite Axis -90 to -179

Things that cause Right Deviation

- COPD
- PE
- Congenital Heart Disease
- Pulmonary Hypertension
- Cor Pulmonale

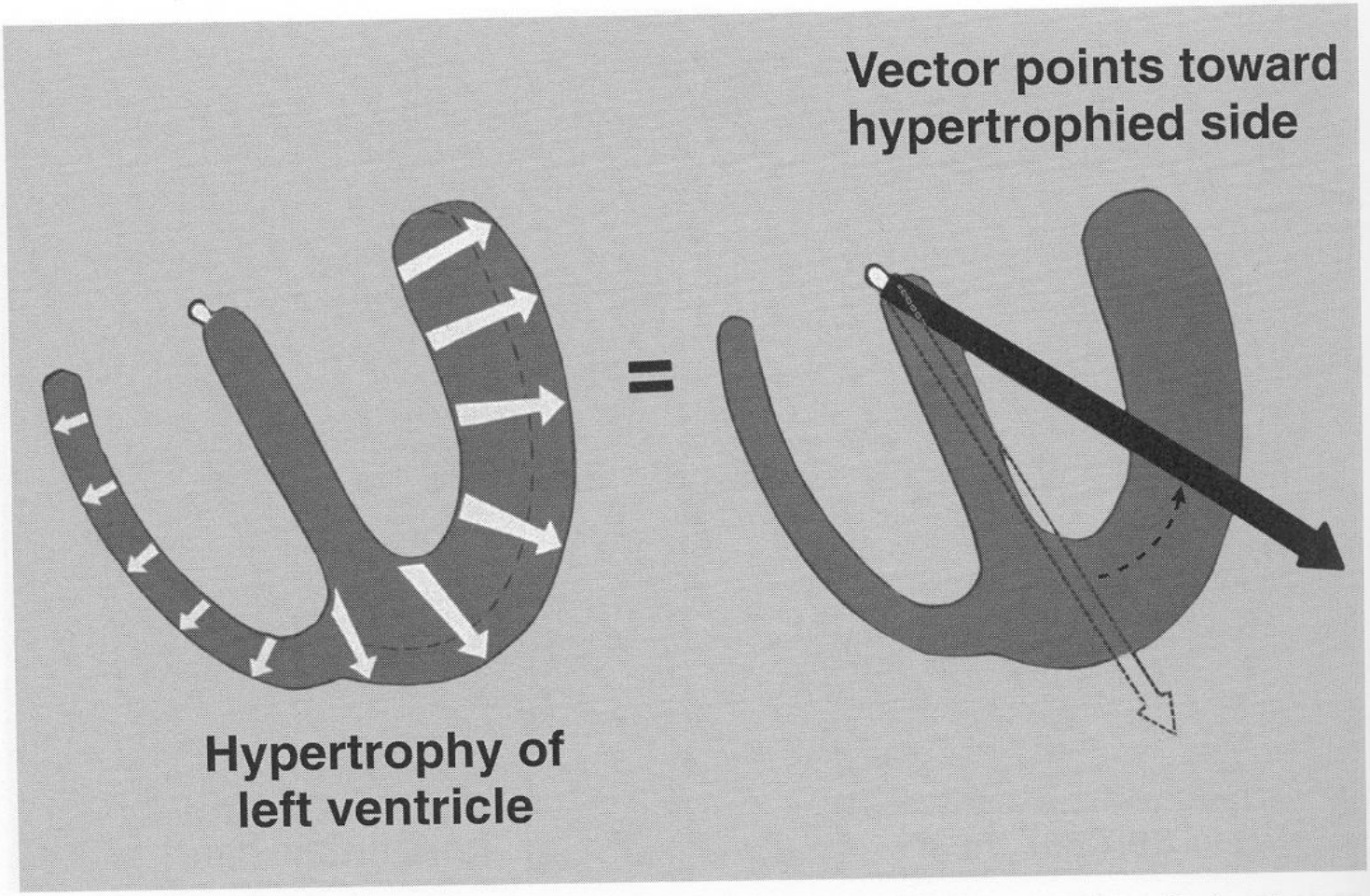
Things that cause a Left Deviation

- Ischemic Heart
- Systemic Hypertension
- Aortic stenosis
- LV Disorders (Hypertrophy)
- Aortic Valve Disease
- WPW
- Lyme Disease

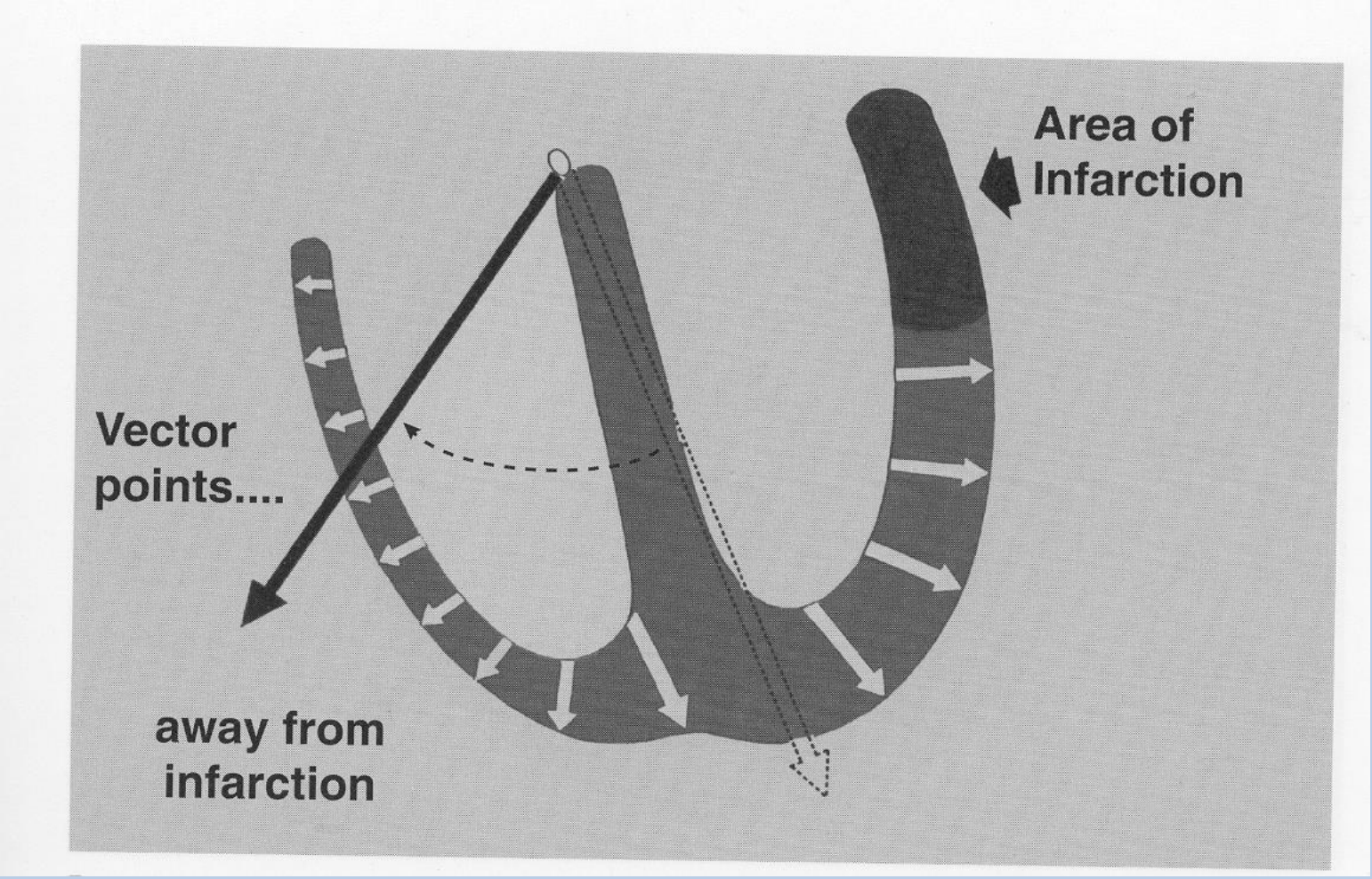
Axis Changers
(That we care about)

- Hypertrophy
- Infarct
- Bundle Branch Blocks

Hypertrophy



Infarct



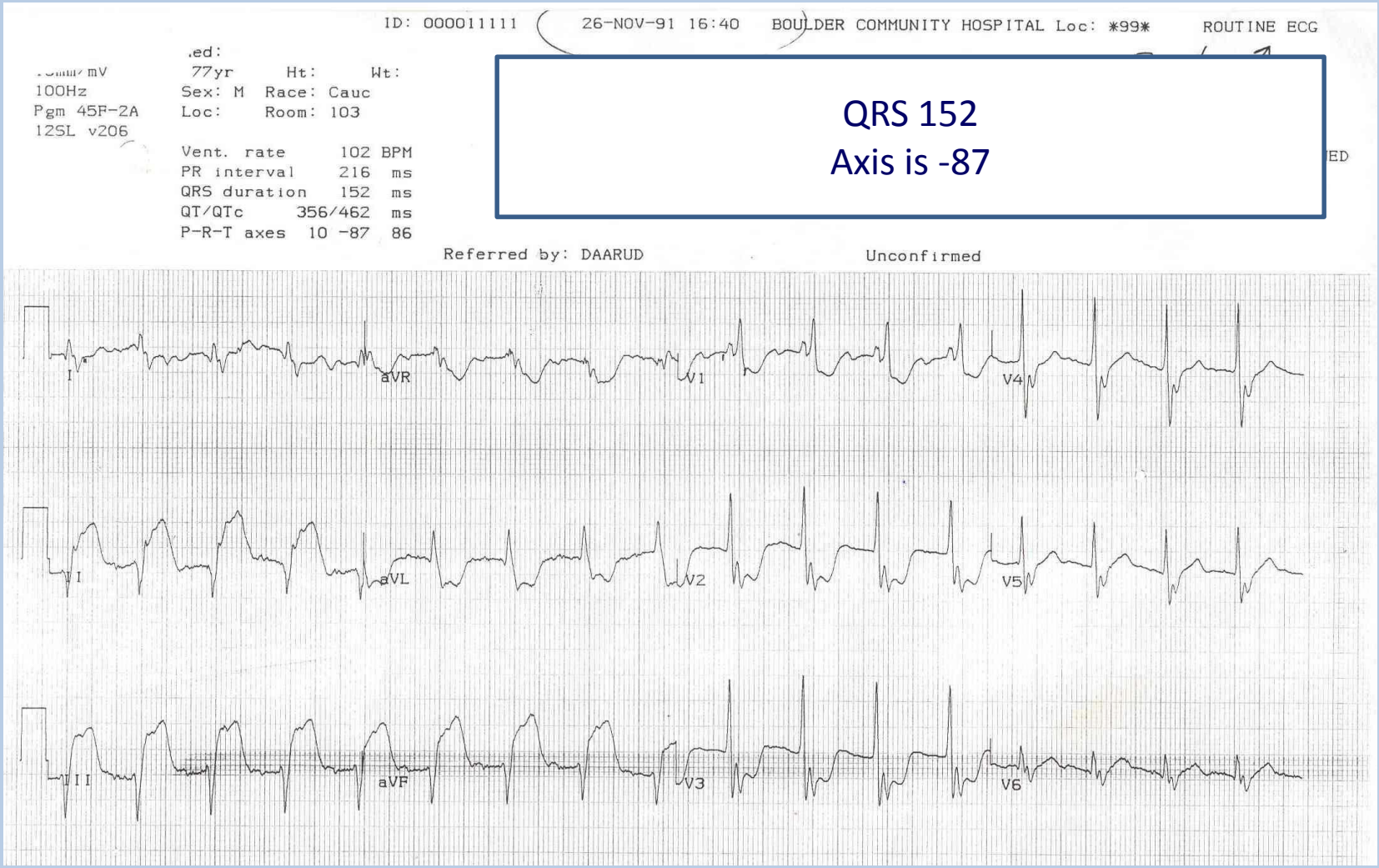
Let er rip Potato Chip!

- LBBB is Dx with QRS > 120 ms and negative terminal force in V1 (Bifascicular)
- RBBB is Dx with QRS > 120 ms and positive terminal force in V1
- RBBB with LAFB is when axis is deviated left
- RBBB with LPFB is when axis is deviated right

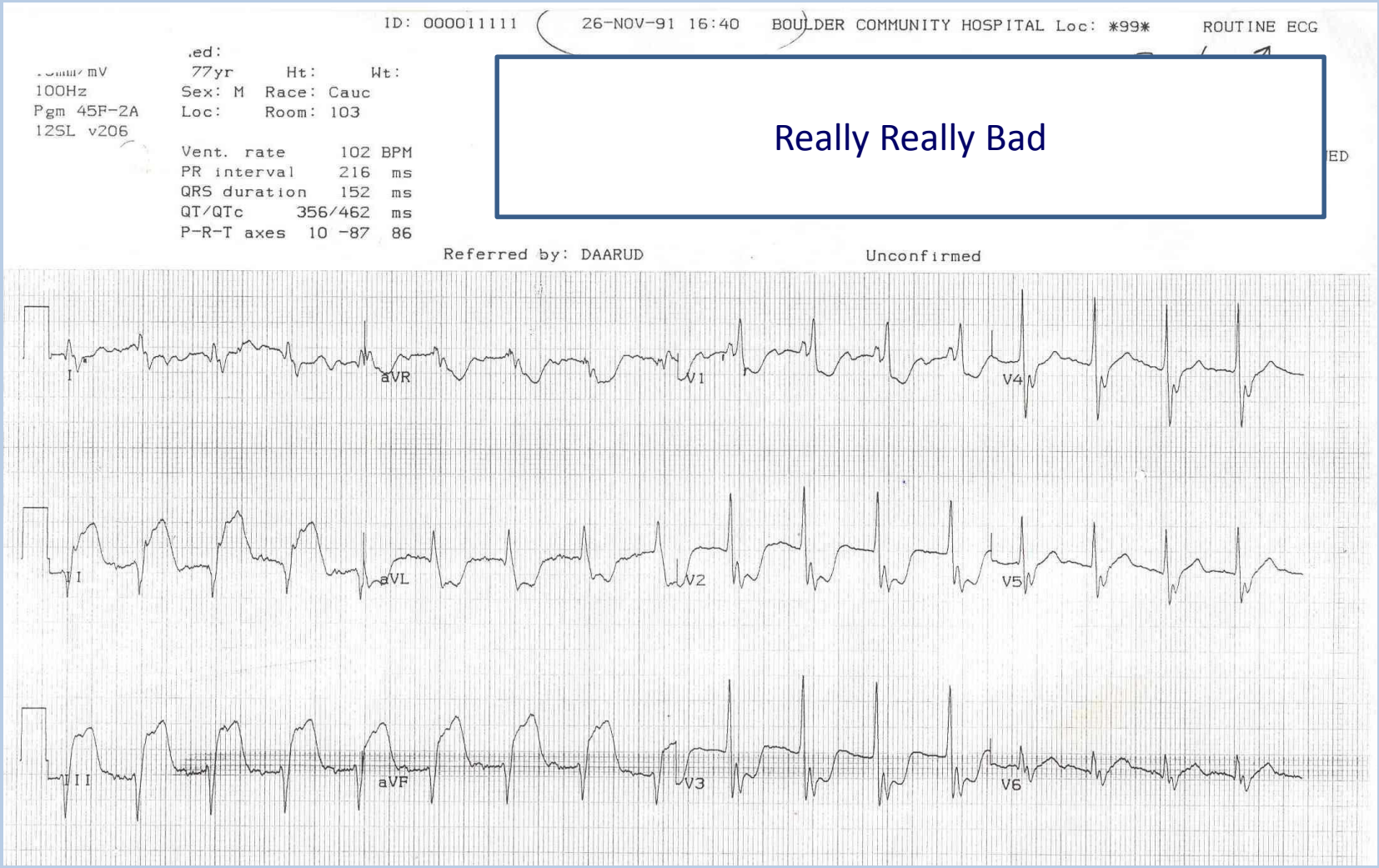
3 am Simplified

- BBB are bad
- LBBB are really bad
- BBB with axis deviation are really really bad
- LBBB with axis deviation are really really really bad
- And now you know so you don’t have to kill nobody…

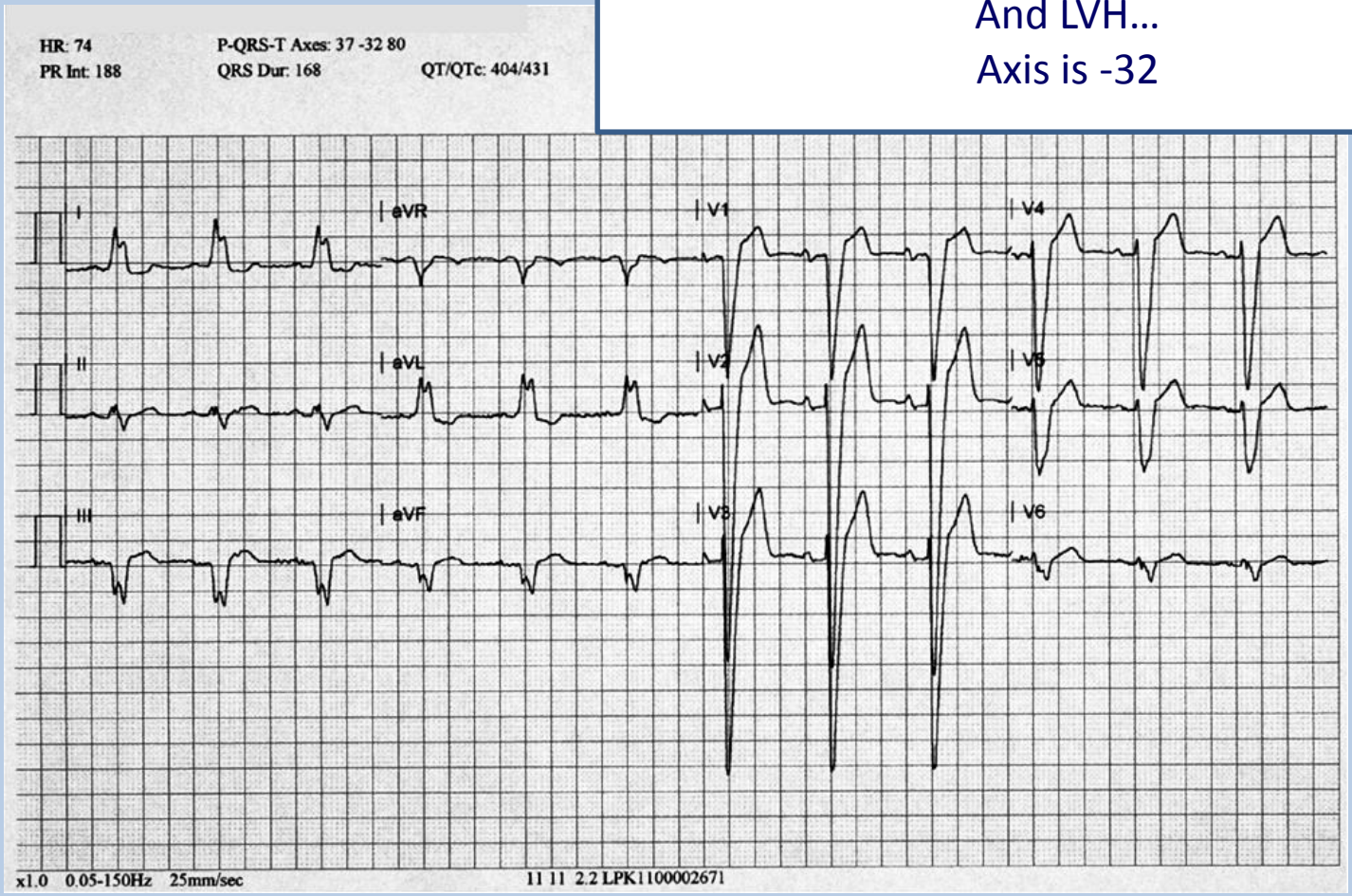
BBB


ID: 000011111
26-NOV-91 16:40
BOULDER COMMUNITY HOSPITAL Loc: *99*
ROUTINE ECG
77yr Ht: Wt:
Sex: M Race: Cauc
Loc: Room: 103
100Hz
Pgm 45P-2A
12SL v206
Vent. rate 102 BPM
PR interval 216 ms
QRS duration 152 ms
QT/QTc 356/462 ms
P-R-T axes 10 -87 86
Referred by: DAARUD
Unconfirmed
QRS 152
Axis is -87
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

RBBB with LAFB



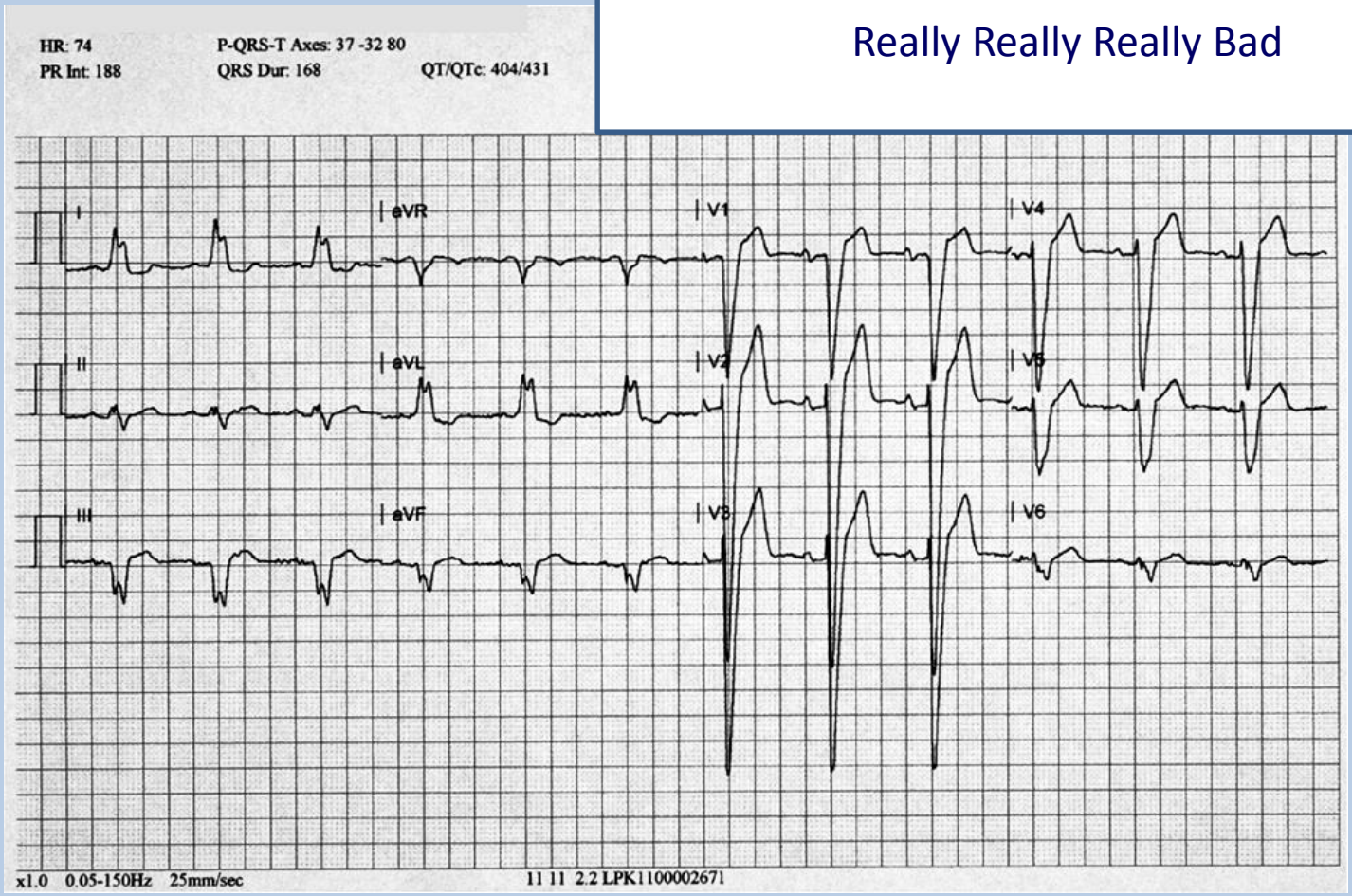
BBB



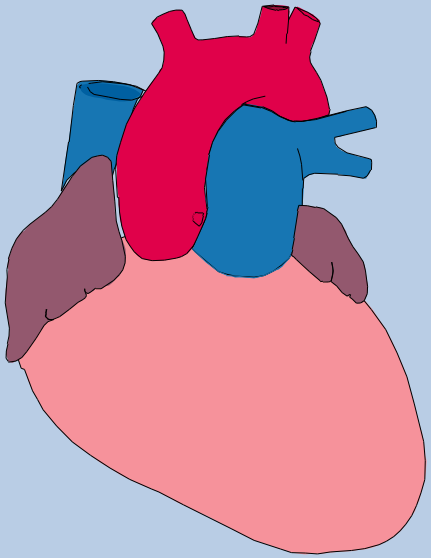
And LVH…
Axis is -32

LBBB

Really Really Really Bad



R-T axis deviation…



T axis Deviation

- Shimizu et al Circulation 2018
- T wave Right axis deviation and T wave Indefinite axis are strong predictors of LV dysfunction
- QRS-T Deviation >43 degrees associated with 140% increased mortality

Salles et al J Cardiology 2006

- Patients going into SCA from Chagas Disease
- Abnormal T axis increases mortality 300%
- Abnormal T axis increases SCA 600%

Scherer et al Scand Card J 2009

- Icelandic Men and Women looking at Cardiac Artery Calcification and T axis deviation
- T wave Deviation accurately associates with a high CAC score
- T wave Deviation accurately predicts atherosclerosis before diagnosis in men and women

Oehler Ann Electrocardiology 2014

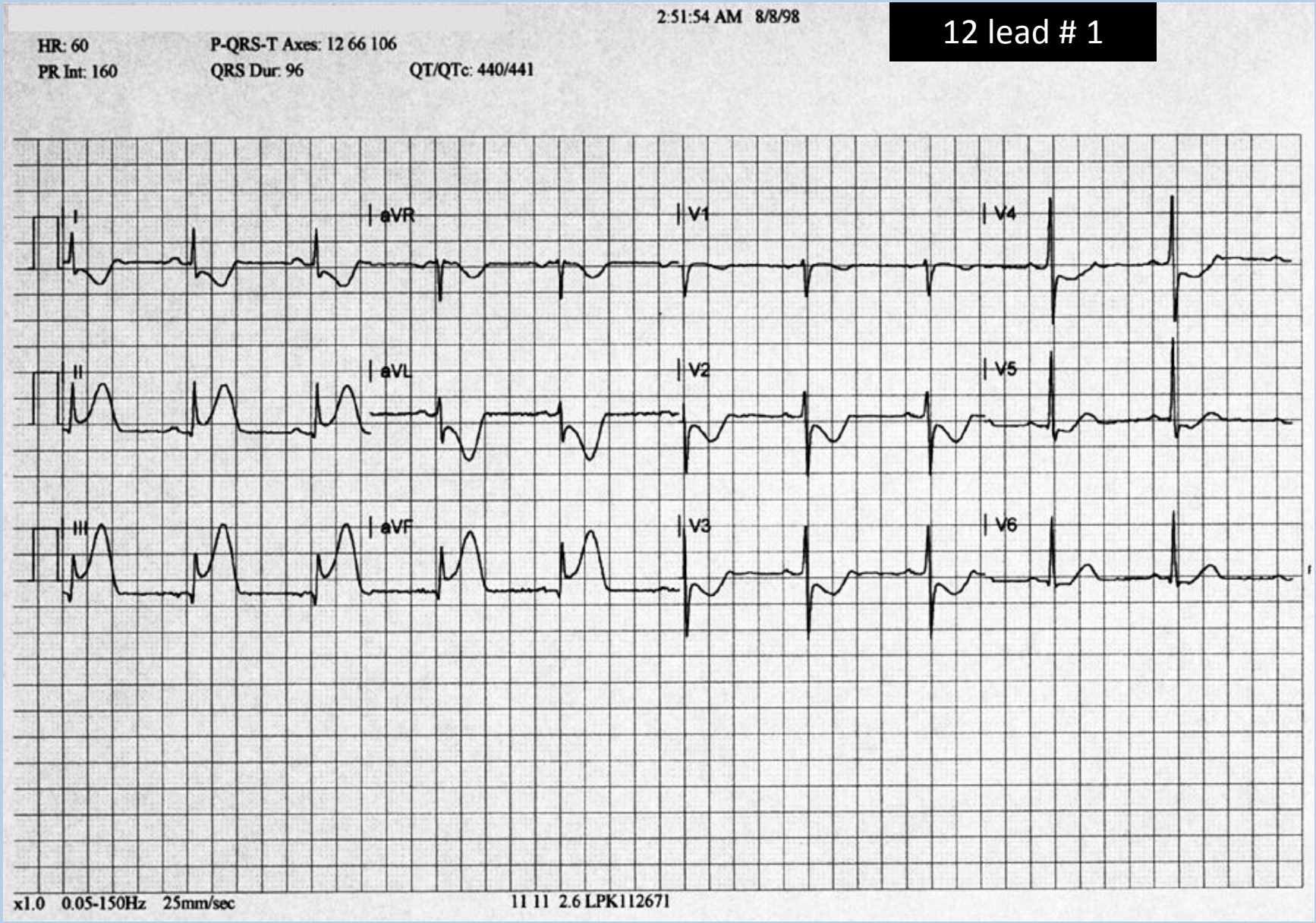
- QRS/T angle greater than 100 is associated with:
  - Higher sudden cardiac arrest
  - Higher incident of ventricular arrythmias
  - Higher mortality rates
  - Higher morbidity

3 am Simplified

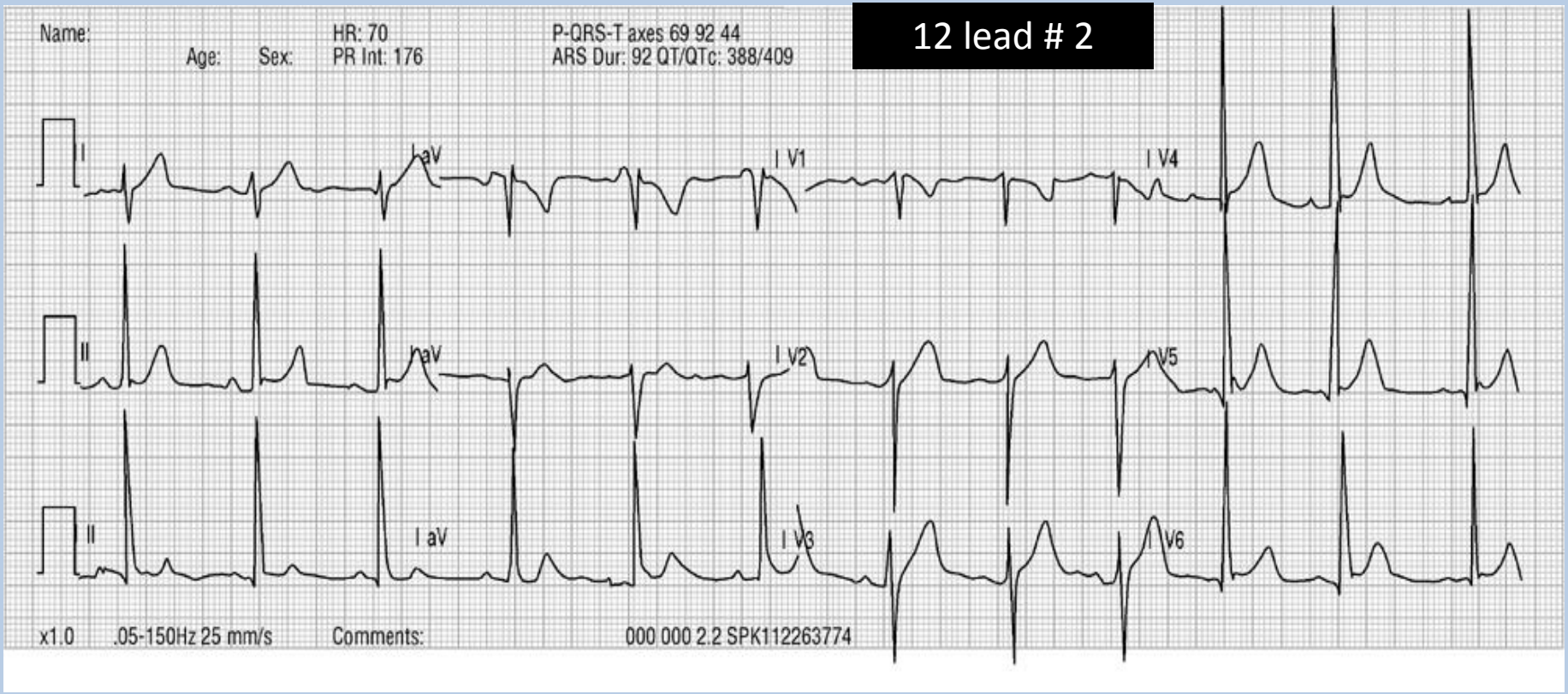
- A QRS-T angle greater than 45 should worry you
- A QRS-t angle greater than 100 should really worry you

Practice 12-Leads

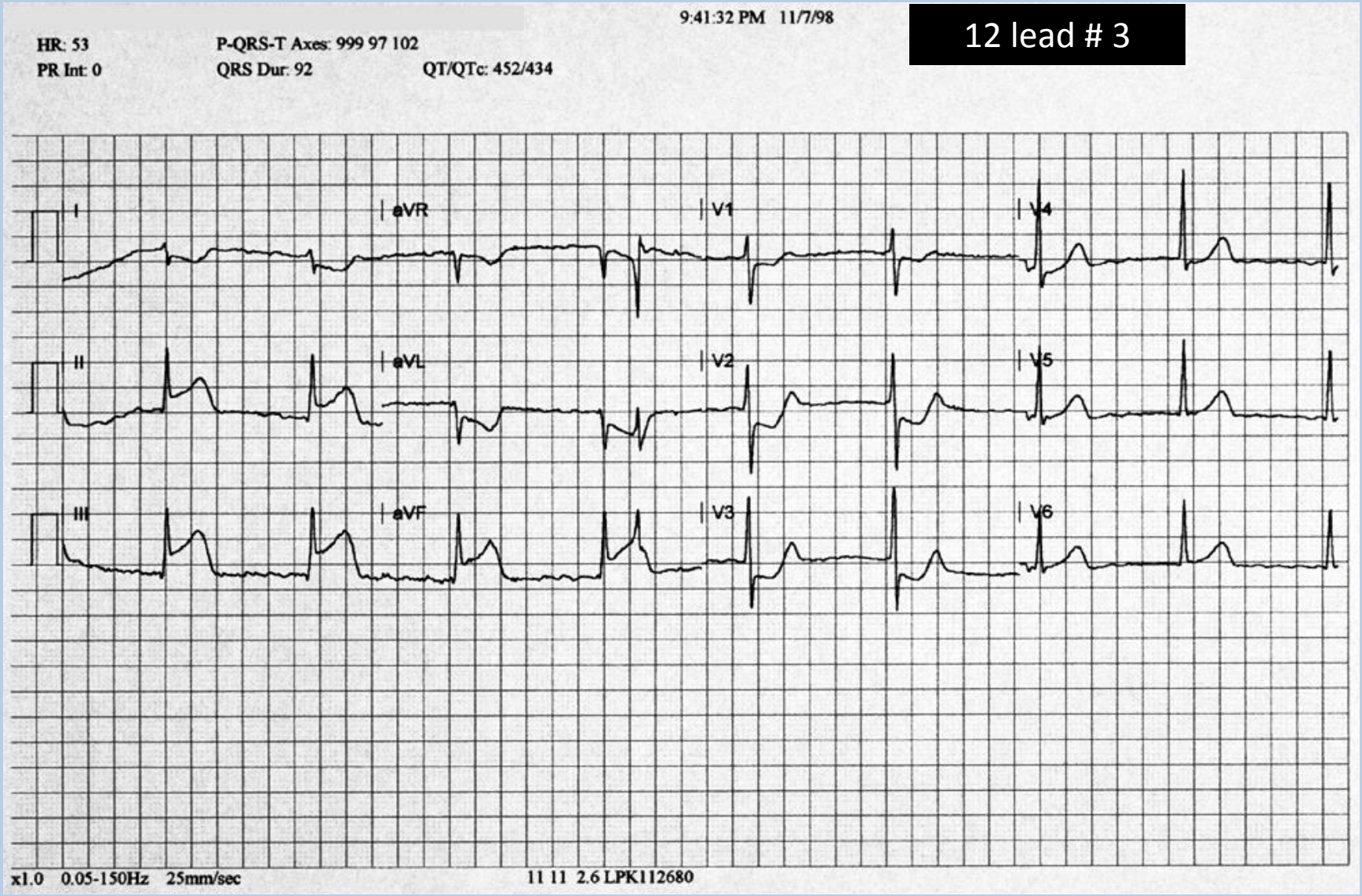
12 lead # 1


2:51:54 AM 8/8/98
HR: 60
PR Int: 160
P-QRS-T Axes: 12 66 106
QRS Dur: 96
QT/QTc: 440/441
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112671

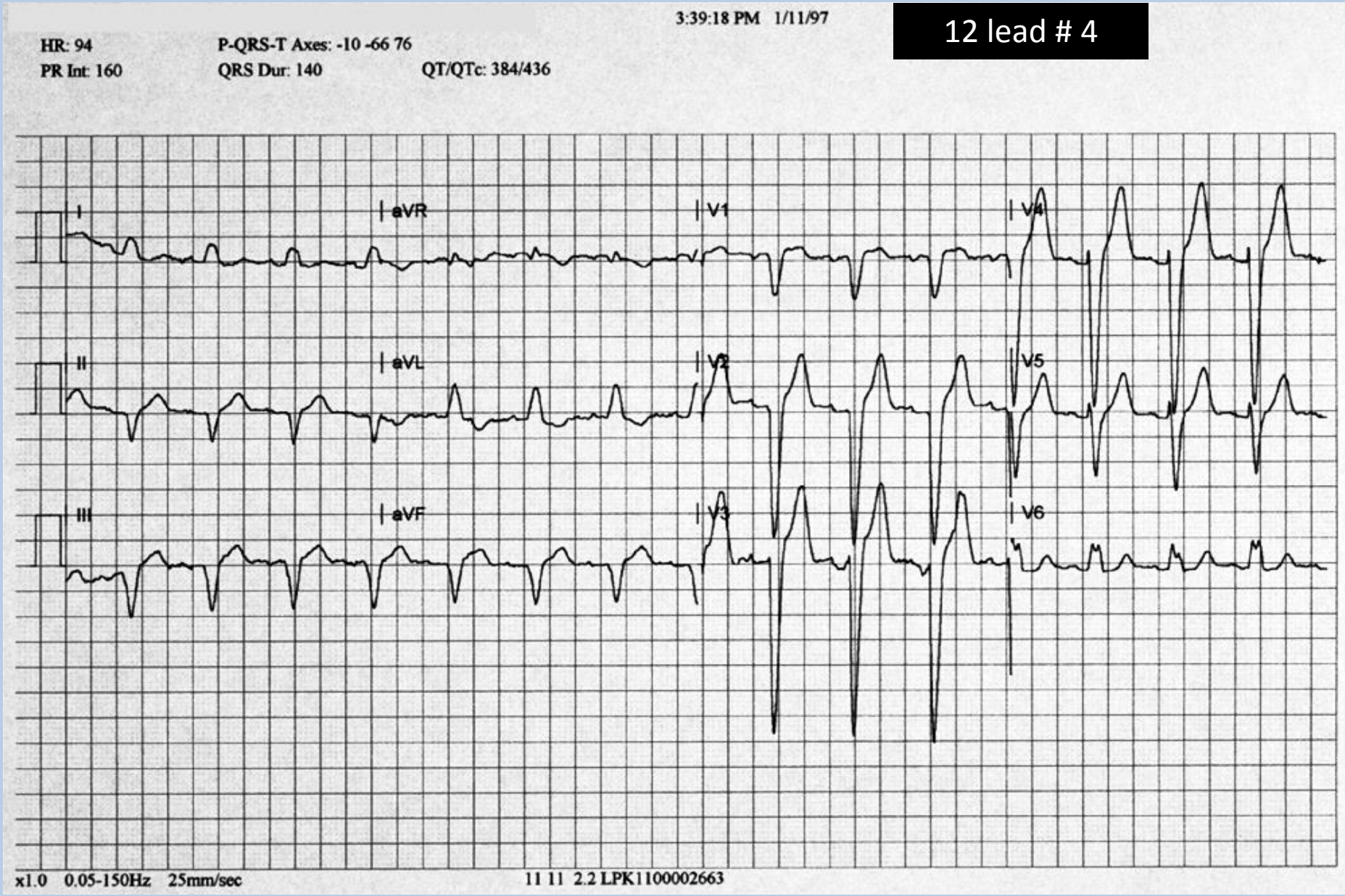
12 lead # 2


Name:
Age: Sex:
HR: 70
PR Int: 176
P-QRS-T axes 69 92 44
ARS Dur: 92 QT/QTc: 388/409
I
aV
V1
V4
II
aV
V2
V5
II
aV
V3
V6
x1.0 .05-150Hz 25 mm/s
Comments:
000 000 2.2 SPK112263774

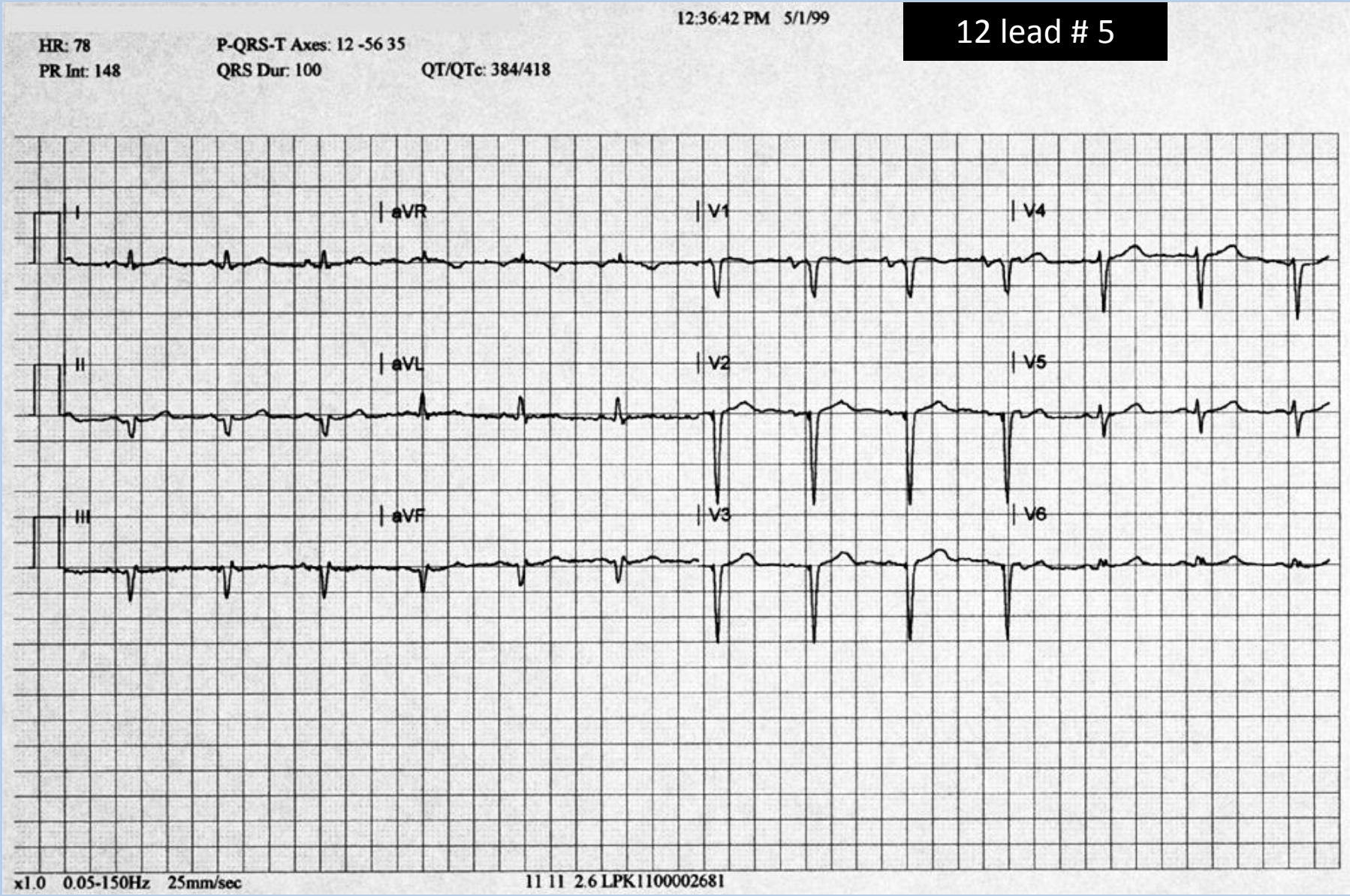
12 lead # 3


9:41:32 PM 11/7/98
HR: 53
PR Int: 0
P-QRS-T Axes: 999 97 102
QRS Dur: 92
QT/QTc: 452/434
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112680

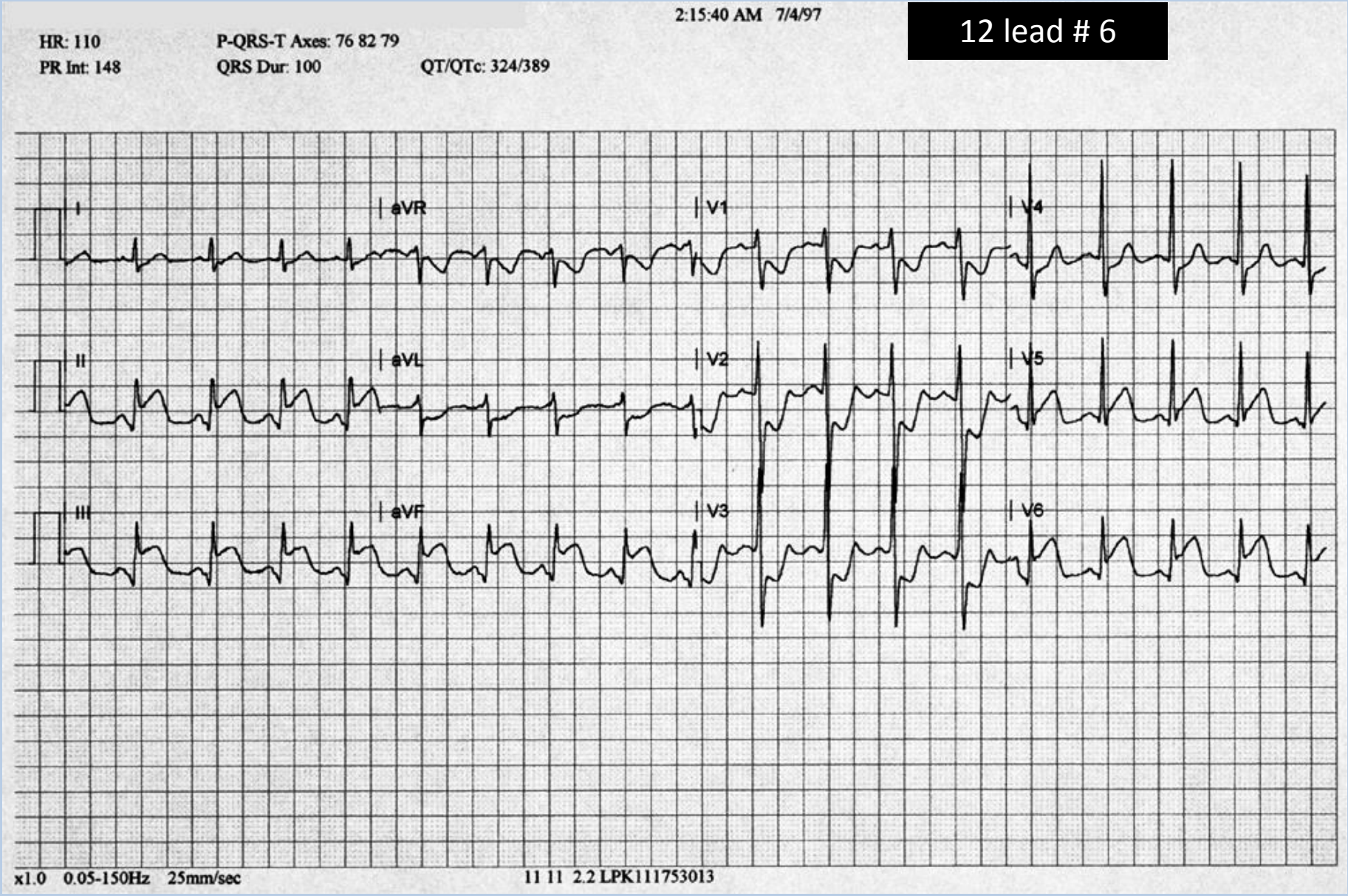
12 lead # 4


3:39:18 PM 1/11/97
HR: 94
PR Int: 160
P-QRS-T Axes: -10 -66 76
QRS Dur: 140
QT/QTc: 384/436
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.2 LPK1100002663

12 lead # 5


12:36:42 PM 5/1/99
HR: 78
PR Int: 148
P-QRS-T Axes: 12 -56 35
QRS Dur: 100
QT/QTc: 384/418
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK1100002681

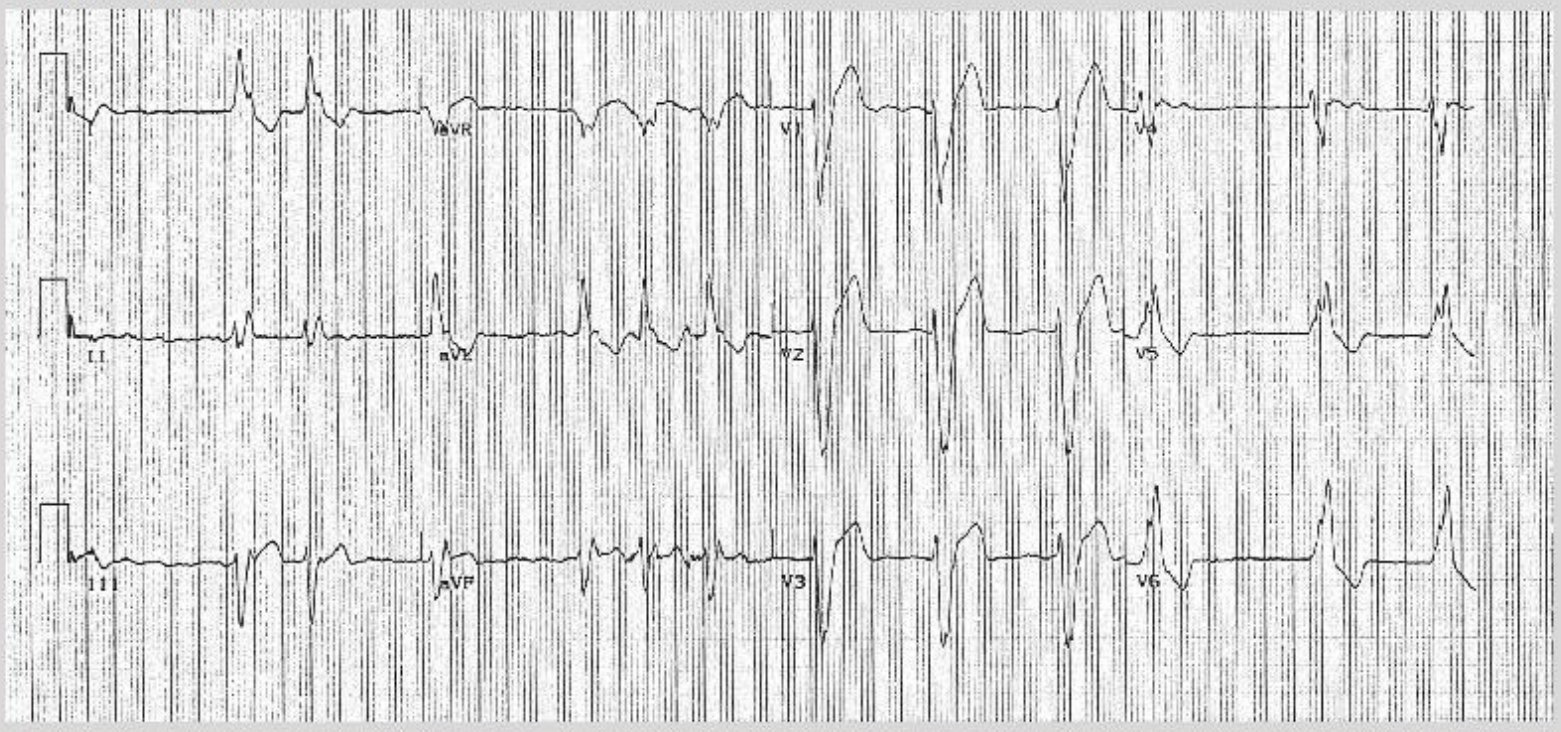
12 lead # 6

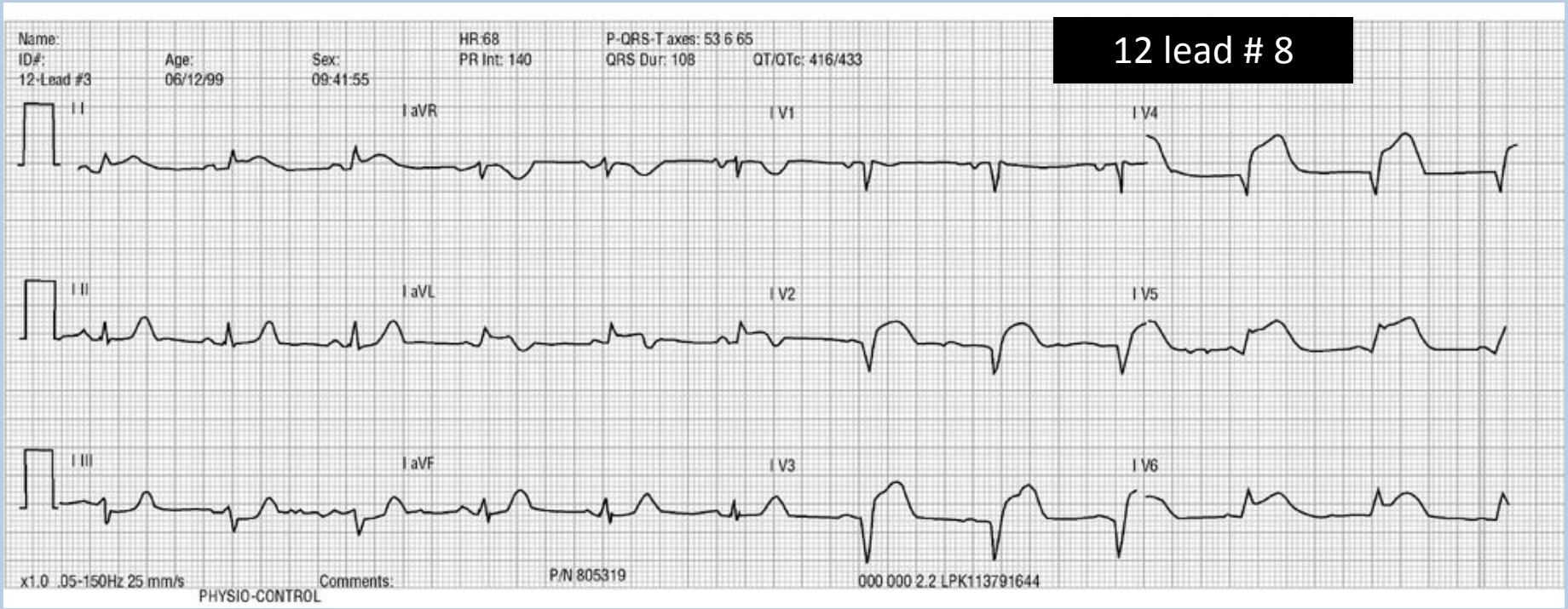

2:15:40 AM 7/4/97
HR: 110
PR Int: 148
P-QRS-T Axes: 76 82 79
QRS Dur: 100
QT/QTc: 324/389
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.2 LPK111753013

12 lead # 7

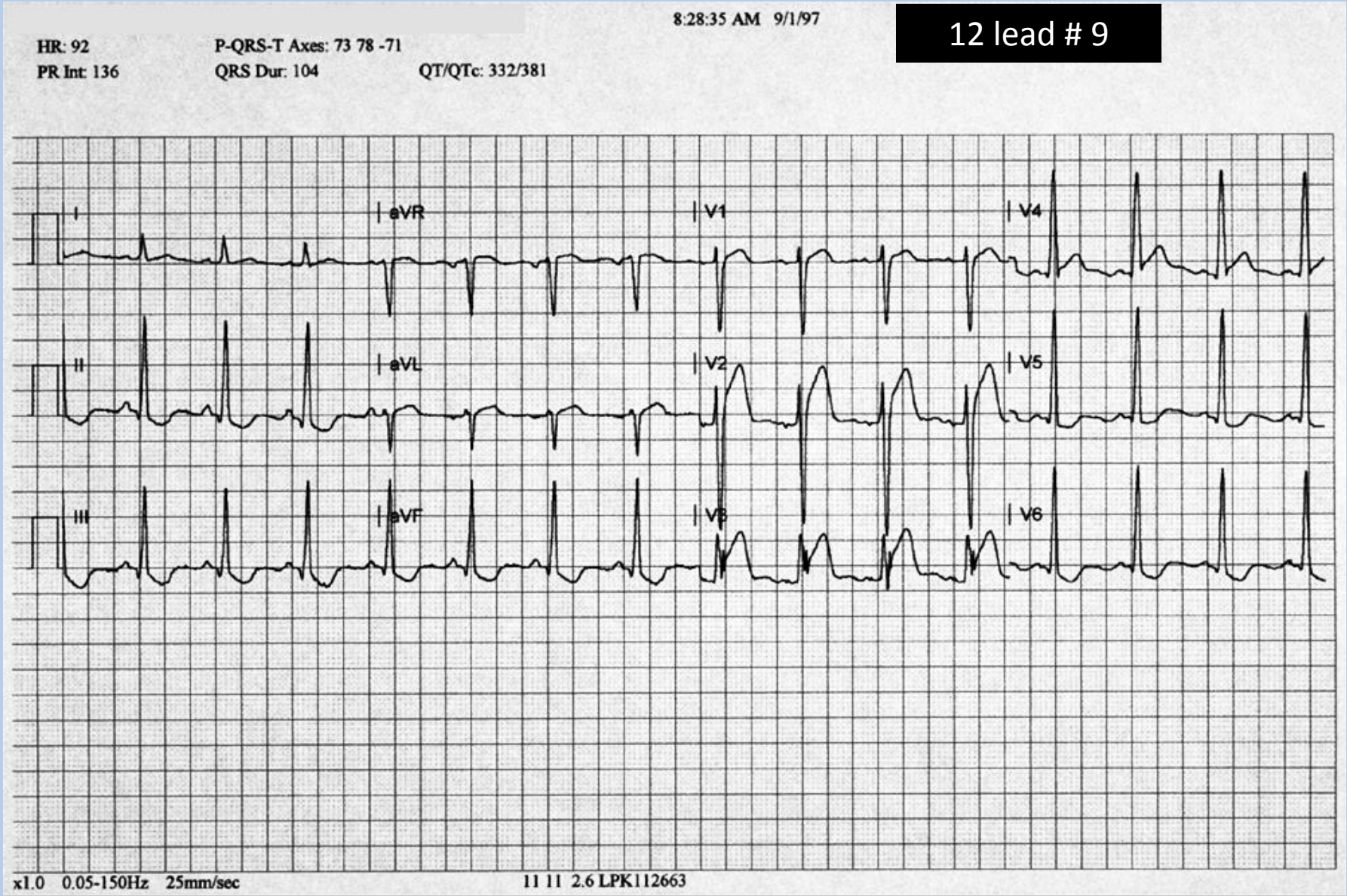
PR *
QRS 176 ms
QT/QTc 428/477

P-R-T Axis * -21 176

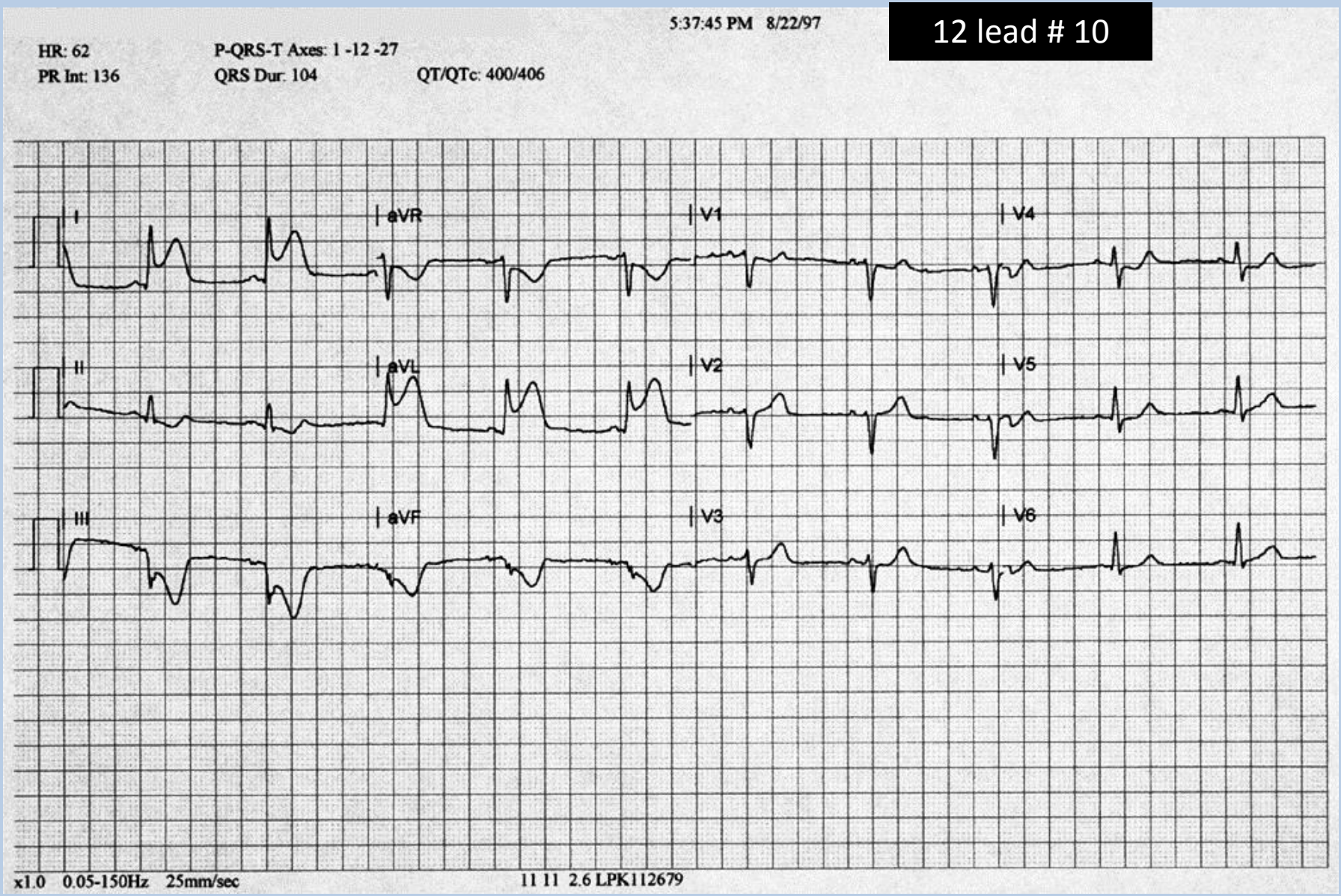



12 lead # 8
Name:
ID#:
12-Lead #3
Age:
06/12/99
Sex:
09:41:55
HR:68
PR Int: 140
P-QRS-T axes: 53 6 65
QRS Dur: 108
QT/QTc: 416/433
I I
I aVR
I V1
I V4
I II
I aVL
I V2
I V5
I III
I aVF
I V3
I V6
x1.0 .05-150Hz 25 mm/s
Comments:
P/N 805319
000 000 2.2 LPK113791644
PHYSIO-CONTROL

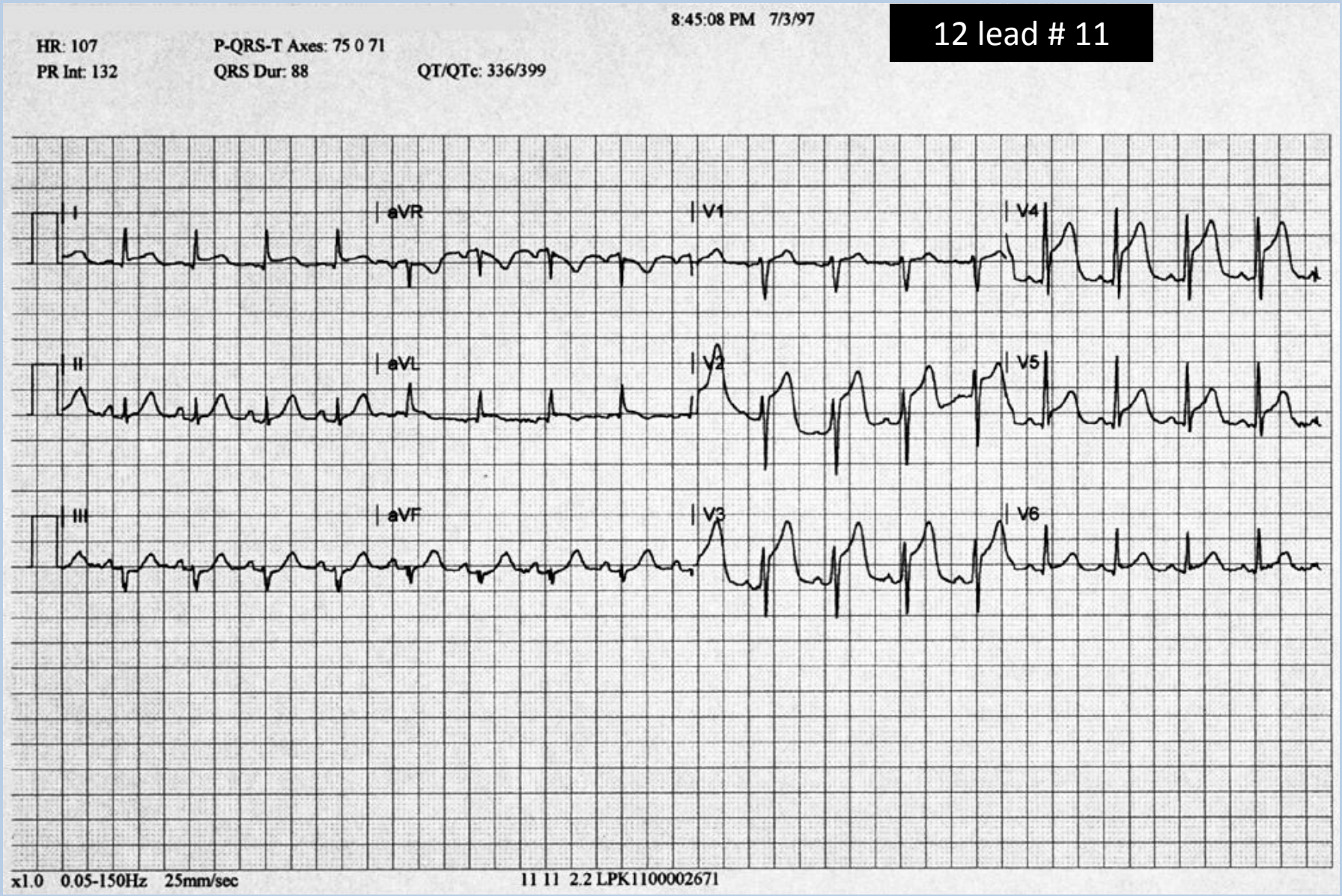
12 lead # 9


8:28:35 AM 9/1/97
HR: 92
PR Int: 136
P-QRS-T Axes: 73 78 -71
QRS Dur: 104
QT/QTc: 332/381
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112663

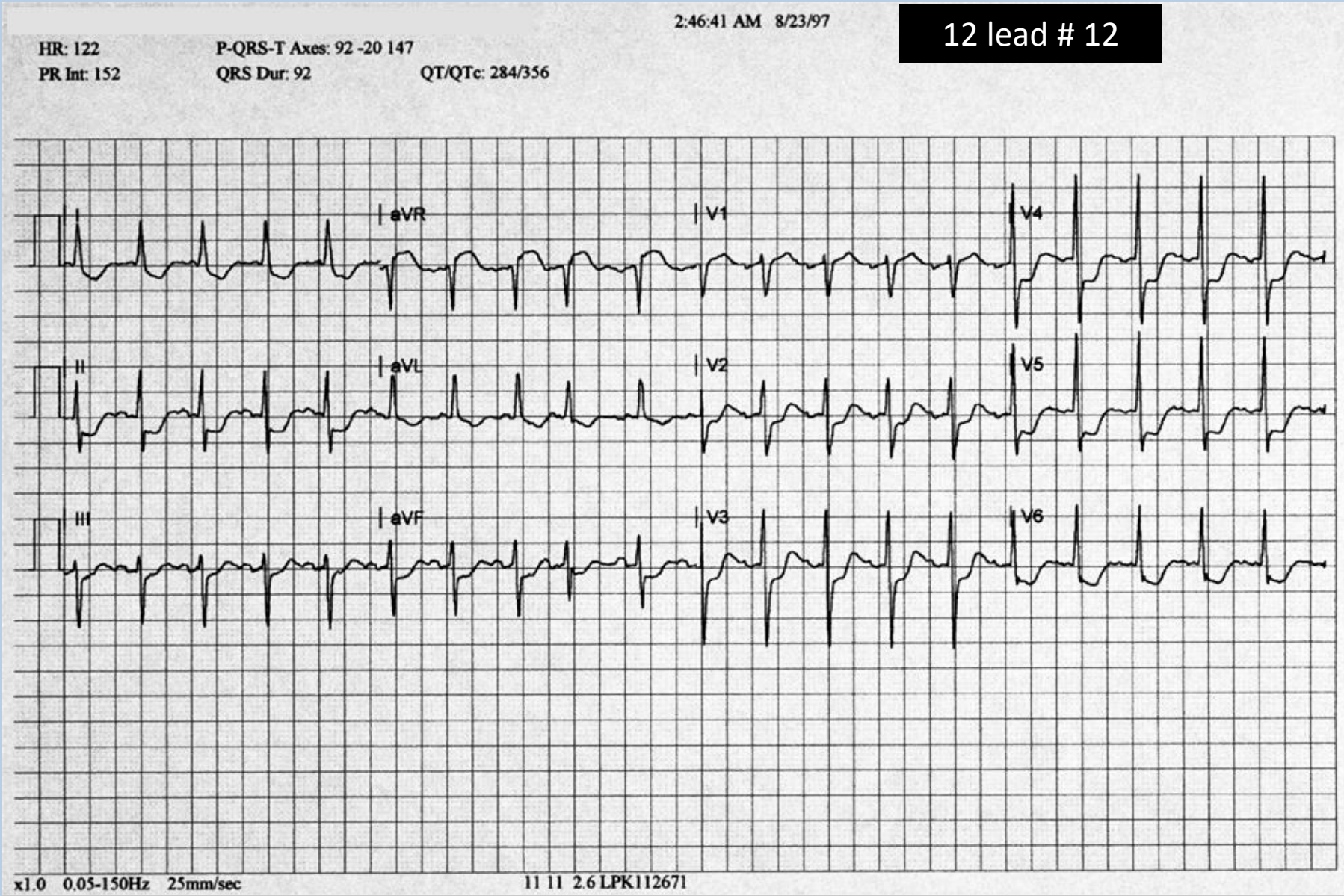
12 lead # 10


5:37:45 PM 8/22/97
HR: 62
PR Int: 136
P-QRS-T Axes: 1 -12 -27
QRS Dur: 104
QT/QTc: 400/406
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112679

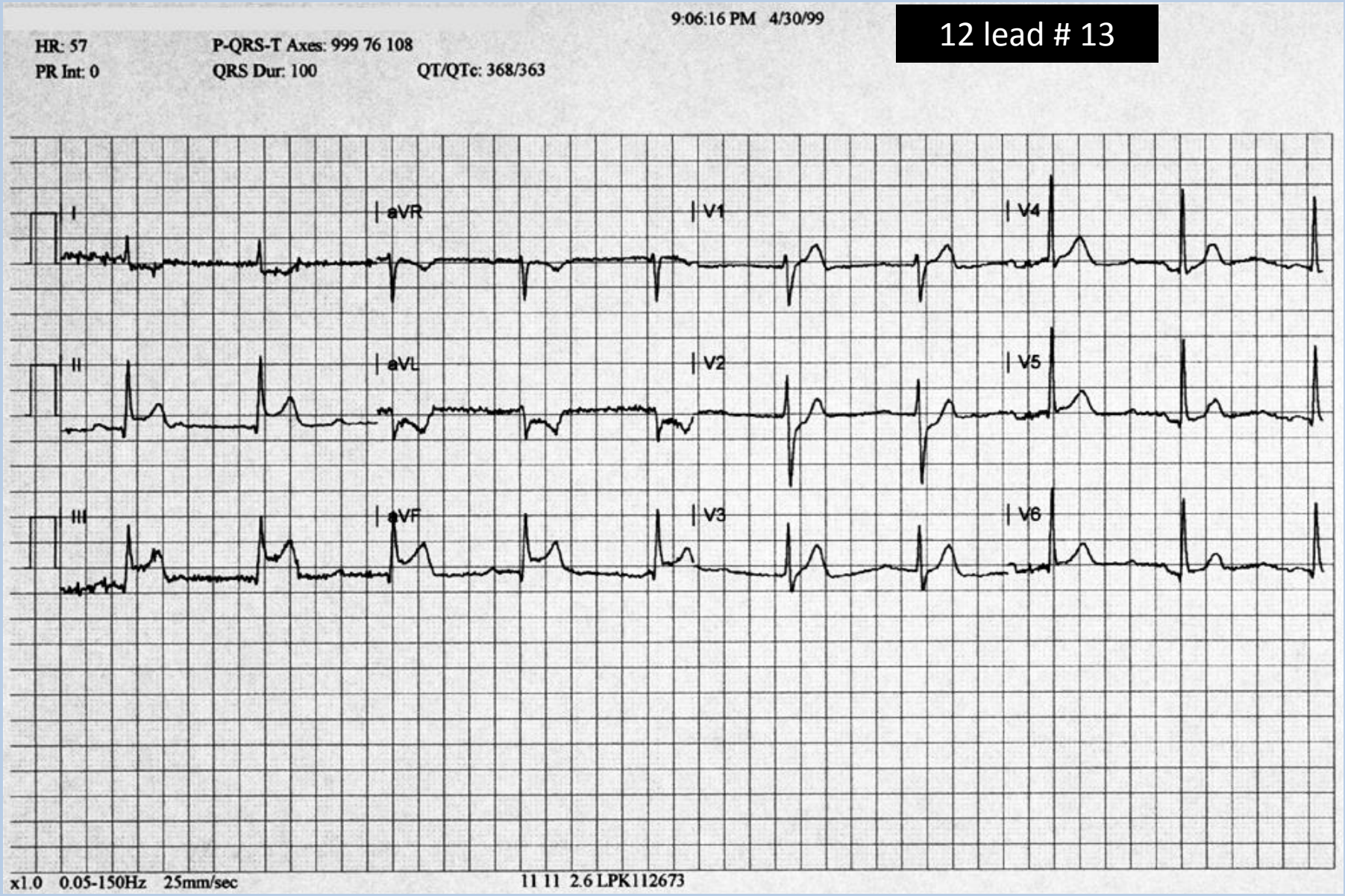
12 lead # 11

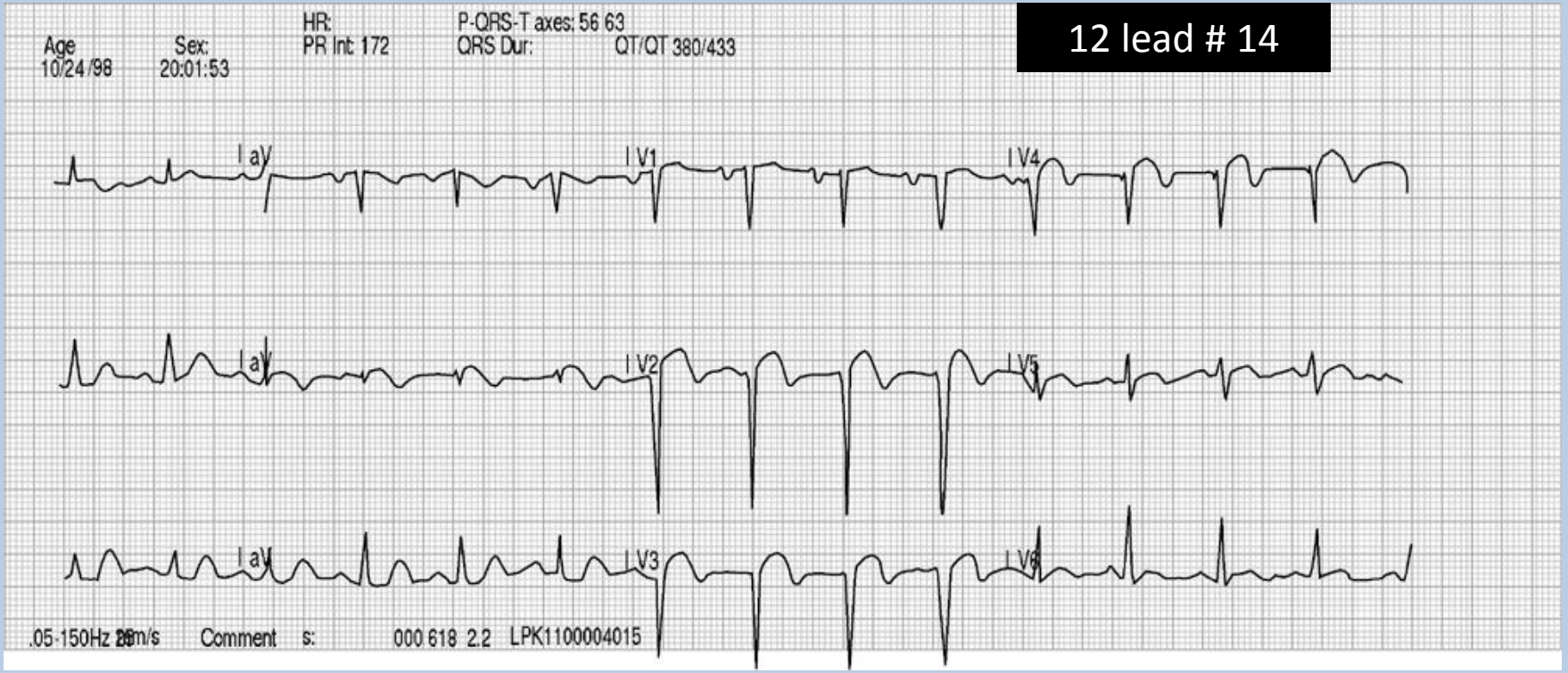

8:45:08 PM 7/3/97
HR: 107
PR Int: 132
P-QRS-T Axes: 75 0 71
QRS Dur: 88
QT/QTc: 336/399
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.2 LPK1100002671

12 lead # 12

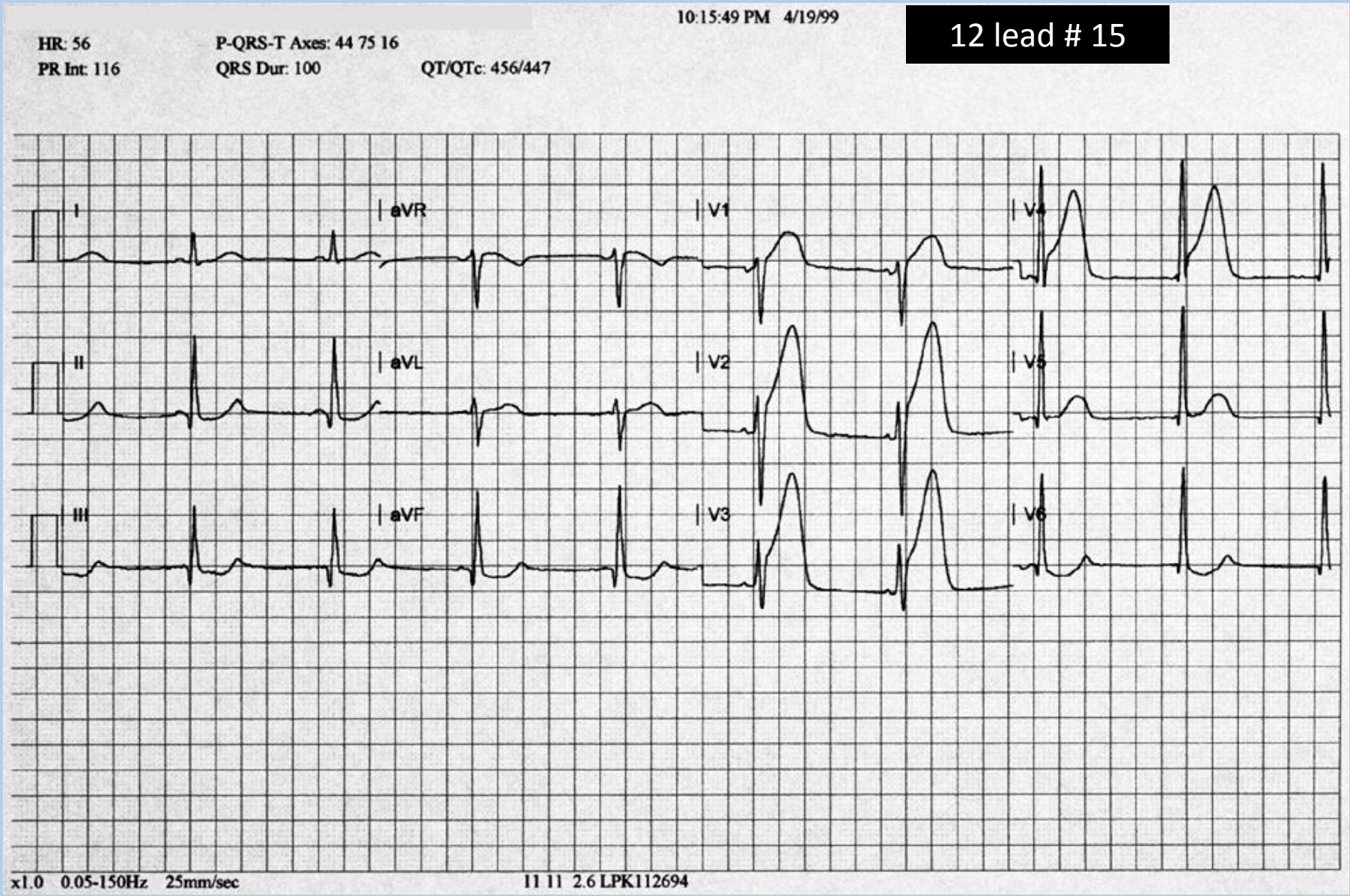

2:46:41 AM 8/23/97
HR: 122
PR Int: 152
P-QRS-T Axes: 92 -20 147
QRS Dur: 92
QT/QTc: 284/356
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112671

12 lead # 13

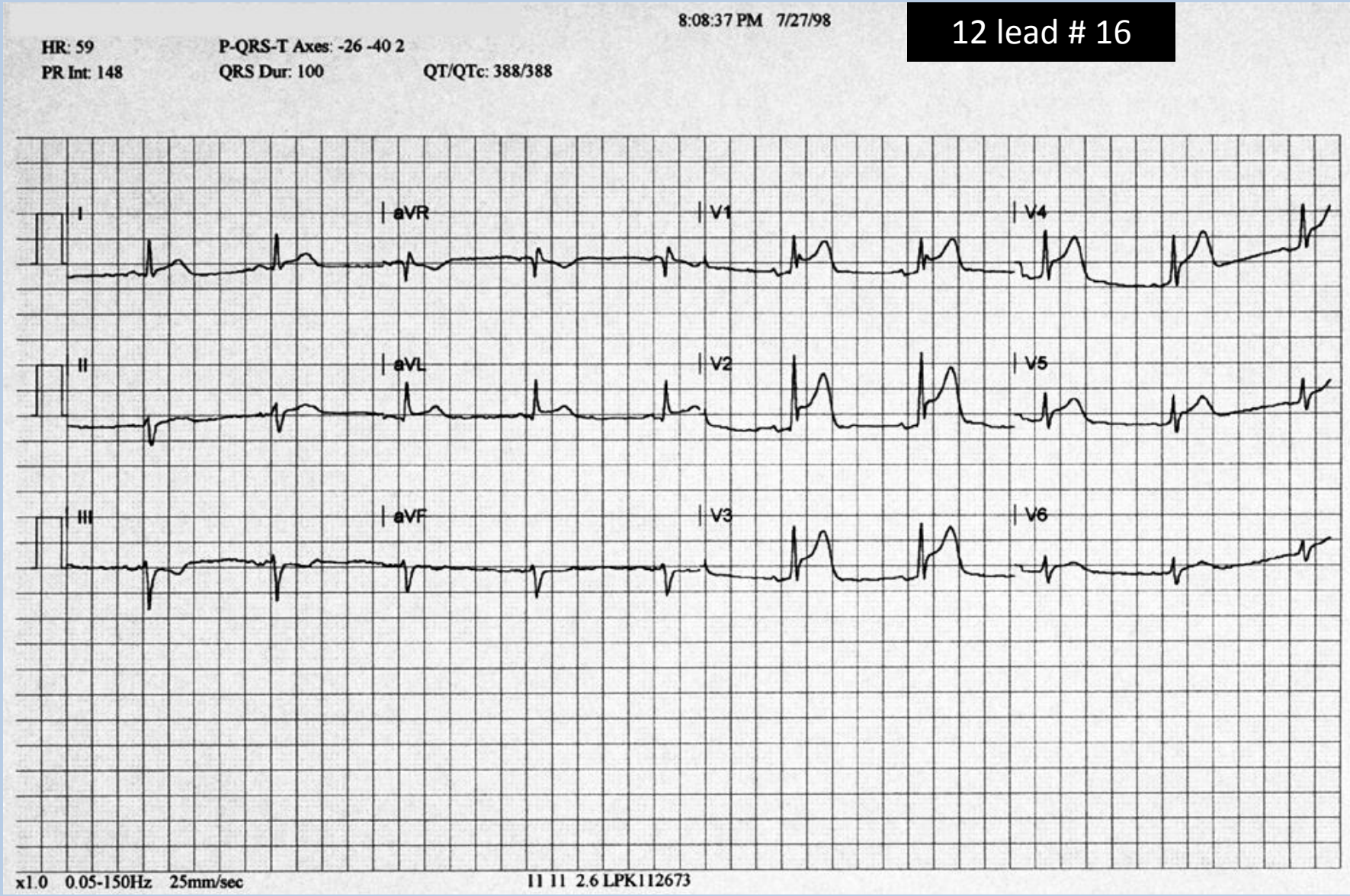

9:06:16 PM 4/30/99
HR: 57
PR Int: 0
P-QRS-T Axes: 999 76 108
QRS Dur: 100
QT/QTc: 368/363
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112673


12 lead # 14
Age
10/24/98
Sex:
20:01:53
HR:
PR Int: 172
P-QRS-T axes: 56 63
QRS Dur:
QT/QT 380/433
I aV
I V1
I V4
I aV
I V2
I V5
I aV
I V3
I V6
.05-150Hz 25m/s
Comment s:
000 618 2.2 LPK1100004015

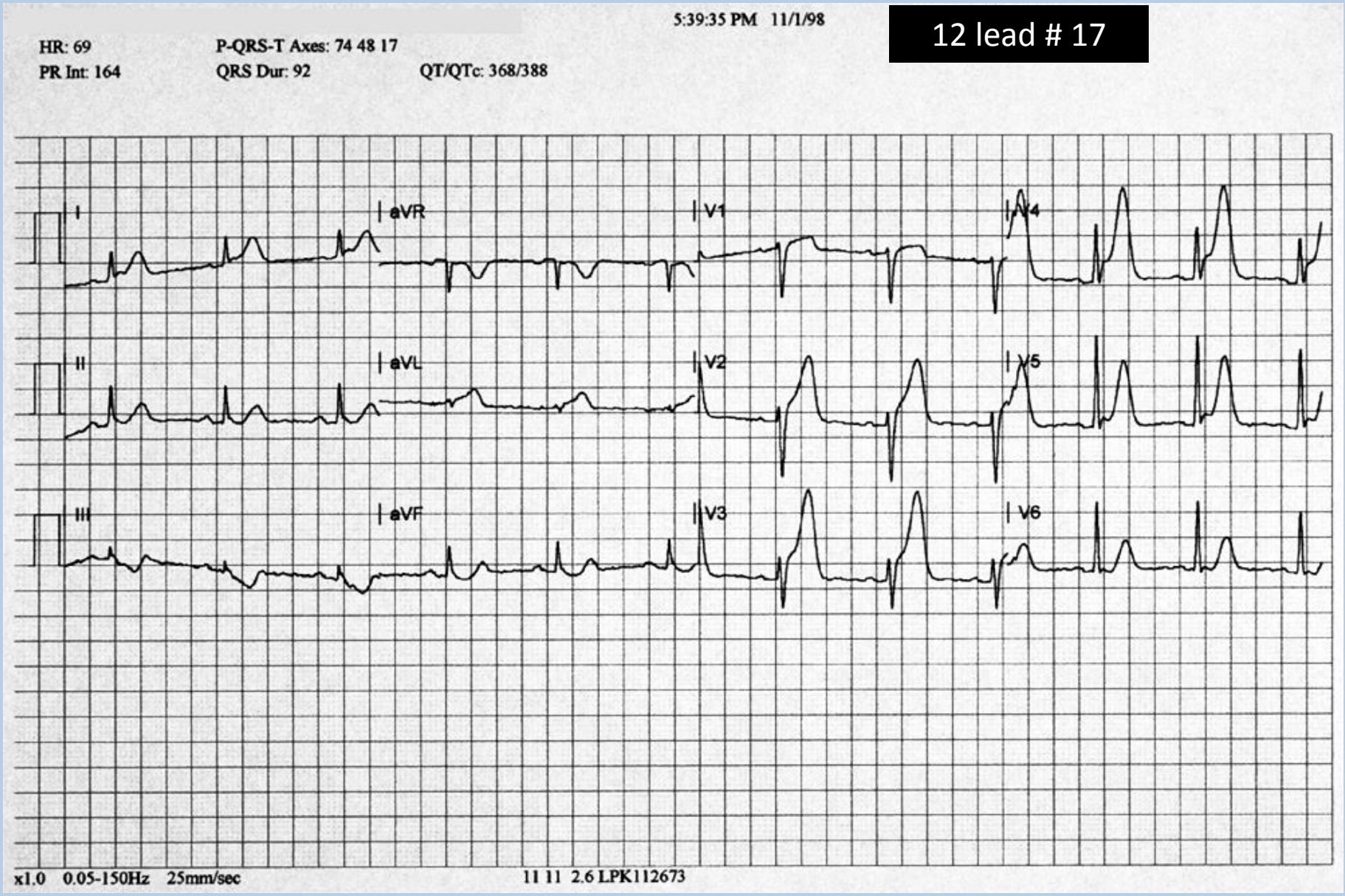
12 lead # 15


10:15:49 PM 4/19/99
HR: 56
PR Int: 116
P-QRS-T Axes: 44 75 16
QRS Dur: 100
QT/QTc: 456/447
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112694

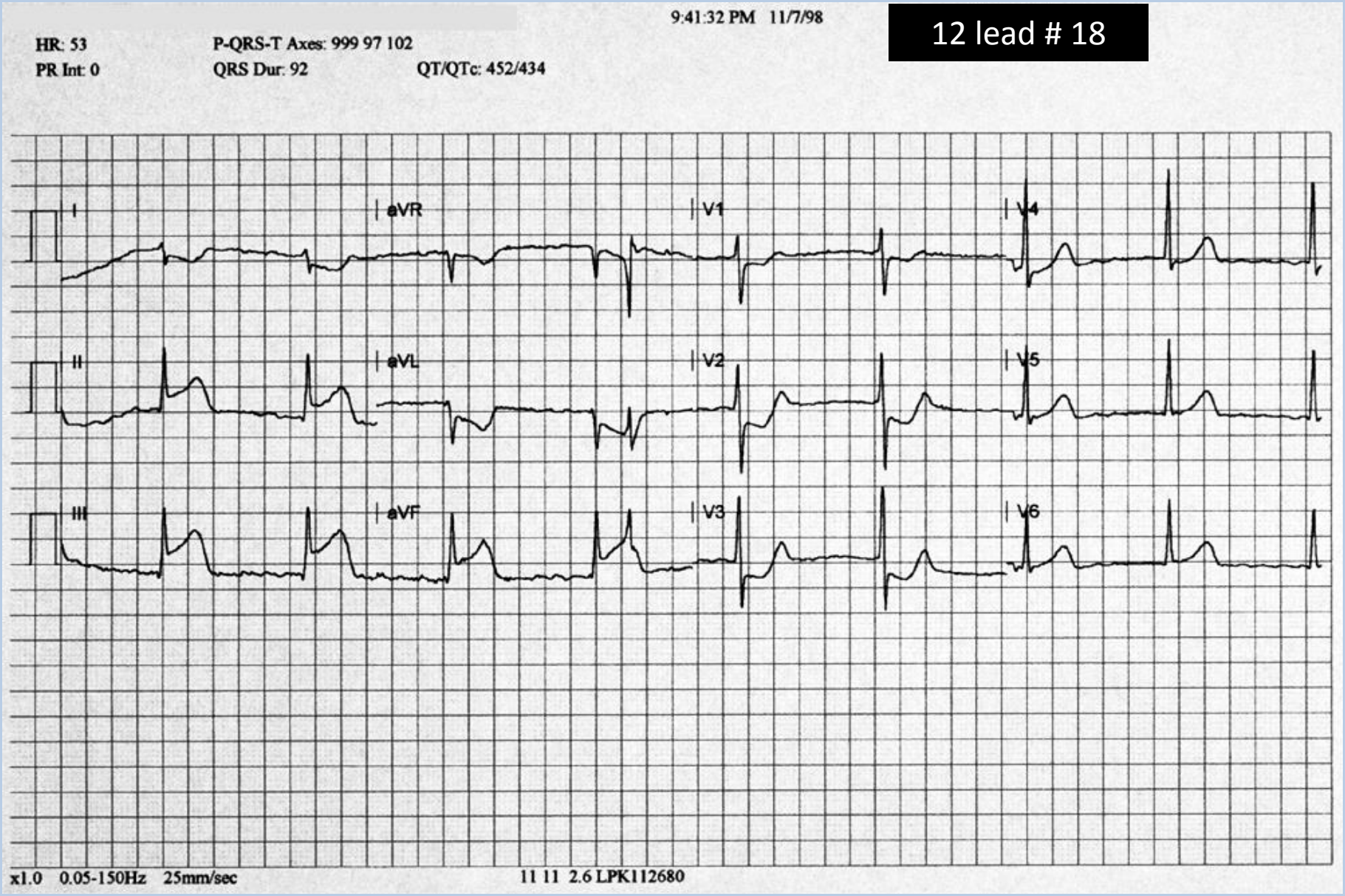
12 lead # 16


8:08:37 PM 7/27/98
HR: 59
PR Int: 148
P-QRS-T Axes: -26 -40 2
QRS Dur: 100
QT/QTc: 388/388
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112673

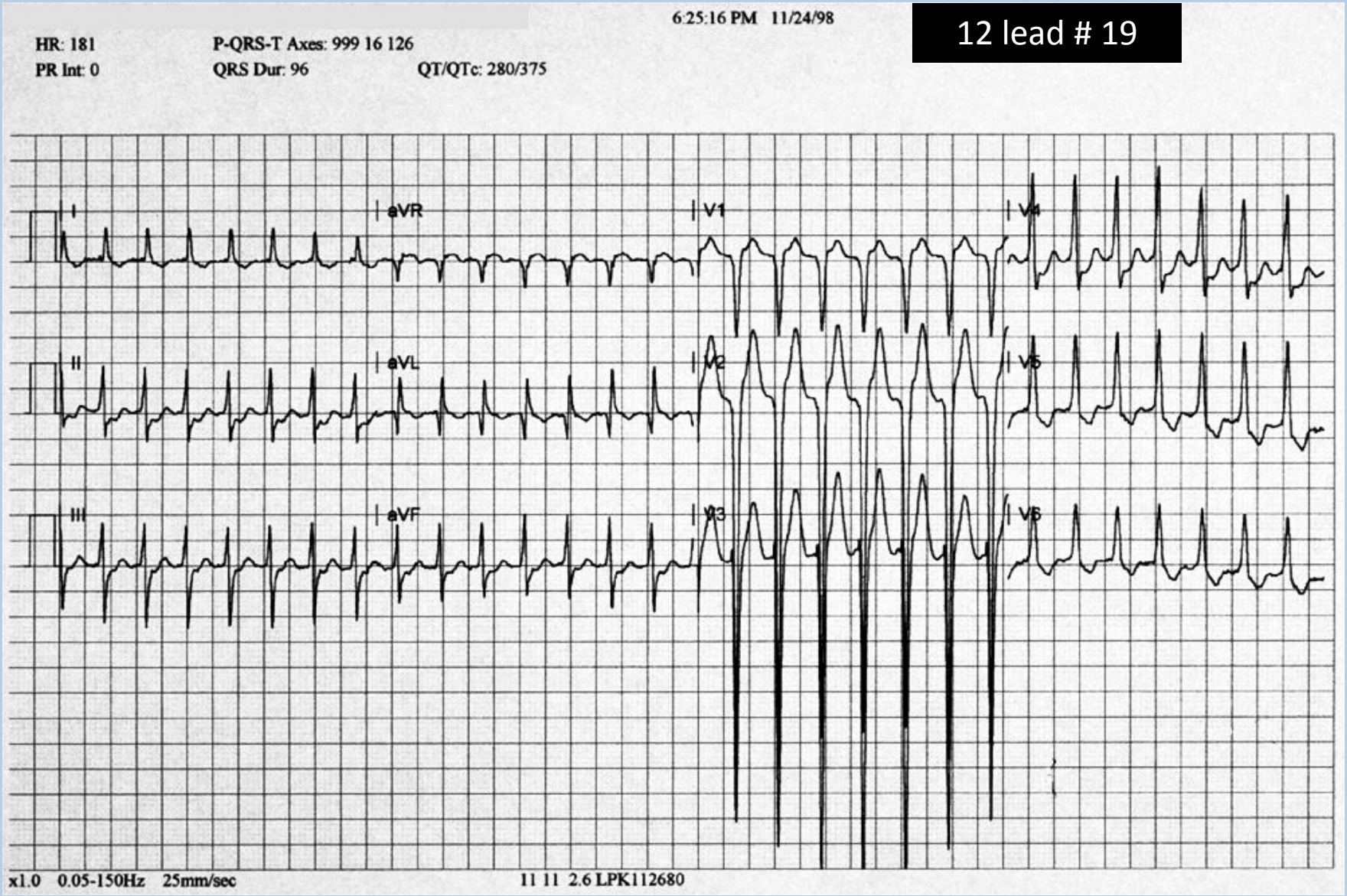
12 lead # 17


5:39:35 PM 11/1/98
HR: 69
PR Int: 164
P-QRS-T Axes: 74 48 17
QRS Dur: 92
QT/QTc: 368/388
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112673

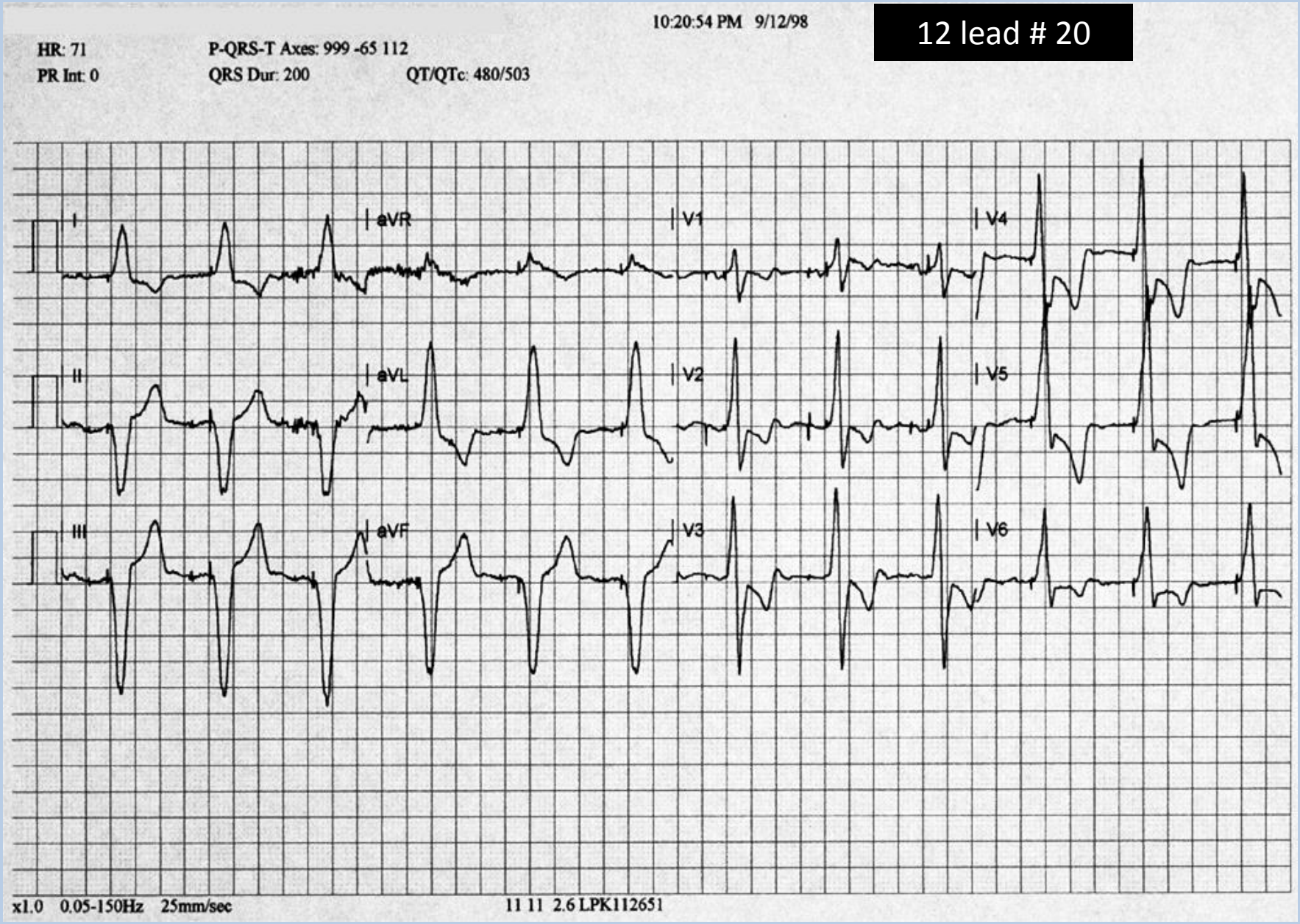
12 lead # 18


9:41:32 PM 11/7/98
HR: 53
PR Int: 0
P-QRS-T Axes: 999 97 102
QRS Dur: 92
QT/QTc: 452/434
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112680

12 lead # 19


6:25:16 PM 11/24/98
HR: 181
PR Int: 0
P-QRS-T Axes: 999 16 126
QRS Dur: 96
QT/QTc: 280/375
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112680

12 lead # 20


10:20:54 PM 9/12/98
HR: 71
PR Int: 0
P-QRS-T Axes: 999 -65 112
QRS Dur: 200
QT/QTc: 480/503
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
x1.0 0.05-150Hz 25mm/sec
11 11 2.6 LPK112651

Questions?

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Thanks to:

Tim Phalen

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