

ECG Course: Pearls and Pitfalls

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Approach to The Critical EKG

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Goals

- Emphasize a methodical approach to assessment
- Focus on findings associated with life-threatening conditions
- Improve identification of significant abnormalities
- Emphasize the differential diagnoses associated with a given EKG finding



OUTLINE

- Background
- Algorithm for diagnosis of Arrhythmia
 - Rate and Rhythm
- Algorithm for diagnosis of ACS – MI and Ischemia
 - 6 Causes of Wide QRS
 - 6 Causes of ST elevation
 - 6 Causes of ST depression
 - T waves and Q waves
 - Other EKG Abnormalities
- Summary

Initial EKG in AMI

- **Diagnostic**
30-50% sensitive for acute MI
- **Non Diagnostic**
Not predictive of ACI
- **Normal ECG's**
1-10% with acute MI will have normal ECG

Diagnostic value of initial EKG

	MI	30 day death/reinfarct
ST elevation/depression	89%	12.4%
ST elevation	81%	9.4%
ST depression	48%	10.5%
T wave inversion	32%	5.5%

Savonitto et al. JAMA. 1999
Feb 24;281(8): 707-13.

Prognostic value of EKG in AMI

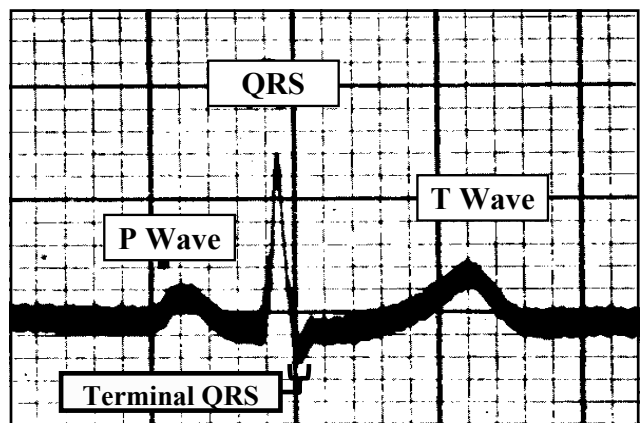
Rate of death or life-threatening events

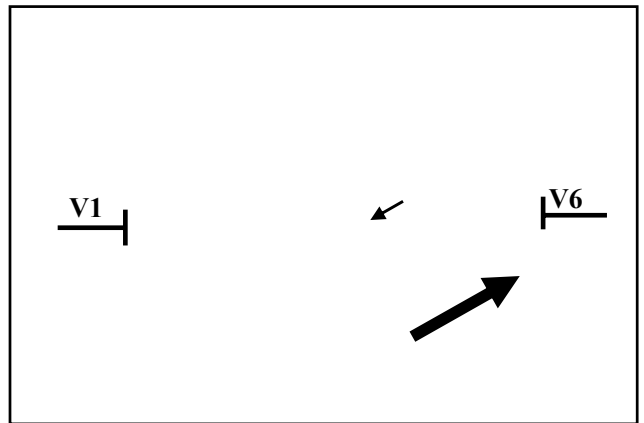
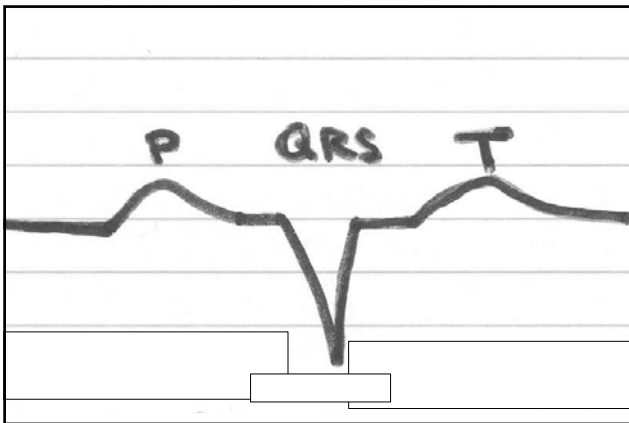
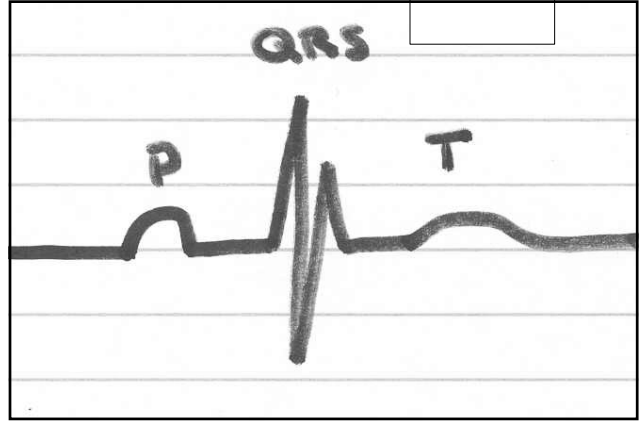
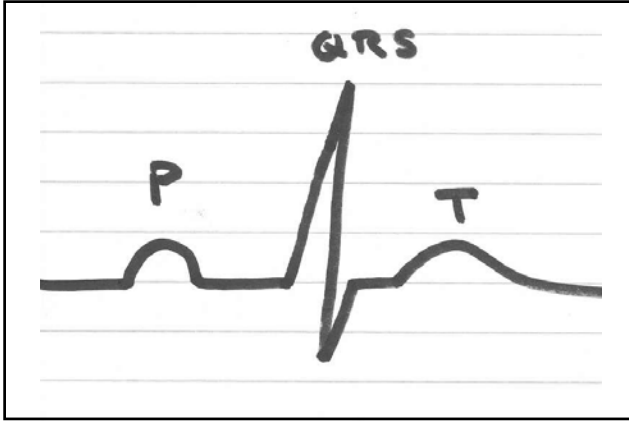
- Normal EKG = 19%
- Non Diagnostic EKG = 27.5%
- Diagnostic EKG = 35%

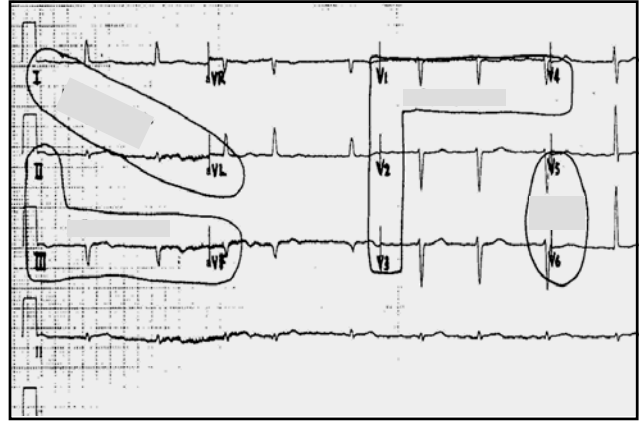
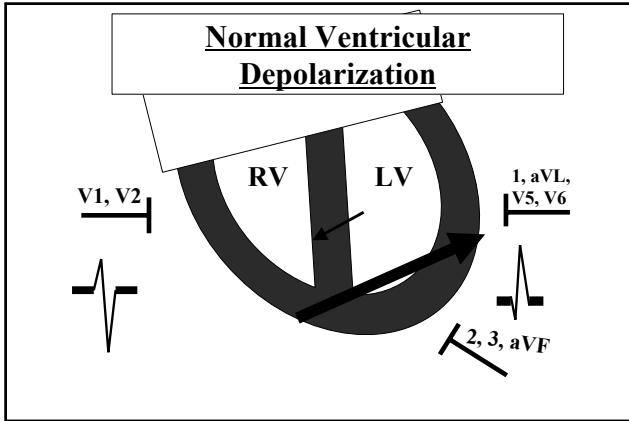
Welch et al. JAMA. 2001
Oct 24-31;286(16):1977-84.

Lesson

An ischemic EKG significantly increases the likelihood of ACS and the risk of adverse outcomes







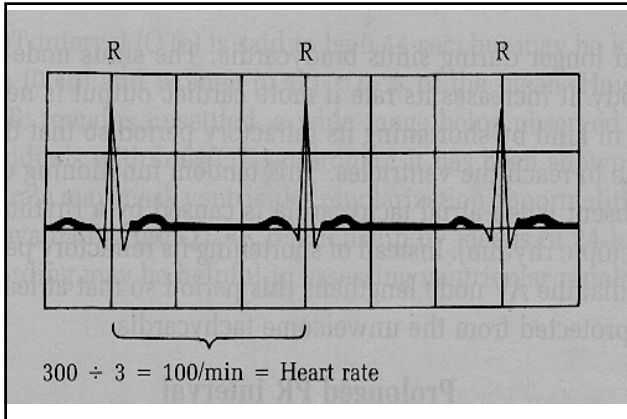
EKG Wall Anatomy

- Diffuse ST elevation
- ST elevation in non-contiguous leads
- ST elevation in 2 myocardial walls
- Inferior ST elevation
- Anterior ST elevation

LIFE THREATENING ARRHYTHMIA

THE TABAS ALGORITHM

- Rate
- Rhythm



Sinus Rhythm

P waves originate from the sinus node

- P is upright in 2, flipped in aVR

Normal AV Conduction

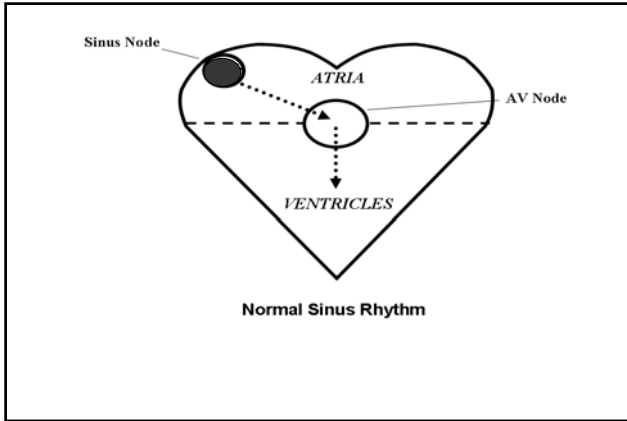
- Each P followed by a QRS
- Constant PR interval

Main Diagnostic Entities for “Not Sinus Rhythm”

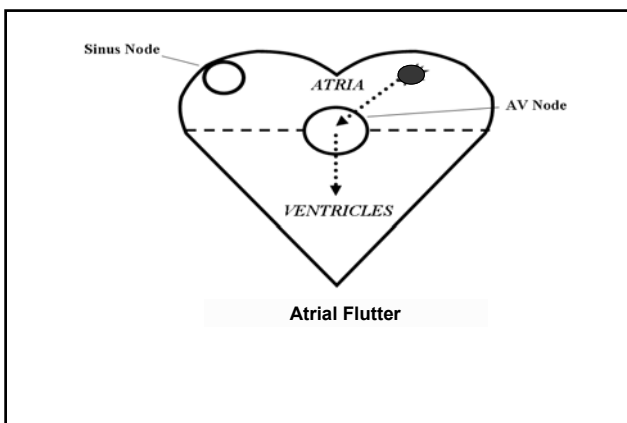
- Is the P wave axis normal?
Abnormal => Limb lead misplacement
- Is the rhythm regular?
Irregular => Atrial Fibrillation
- Is the QRS wide?
Wide Reg => V tach
Narrow Reg => Sinus Tach vs. SVT or Flutter
- Is the rhythm slow?
=> Junctional, Dig Toxicity, Hyperkalemia

Narrow& Regular Sinus Tach

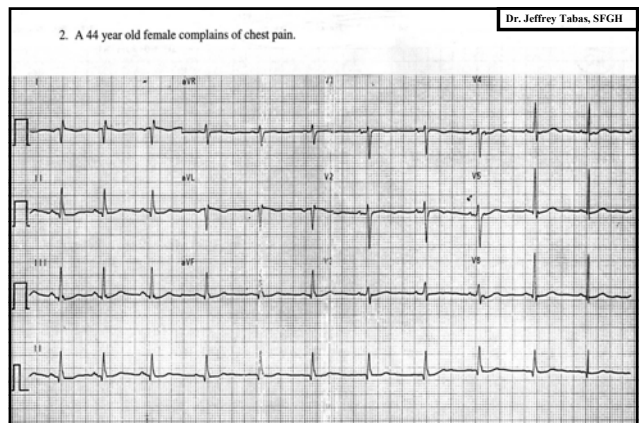
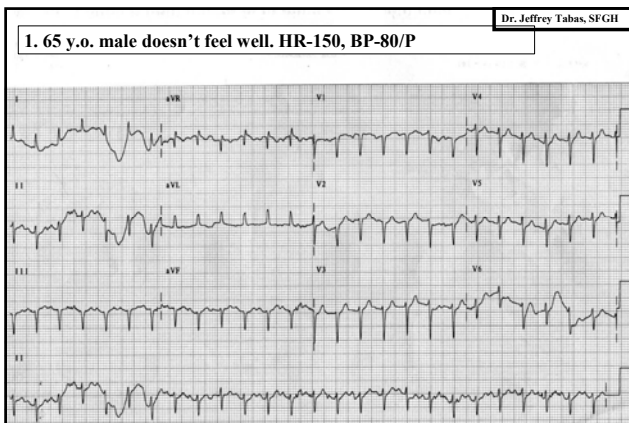
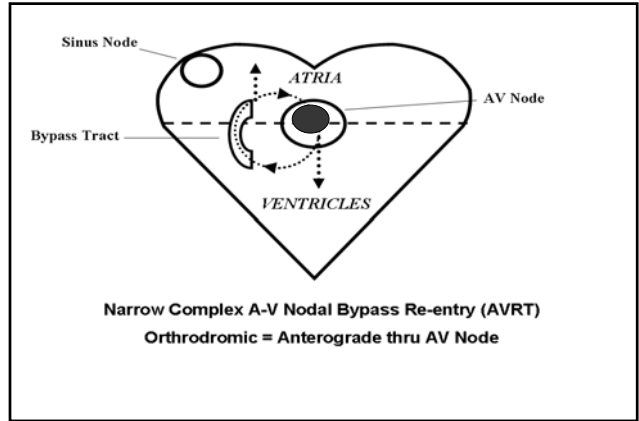
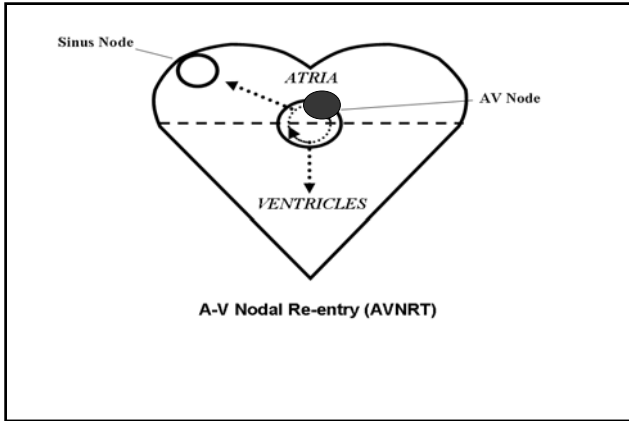
- P wave upright in 2
- P wave inverted in aVR
- P followed by QRS
- Rate should slow with fluids or fever reduction
- Adenosine will block AV node

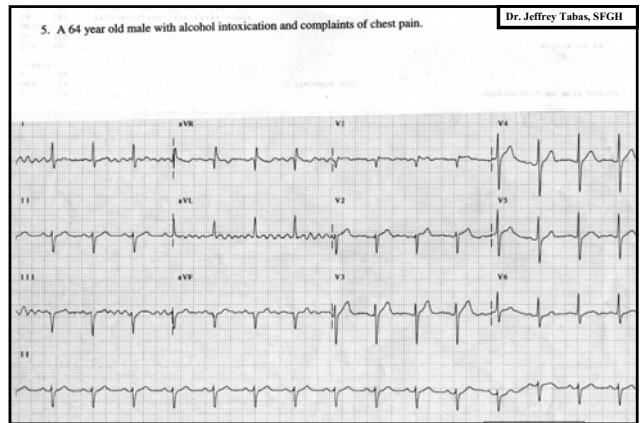
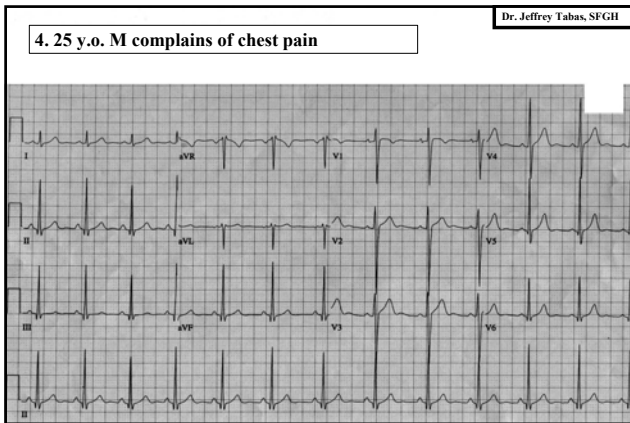
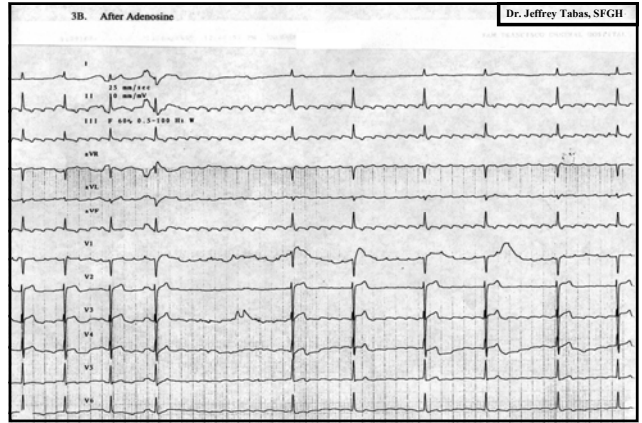
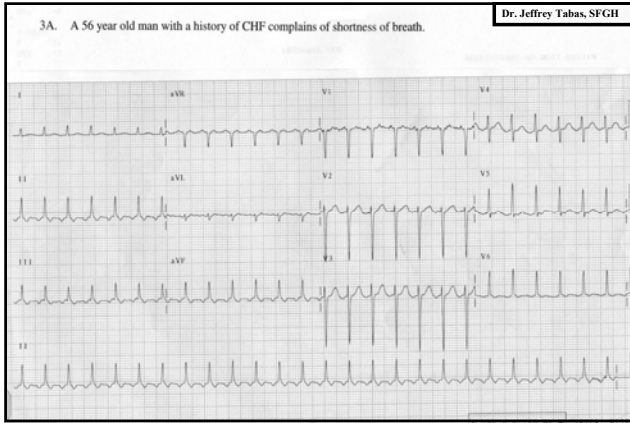


- ### Narrow and Regular Atrial Flutter
- Flutter waves best seen in 2 and V1
 - May have some irregularity due to varying AV node block
 - Rate may or may not change with fluids or fever reduction
 - Adenosine will reveal underlying flutter waves



- ### Narrow and Regular SVT
- Rate will not vary or change
 - When Adenosine given, will convert to sinus







Assessment for Acute Ischemia

Is there ST elevation signifying acute injury?



ST ELEVATION Show me the money

AMI with ST elevation has worse prognosis than without

AMI with ST elevation is an indication for thrombolytics

- Ongoing CP (Sx's) < 12 hours
- 1 mm elevation in 2 contiguous leads
- or LBBB

Non STEMI / USA

- **NO BENEFIT** from THROMBOLYSIS in absence of ST elevation!
- Benefit from aspirin, beta blockers (maybe nitrates, heparin, clopidogrel, GP 2b3a's)
- Probable benefit from revascularization (stents, angioplasty, etc)

Assessment for Acute Ischemia

THE TABAS ALGORITHM

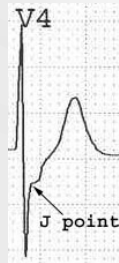
- Widened QRS - 6 causes
- ST Elevation - 6 causes
- ST Depression - 6 causes
- Other Findings of Ischemia

6 CAUSES - WIDE QRS

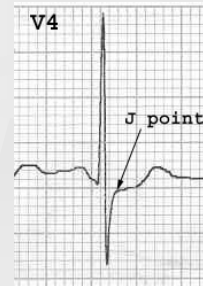
- Bundle branch block
- Ventricular rhythm
- Hyperkalemia
- Medications
- Paced rhythm
- WPW

THE J POINT

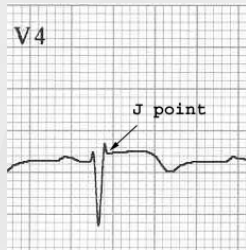
- Measure at the end of the QRS
- Compare to height of T-P segment



THE J POINT



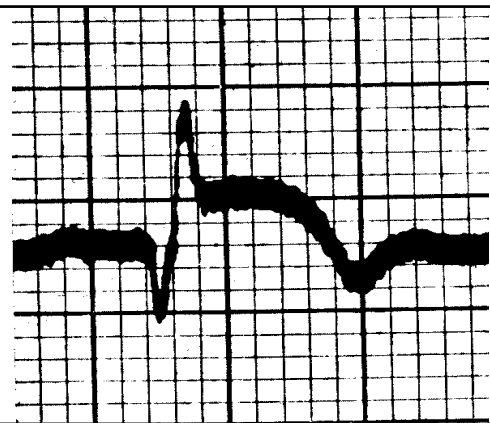
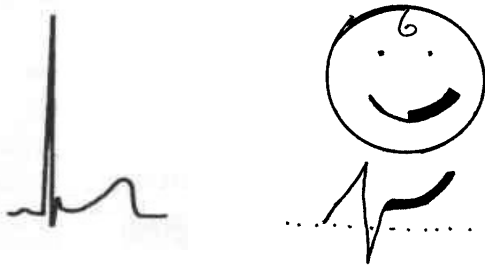
THE J POINT

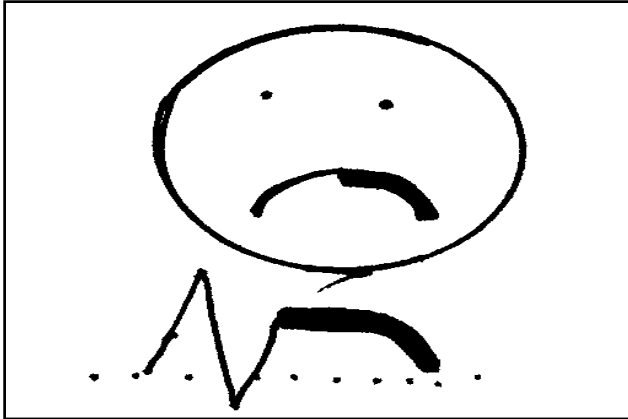


6 CAUSES – ST Elevation

- Benign Early Repolarization (BER)
- Acute MI
- Pericarditis
- LV Aneurysm
- Prinzmetal's Angina (Vasospasm)
- Bundle Branch Block

CONTOUR

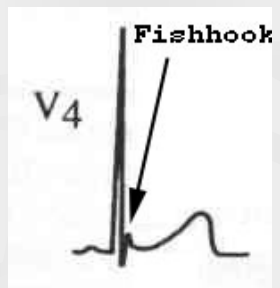




Benign Early Repolarization (J Point Elevation)

- Smiley Face Contour
- Anterior Leads (V1-V4)
- Does not evolve / Present on old EKG
- Often associated with LVH
- “Fishhook” Contour in V4

Clues to Early Repolarization



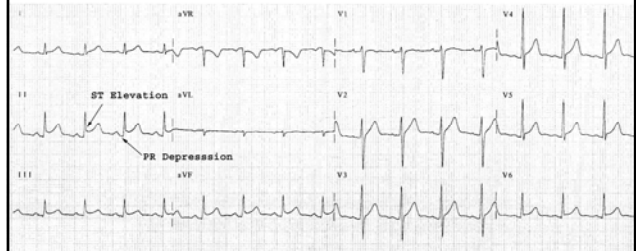
ACUTE MI

- Frowny Face Contour
- Reciprocal Changes
- Contiguous leads
- Evolution / Change from old ECG
- Other Findings of Ischemia

Pericarditis

- Diffuse ST elevation
- Benign morphology
- PR depression is diagnostic
- Clinical presentation:
Stabbing / burning; worse lying flat / relieved sitting up; persistent and prolonged

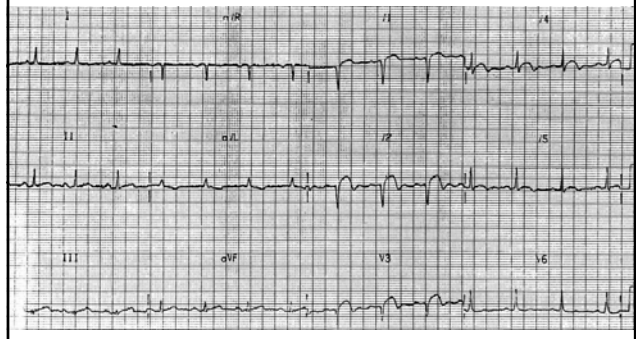
Findings in Pericarditis



LV aneurysm

- ST segment elevation in V1 - V2
(benign or concerning morphology)
- Evidence of previous anterior MI
Q waves in V1 - V4
- Lack of:
New Changes
Evolution
Reciprocal Depression

Findings in LV Aneurysm



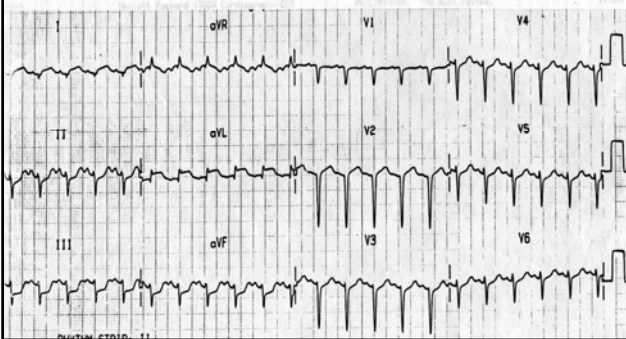
Prinzmetal's angina (Vasospasm)

- Occurs Rarely
- Resolution of ST segment elevation without revascularization
- Occurs in setting of baseline coronary artery disease

Bundle Branch Block

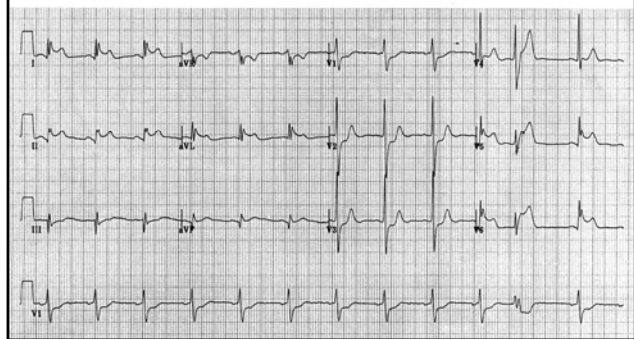
- QRS is greater than .12 msecs
- ST segments are in opposite direction of terminal QRS

7. 73 year old female complains of feeling weak. Heavy smoker in the past. High cholesterol.



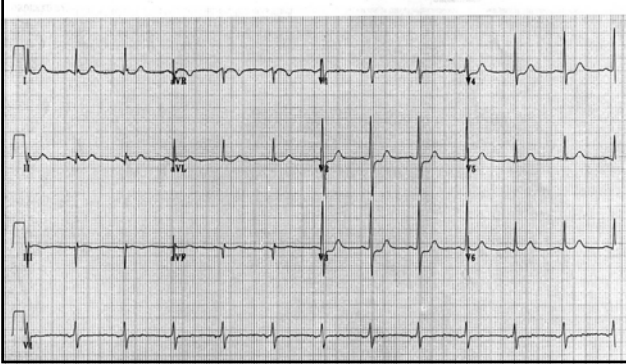
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8. 65 year old man with known angina complains of chest pain for 30 minutes. Awoke him from sleep.

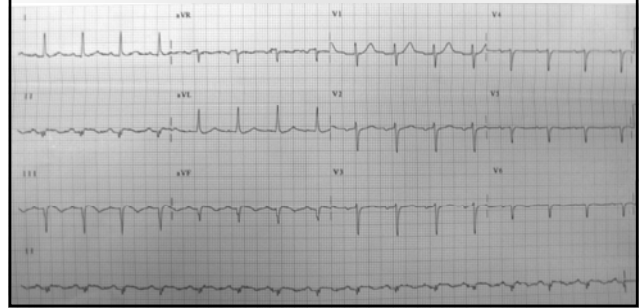


8b. Repeat EKG after pain free with 3 sublingual Nitroglycerin.

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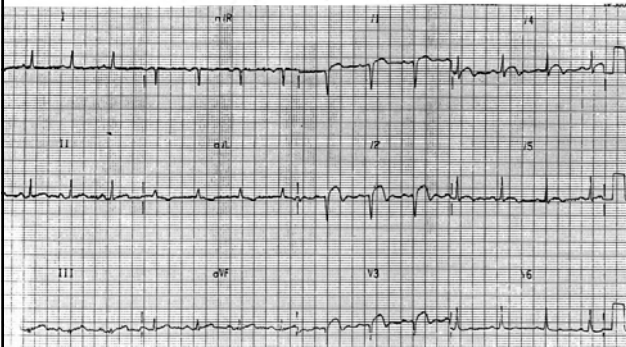


9. 75 y.o. female with SOB



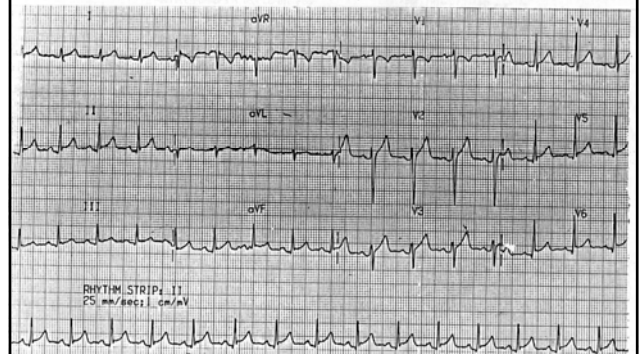
10. 60 year old male complains of 3 days of right sided chest pain, worse with movement. MI in the past.

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11. 51 year old male with AIDS awake from sleep with severe chest pain. Improved with sitting up.

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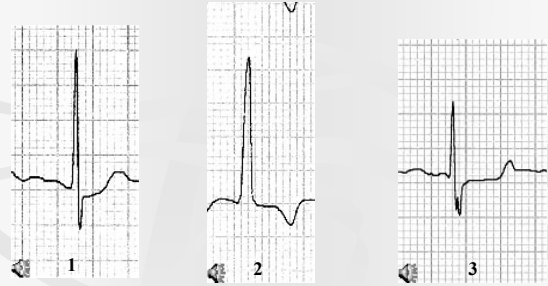


ST SEGMENT DEPRESSION

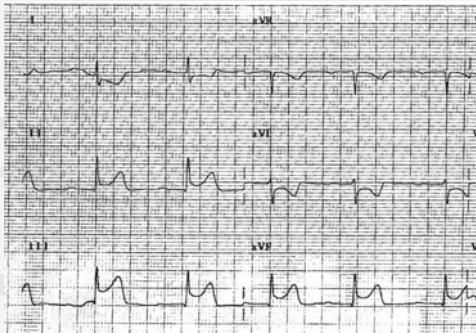
6 CAUSES

- Reciprocal Changes
- Subendocardial Infarct
- Posterior MI
- Ischemia
- LVH with repol abnmlty = STRAIN
- Digoxin

ST Depression - Contours



Reciprocal Changes

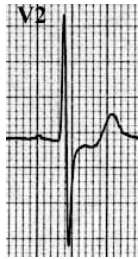


SUBENDOCARDIAL INFARCTION OR ISCHEMIA

Flat or "PLANAR"
ST Depression



Acute Posterior MI



- ST Depression in V1-V3
- Upright T wave in same leads
- May have Tall R wave in V2
- Obtain posterior leads for diagnosis



Posterior Leads

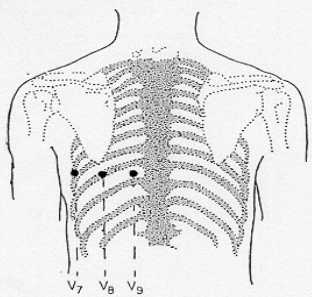
Look for ST elevation in V8 to diagnose Posterior MI

Normal V8

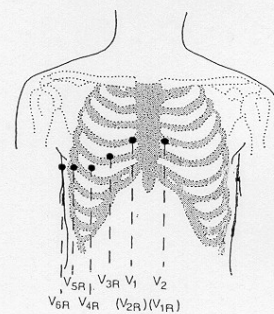
V8 in Posterior MI



Posterior lead ECG

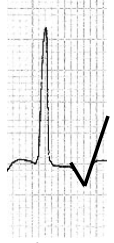


Right sided lead ECG



“Strain” Pattern of LVH

Left Chest Leads



Asymmetric Inverted T Wave

LVH

1. High Voltage

- S (in V1 or V2) + R (in V5 or V6) is >35 mm
- AVL > 11 (or 13) is diagnostic
- Any R wave > 20 mm in limb or 25mm in precordial

2. Strain Pattern

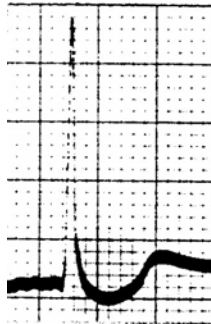
- ST Depression with asymmetric T waves

3. Left Atrial Enlargement

- Terminal P is 1x1 box in V1

EKG diagnosis is 95% specific/ but only 15-30% sensitive

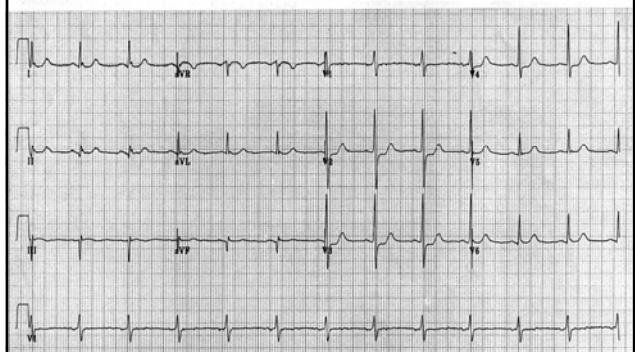
DIGOXIN EFFECT

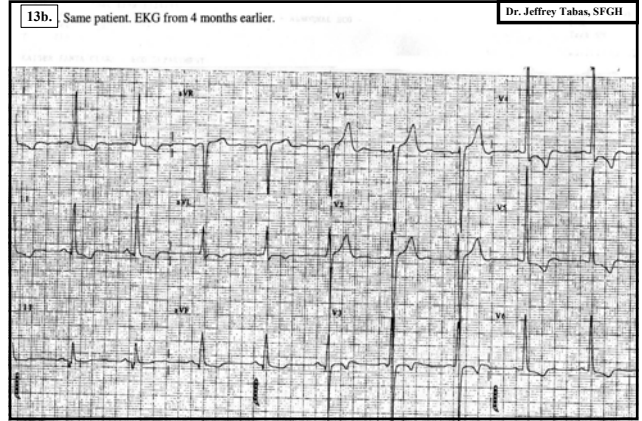
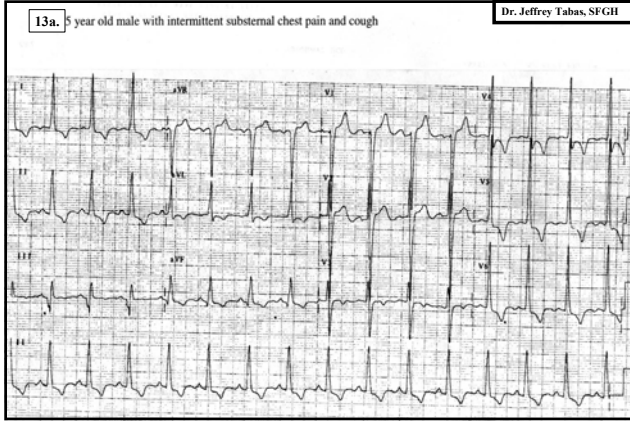


Swooping ST segments

12, 50 y.o. M with episode of near syncope

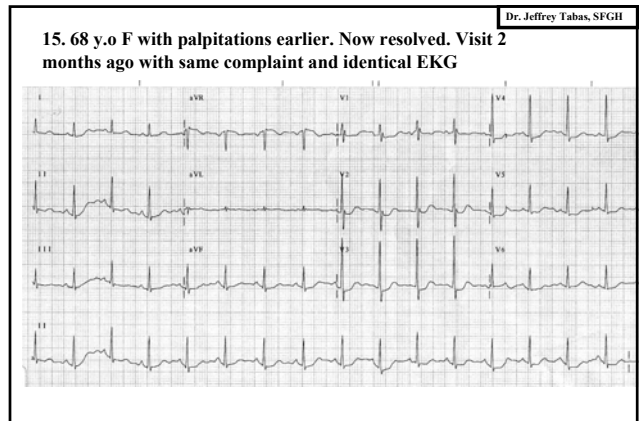
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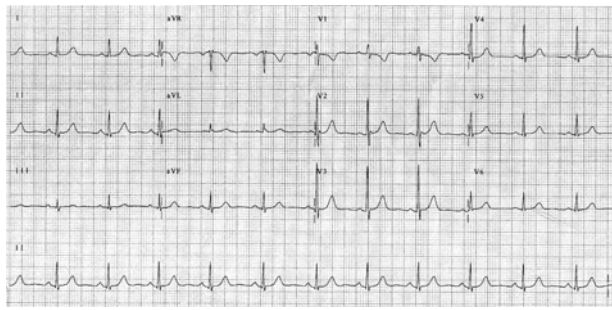


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14. Patient discharged home in study of missed MI's
ED interpretation: NSR, LVH with strain



15b. 68 y.o F post treatment with beta blockers



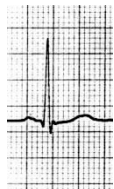
Other Findings of Ischemia

- Q Waves
- T Wave abnormalities

Insignificant Q Waves



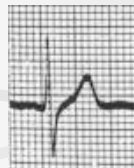
2, 3, F



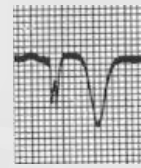
1, L, V5, V6

Less than 1 box wide (0.04 msec) and 1/4 the height of QRS

T Waves



A



B

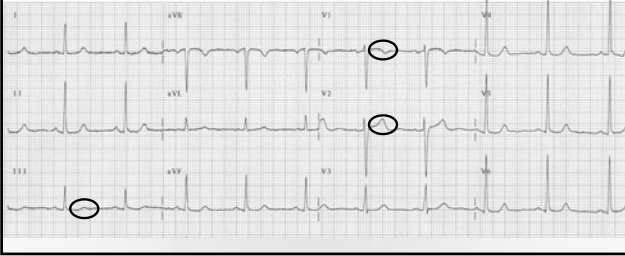


C

Enlargement, Symmetry, and Inversion suggest pathology

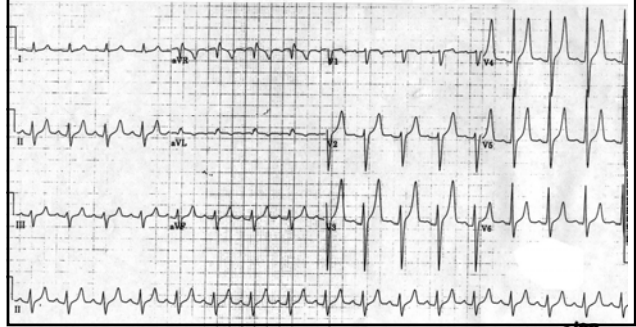
T Wave Inversion

Inversion is normal in Lead V1
Inversion is acceptable in Lead 3 and V2 as well



16. 40 year old male with pneumonia. Missed hemodialysis.

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17. 55 y.o. F with pleuritic chest pain for 10 hours

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Rate 122 - Sinus tachycardia, rate 122 Normal P axis, rate > 100 DE
PR 166 - Vertical axis, normal for age QRS axis II in 90 & age > 40
QRS 49 - Consider Anterior infarct Q wave in V3
QT 258 - Nonspecific inferior T abnormalities T neg or T/QRS ratio < .35 2,3,7
QTc 343

P 78
QRS 48
T -48
- ABNORMAL ECG -
PRELIMINARY-MD MUST REVIEW

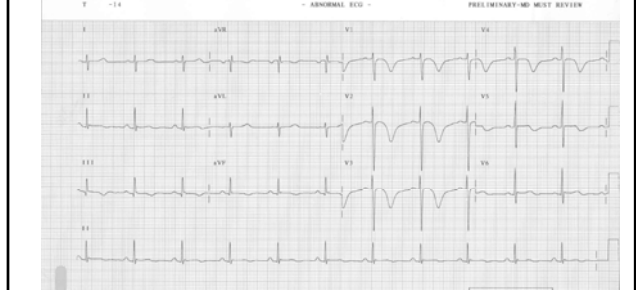


18. Another patient with same diagnosis

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DE: NORMAL SINUS RHYTHM, RATE 88 Normal P axis, PR, rate & QRS
Rate 88 - NORMAL SINUS RHYTHM, RATE 88 Normal P axis, PR, rate & QRS
PR 178 - ABNORMAL T, PROBABLE ISCHEMIA, ANTERIOR LAD Tc-Q, SWS T, aVL, V2-V6
QRS 82 - MINIMAL ST ELEVATION, INFERIOR LEADS STc, SWS T, III, aVF
QTc 473

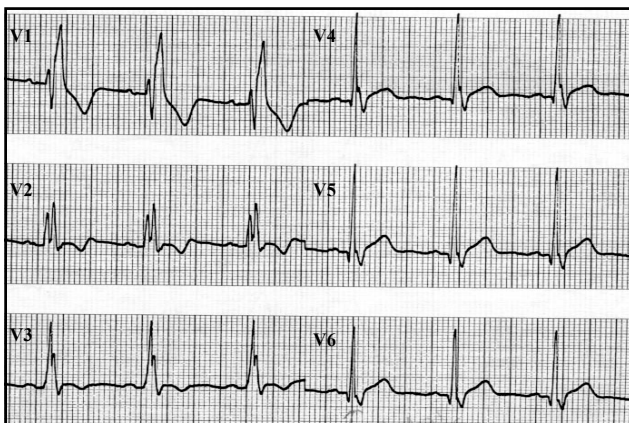
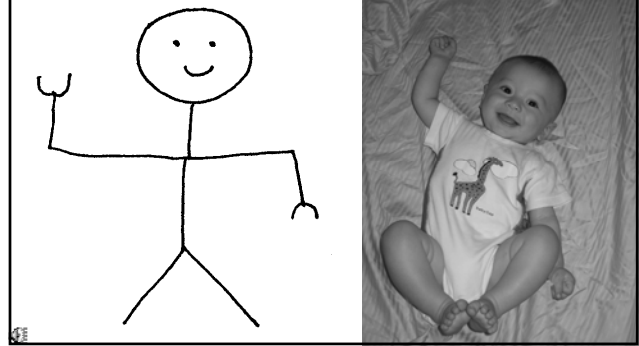
---AXIS---
P 81
QRS 89
T -14
- ABNORMAL ECG -
PRELIMINARY-MD MUST REVIEW



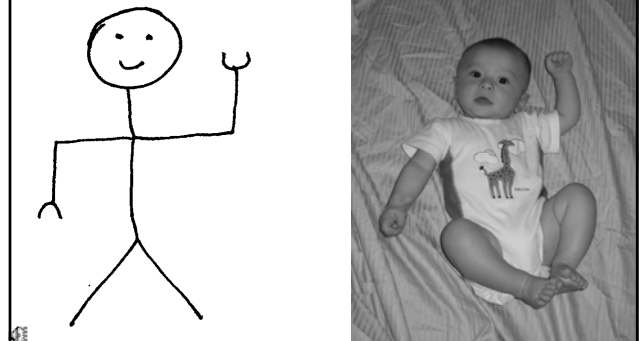
BUNDLE BRANCH BLOCKS

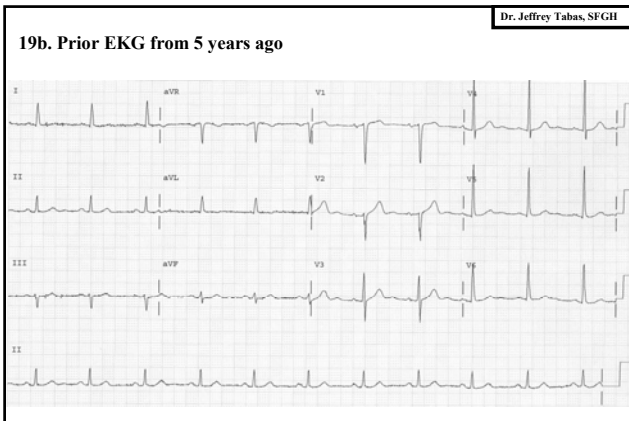
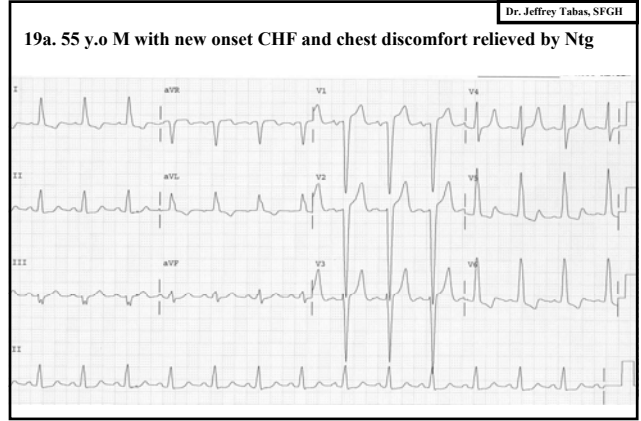
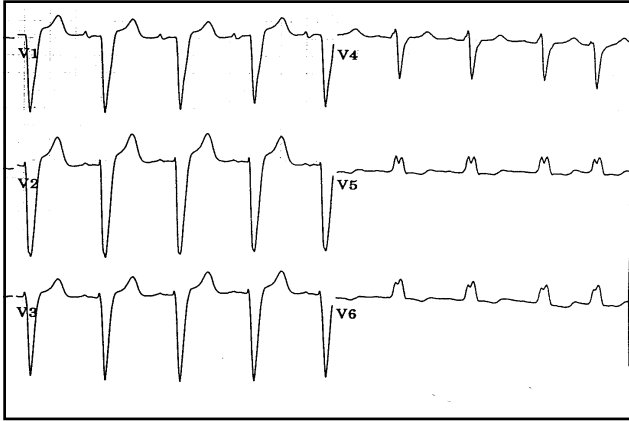
- The QRS is wide, usually > 0.14
- Look at TERMINAL portions of the QRS in leads V1 and V6
 - Terminal R wave in V1 = Right BBB
 - Terminal R wave in V6 = Left BBB
 - The opposite lead shows a widened S wave
- The ST segments are opposite to the terminal portion of the QRS

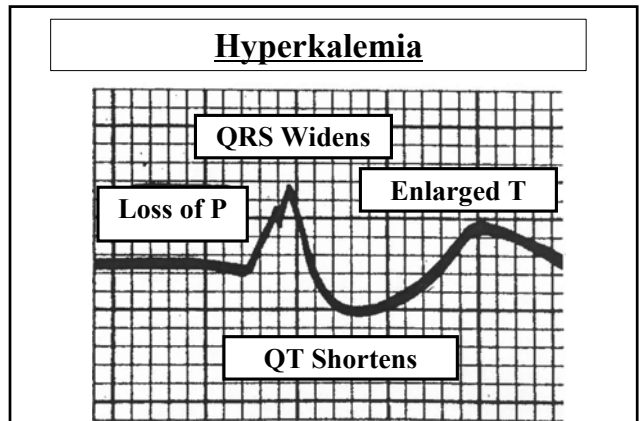
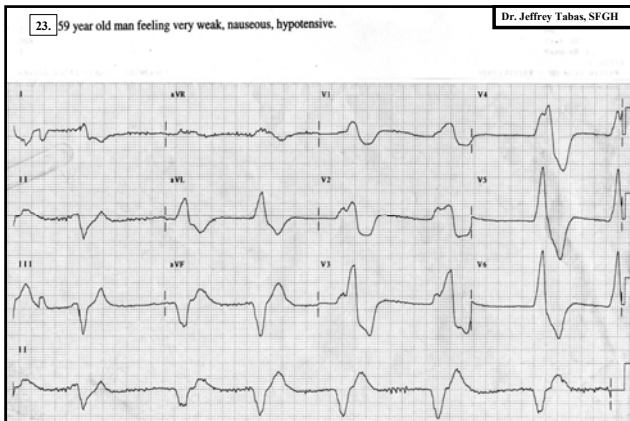
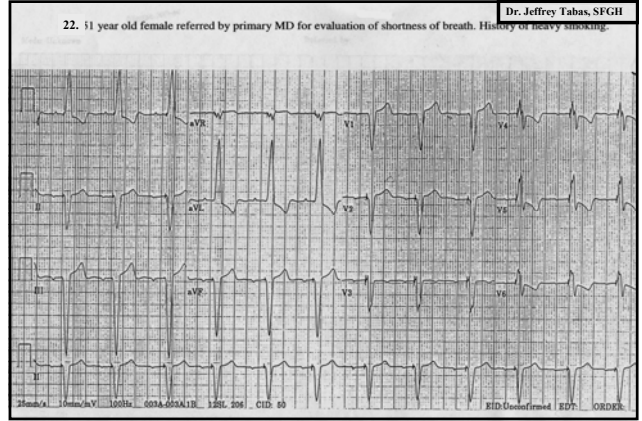
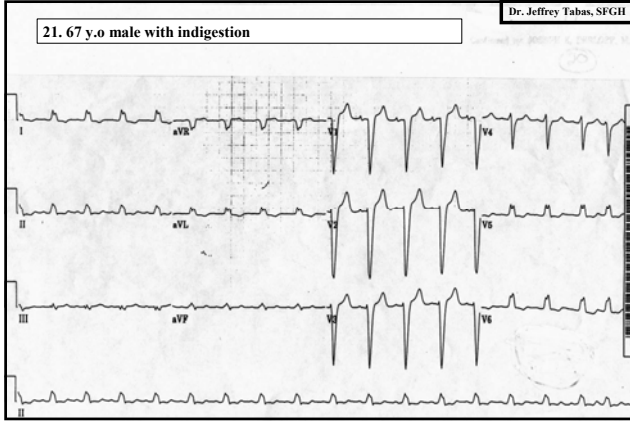
Right Bundle Man

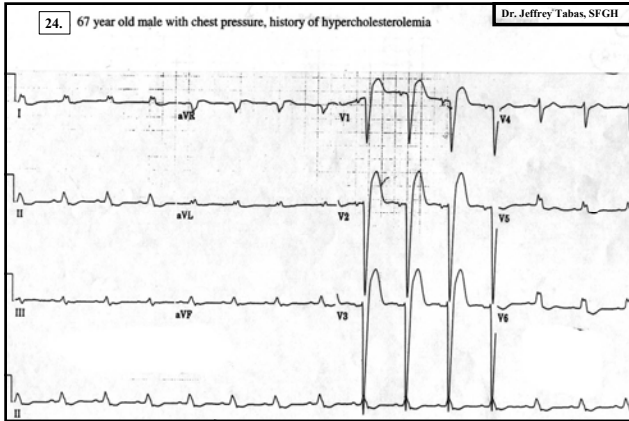


Left Bundle Man



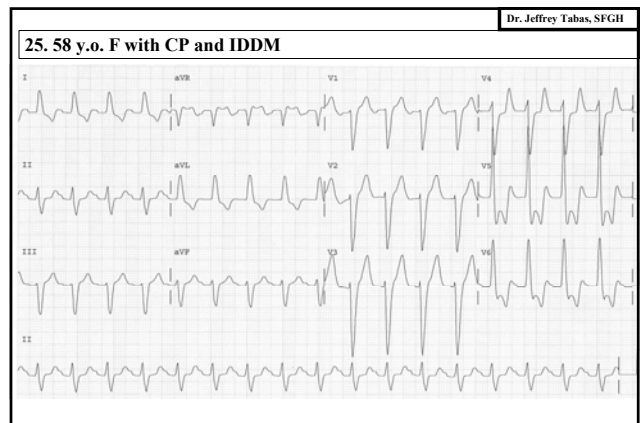
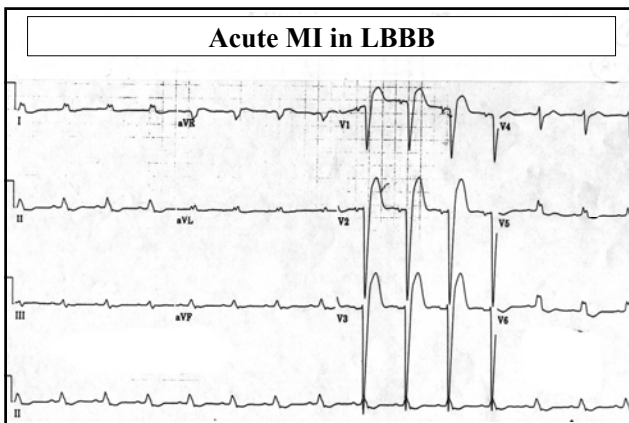




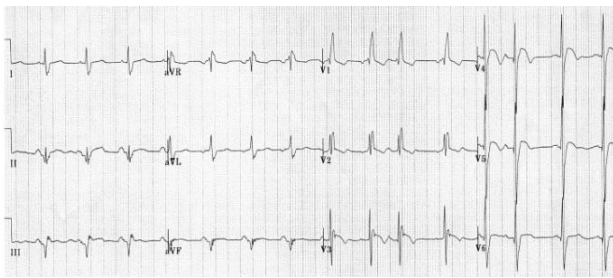


ACUTE MI in LBBB

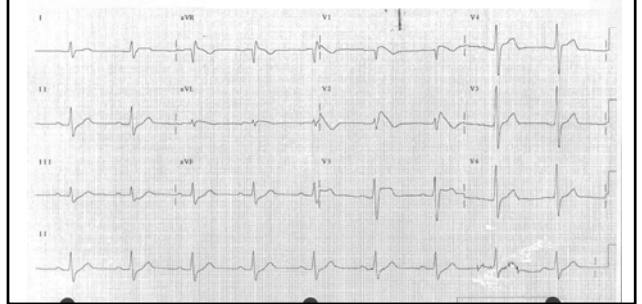
- 1 mm ST segment change in same direction as terminal QRS
- More than 5 mm ST elevation in direction opposite direction to terminal QRS



26. Patient discharged home: ED interpretation = NSR, RBBB



27. 20 y.o male with Syncope

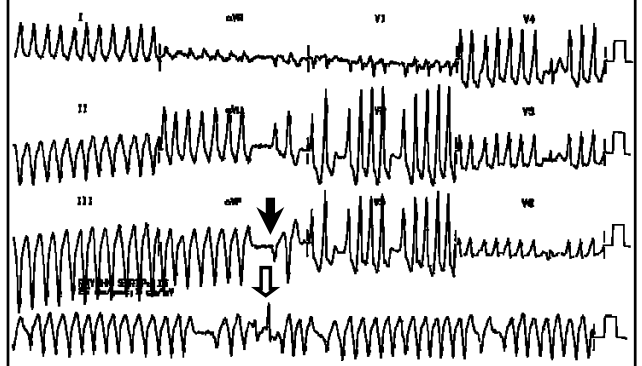


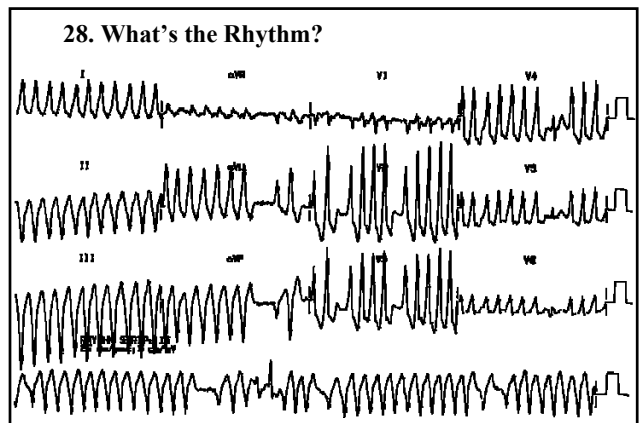
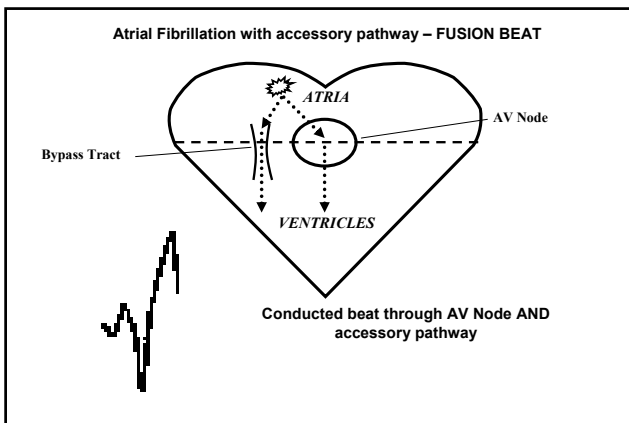
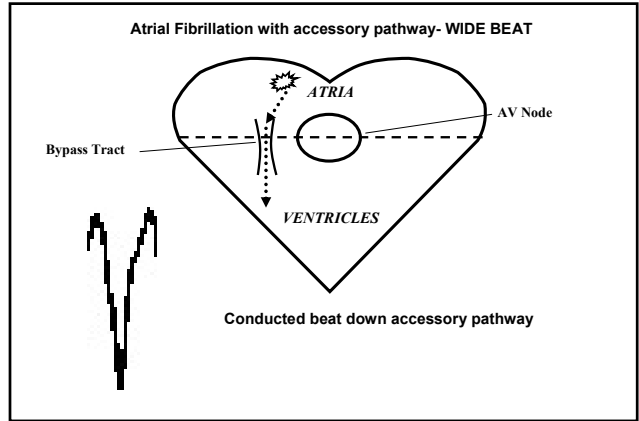
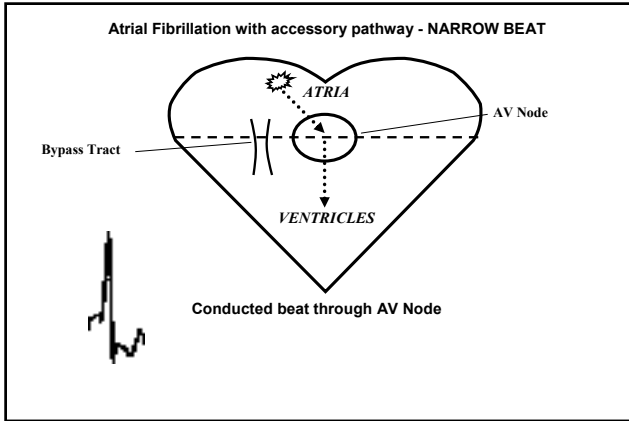
Brugada Syndrome

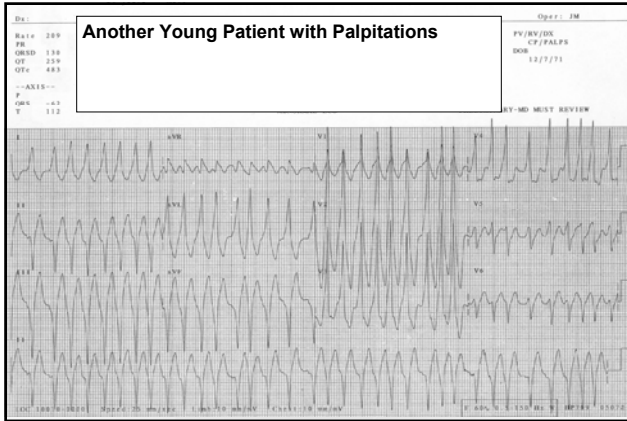


- RBBB Pattern in leads V1-V3
- ST elevation in leads V1-V3
- AICD's decrease Sudden Cardiac Death rate to 0!

28. What's the Rhythm?





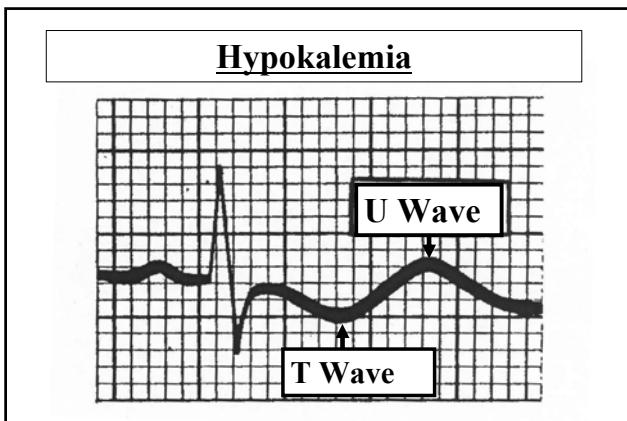


LOW VOLTAGE

< 5mm in all limb leads or
<10mm average of V1-V6

Clinical signs of tamponade!

- tachycardia,
- hypotension,
- elevated neck veins



EKG ALGORITHM

Arrhythmia

- Rate
- Rhythm

Acute Coronary Syndrome

- QRS width
- ST Elevation
 - Distribution, Contour, Comparison, Evolution
- Other findings of ACS
 - ST depression, T waves, Q waves

Take Home Points

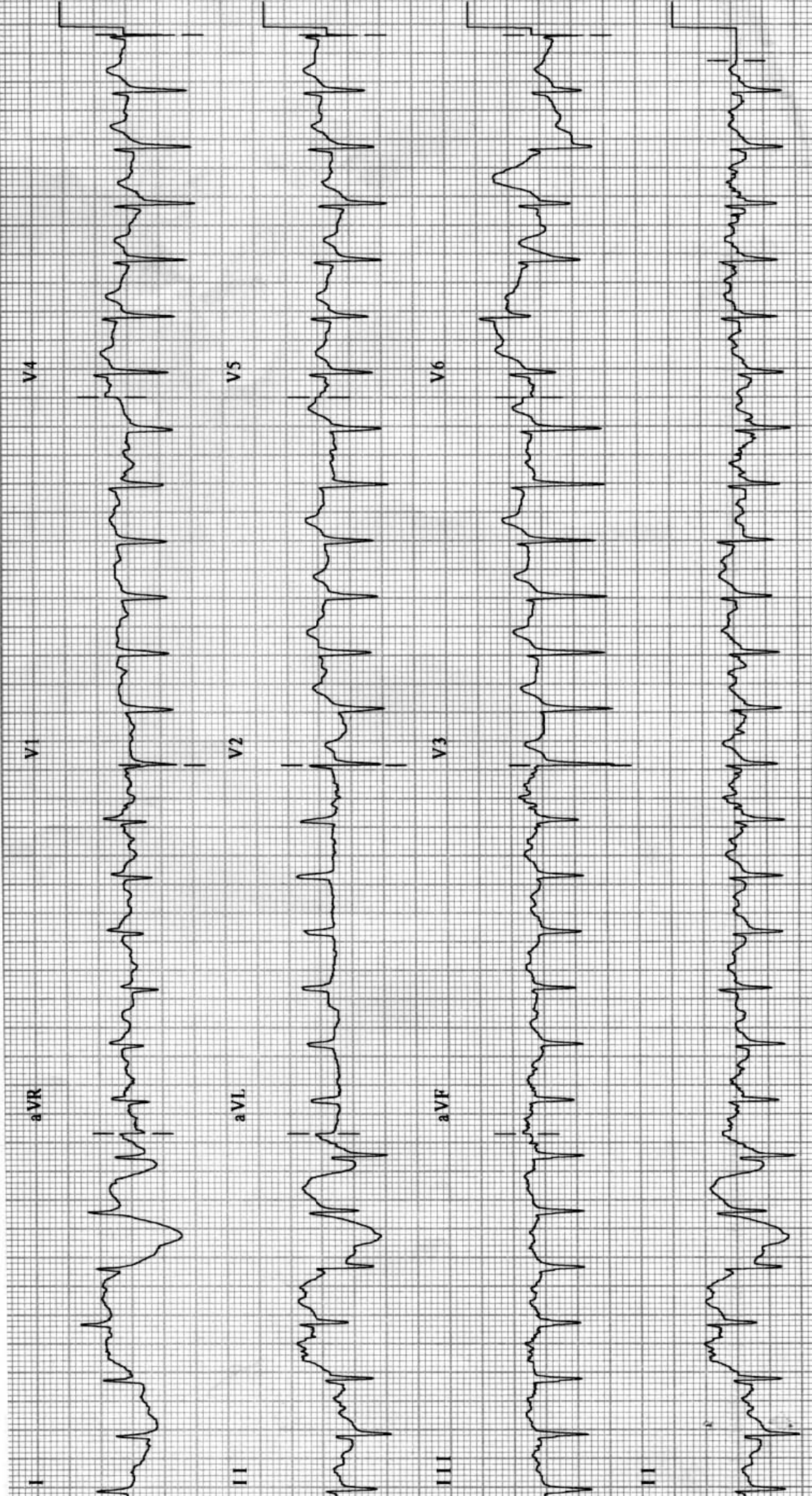
- Use a methodical approach
- An EKG in isolation is not diagnostic
- Consider the entire range of diagnoses when an abnormality is found
- Identify normal and abnormal ST segments in patients with Bundle Branch Block



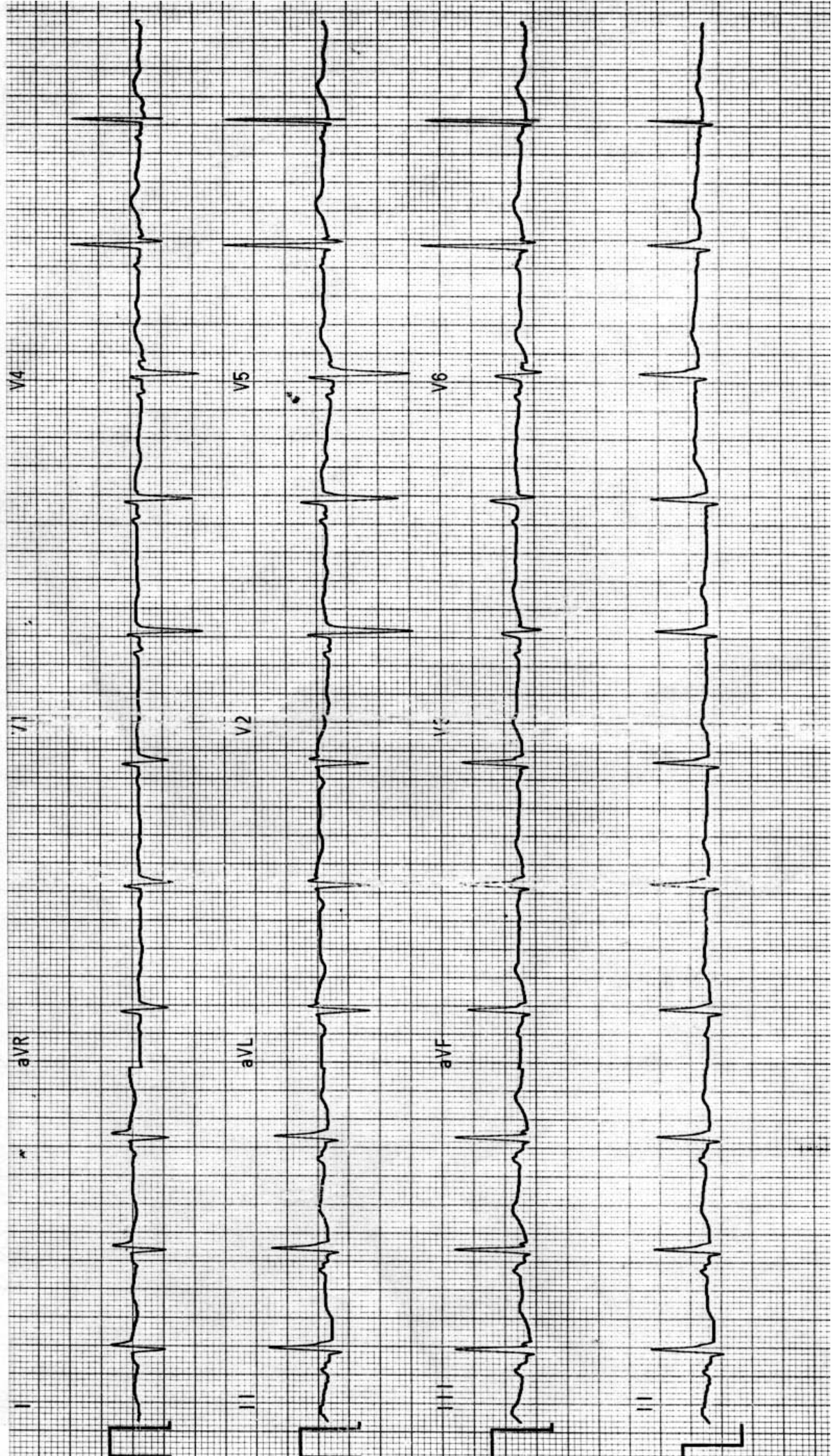
**Your Head Might Be
Spinning – Review at Home!**



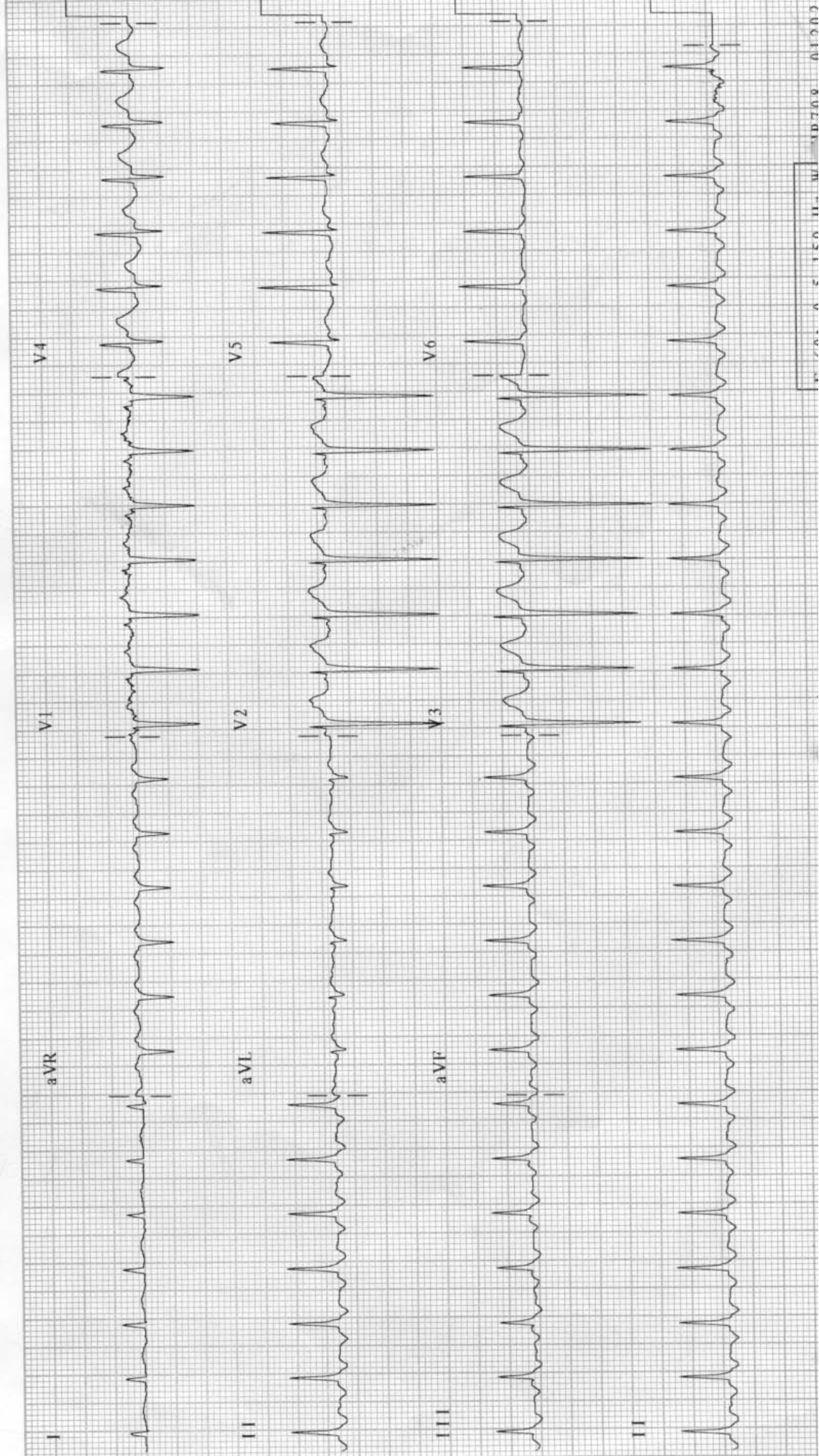
1. 65 y.o. male doesn't feel well. HR-150, BP-80/P



2. A 44 year old female complains of chest pain.



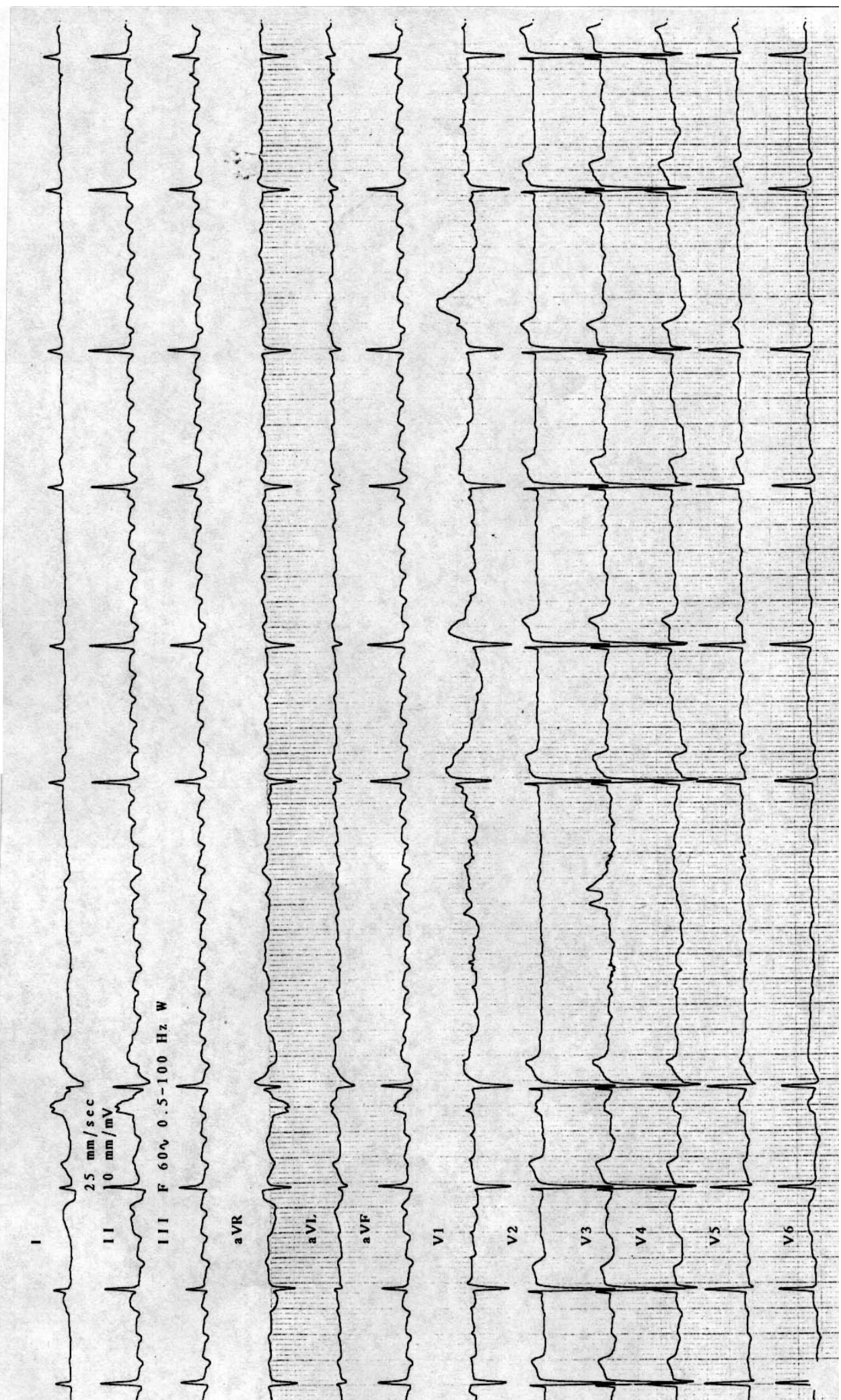
3A. A 56 year old man with a history of CHF complains of shortness of breath.



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1017000 012003

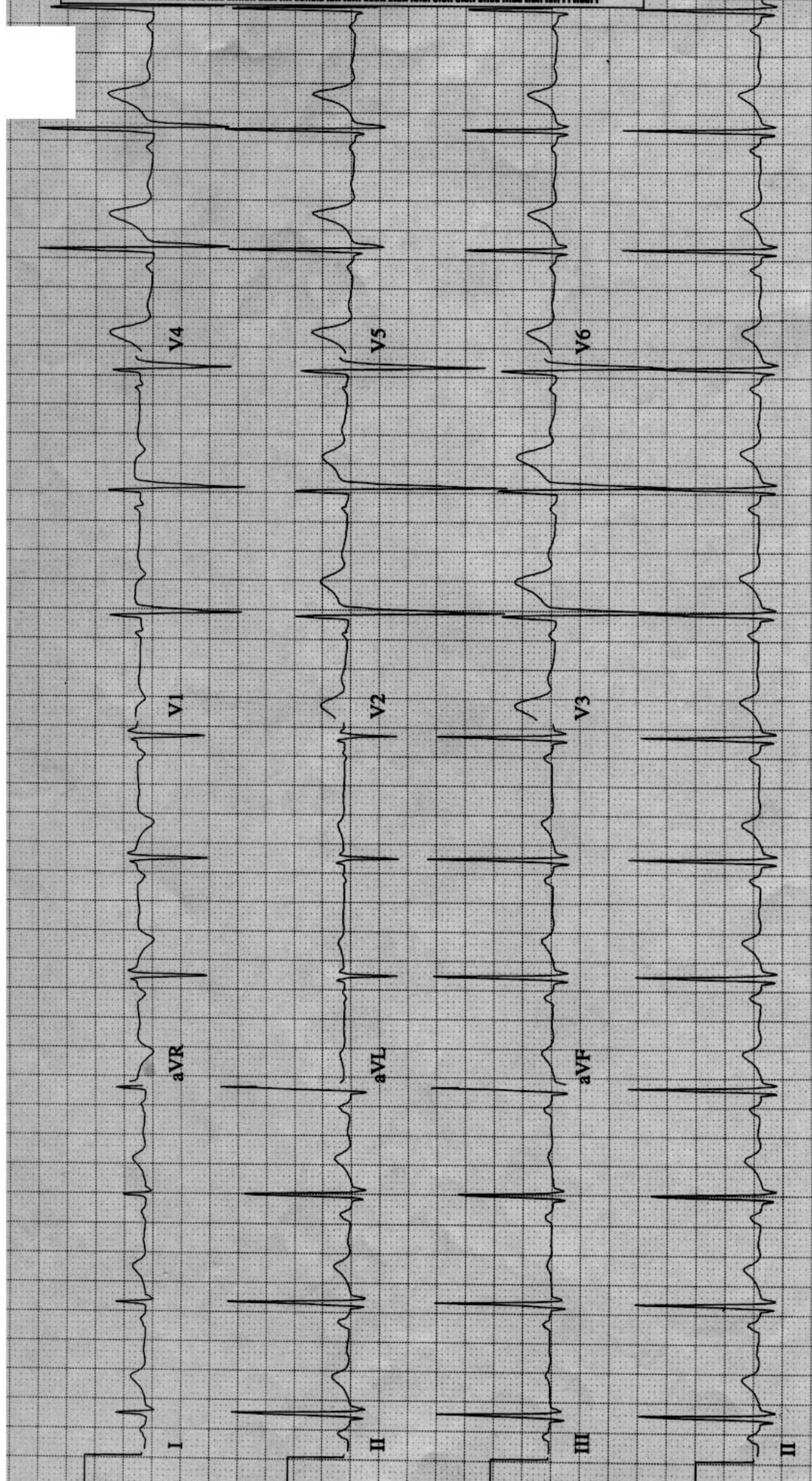
3B. After Adenosine

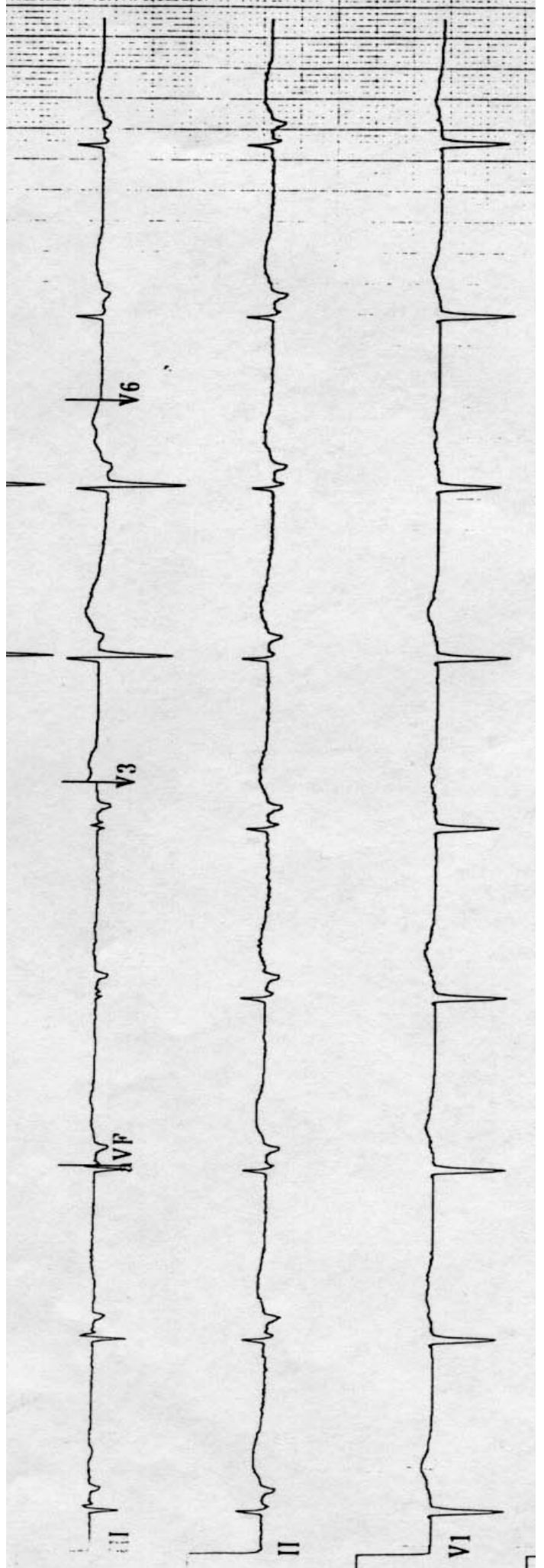
SAN FRANCISCO GENERAL HOSPITAL



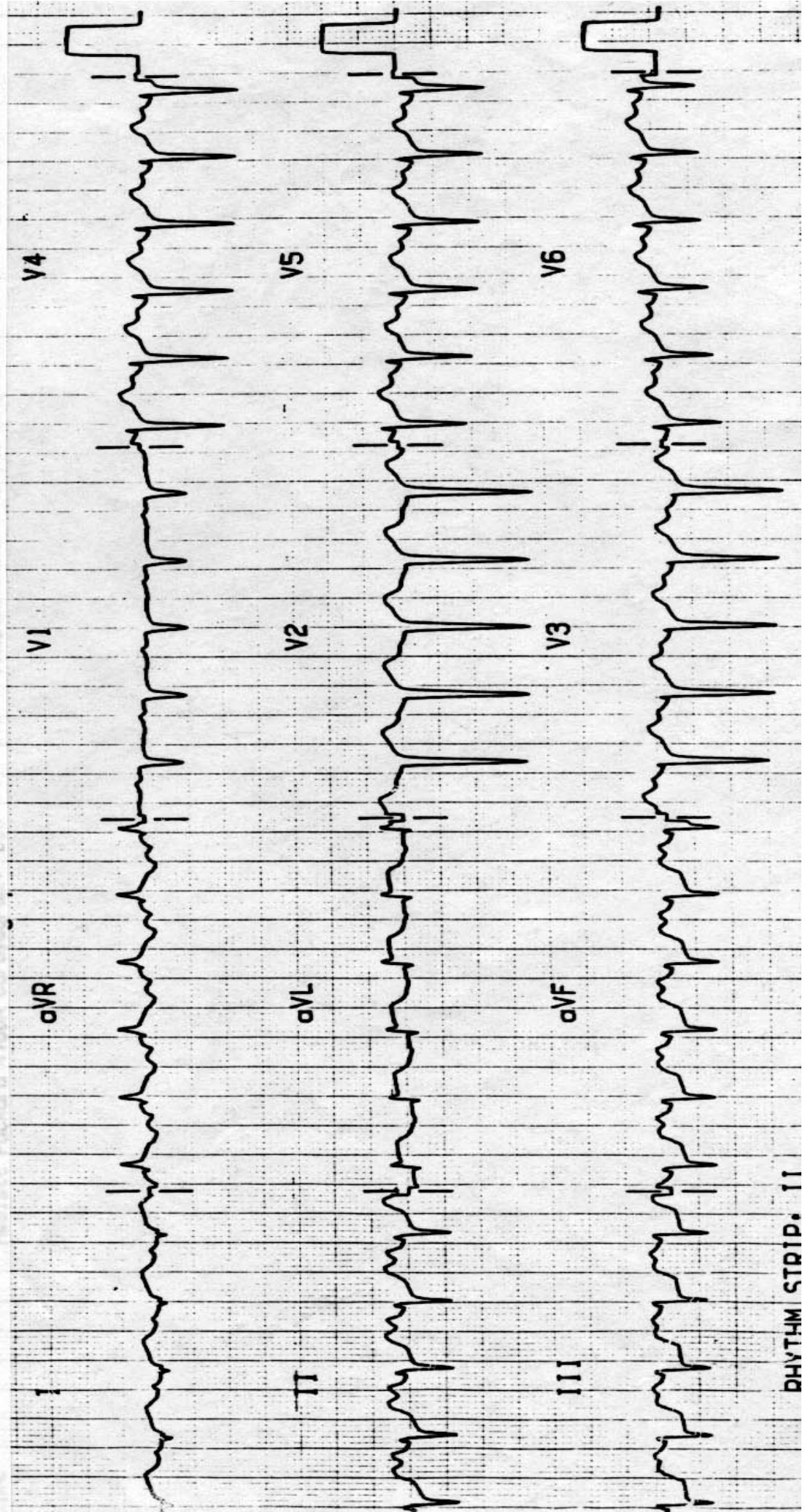
4. 25 y.o. M complains of chest pain

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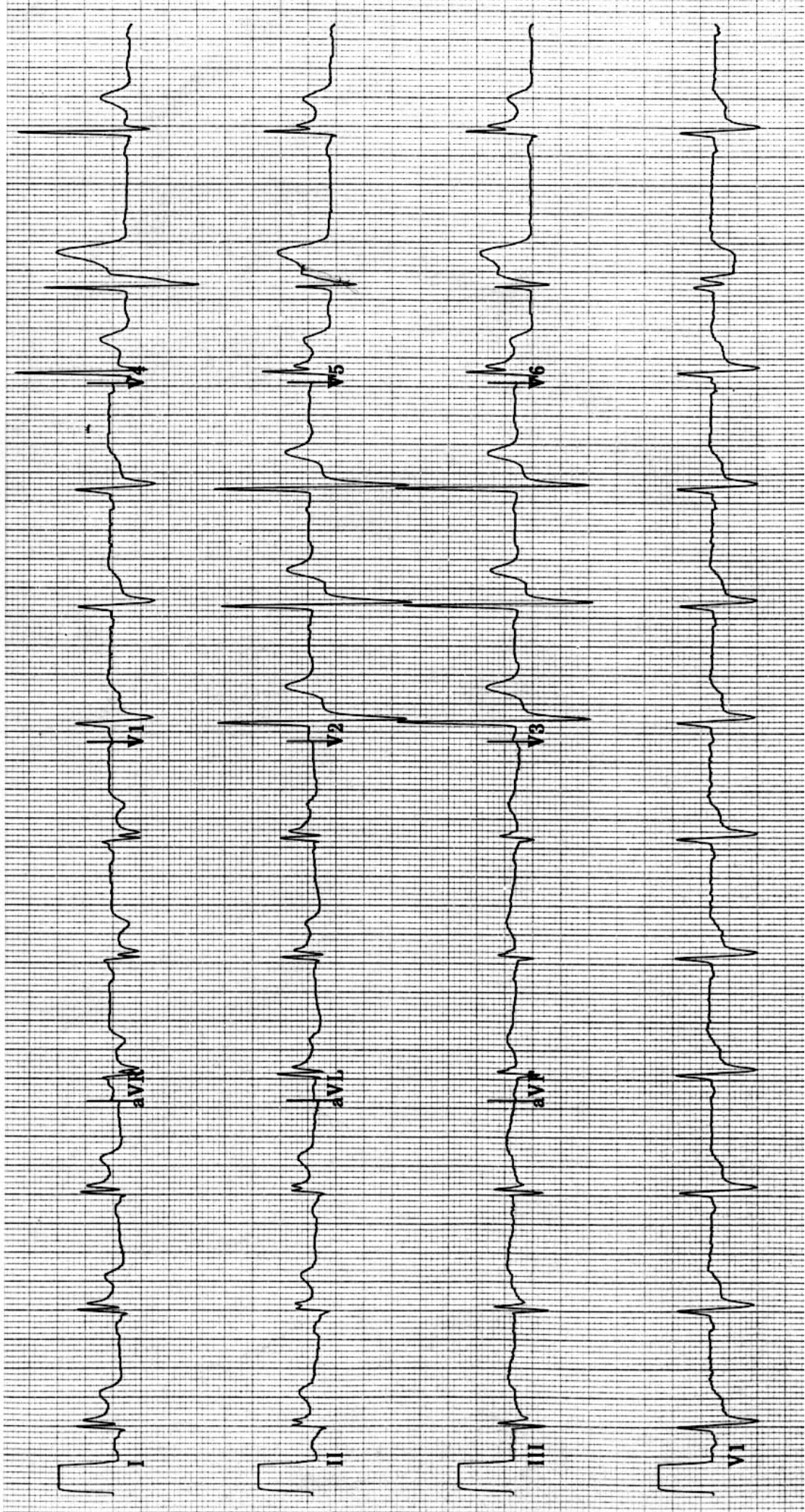




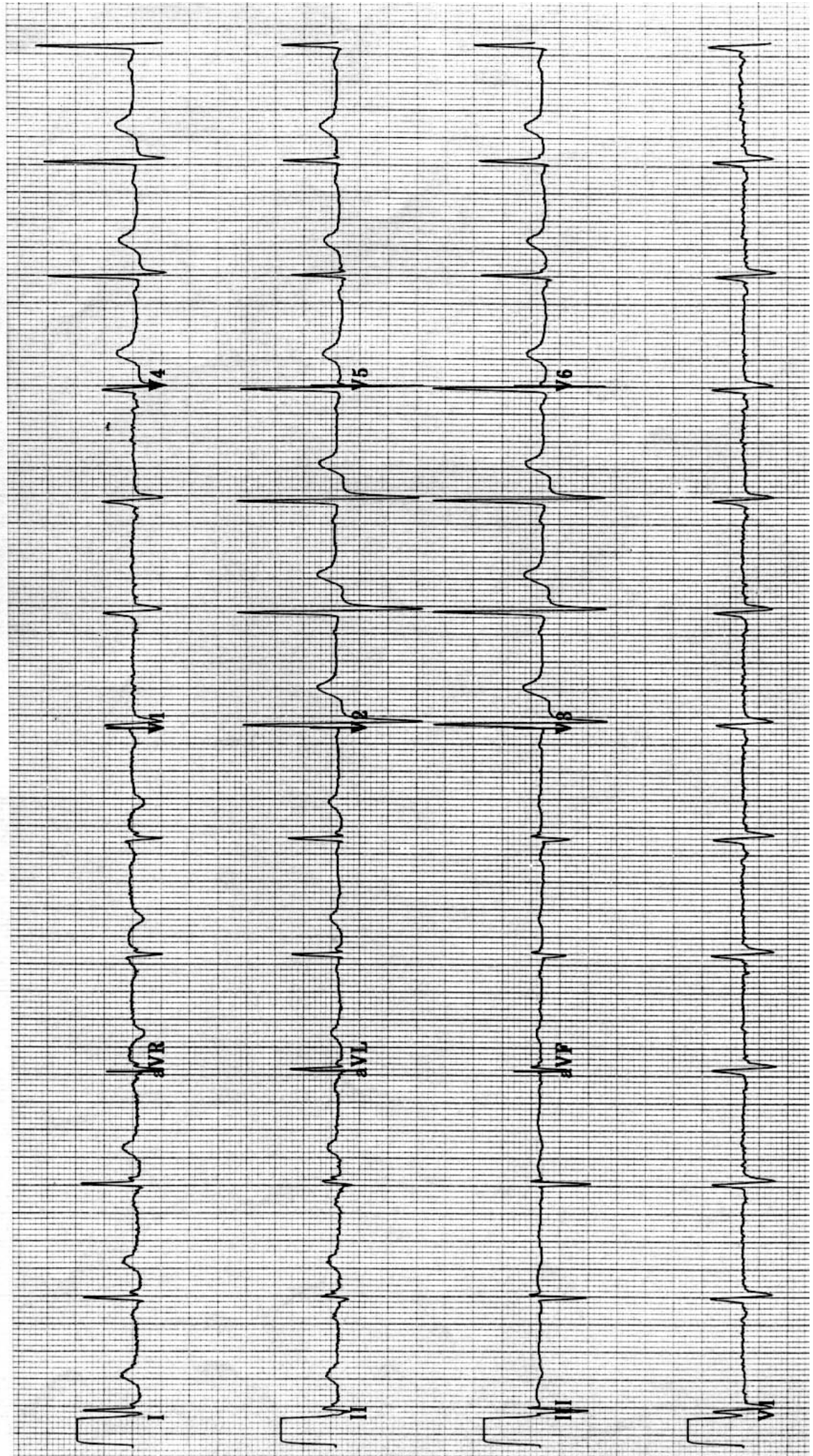
7. 73 year old female complains of feeling weak. Heavy smoker in the past. High cholesterol.



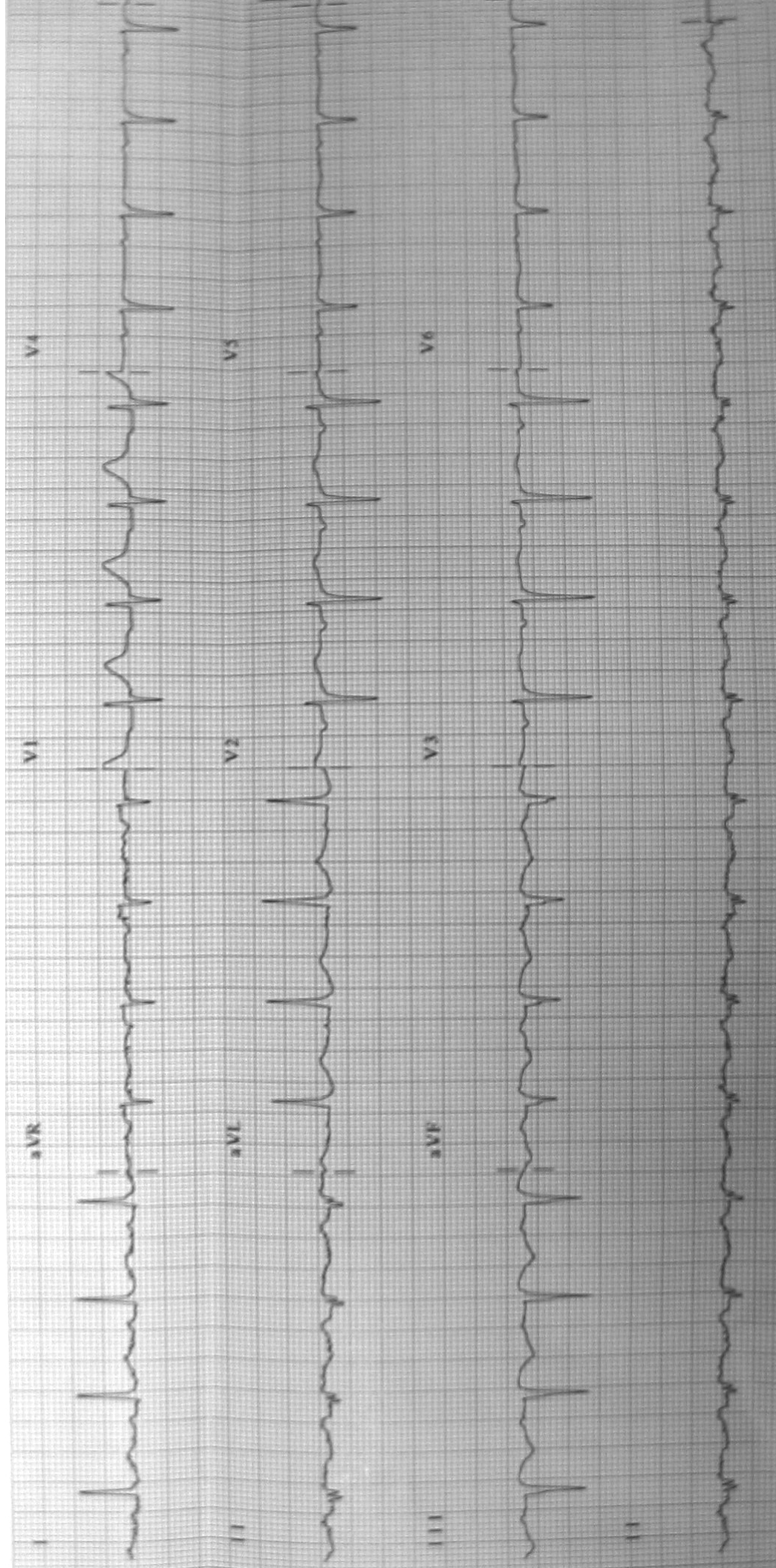
8. 65 year old man with known angina complains of chest pain for 30 minutes. Awoke him from sleep.



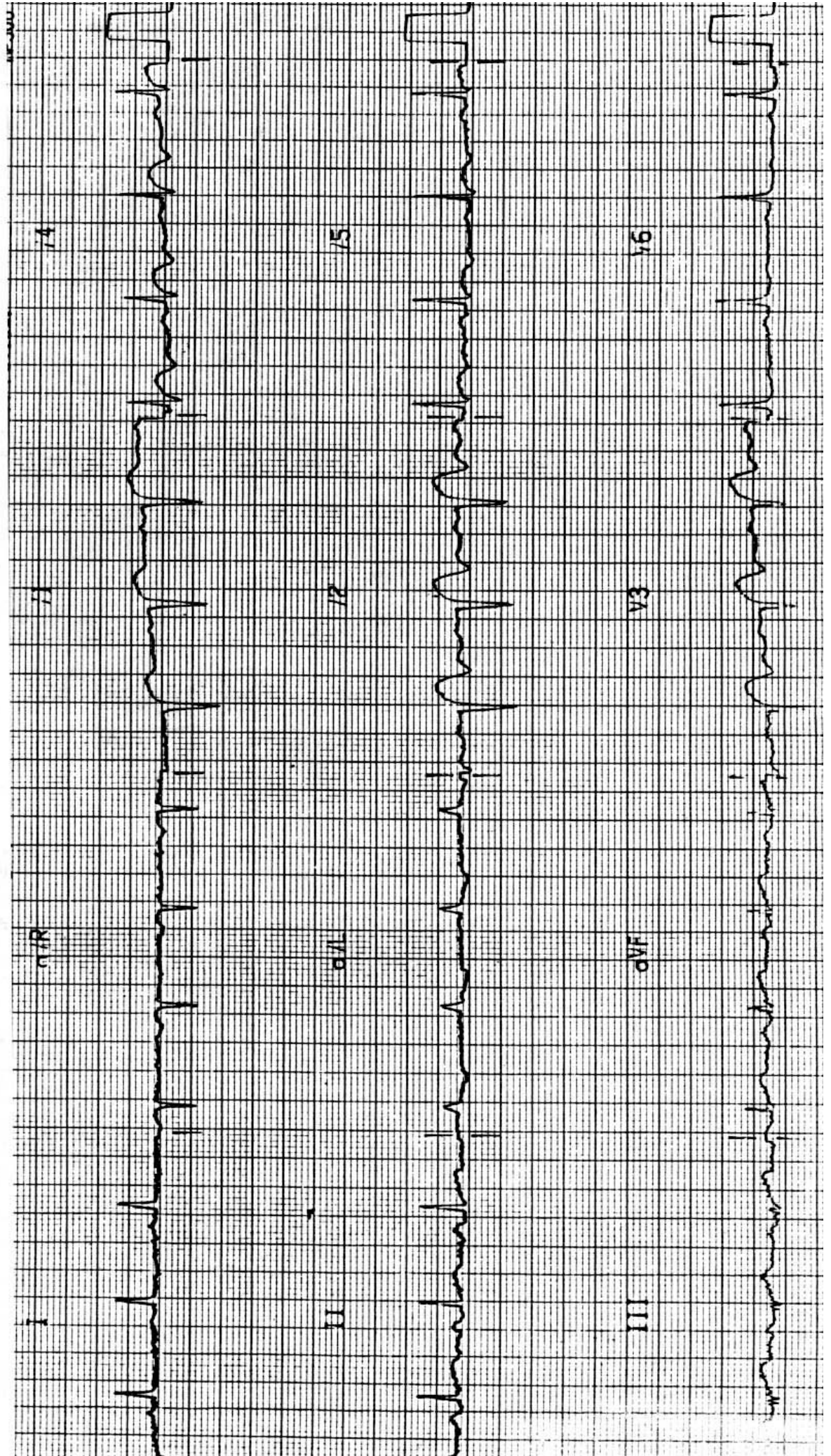
8b. Repeat EKG after pain free with 3 sublingual Nitroglycerin.



9. 75 y.o. female with SOB



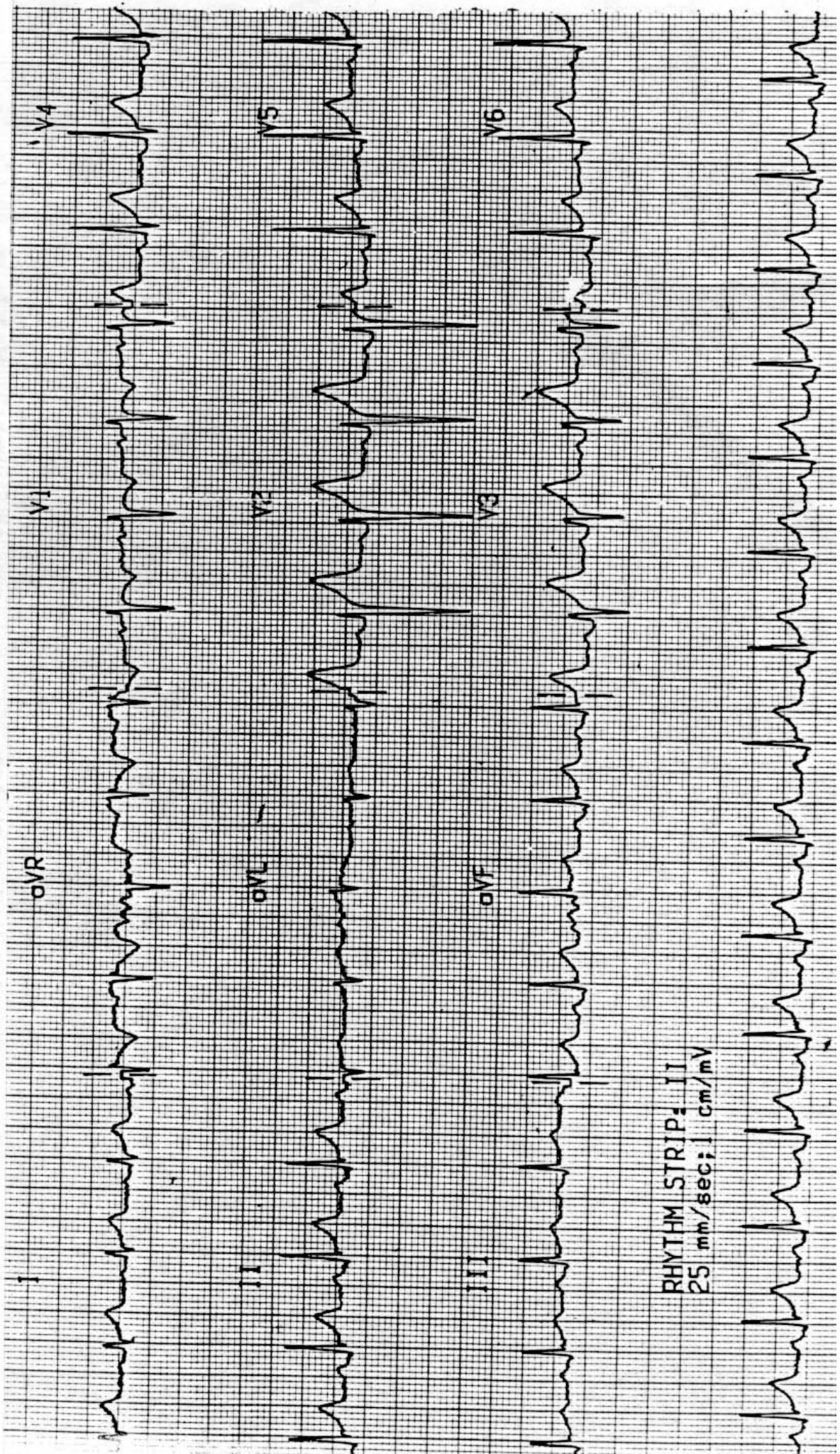
10. 60 year old male complains of 3 days of right sided chest pain, worse with movement. MI in the past.



11.

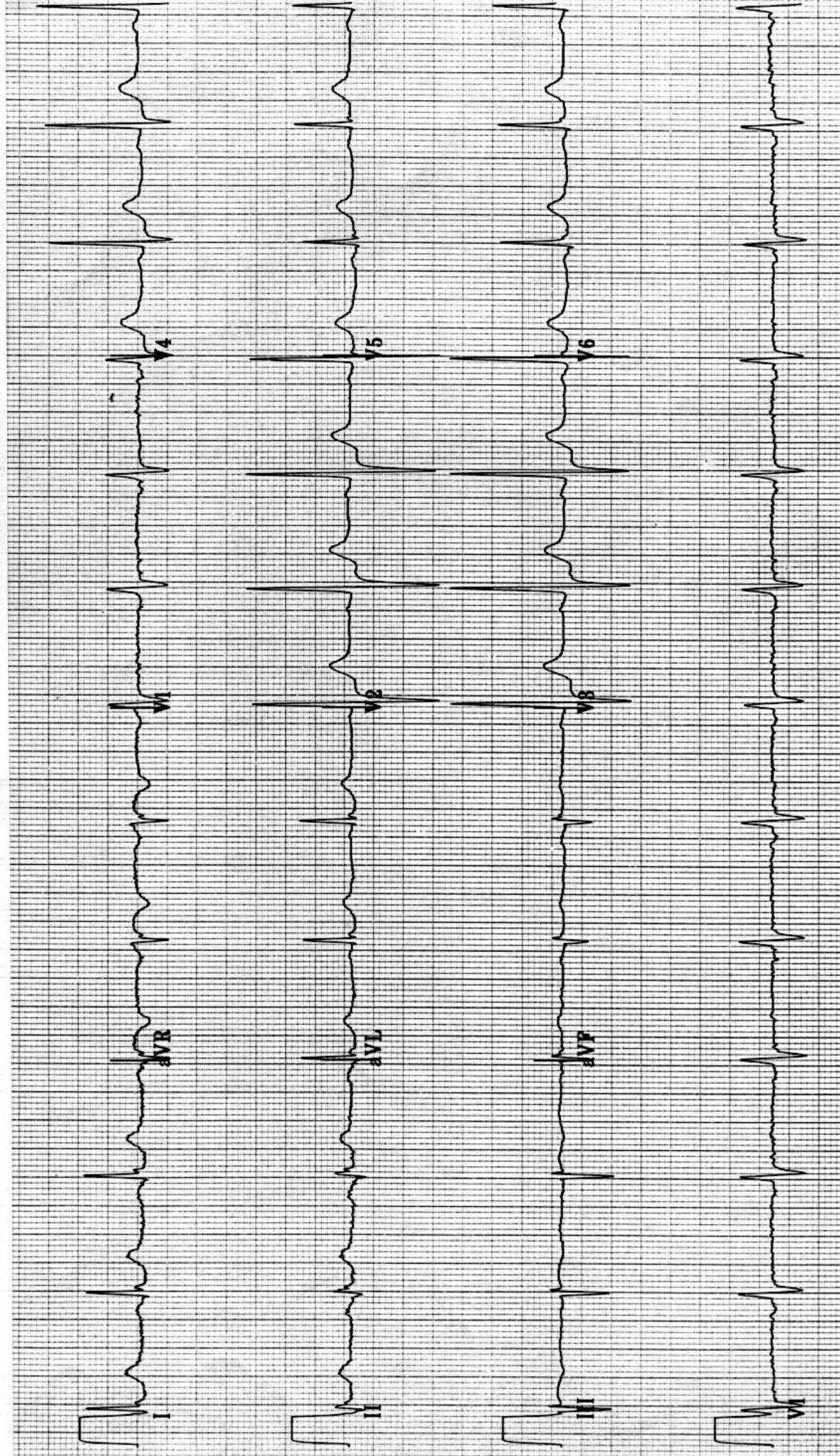
31 year old male with AIDS awake from sleep with severe chest pain. Improved with nitroglycerin.

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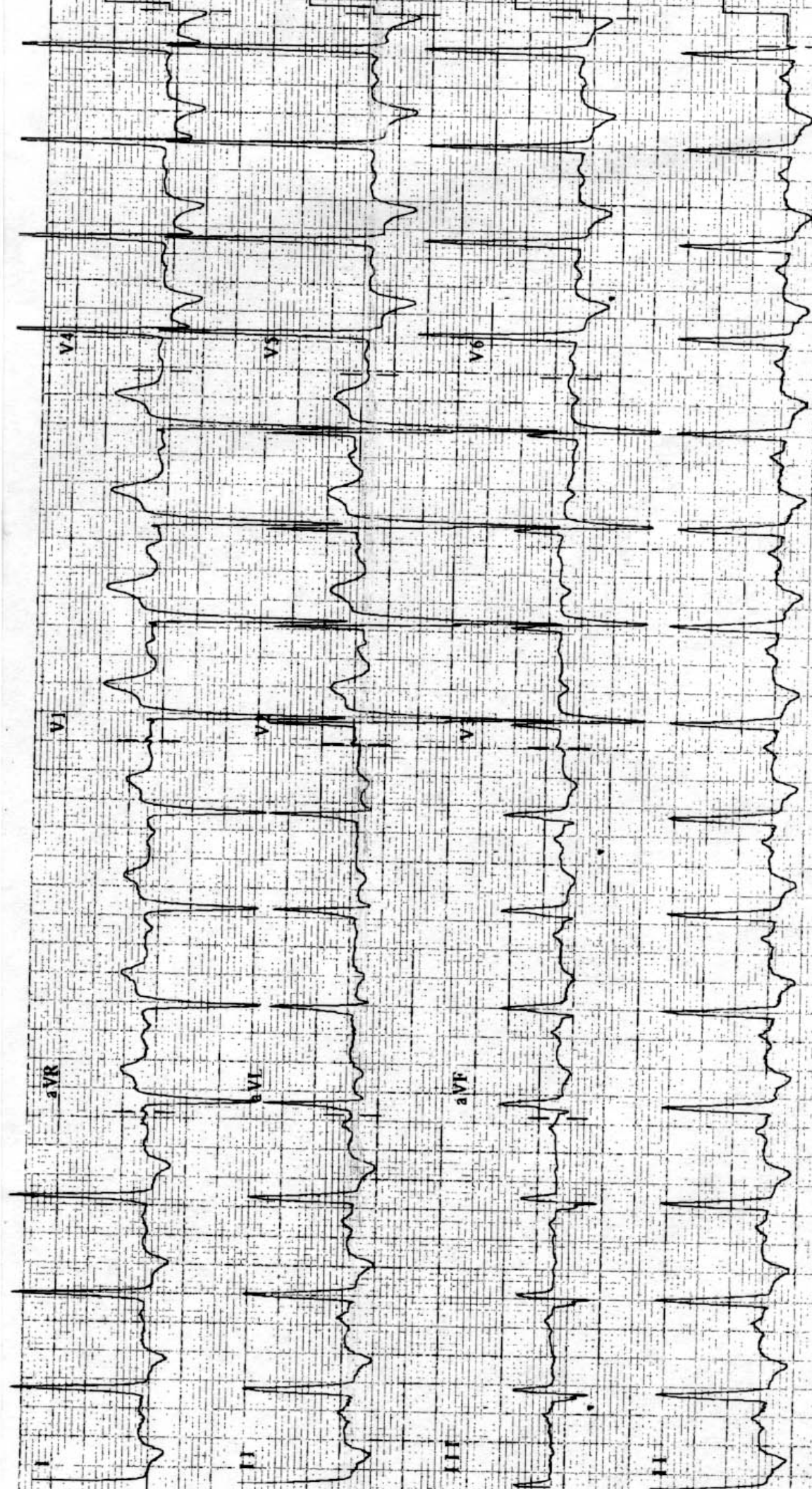


12. 50 y.o. M with episode of near syncope

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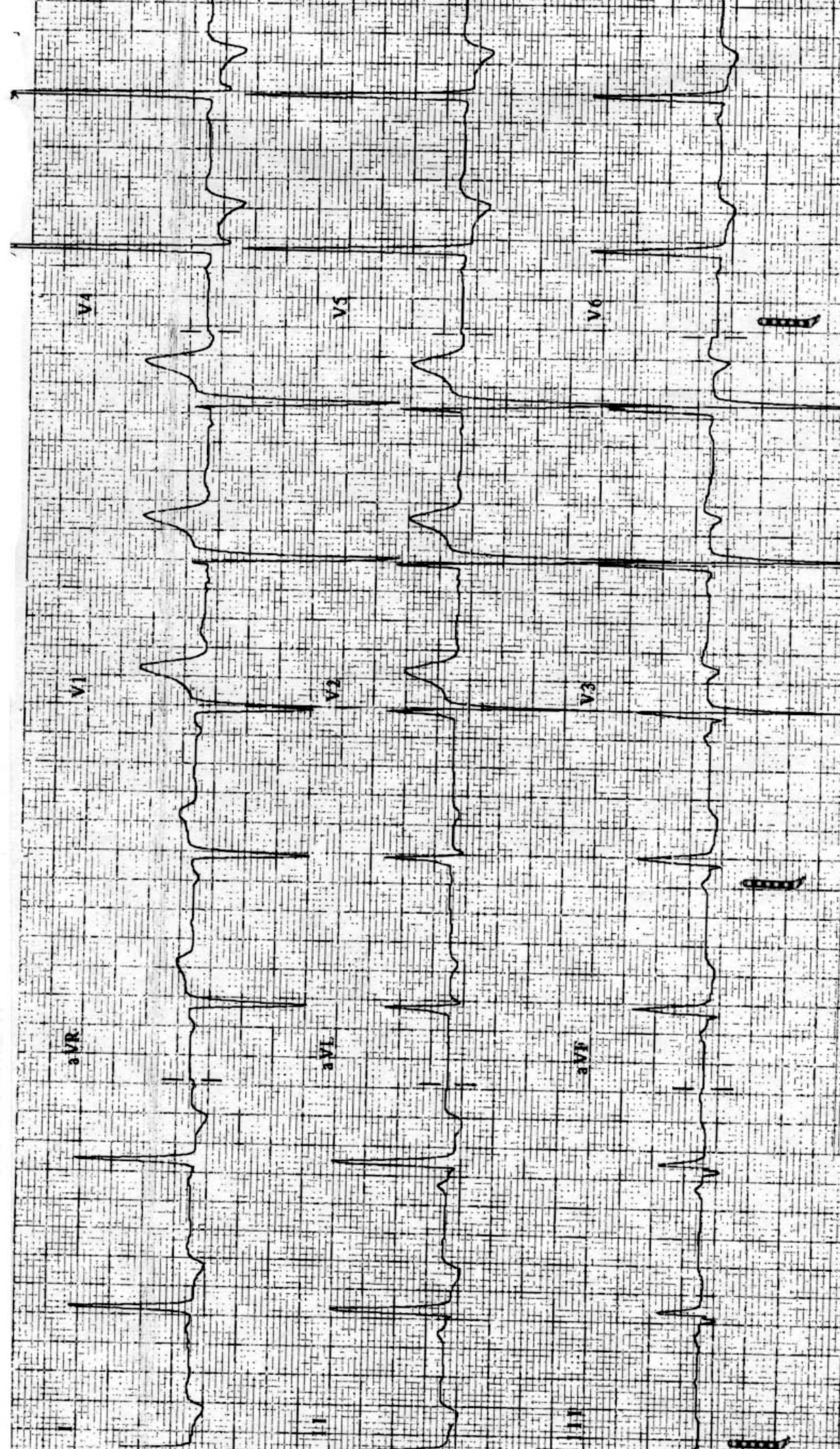


13a. 5 year old male with intermittent substernal chest pain and cough



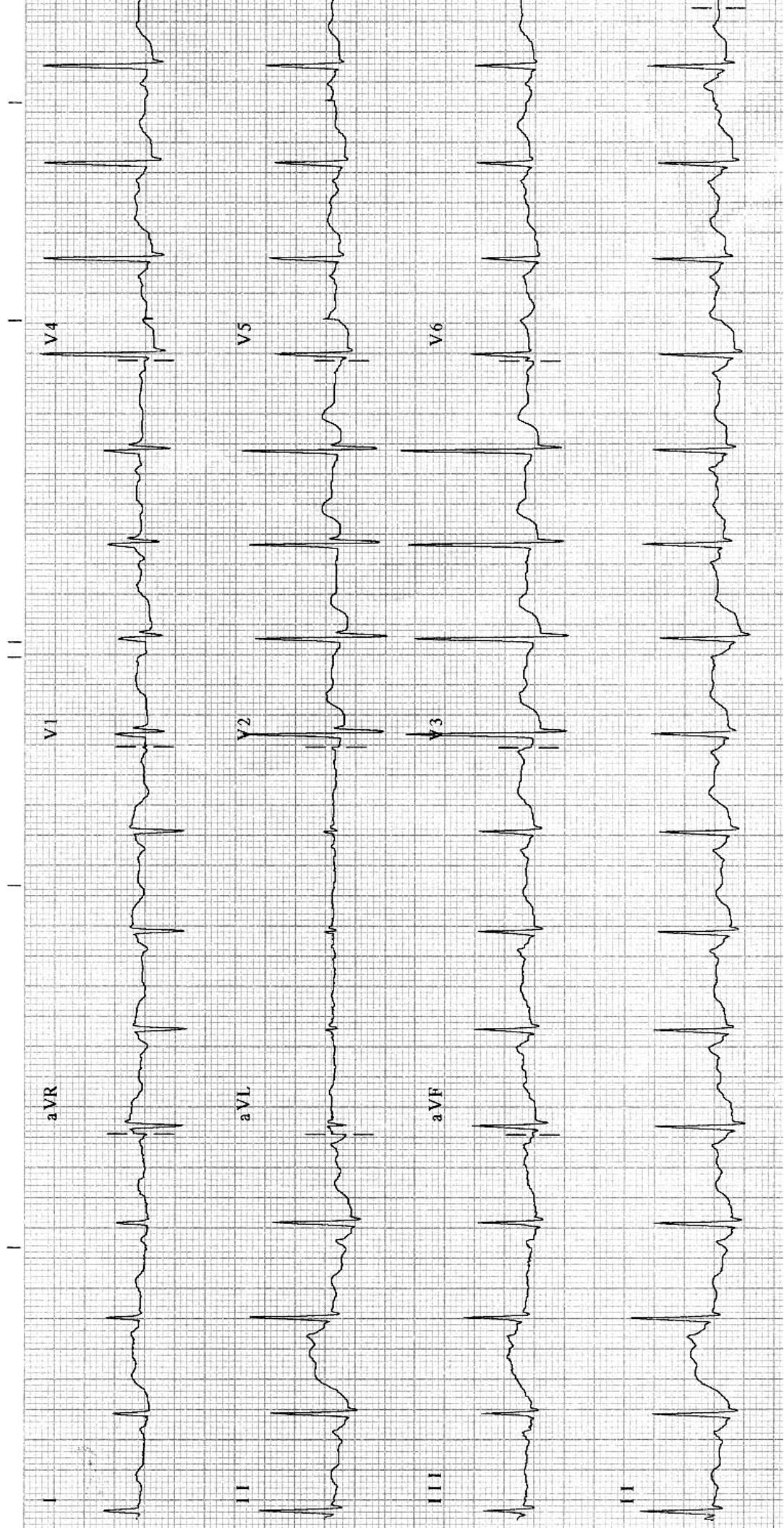
13b. Same patient. EKG from 4 months earlier.

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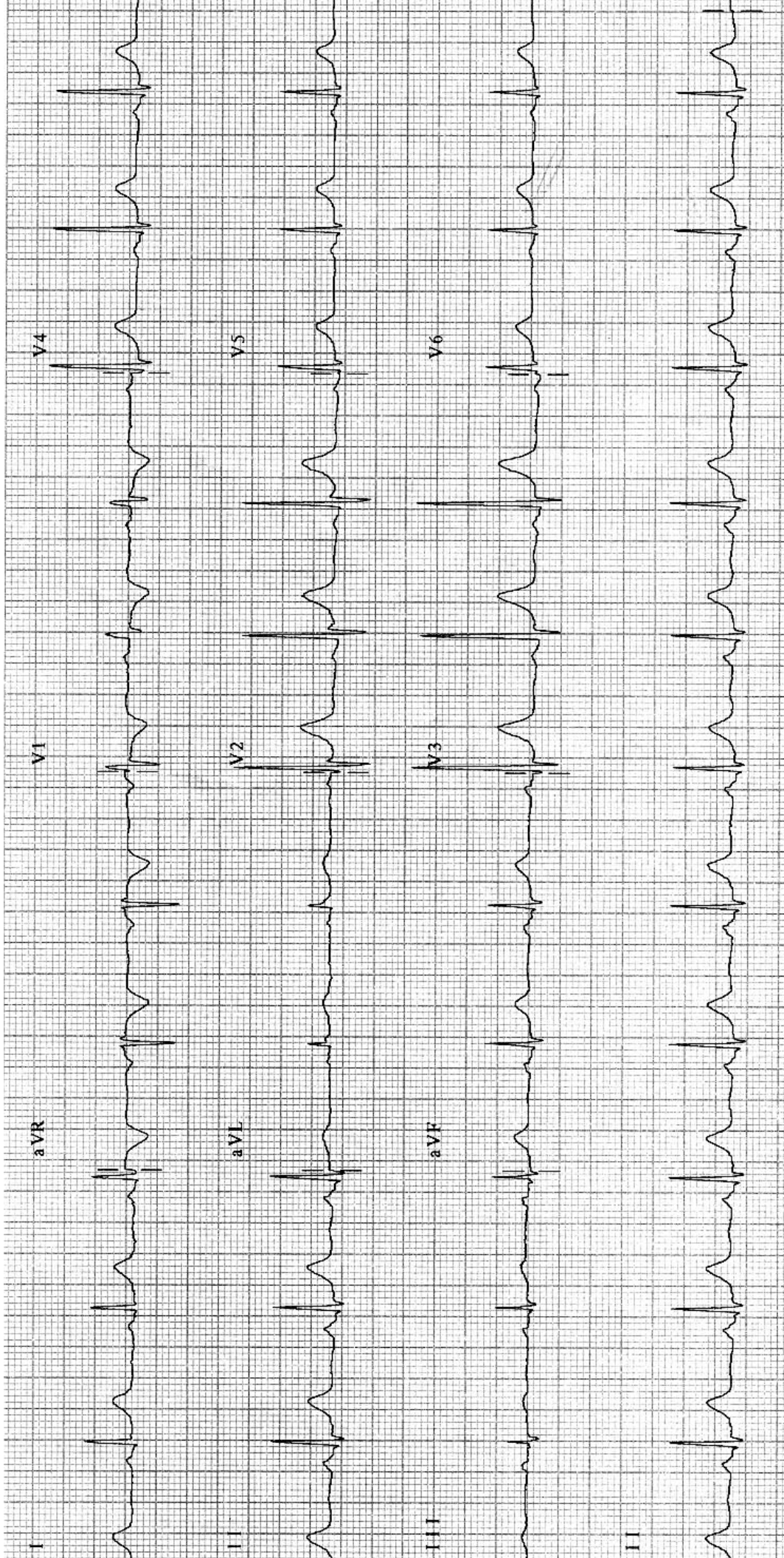


**14. Patient discharged home in study of missed MI's
ED interpretation: NSR, LVH with strain**

**15. 68 y.o F with palpitations earlier. Now resolved. Visit 2
months ago with same complaint and identical EKG**

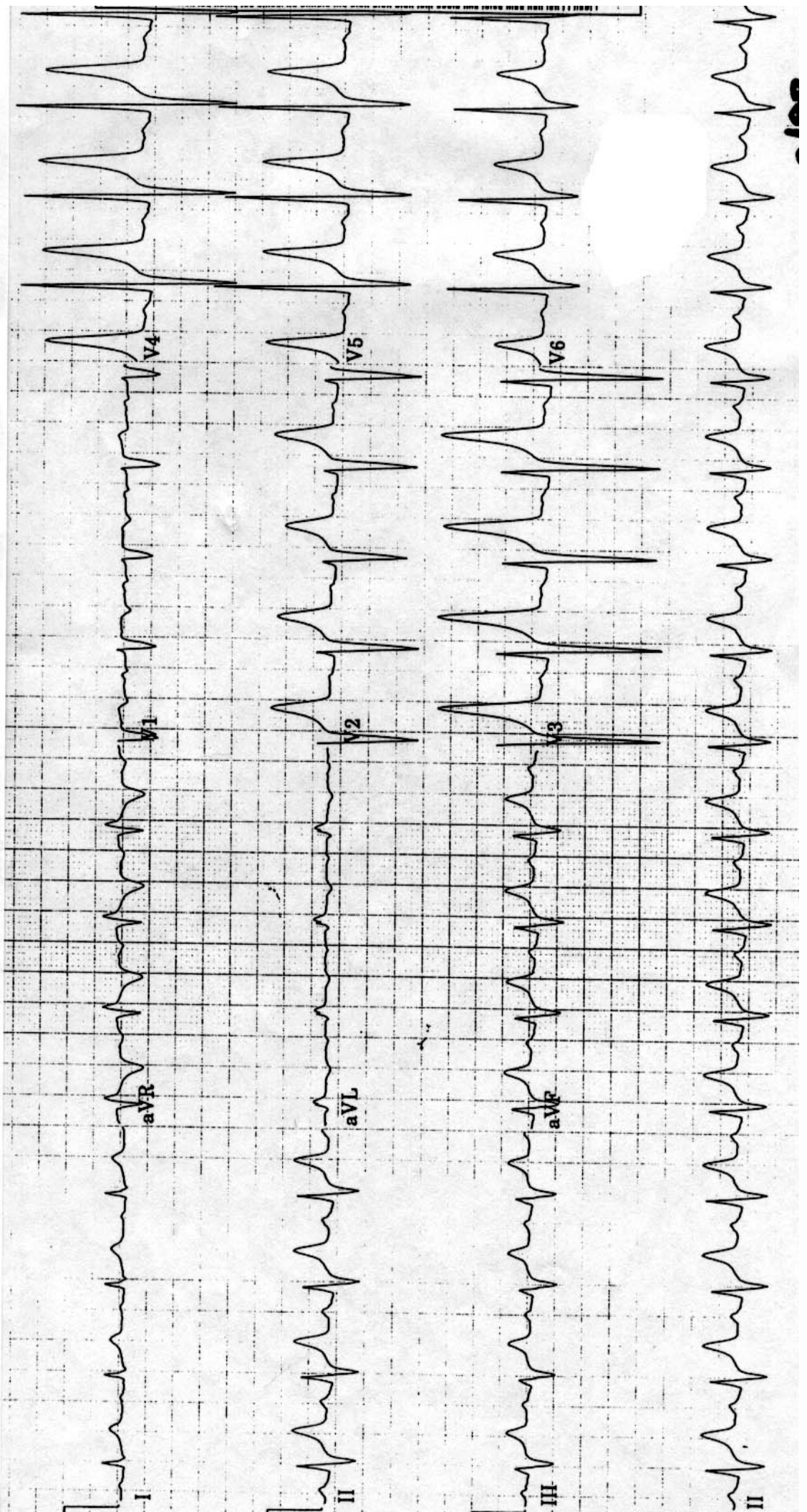


15b. 68 y.o F post treatment with beta blockers



16. 40 year old male with pneumonia. Missed hemodialysis.

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17.55 y.o. F with pleuritic chest pain for 10 hours

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Rate 122 . Sinus tachycardia, rate 122.....Normal P axis, rate \geq 100
 PR 166 . Vertical axis, unusual for age.....QRS axis 81 to 90 & age $>$ 40
 QRSD 69 . Consider Anterior infarct.....Q wave in V3
 QT 256 . Nonspecific Inferior T abnormalities.....T neg or T/QRS ratio $<$.05 2,3,F
 QTc 365

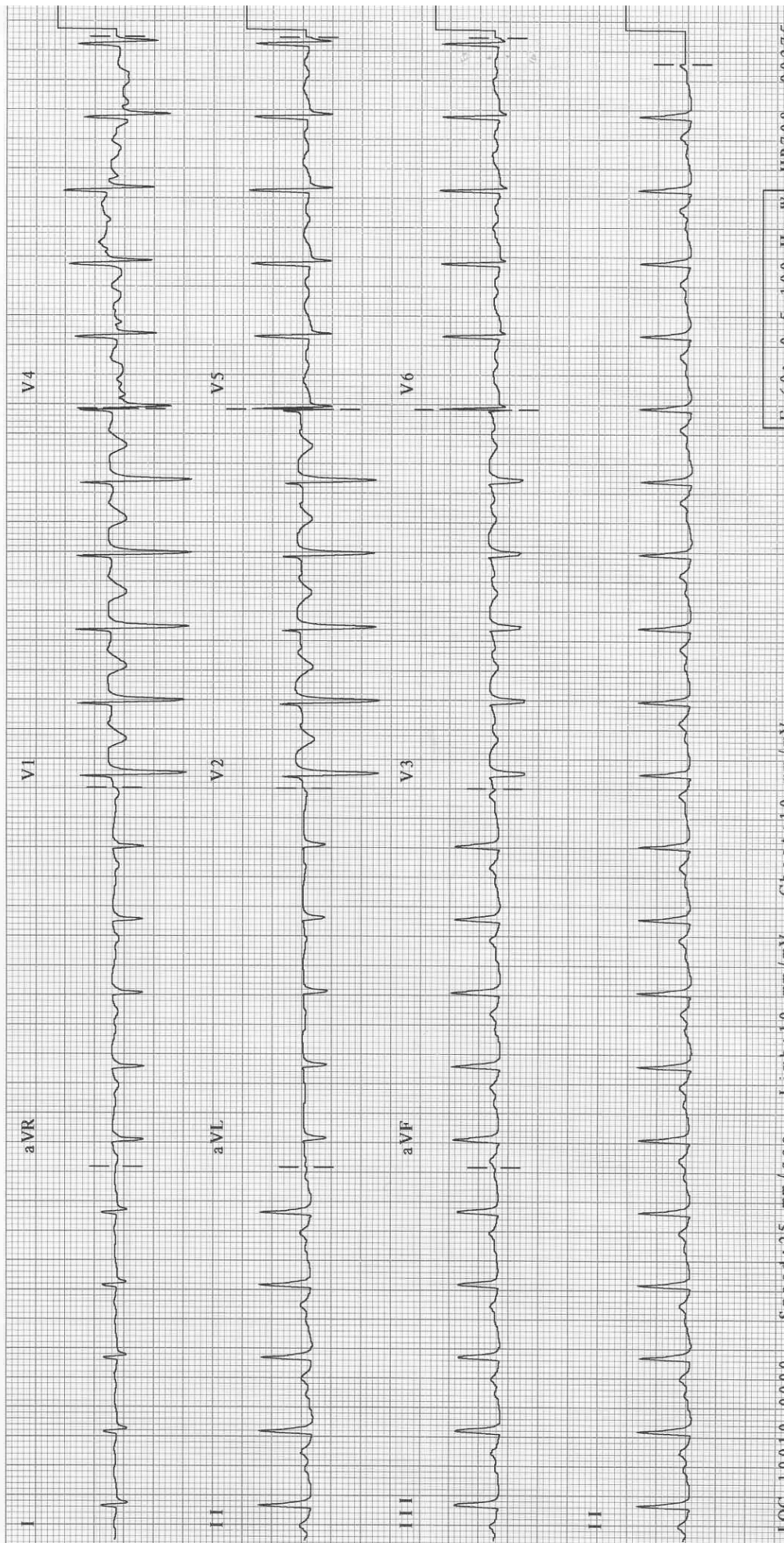
DX

ER

P 70
 QRS 88
 T -68

- ABNORMAL ECG -

PRELIMINARY-MD MUST REVIEW



18. Another patient with same diagnosis

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Dx:

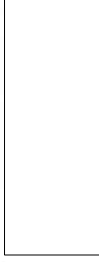
Oper: GRL

- . NORMAL SINUS RHYTHM, RATE 66.....normal P axis, PR, rate & rhythm
- . BORDERLINE RIGHT AXIS DEVIATION.....age-specific ranges
- . ABNORMAL T, PROBABLE ISCHEMIA, ANTEROLAT LDS.....T<-0.5mV I aVL V2-V6
- . MINIMAL ST ELEVATION, INFERIOR LEADS.....ST>.06mV II III aVF

Rate 66
 PR 178
 QRSD 82
 QT 475
 QTc 498

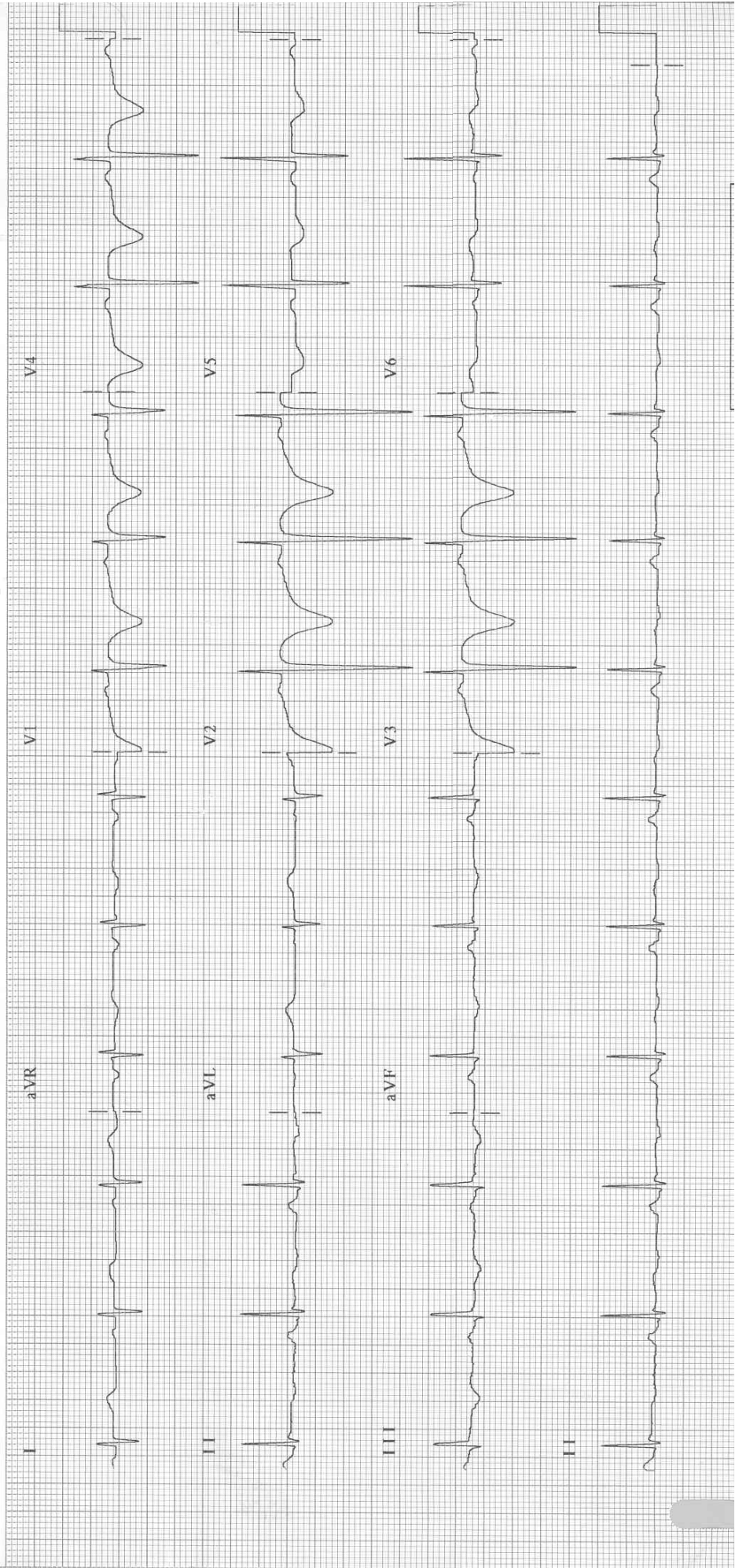
--AXIS--
 P 61
 QRS 89
 T -14

PV/RV/DX
 SOB

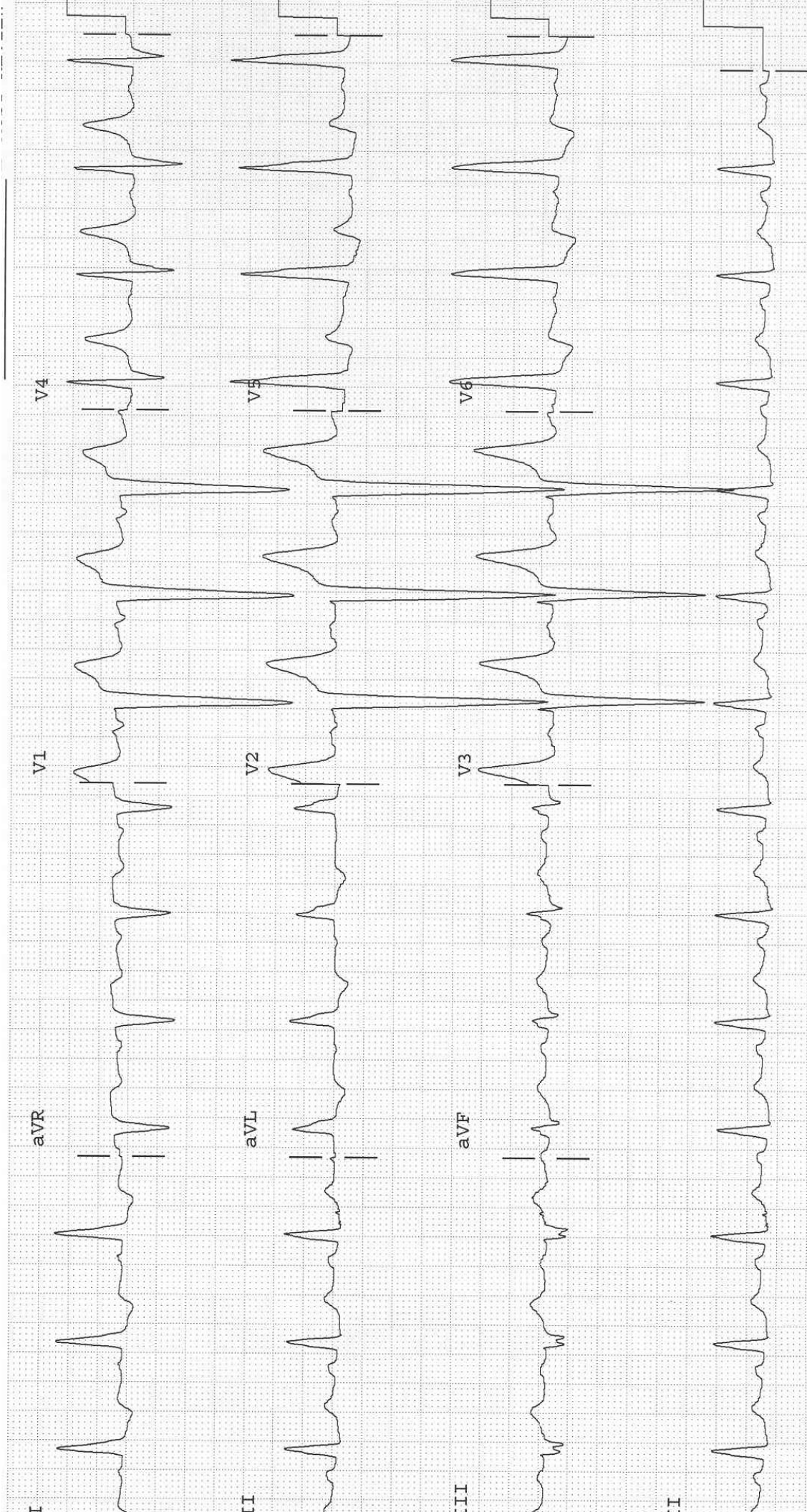


- ABNORMAL ECG -

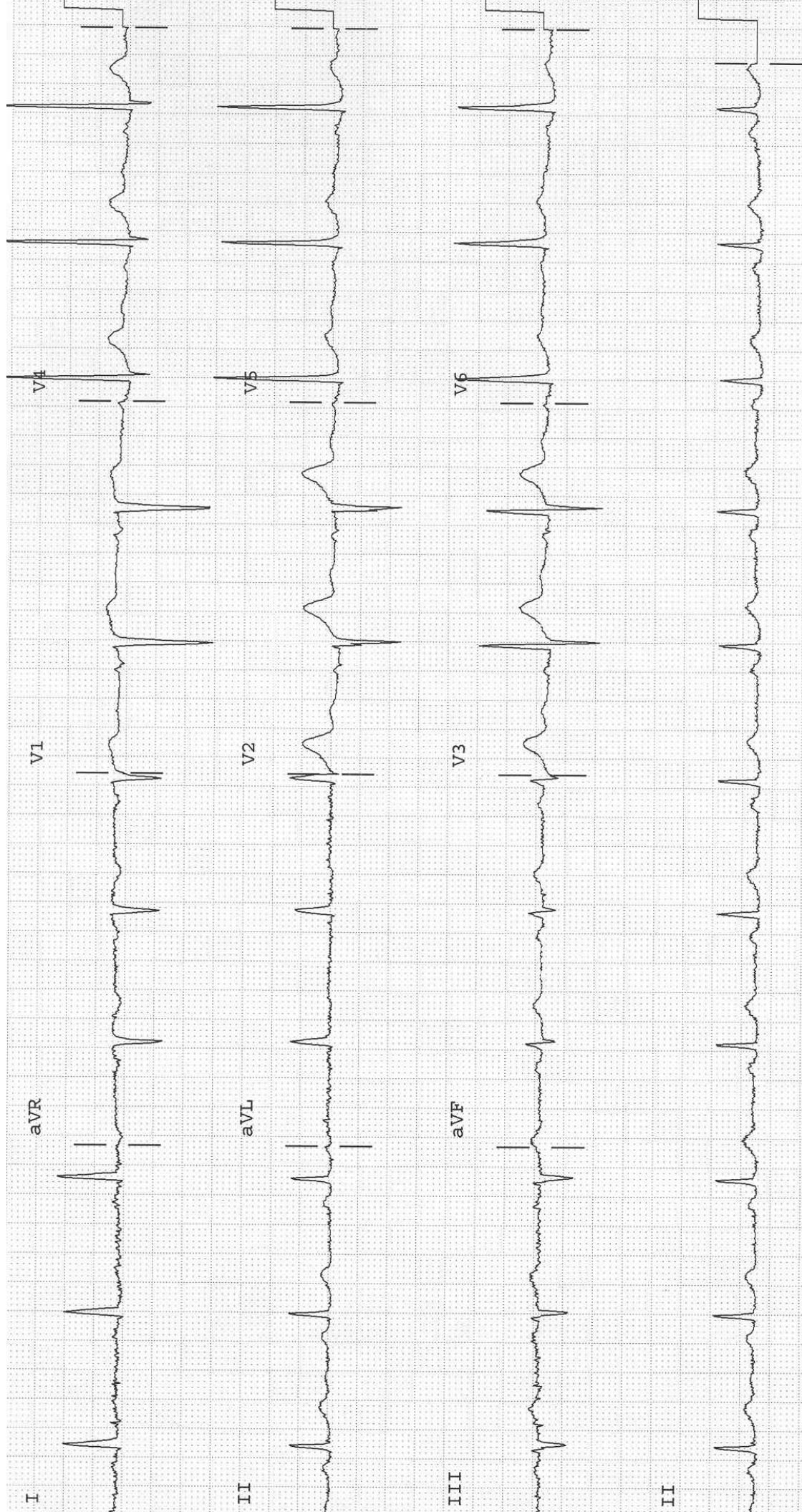
PRELIMINARY-MD MUST REVIEW

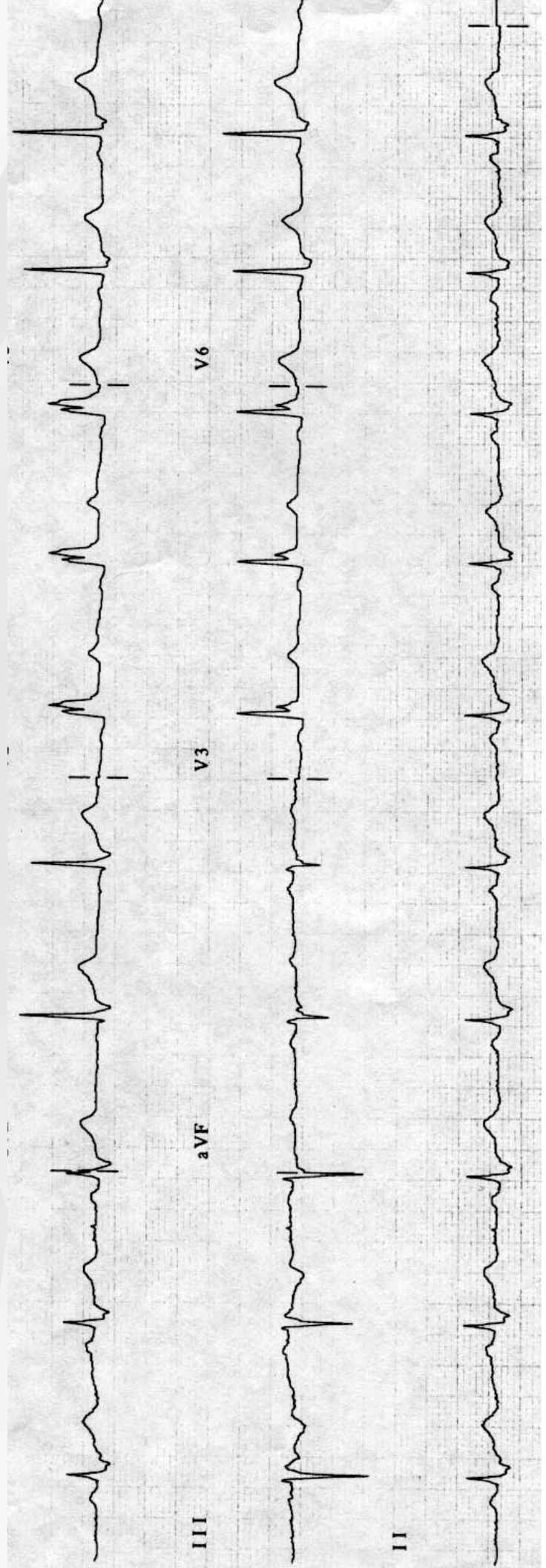


19a. 55 y.o M with new onset CHF and chest discomfort relieved by Ntg

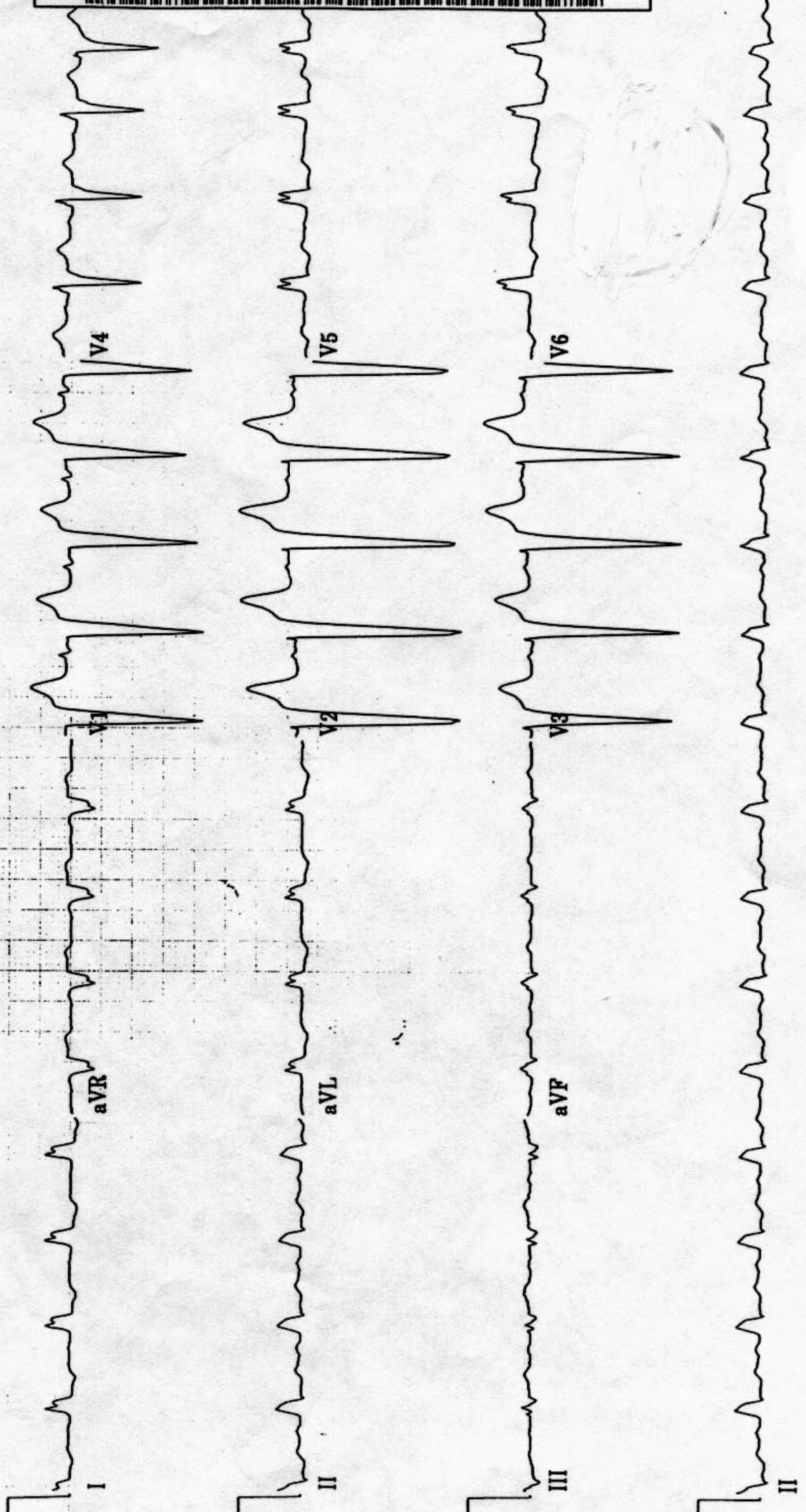


19b. Prior EKG from 5 years ago

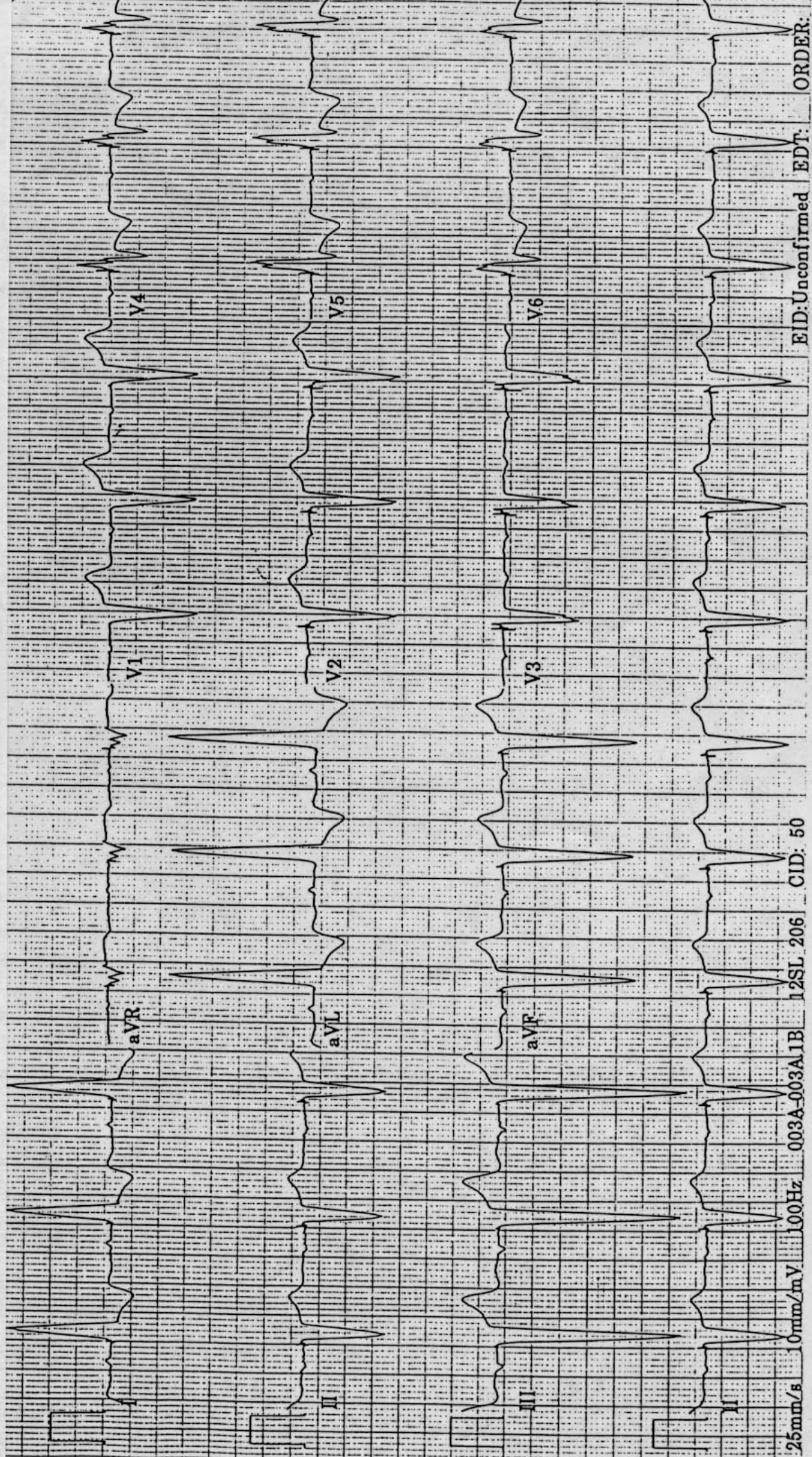




21. 67 y.o male with indigestion

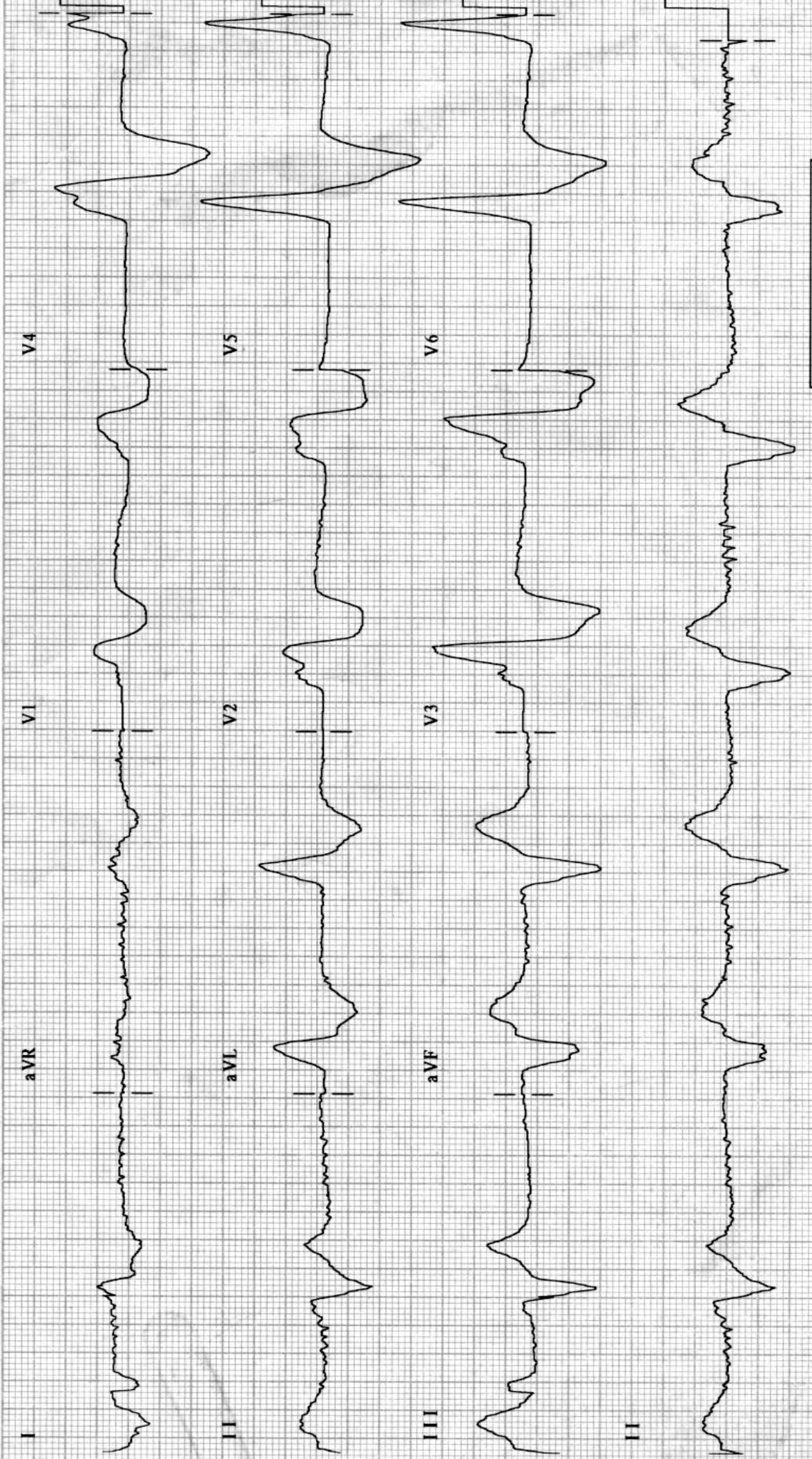


22. 51 year old female referred by primary MD for evaluation of shortness of breath. History of heavy smoking.

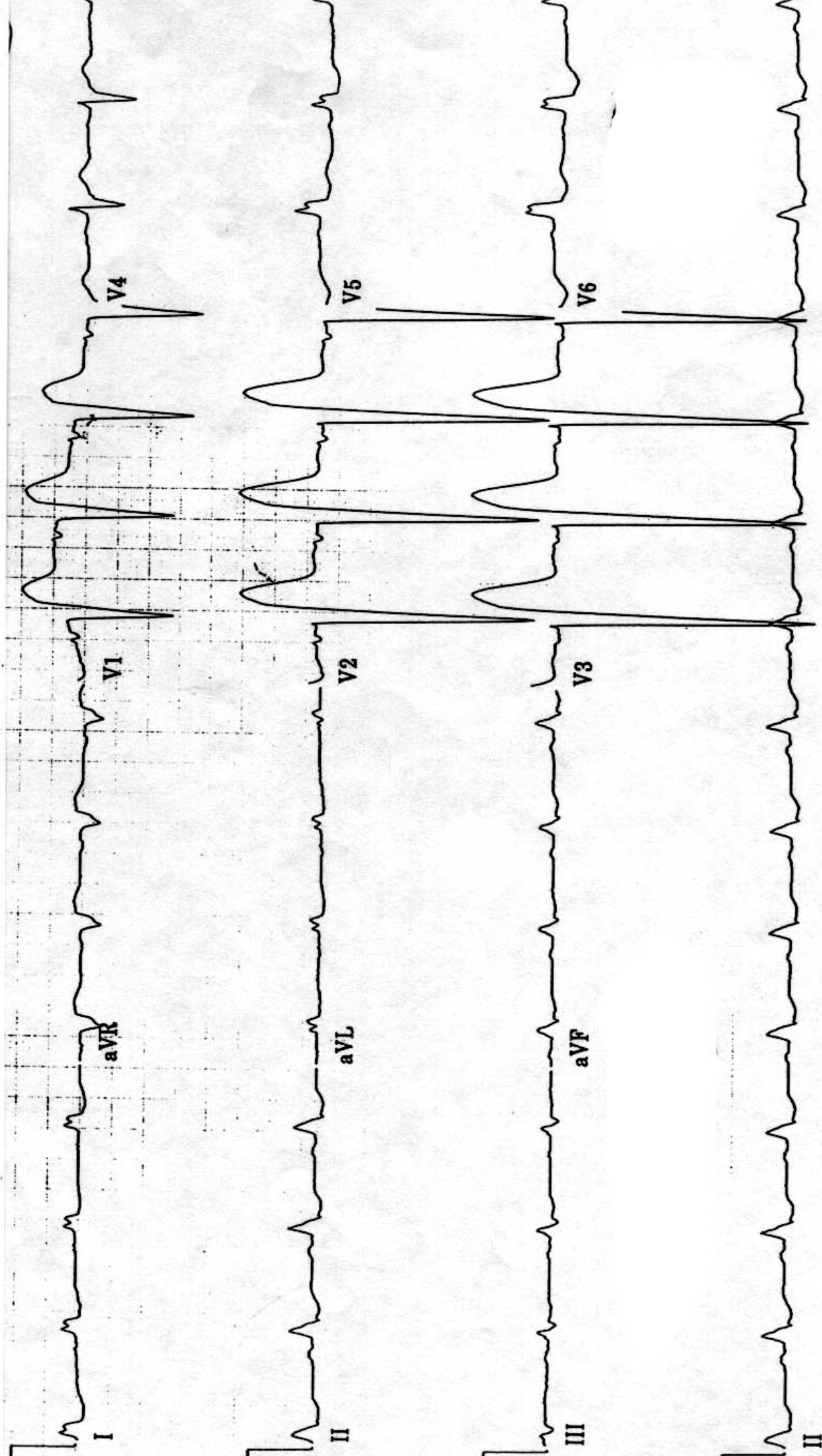


23. 59 year old man feeling very weak, nauseous, hypotensive.

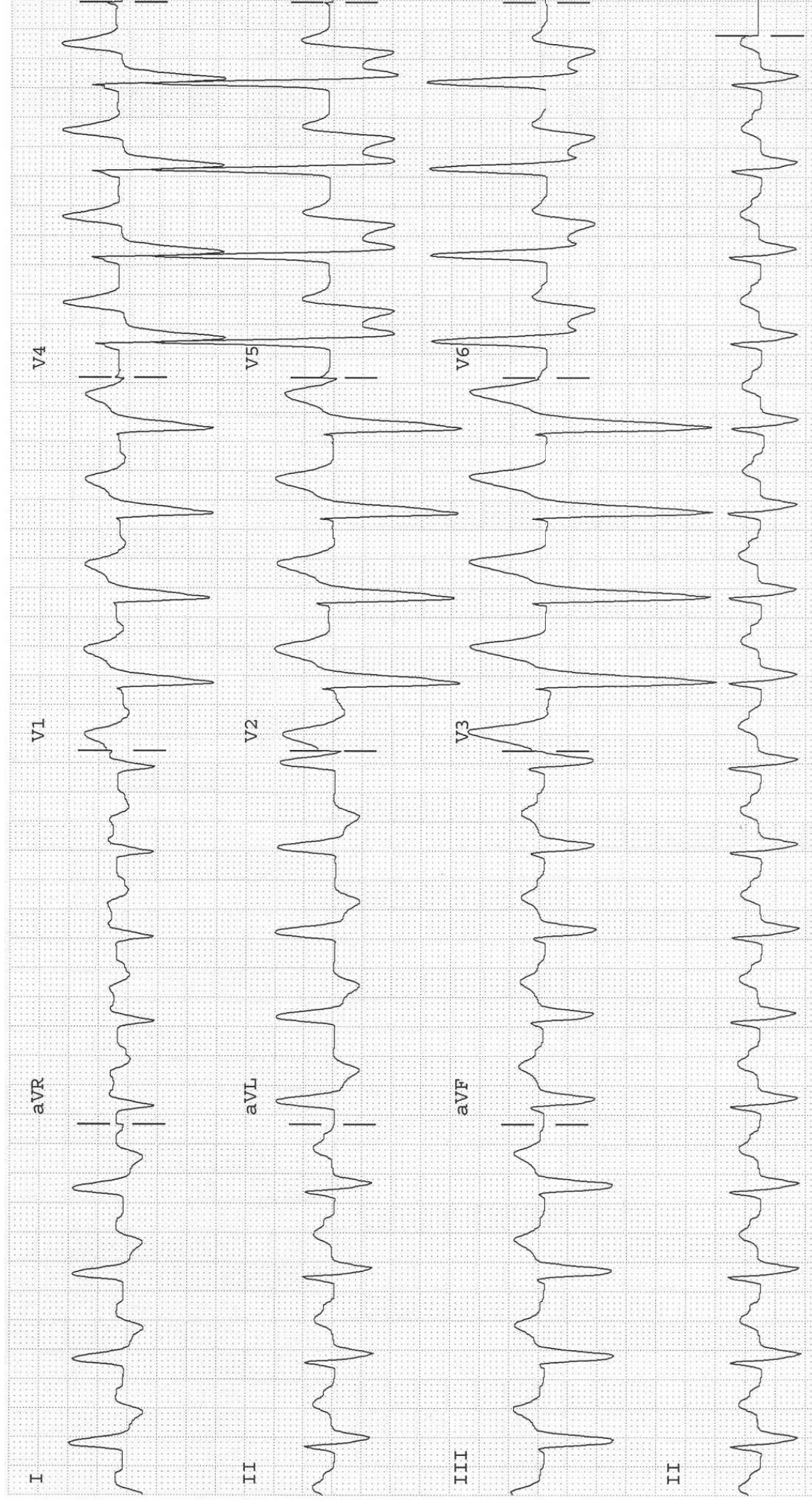
DRS
1
KAYLA R. T. CLAF. ENCLFAD
10/11/03
10:00 AM
Room 401
PSYCHIATRY - MD W. S. BRIDGM



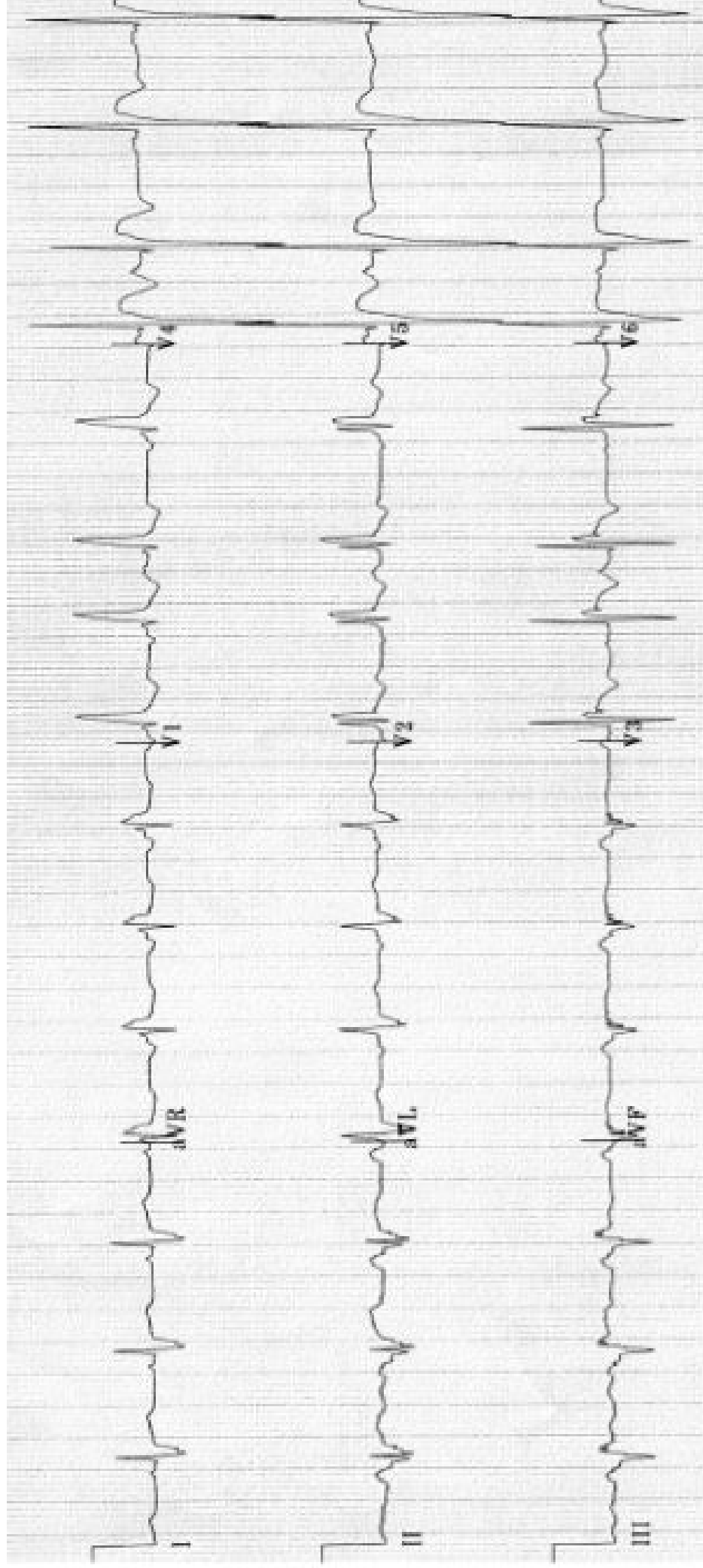
24. 67 year old male with chest pressure, history of hypercholesterolemia



25. 58 y.o. F with CP and IDDM



**26. Patient discharged home: ED interpretation = NSR,
RBBB**



AGE NOT ENTERED, ASSUMED TO BE 50 YEARS FOR PURPOSE OF ECG INTERPRETATION

PV/RV/DX

Rate 56 SINUS RHYTHM, RATE 56 normal P axis, rate

PR 236 FIRST DEGREE AV BLOCK PR>210 age 16-60 rate 51-90

QRS 134 NONSPECIFIC INTRAVENTRICULAR CONDUCTION DELAY QRS>120, not LBBB/RBBB

QT 430

QTc 415

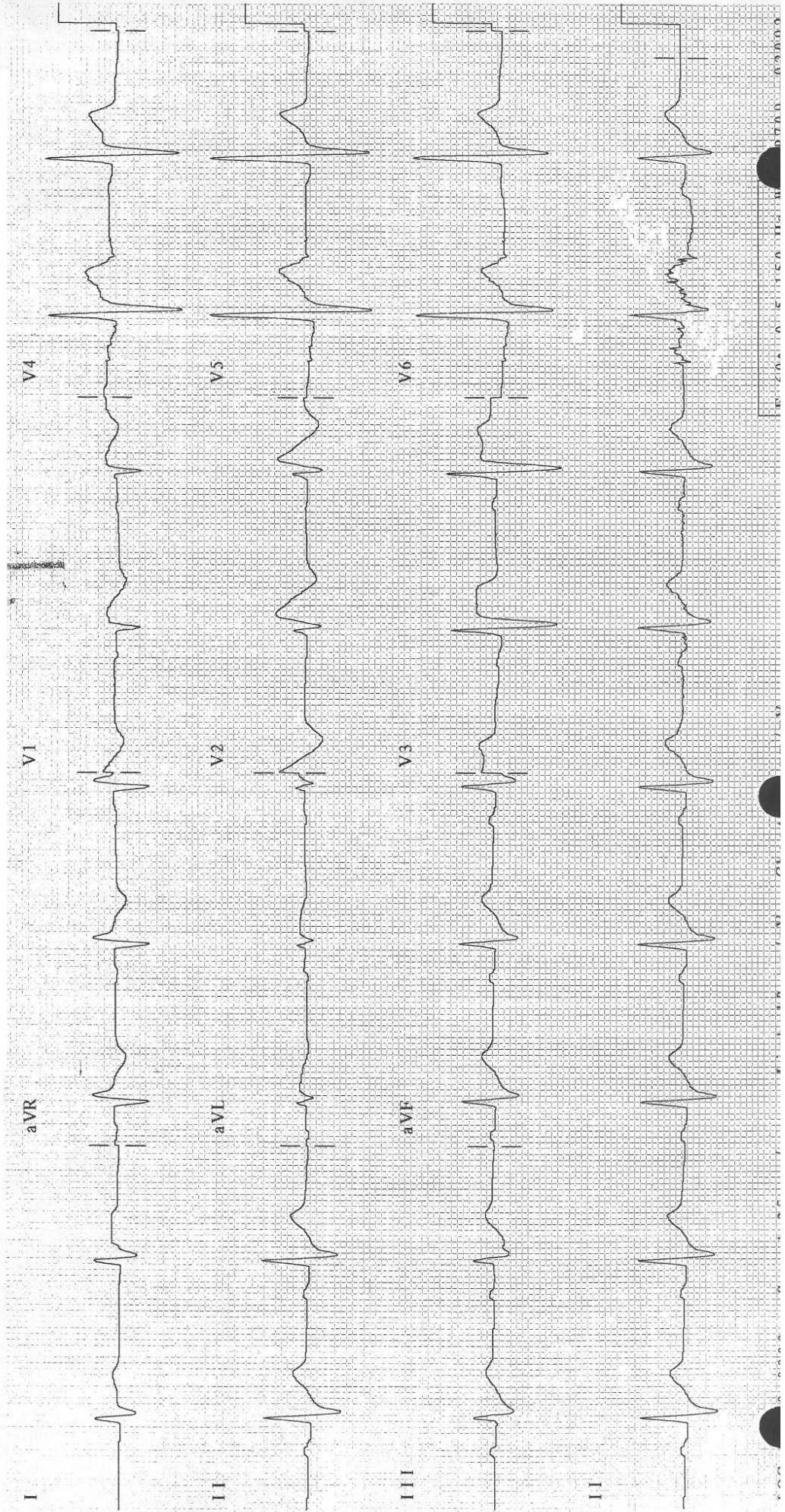
--AXIS--

P 64

QRS 34

T 63

27. 20 y.o male with Syncope



Essentials EKG Answer Sheet
Jeffrey Tabas MD

1. Sinus Tach – Upright P waves in 2 and inverted in aVR. Pt had urosepsis
2. Limb lead reversal – Upright P waves in 2 and upright in aVR.
3. Atrial Flutter
4. Sinus rhythm
5. Sinus rhythm with artifact
6. Junctional rhythm with retrograde P waves
7. Sinus Tach, Lateral MI with ST elevations in 1, aVL and reciprocal ST depression in 2,3,F. Also very poor R waves in anterior leads
8. ST elevation laterally in 1,L, V5, V6 and also in 2. ST depression in V1 and V2 that could be due to reciprocal changes or posterior wall MI. A misleading PVC.
- 8b. Immediate resolution of ST elevation consistent with Prinzmetal's Angina
9. Subtle ST elevation in 2,3,aVF and subtle reciprocal ST depression in aVL
10. ST elevation in V1-V4 consistent with Anterior STEMI or LV aneurysm
11. Pericarditis with PR depression and diffuse ST elevation
12. ST depression in V2,V3 with tall R waves consistent with posterior MI or anterior NTSE-ACS
- 13a. Marked strain pattern in the lateral leads, probably accentuate by hypertension and tachycardia. Atypical extension in V3 and V4 should raise suspicion of ischemia, which was not the case
- 13b. Prior EKG showing baseline strain pattern.
14. Ischemic ST depression in 1, L, V5,V6. ? subtle inferior ST elevation, poor anterior R waves
- 15a. Probably ischemic ST depressions in V1-V4
- 15b. Resolution of ST depression post Rx
16. Hyperkalemia = 7.2
17. Anterior flipped T waves c/w ischemia or PE. This was a PE
18. Another PE
- 19a. LBBB without ischemic findings. Pt ruled out for ACS
- 19b. Progression over 5 years.
20. RBBB without ischemia
21. LBBB without ischemia
22. Paced
23. Hyperkalemia = 7.4
- 24 LBBB with Anterior STEMI. Discordant ST elevation > 5mm in V2 and V3
25. LBBB with ischemic ST depression in V5 and V6 consistent with AMI
26. RBBB with concordant ST elevation in V3 consistent with STEMI. Also ST elevation in V4-V6 consistent with STEMI
27. Brugada syndrome. RBBB pattern with STE in V1-V3
- ~~28. Afib with WPW. Irregular, markedly fast, wide complex tachycardia.~~

NOTES

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