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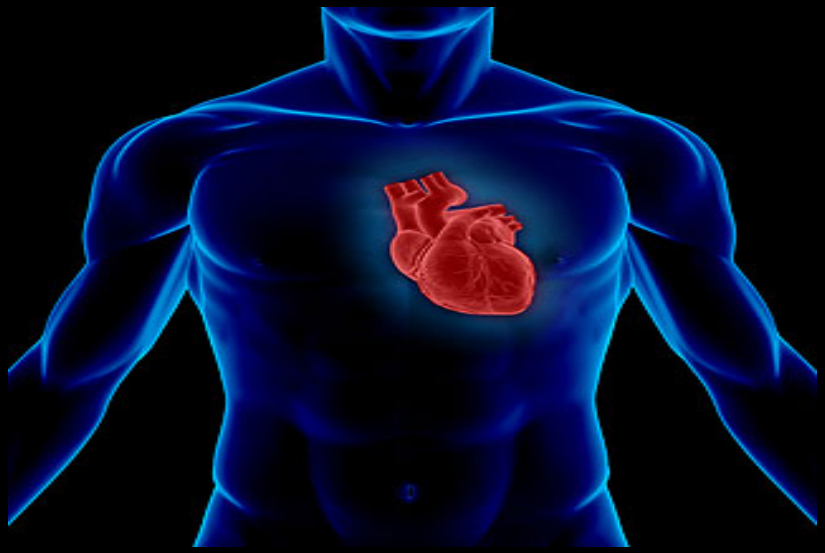
Interpreting ECGs



Dr James Roy

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MB,BCh,BAO(Hons),FRACP

ECG Discussion

1. *Normal - brief review*
2. *Fast*
3. *Slow*
4. *Chest Pain*
5. *Case Examples*

Rhythm…Fast

- AF
- SVT
- Atrial flutter
- VT

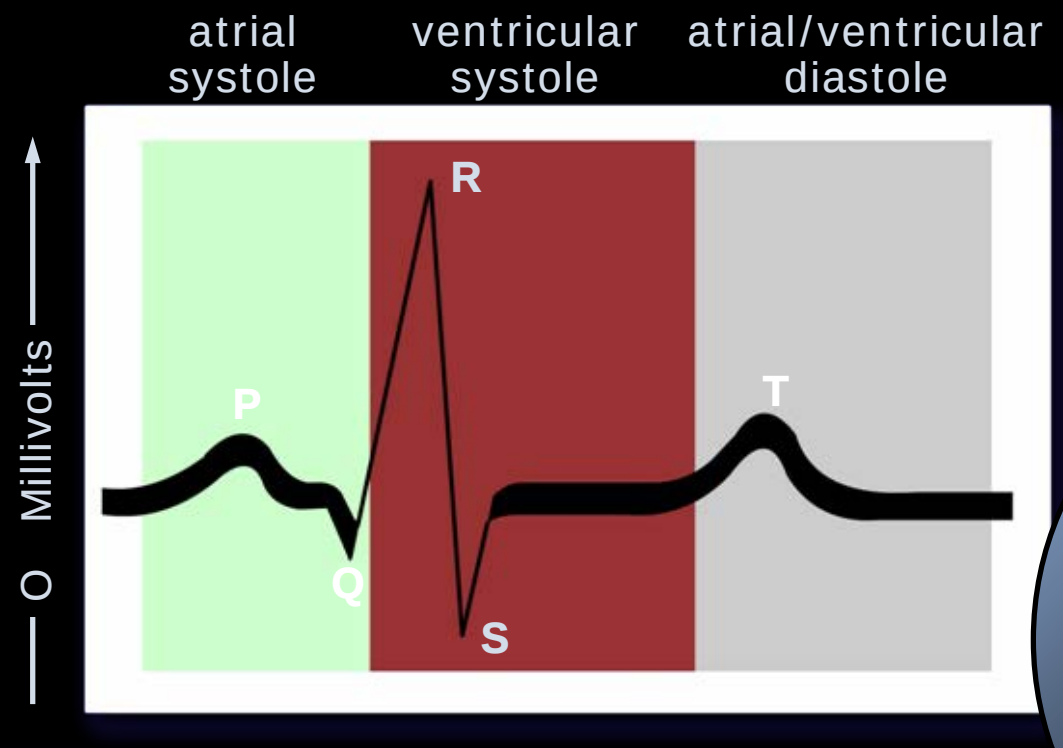
Rhythm…Slow

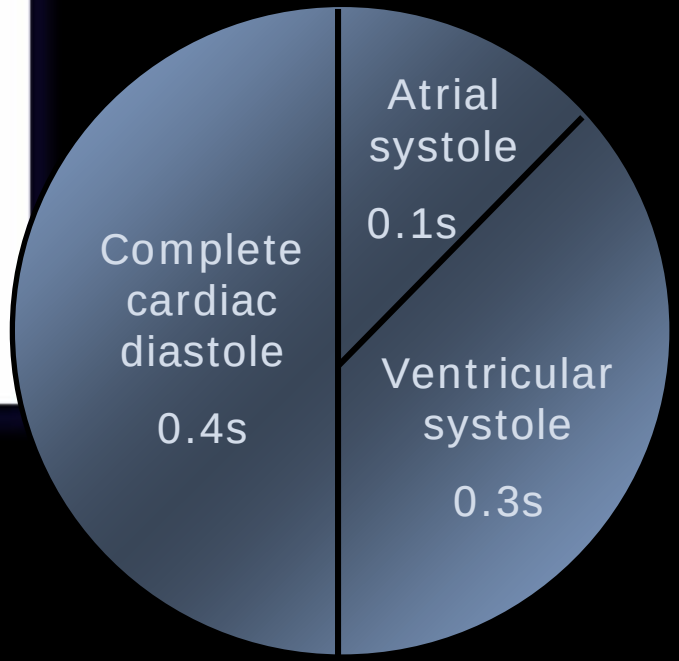
- Sinus bradycardia
- Slow AF
- Heart block

Chest pain

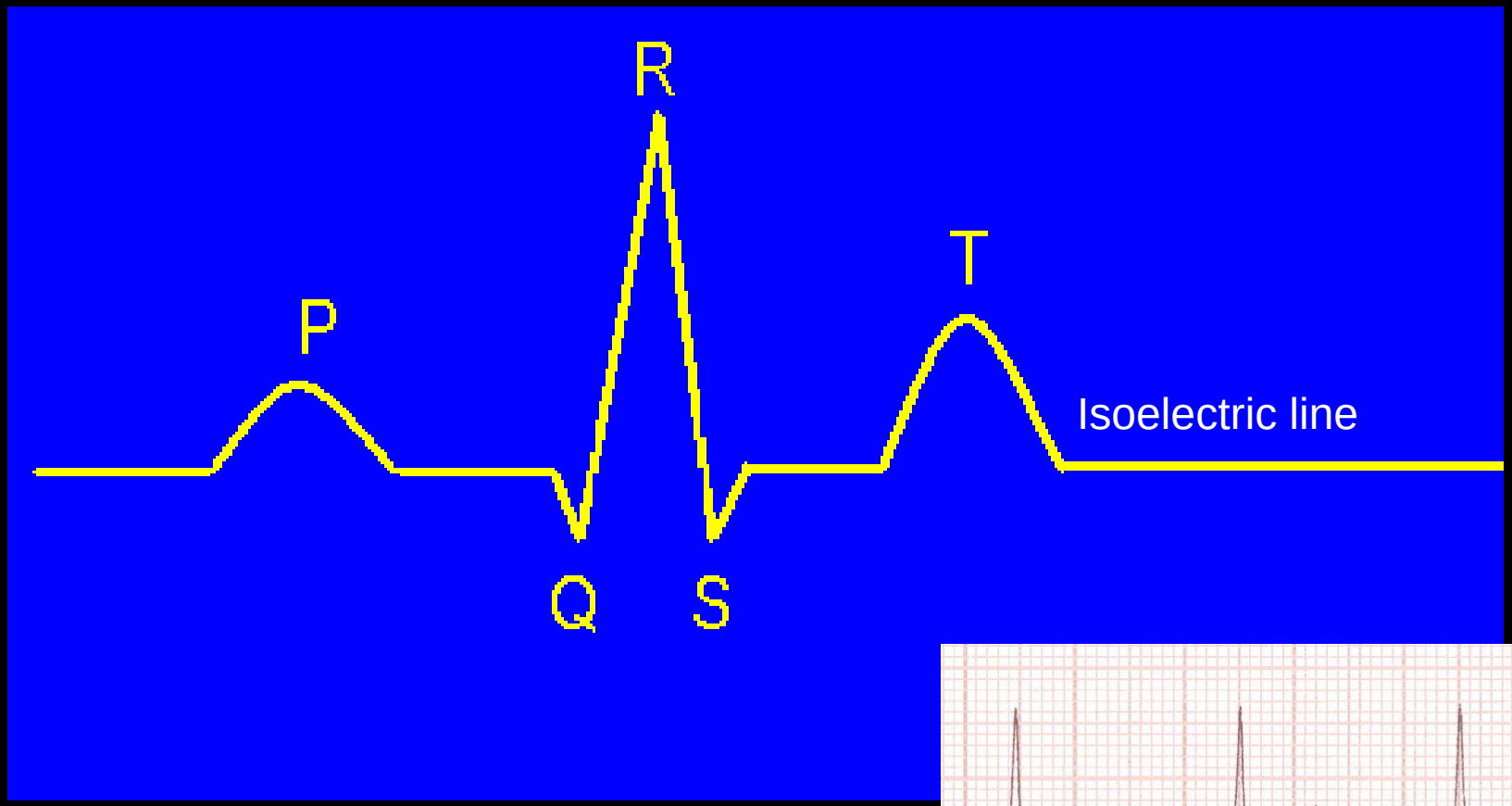
- HISTORY.. History
- ST depression
- ST elevation!!!

ECG: Wave pattern

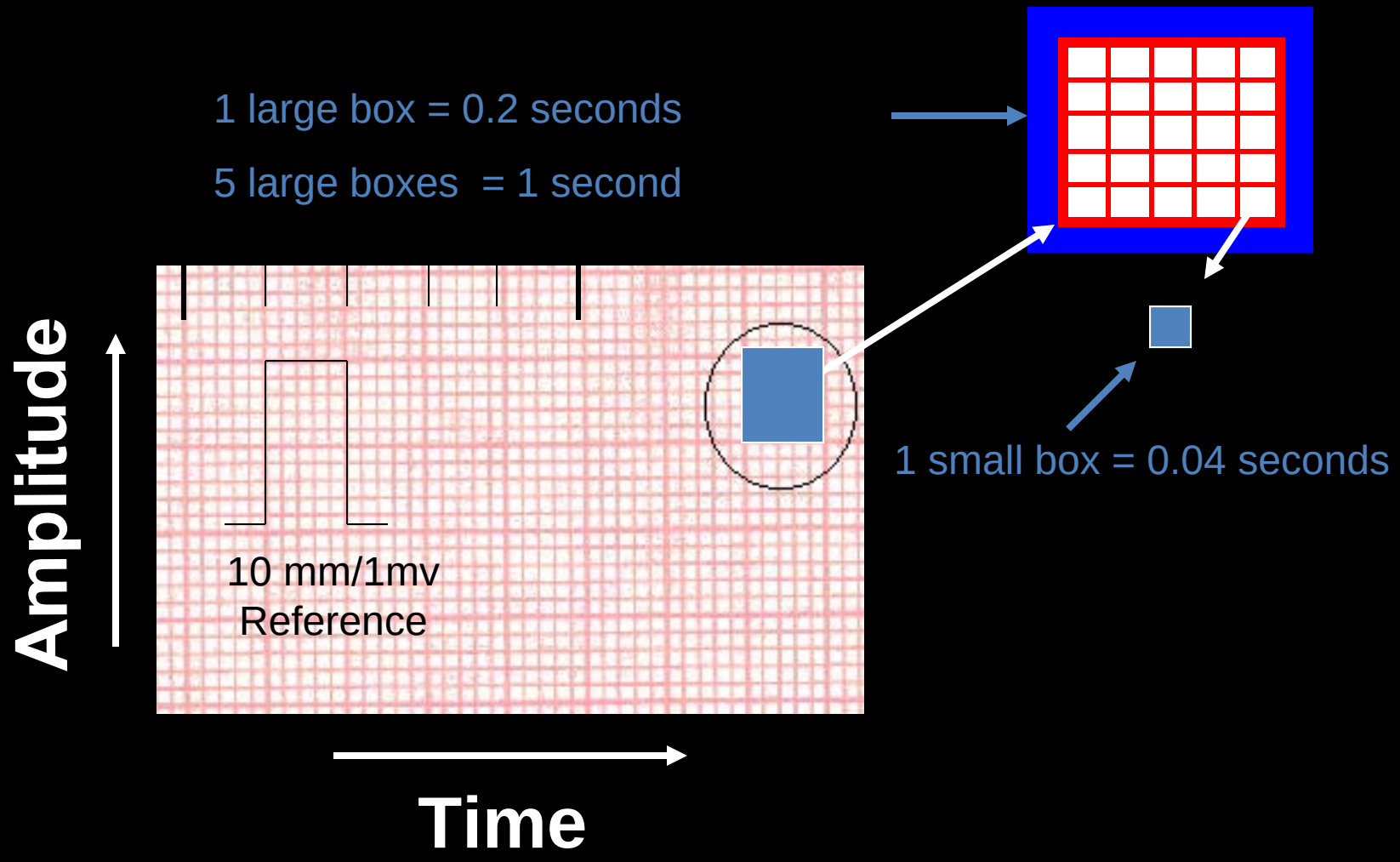




PQRST Complex

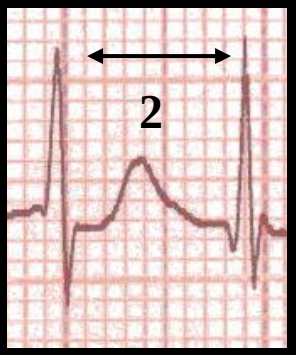


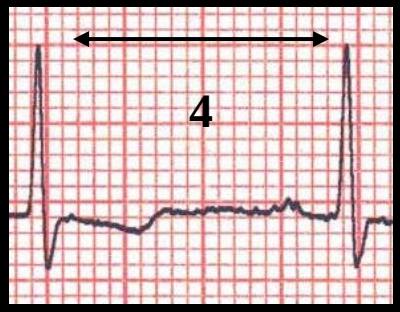
ECG Paper

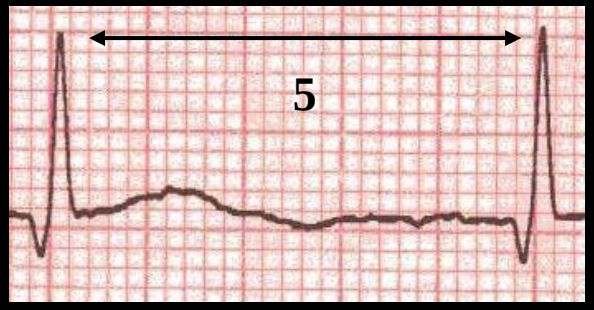

1 large box = 0.2 seconds
5 large boxes = 1 second
1 small box = 0.04 seconds
Amplitude
10 mm/1mv
Reference
Time

ECG Rate

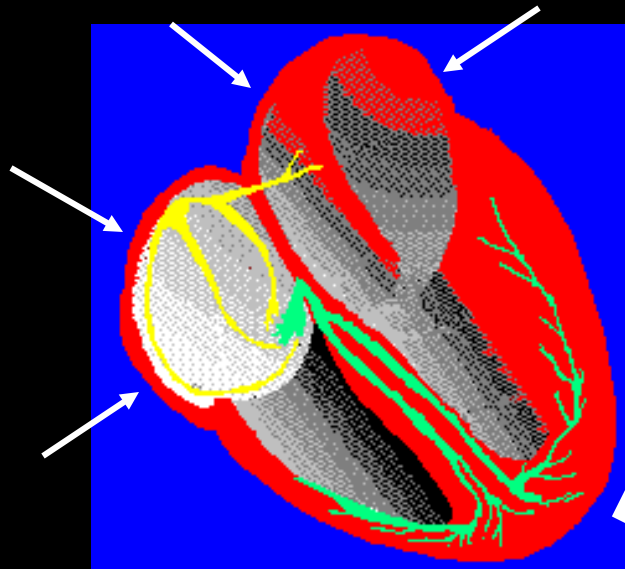
- 1 Sq = 300 bpm
- 2 Sq = 150 bpm
- 3 Sq = 100 bpm
- 4 Sq = 75 bpm
- 5 Sq = 60 bpm
- 6 Sq = 50 bpm

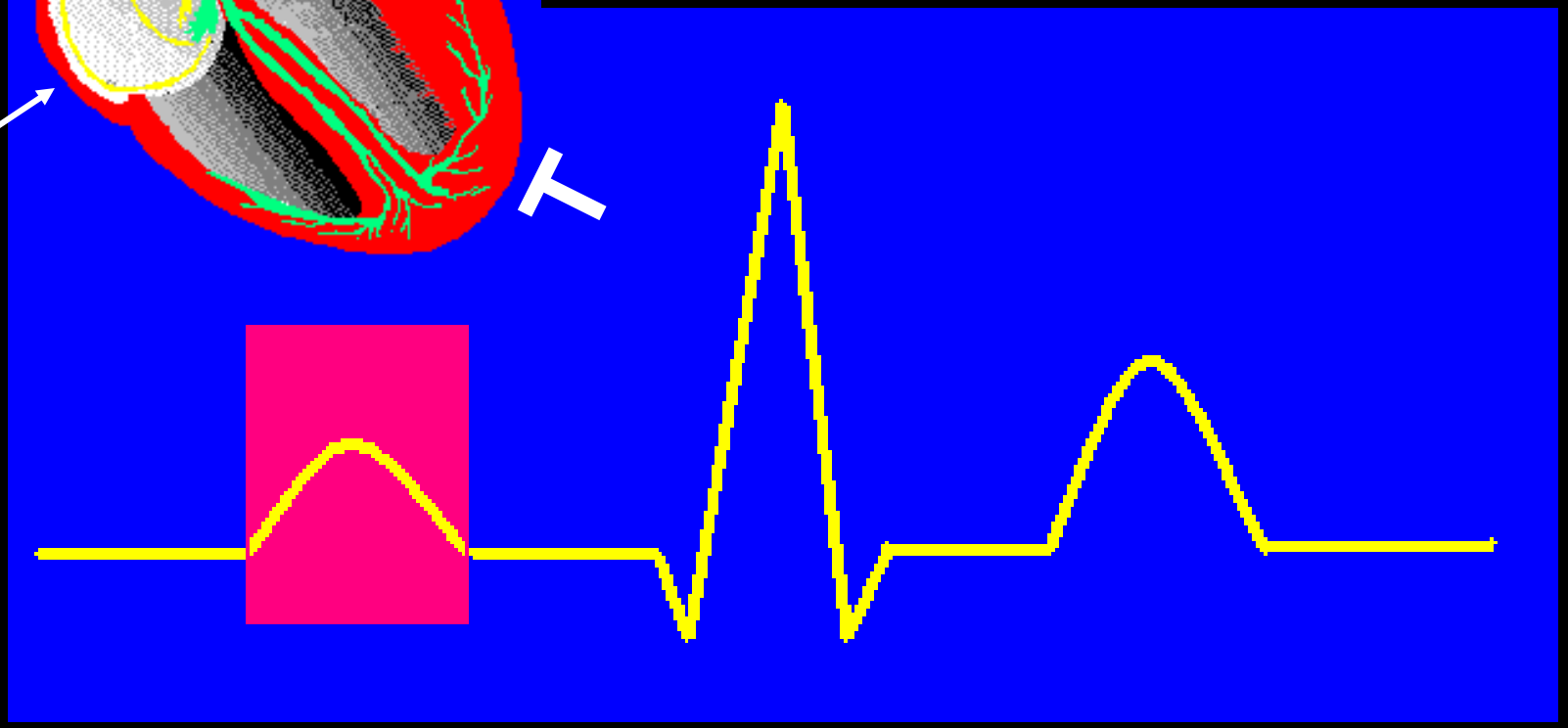




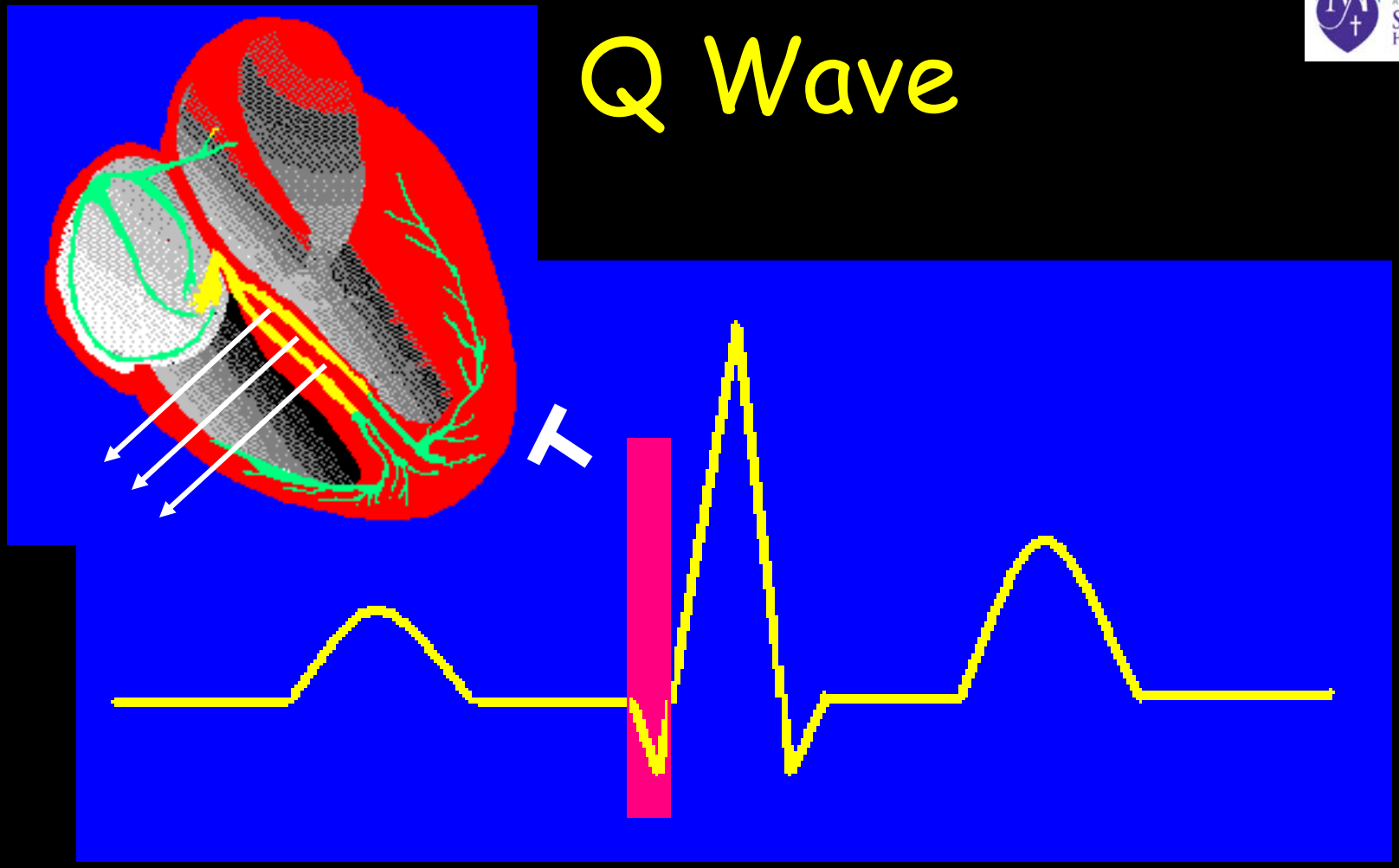


P Wave



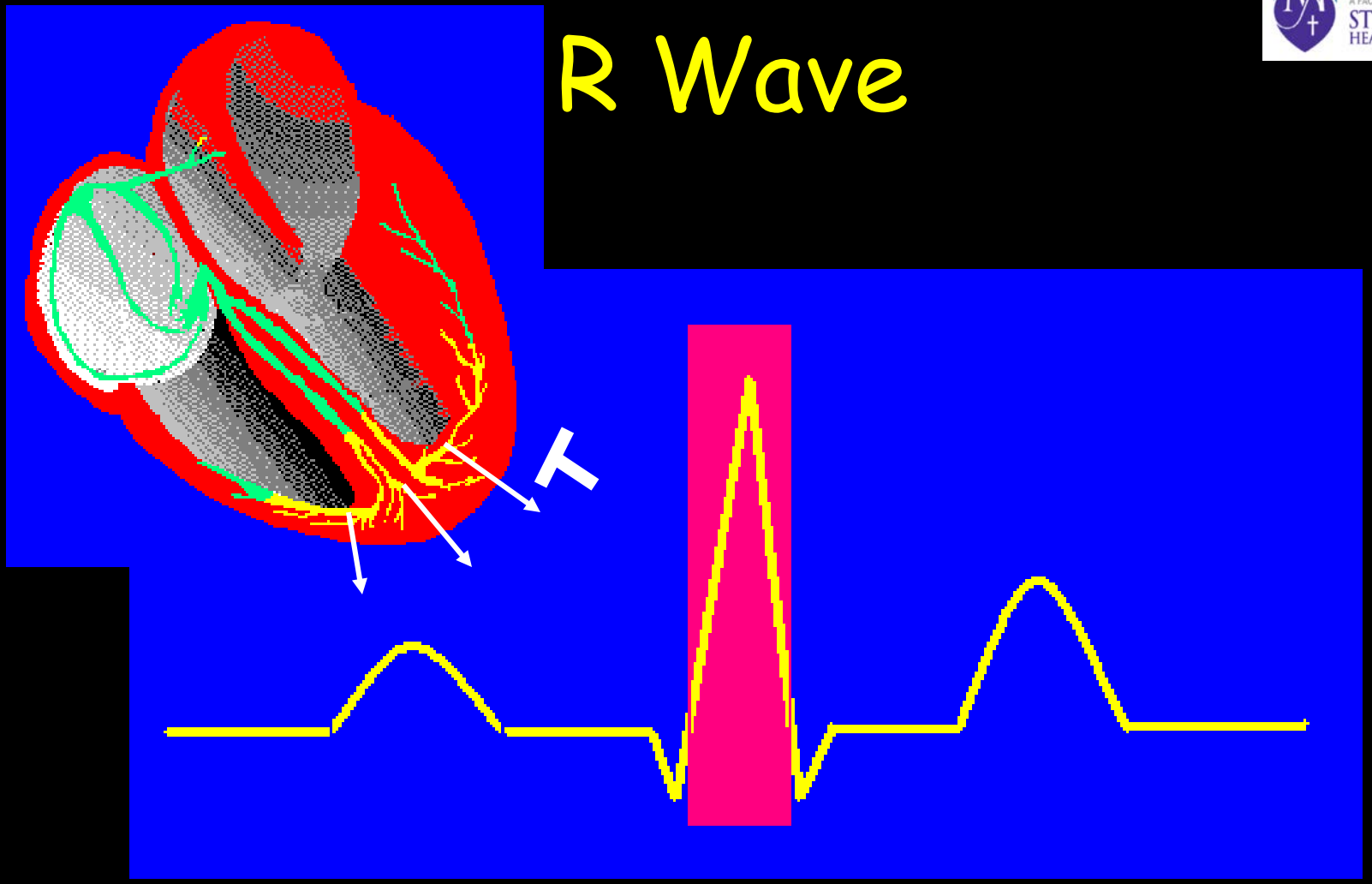


Q Wave

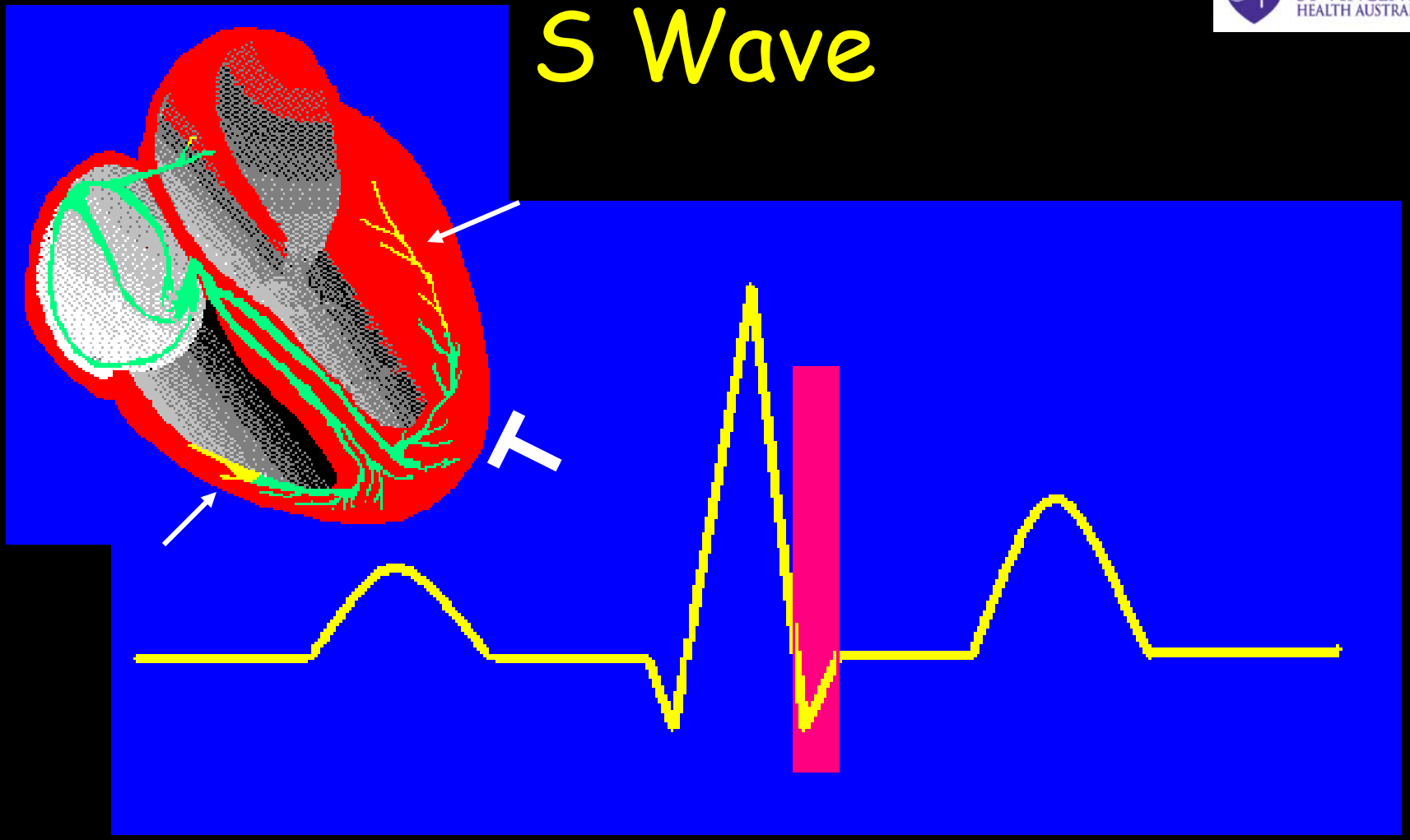


The septum depolarises from left to right

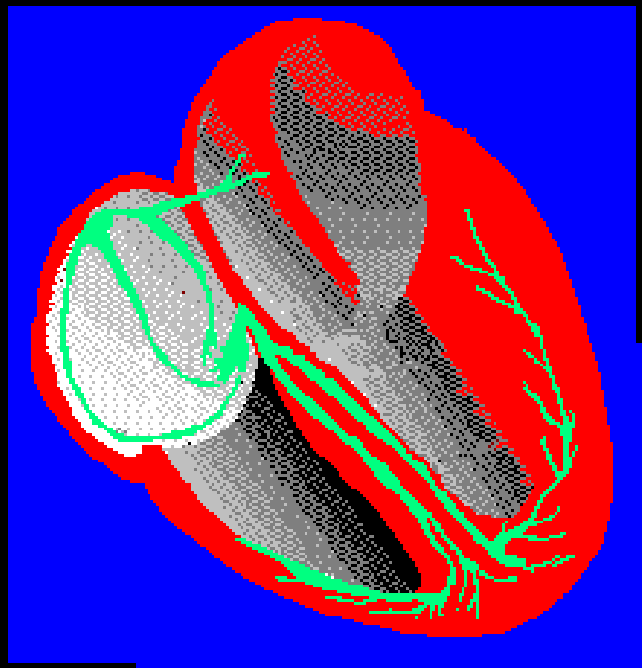
R Wave

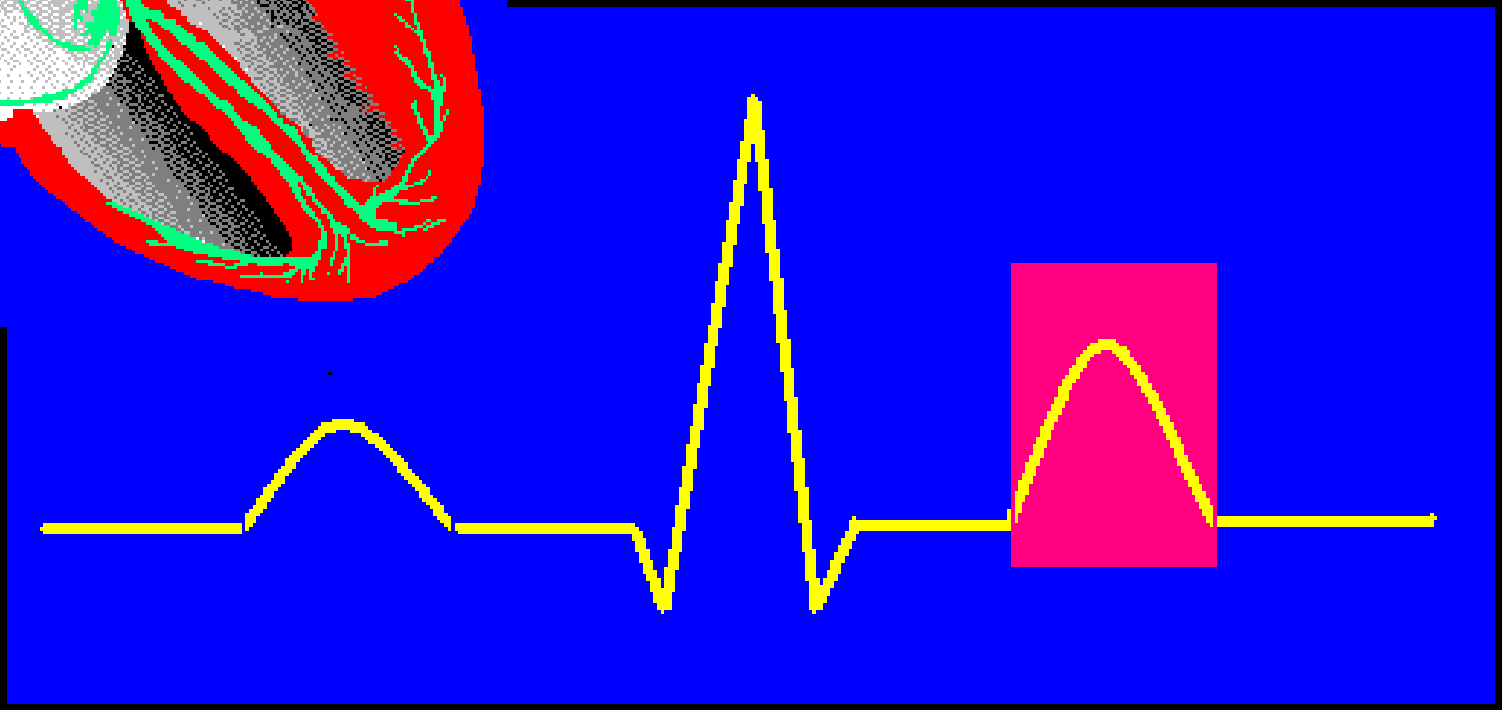


S Wave

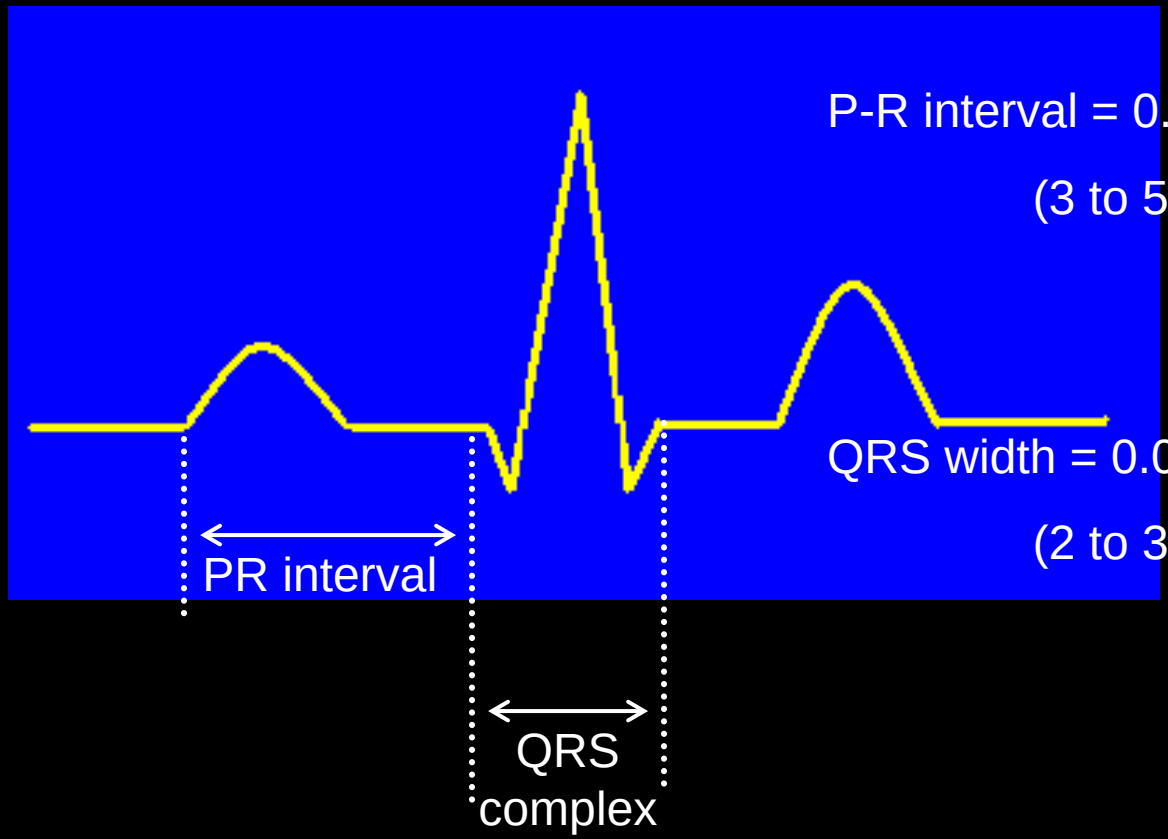


T Wave





Normal Intervals



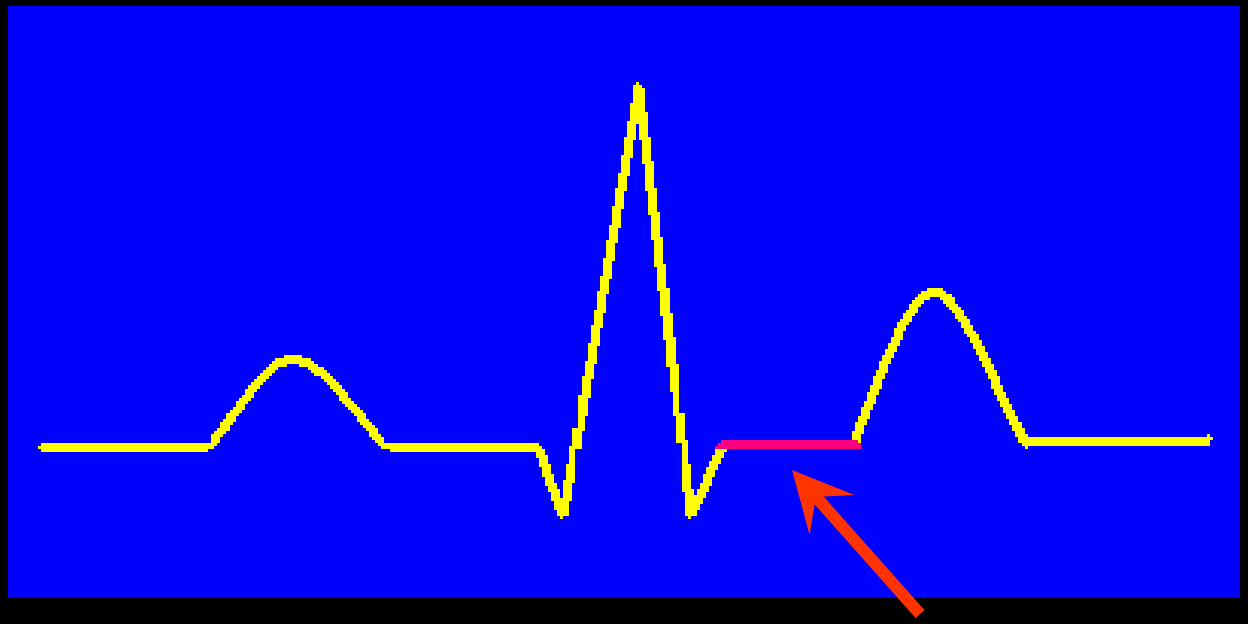
P-R interval = 0.12 - 0.20 sec

(3 to 5 small squares)

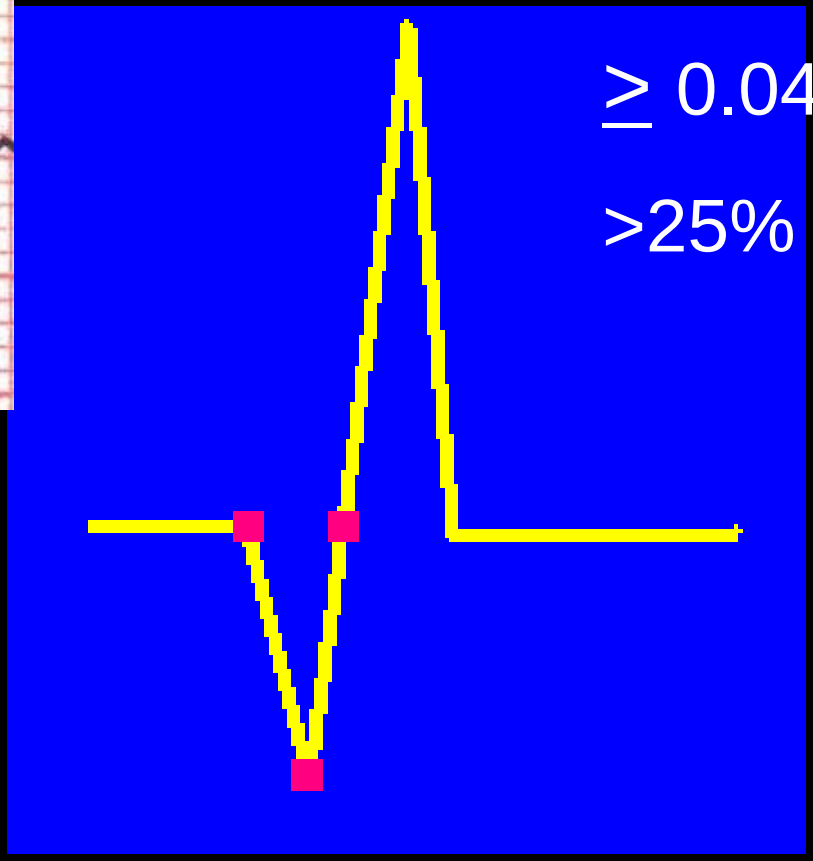
QRS width = 0.08 - 0.12 sec

(2 to 3 small squares)

ST Segment



Pathological Q Wave

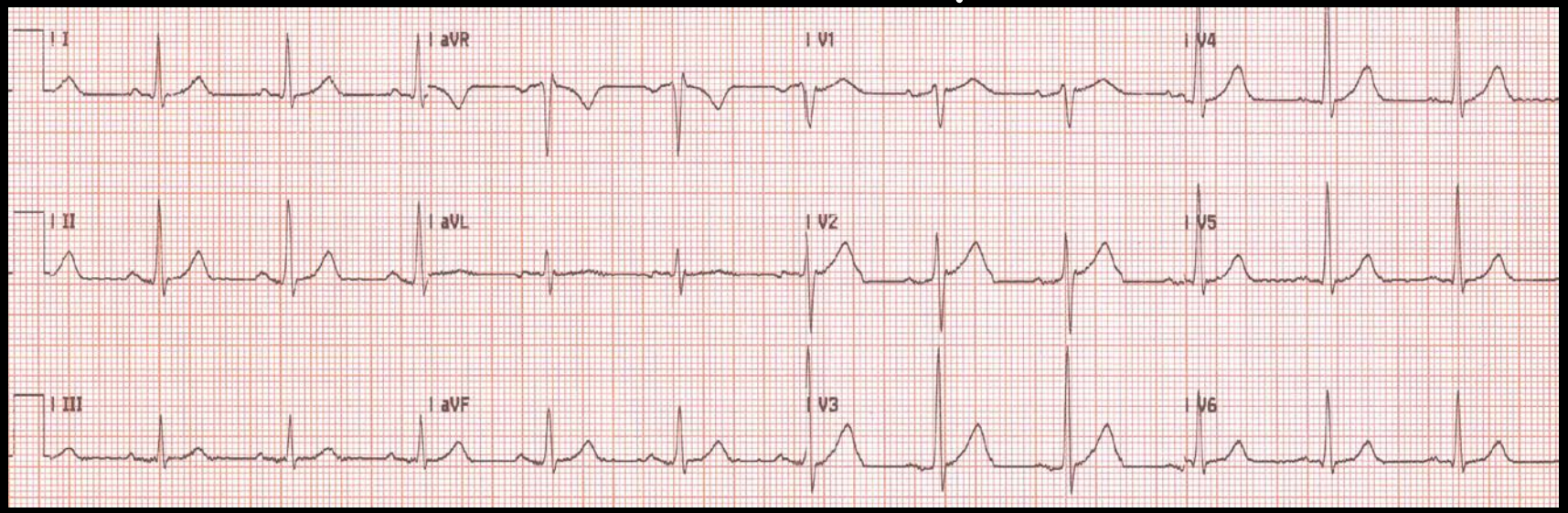


≥ 0.04 sec wide

>25% of R wave

Normal 12 Lead ECG

- All ST segments remain on the isoelectric line.
- aVR should always be negative.
- ST elevation in V1-V2 may be a normal variant.
- T wave inversion in V1-V4 may be a normal variant



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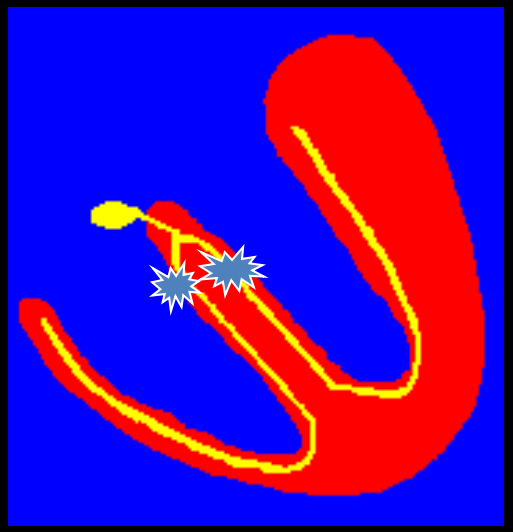
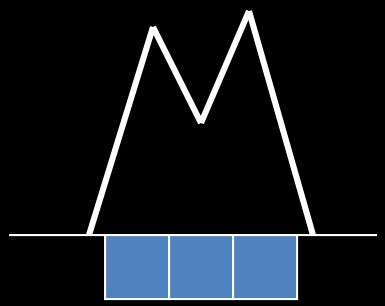
Bundle Branch Blocks

Bundle Branch Block

- This can be a pre-existing condition
- It could be caused by either a new or old MI.
- It may produce or hide ST elevation/depression.

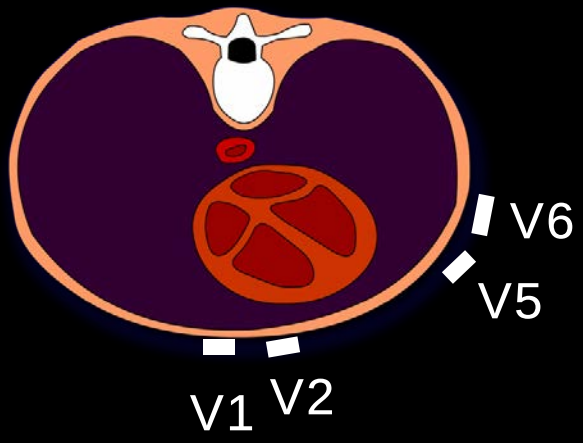


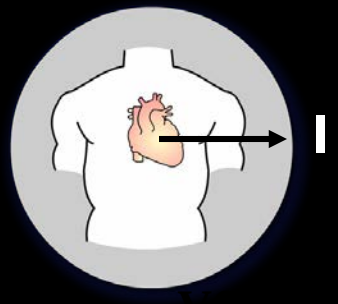
Bundle Branch Block



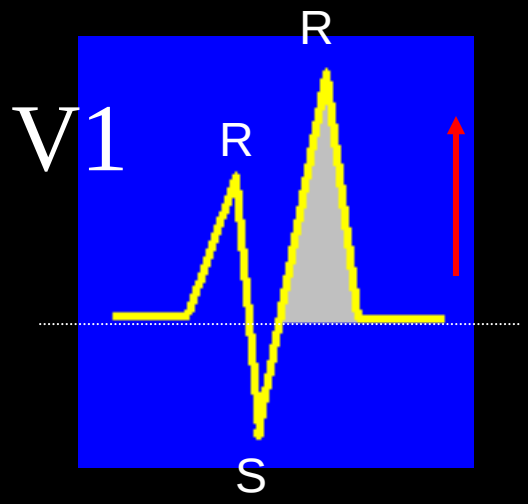
- Normally both bundle branches transmit a stimulus to the 2 ventricles simultaneously.
- The QRS duration will be less than 0.12 seconds (3 small squares).
- If one of the bundle branches is blocked, the ventricles will fire independently causing the QRS duration to be greater than 0.12 seconds

ECG Leads

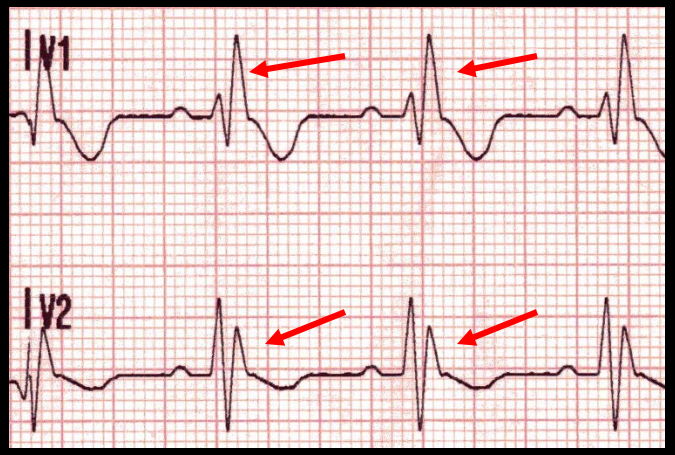




- To be able to identify which bundle branch is blocked, you will need to know which leads are associated with each bundle branch
- The leads looking directly at the right bundle branch are V1 & V2
- The leads looking at the left are V5,V6 & lead I

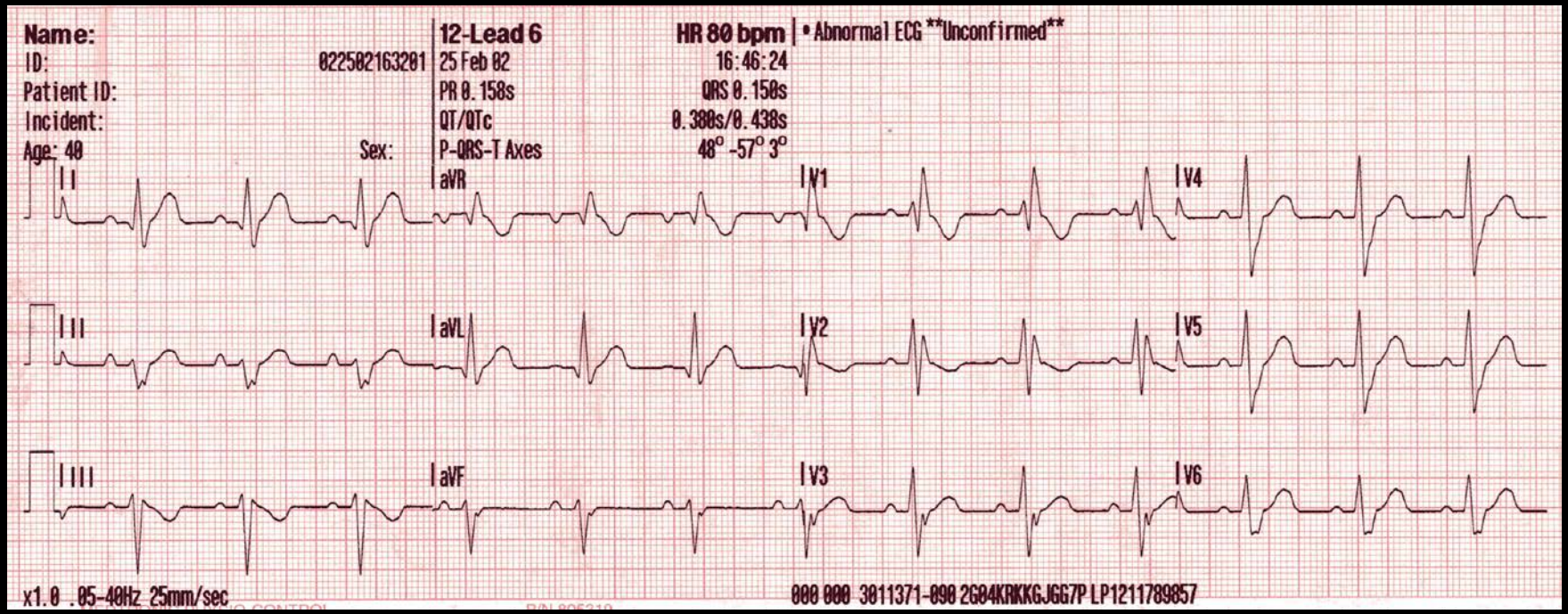


RBBB

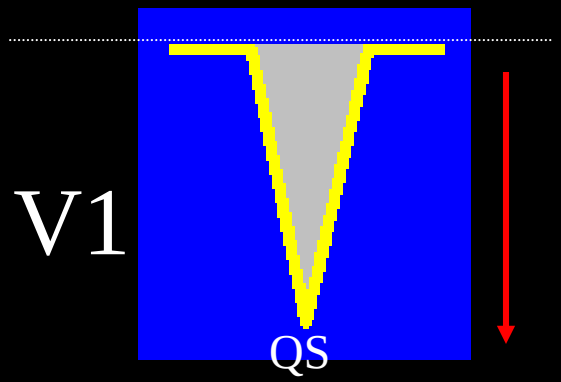


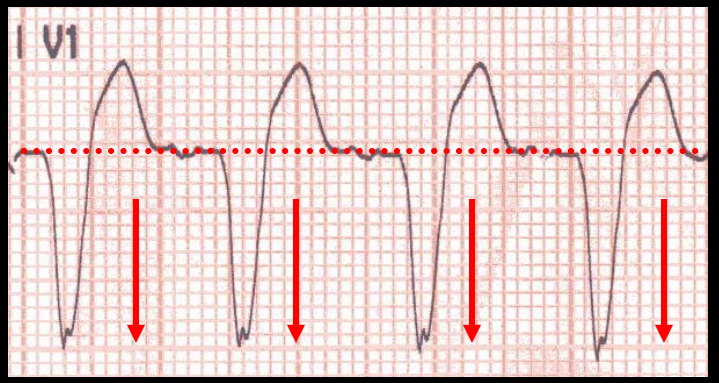
- As the right ventricle depolarises after the left, caused by a block in the RBB, this will cause a widened notched RSR complex in the right chest leads (V1 & V2)
- If the tail end of of this complex is above the isoelectric line in leads V1 / V2 it will be a right bundle branch block (RBBB)

RBBB

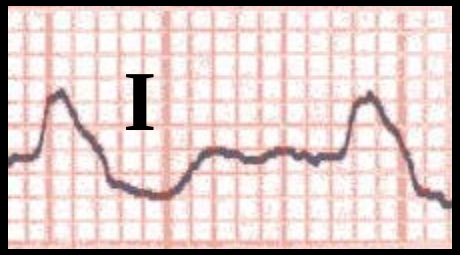

Name:
ID: 022502163201
Patient ID:
Incident:
Age: 40 Sex:
12-Lead 6
25 Feb 02
PR 0.158s
QT/QTc
P-QRS-T Axes
HR 80 bpm
16:46:24
QRS 0.150s
0.380s/0.438s
48° -57° 3°
• Abnormal ECG **Unconfirmed**
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
x1.0 .05-40Hz 25mm/sec
000 000 3011371-090 2G04KRKKGJGG7P LP1211789857

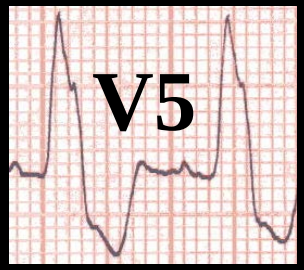
LBBB

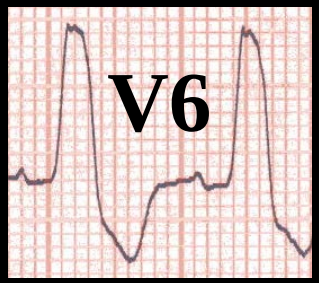




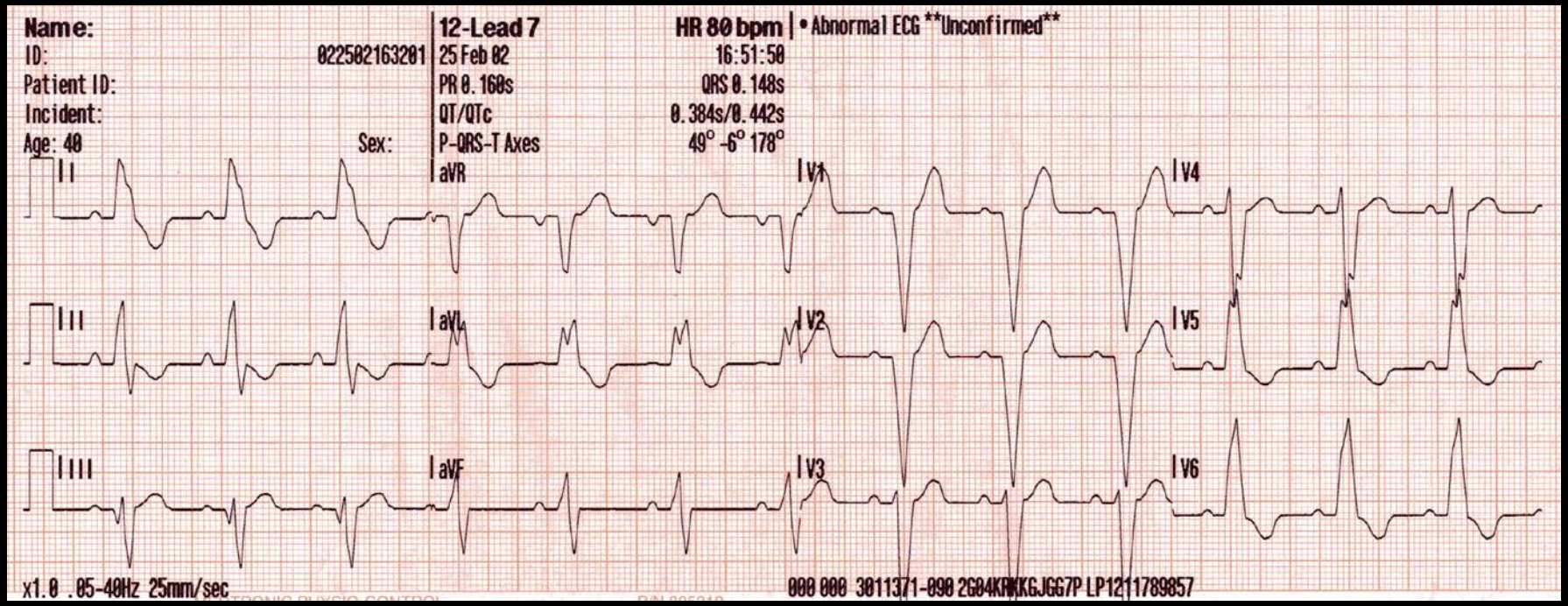
- With LBBB you get a QS (negative complex) in V1 and wide notched complexes in the Left limb / chest leads (I, V5 & V6)





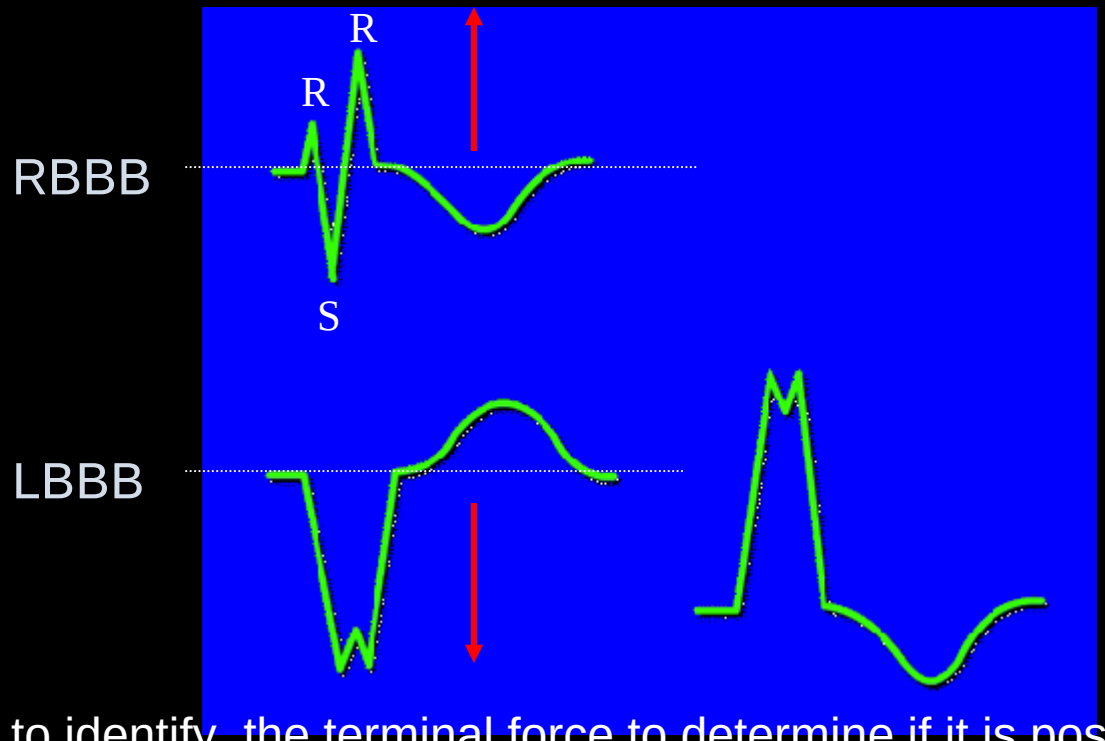


LBBB


Name:
ID: 022582163201
Patient ID:
Incident:
Age: 48 Sex:
12-Lead 7
25 Feb 02
PR 0.160s
QT/QTc
P-QRS-T Axes
HR 80 bpm
16:51:50
QRS 0.148s
0.384s/0.442s
49° -6° 178°
• Abnormal ECG **Unconfirmed**
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
x1.0 .05-40Hz 25mm/sec
000 000 3011371-090 2G04KRKKGJGG7P LP1211789857

RBBB vs LBBB

VI-V2 **V5-V6**



Use V1 to identify the terminal force to determine if it is positive or negative

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Identify which Bundle Branch is blocked on the following 6 ECGs which all have a QRS > 0.12

Write Your Answers LBBB or RBBB for Each

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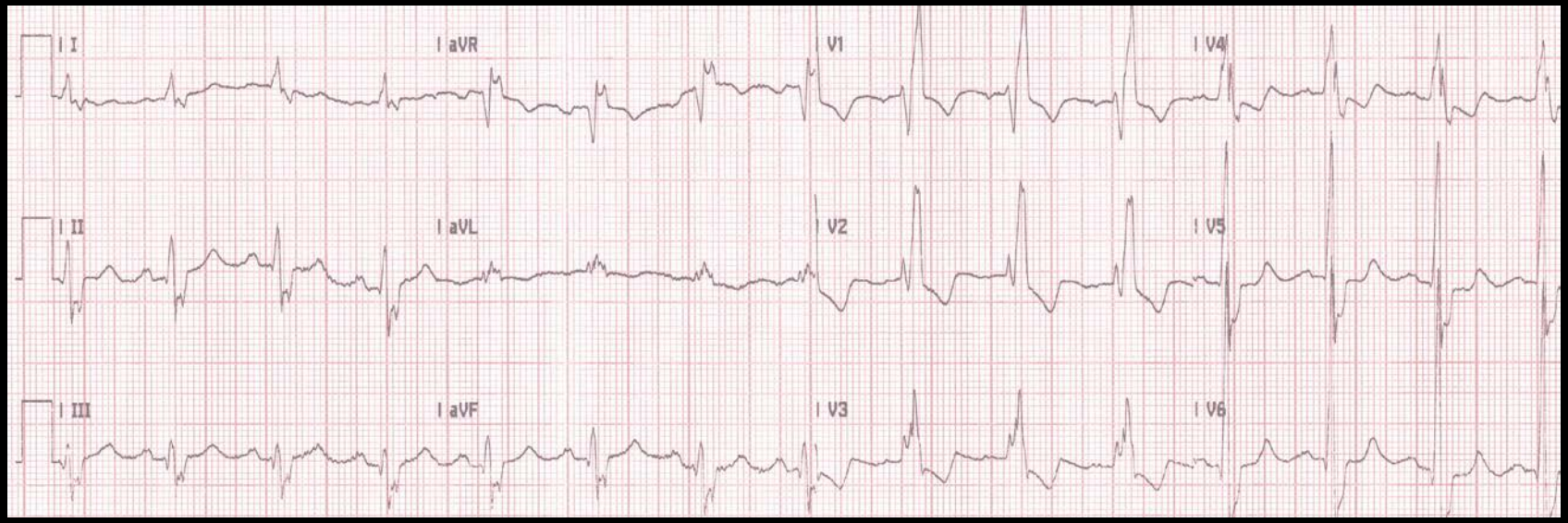
ECG 1



LBBB or RBBB ?

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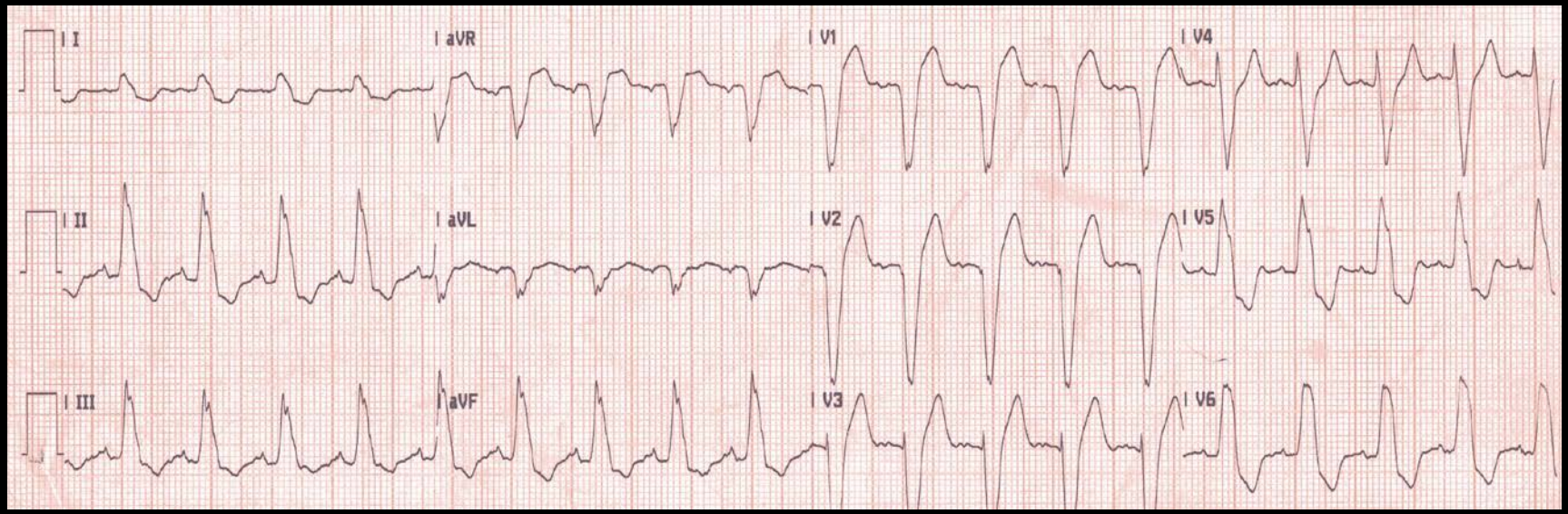
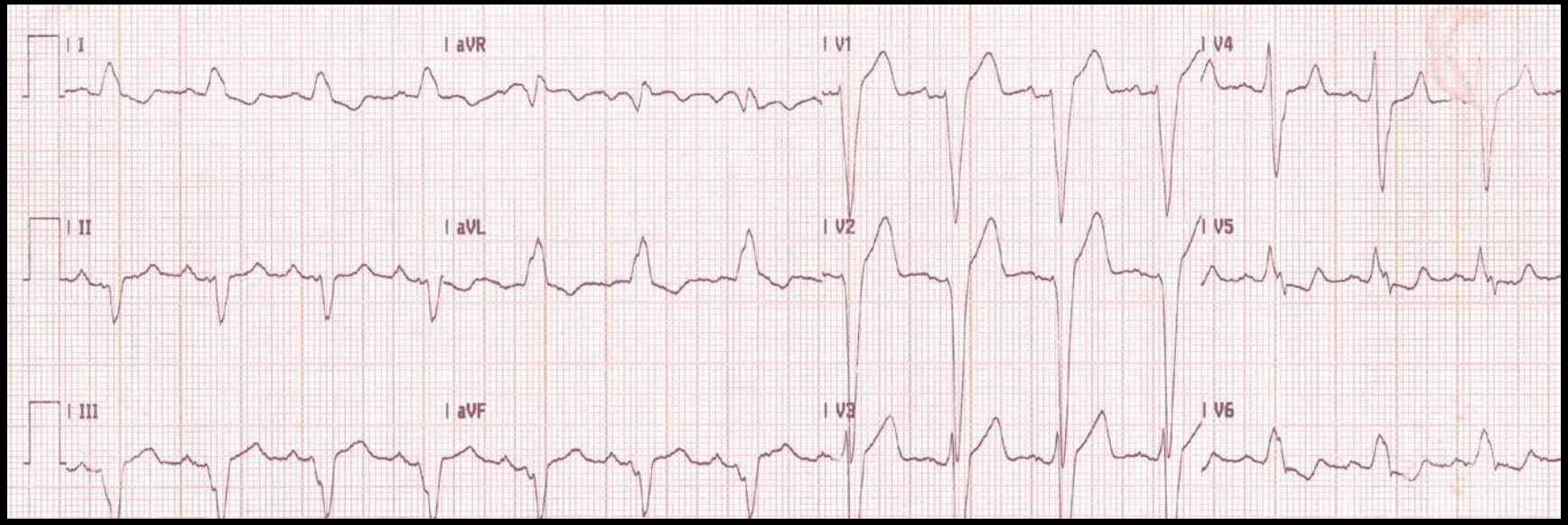
ECG 2



LBBB or RBBB ?

ECG 3



LBBB or RBBB ?

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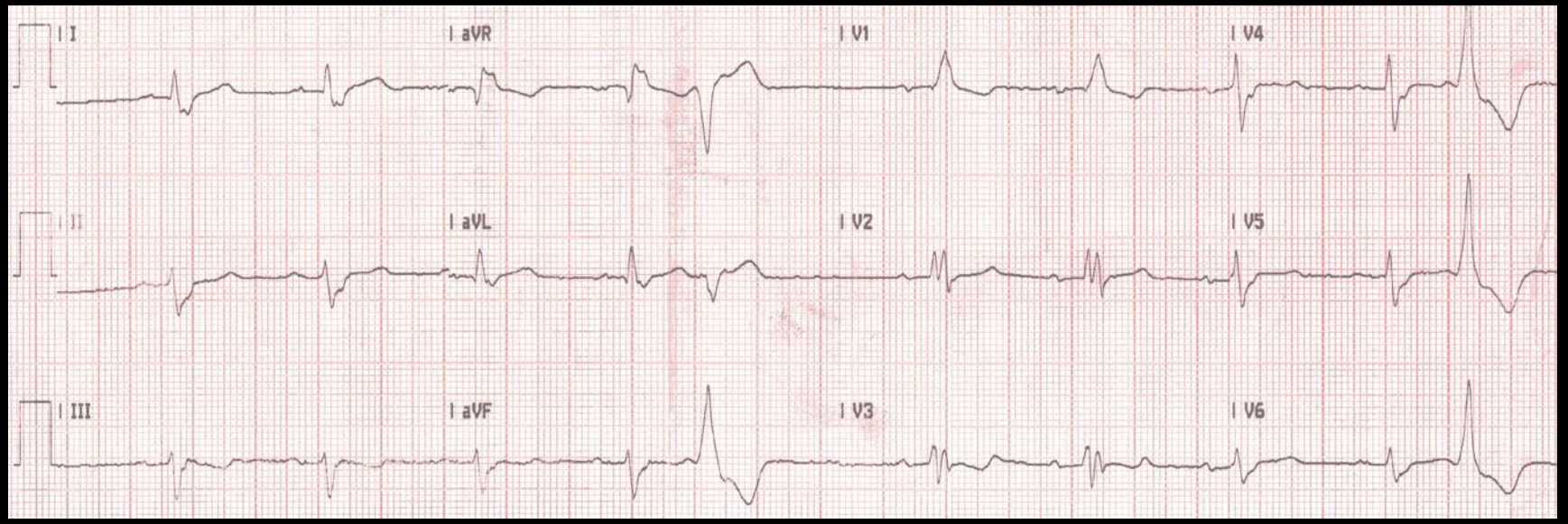
ECG 4



LBBB or RBBB ?

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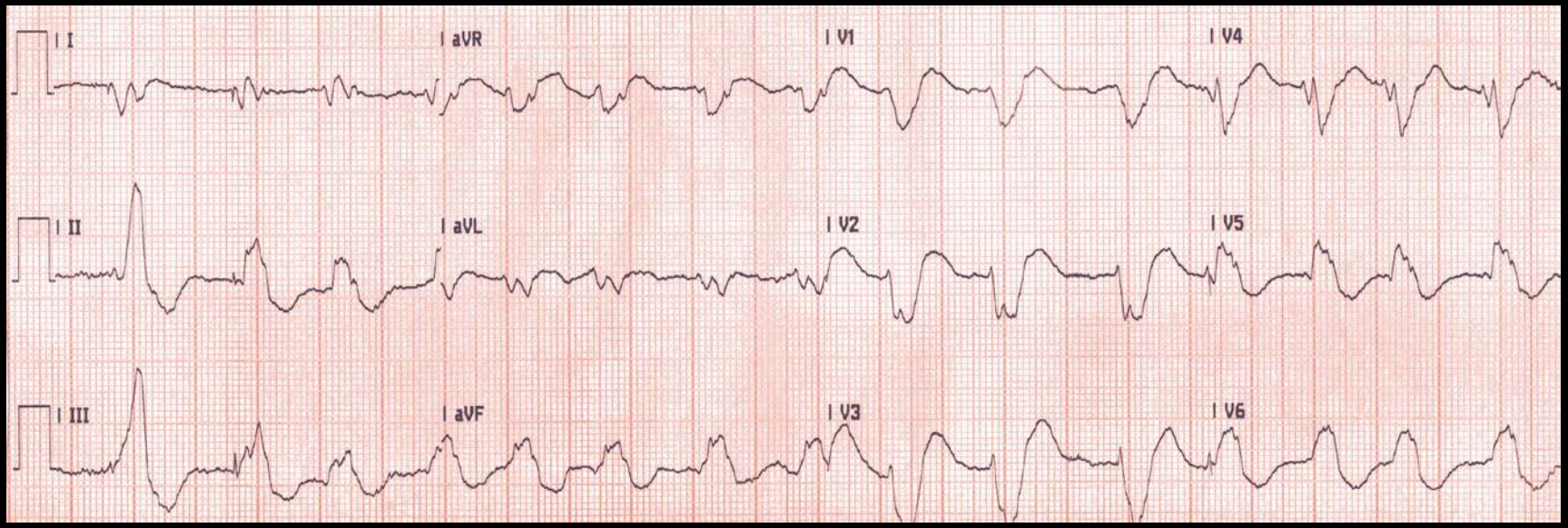
ECG 5



LBBB or RBBB ?

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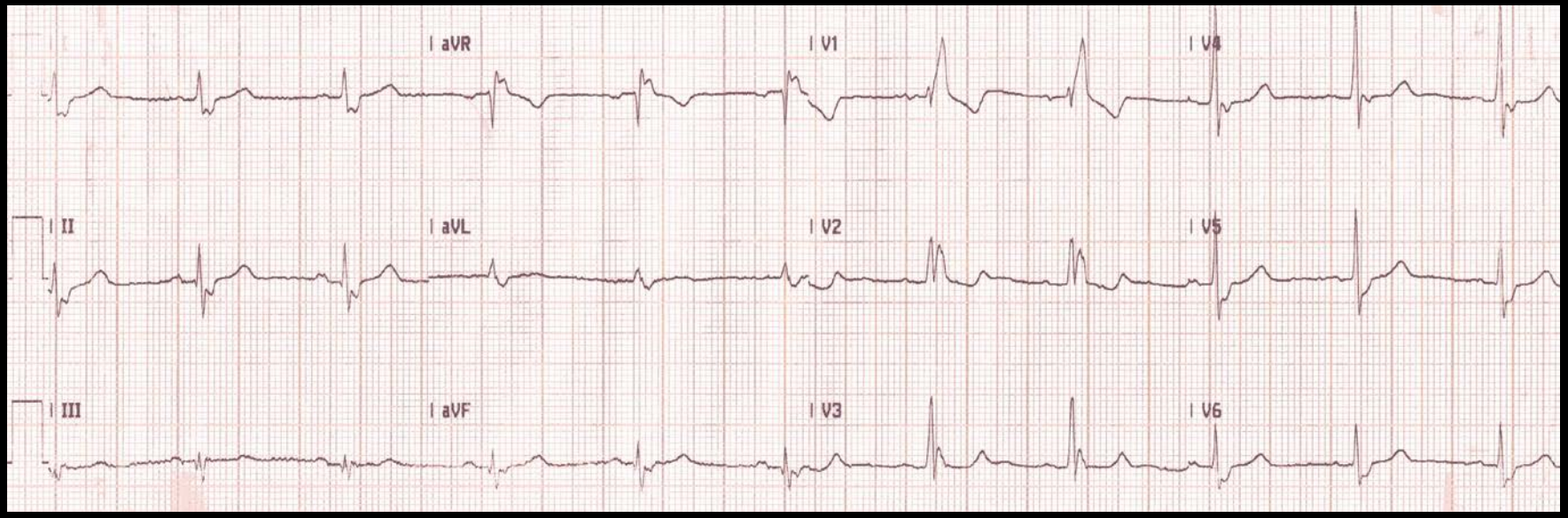
ECG 6

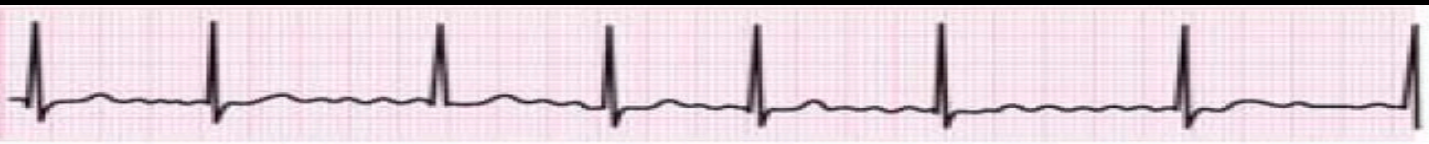


LBBB or RBBB ?

Answers

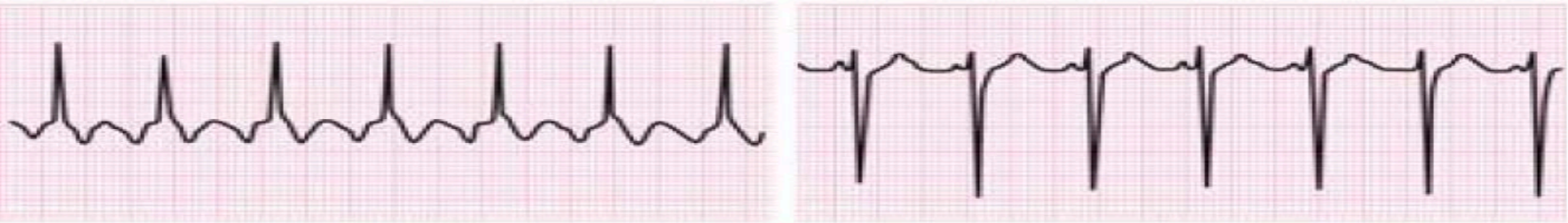
- 1. Right Bundle Branch
- 2. Left Bundle Branch
- 3. Left Bundle Branch
- 4. Right Bundle Branch
- 5. Left Bundle Branch
- 6. Right Bundle Branch

FAST RHYTHM



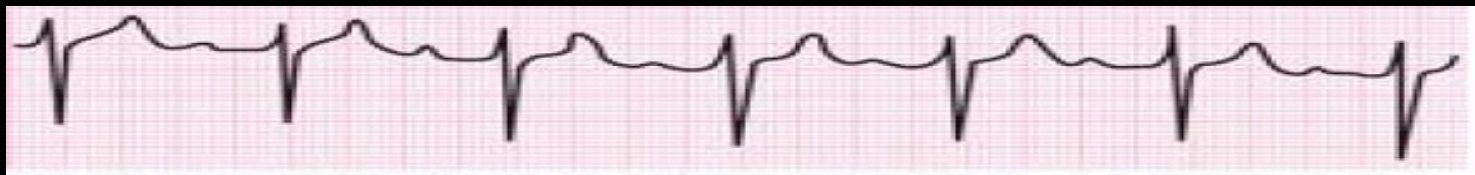
Atrial fibrillation

Atrial fibrillation with a rapid ventricular response. Diagnosis is based on the totally irregular ventricular rhythm.

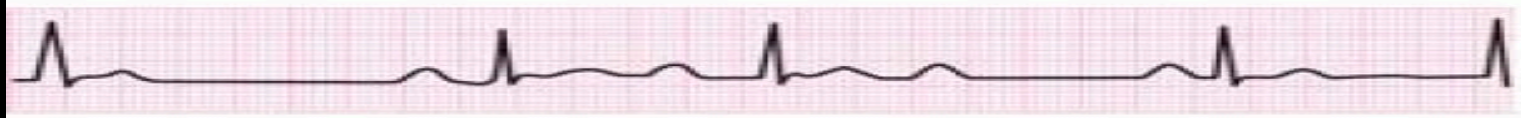


Atrial flutter with 2:1 AV block. Lead aVF (on left) shows the characteristic saw-tooth baseline whereas lead V1 (on right) shows discrete atrial activity, alternate 'F'waves being superimposed on ventricular T waves.

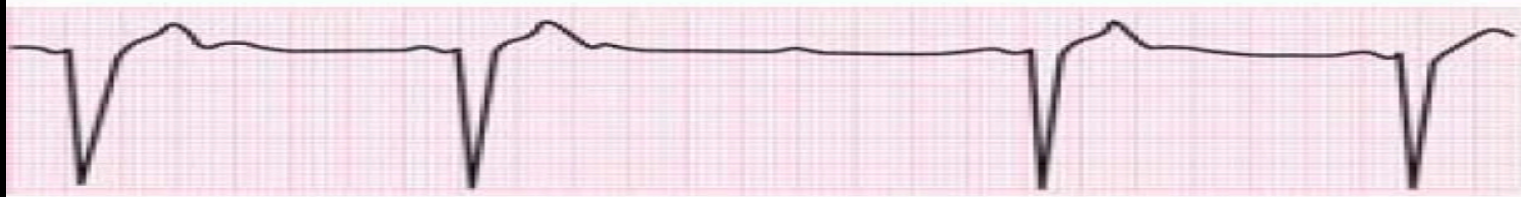
SLOW RHYTHM



First degree AV block. P-R interval = 0.28s



Mobitz type I (Wenckebach) AV block. With each succesive QRS, the P-R interval increases-until there is a non-conducted P wave.



Mobitz type II AV block. Ratio of AV conduction varies from 2:1 to 3:1

Complete AV block with narrow ventricular complex.
There is no relation between atrial and the slower ventricular activity.

SLOW RHYTHM

Indications for a permanent pacemaker

- Complete AV block (Stokes-Adams attacks, asymptomatic, congenital)
- Mobitz type II AV block (p119)
- Persistent AV block after anterior MI
- Symptomatic bradycardias (eg sick sinus syndrome, p118)
- Heart failure (cardiac resynchronization)
- Drug-resistant tachyarrhythmias

A normal 12-lead ECG

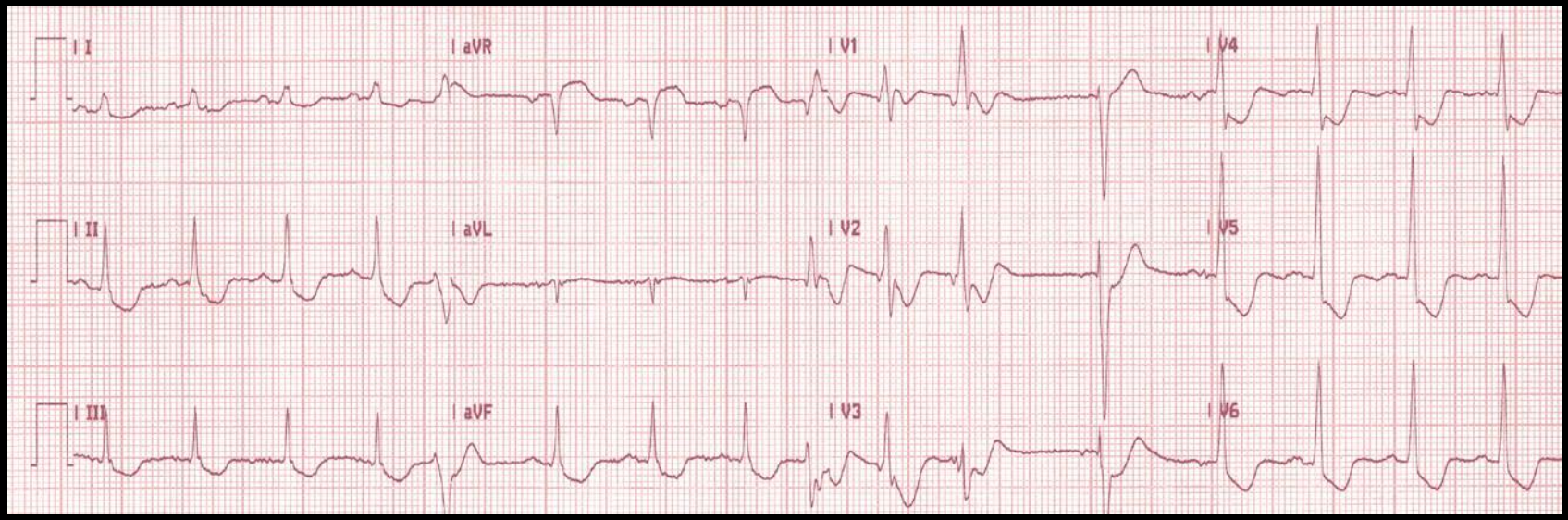
DOES NOT

rule out an

acute myocardial infarction

Ischaemia

- Inadequate myocardial oxygen supply
- Can present with ST depression or T wave inversion

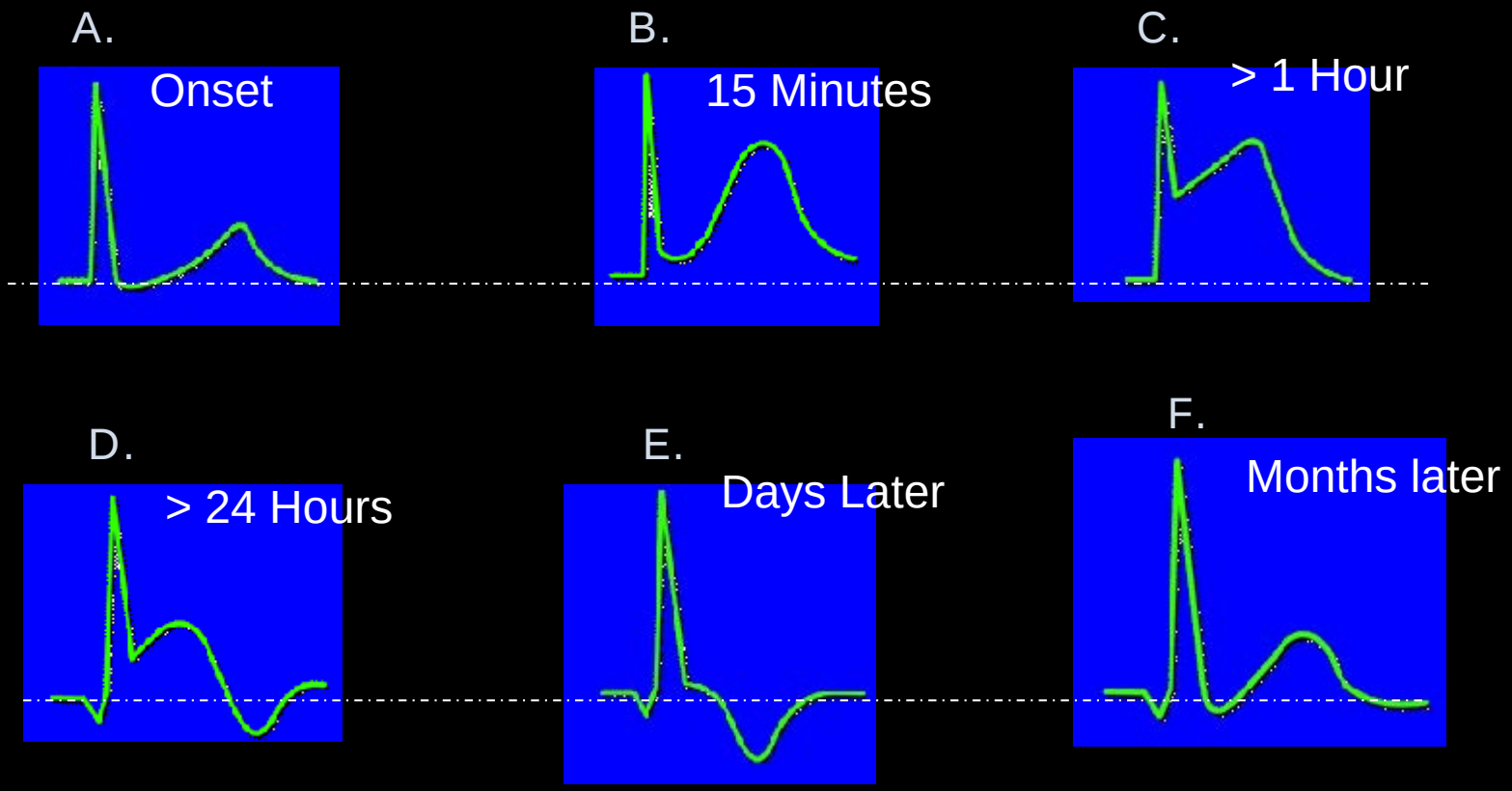


Acute Myocardial Infarction

- ST elevation >1mm in the limb leads and >2mm in the V leads in >2 consecutive leads
- Myocardial injury presents as raised ST
- Infarction can present as Q wave

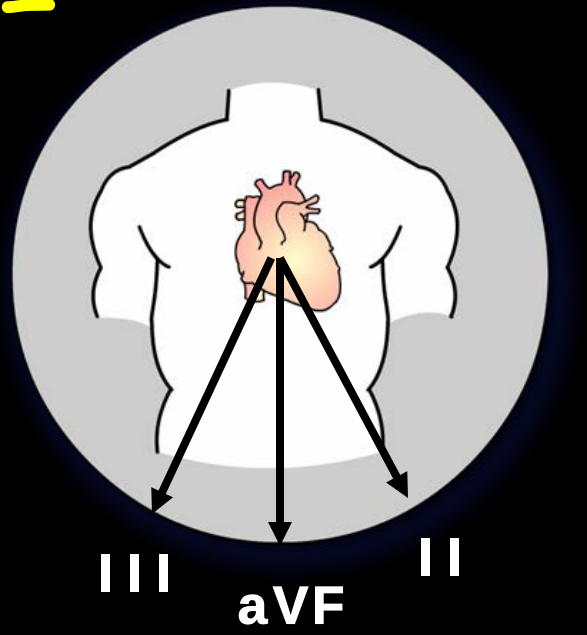
I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

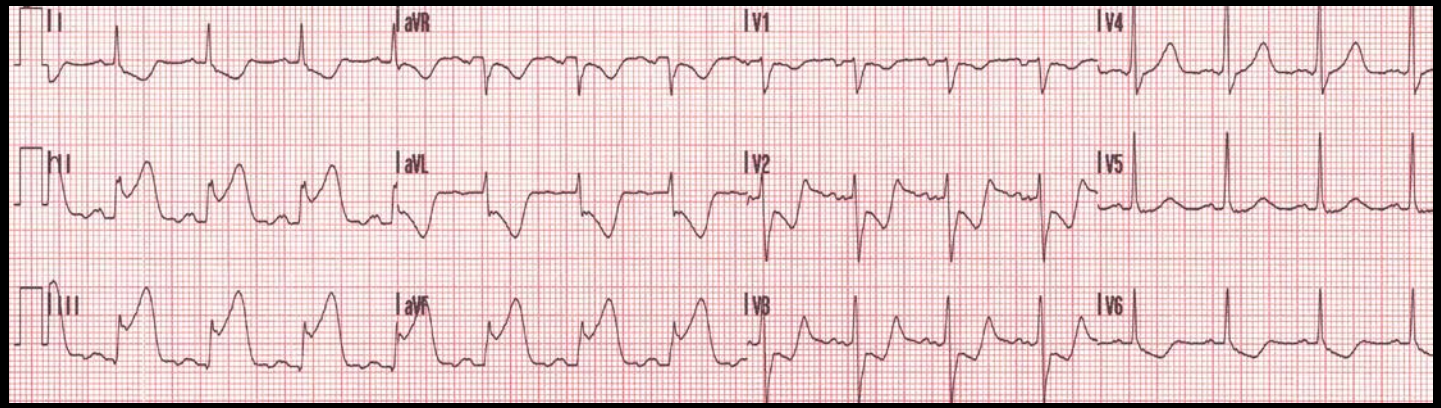
Evolution of acute myocardial infarction



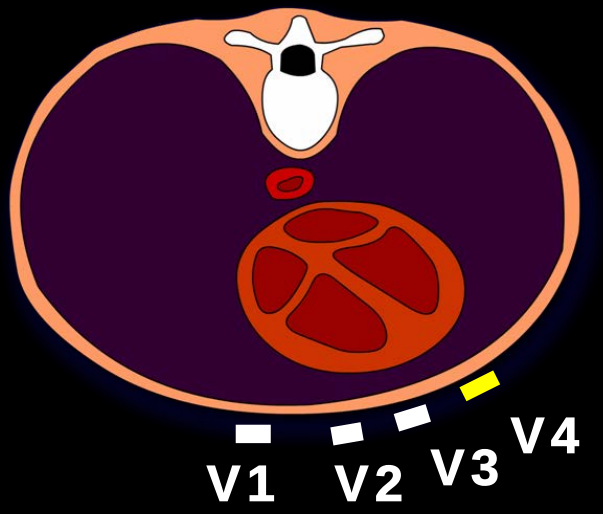
Inferior AMI

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

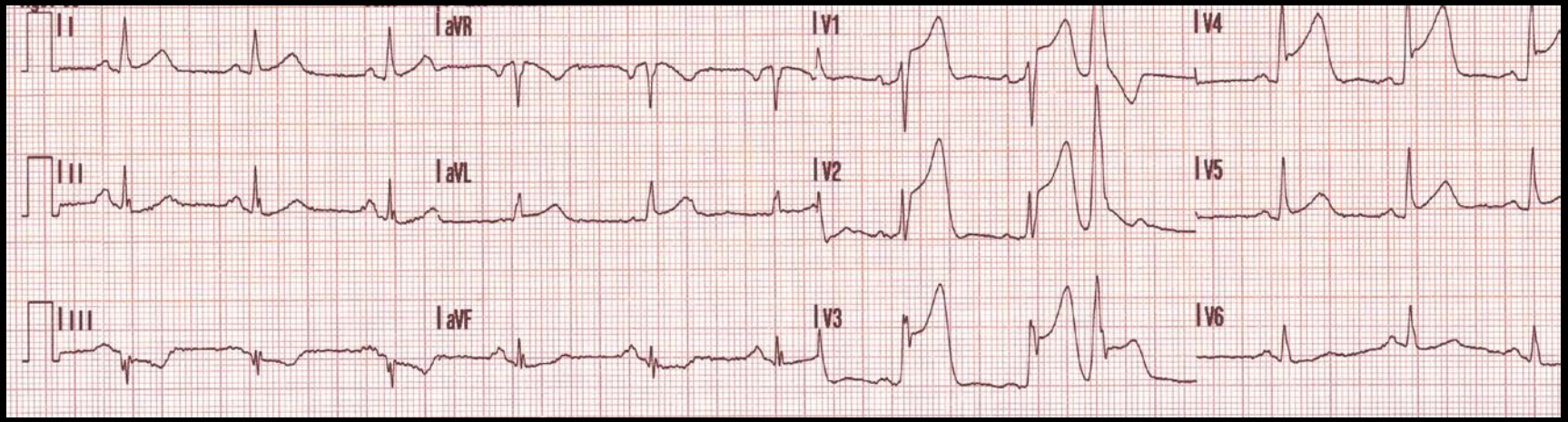




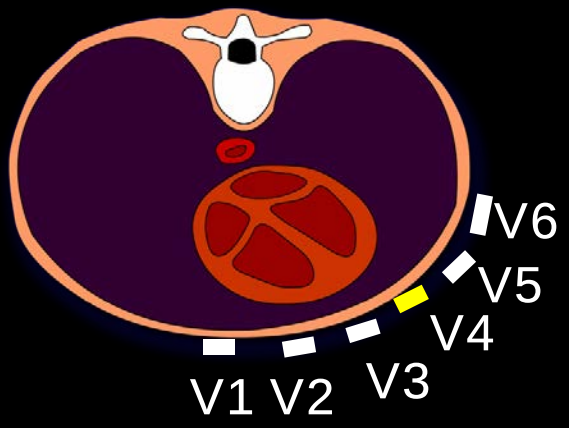
Antero-septal AMI



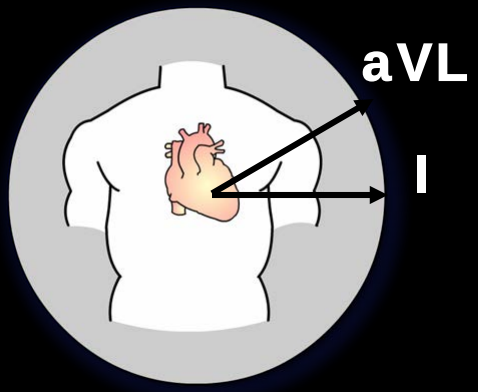
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

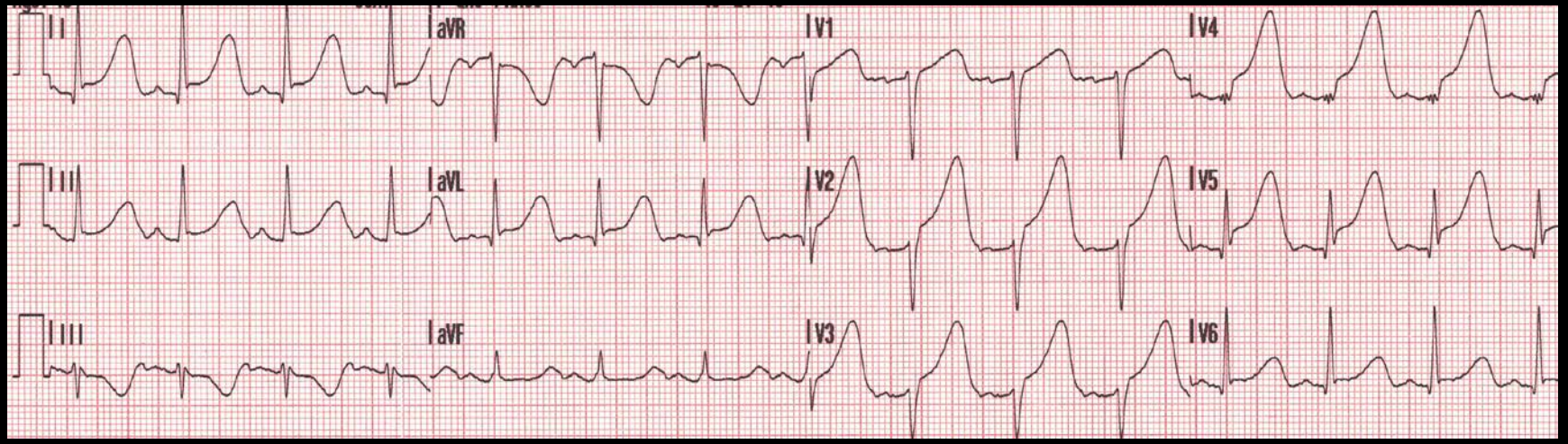


Antero-lateral AMI

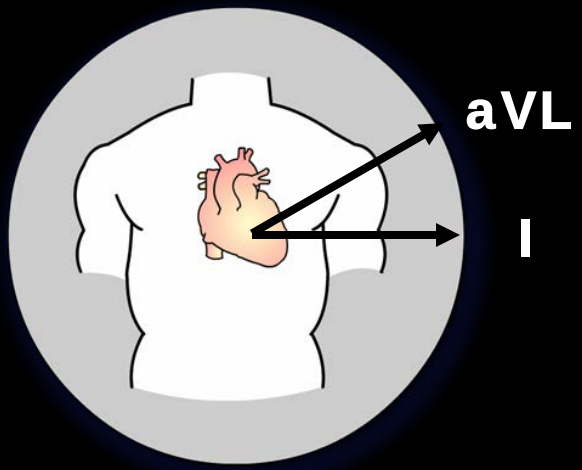


I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

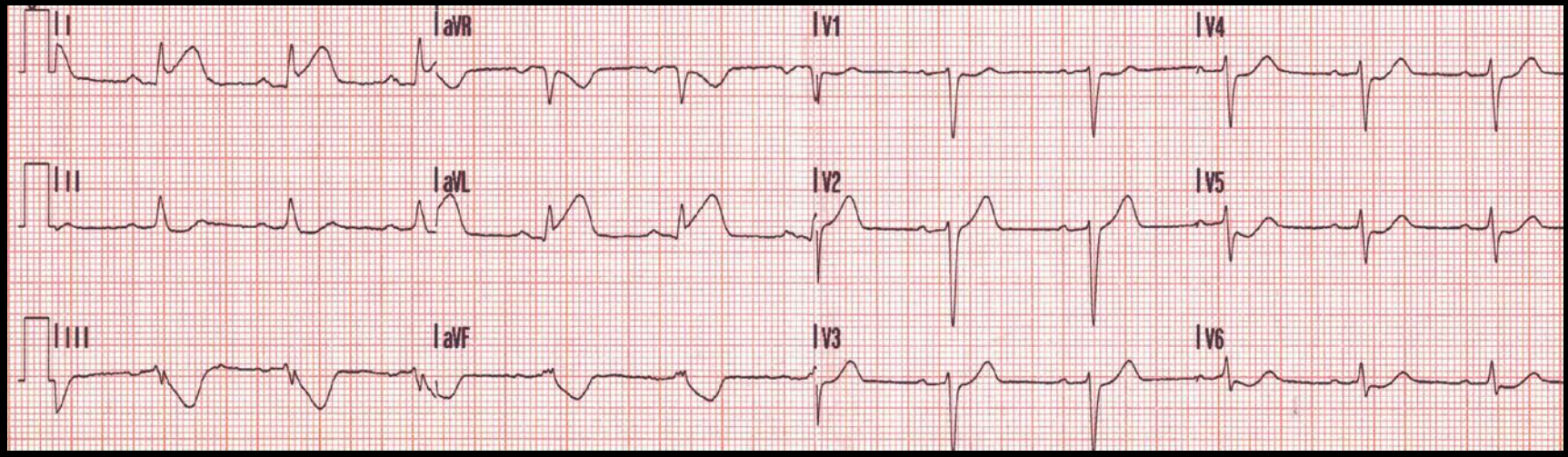




Lateral AMI

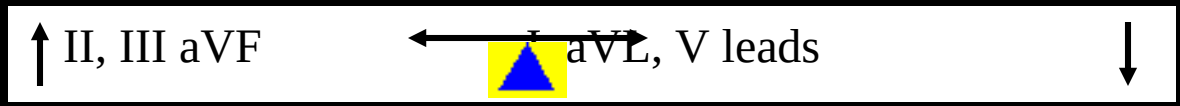


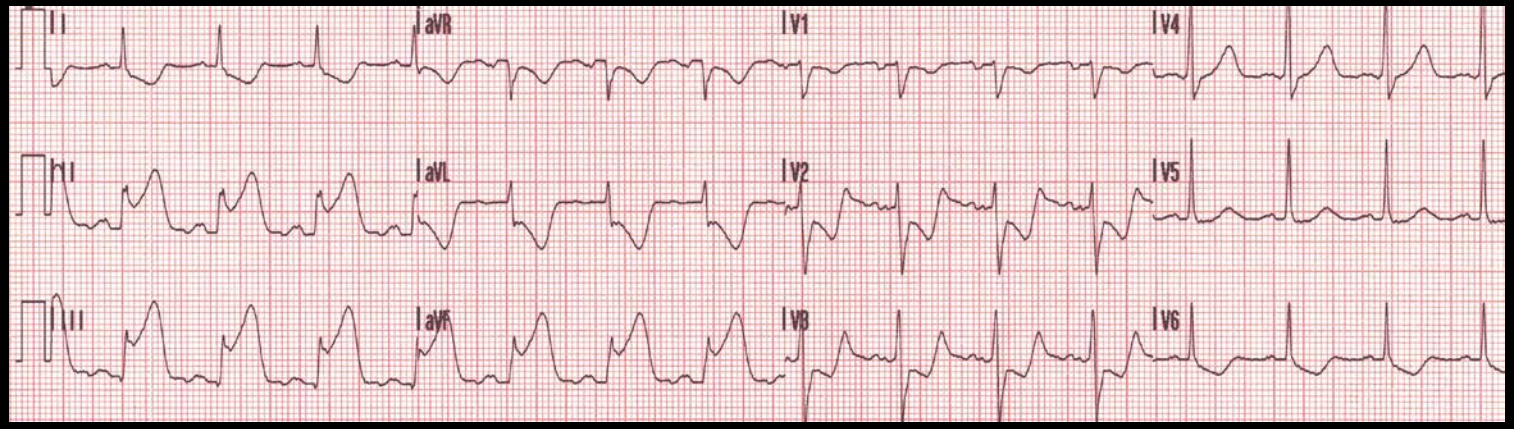
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6



Reciprocal Changes

- If a lead is looking directly at the infarct site it will produce ST segment elevation
- When a lead sees the infarct from the opposite perspective, the ST segment may become depressed in that lead





Caution

Atypical presentations of AMI can be seen in

- *Females*
- *Elderly*
- *Diabetics*

Case Study 1

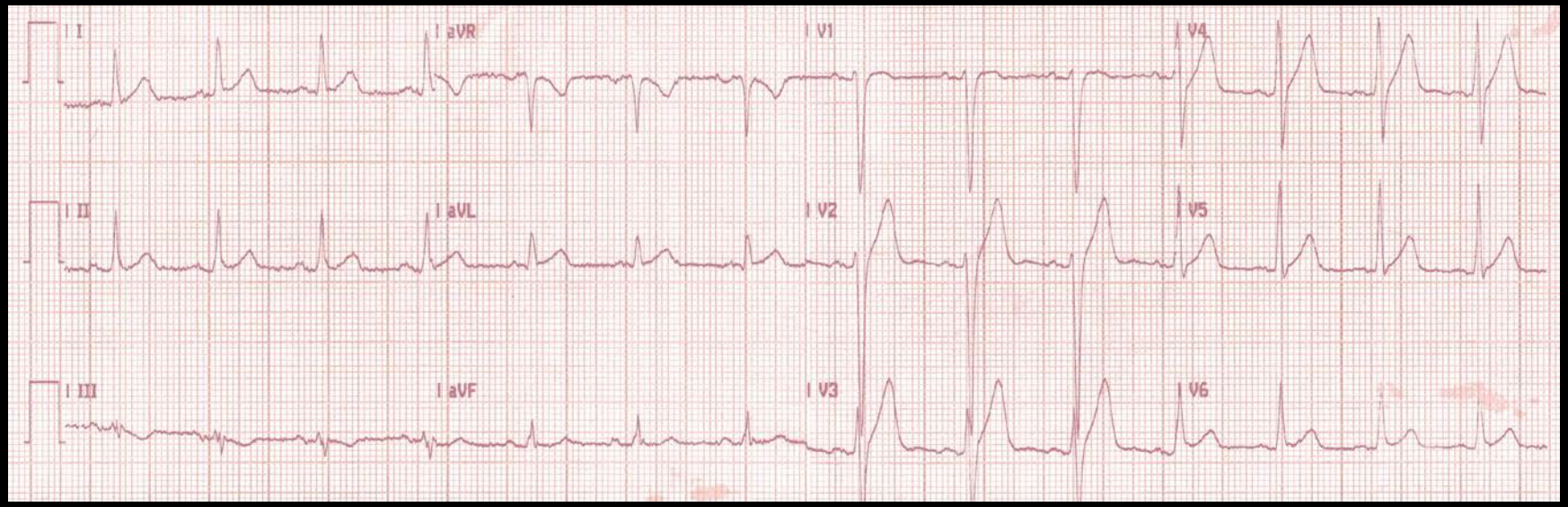
A 43 year old male is normally very fit and well & is employed as a gardener. Whilst at work on a hot summers day he started complaining of central chest pain with pin & needles down his left arm which started last night (16 hours ago).

He was hyperventilating, pale, dry skin, pulse 80/reg & BP 140/60.

3 lead ECG showed a Normal Sinus Rhythm

"What should we do now"

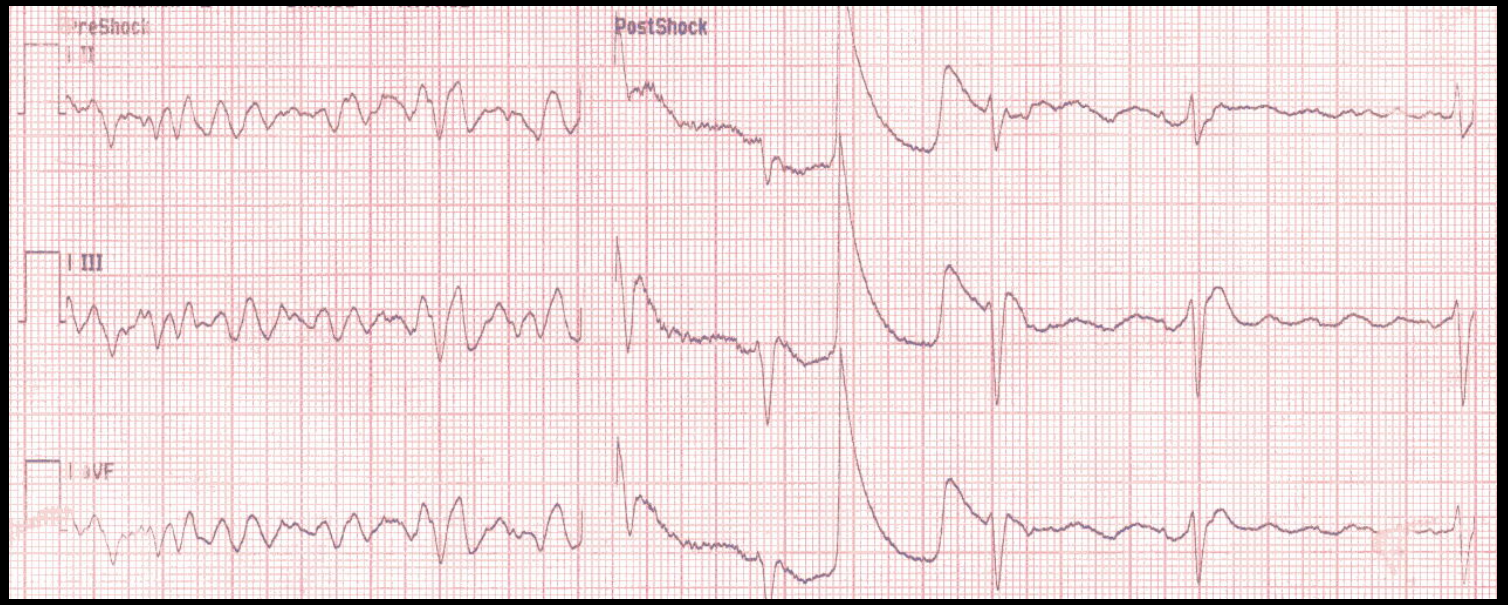
Case Study 1



After slowing his breathing down he received oxygen, aspirin, GTN & IV analgesia. A 12 lead ECG was taken whilst on route to hospital.

"What should you now suspect with this patient"

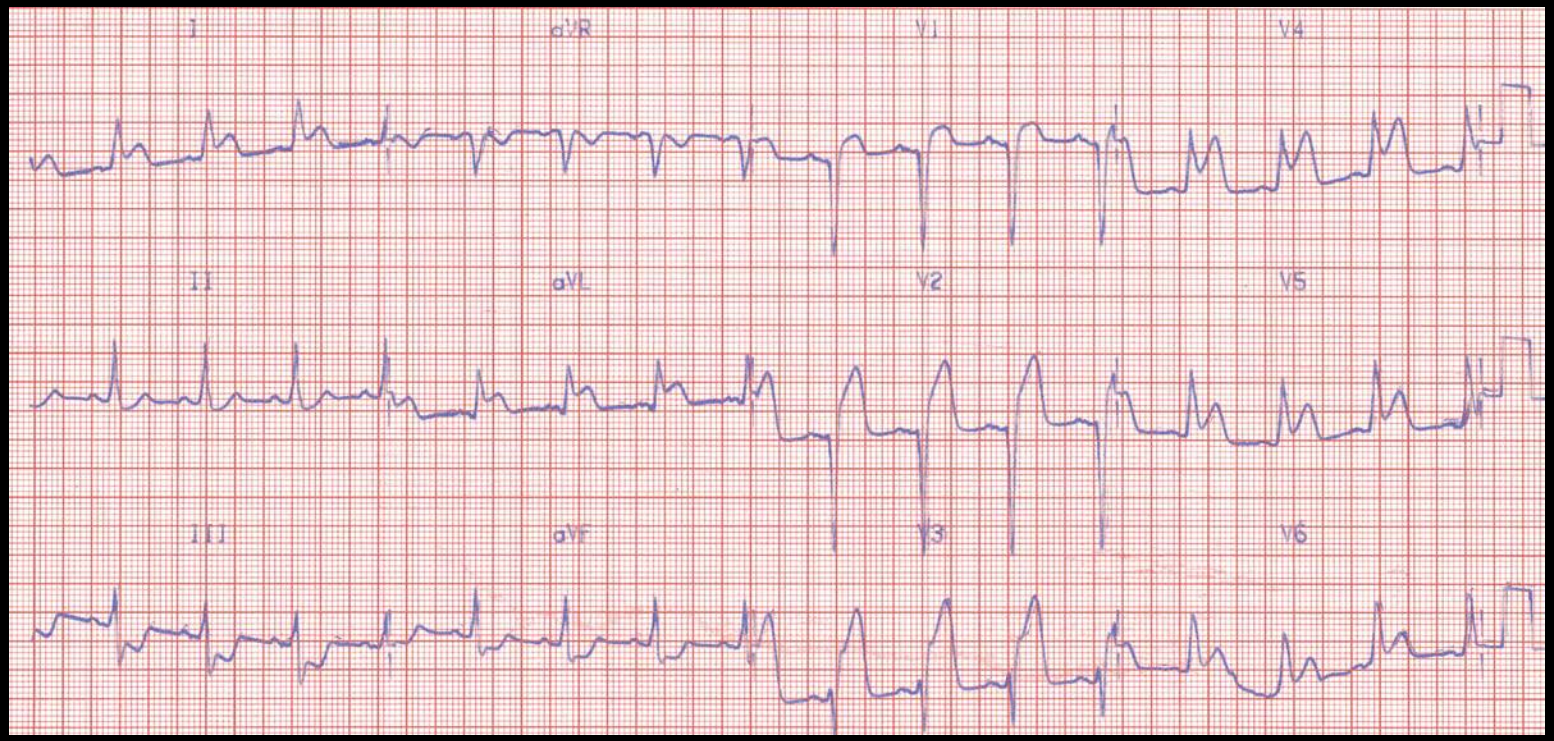
Case Study 1



During the journey the patient was distressed and went into VF. He was shocked twice before reverting back into a sinus rhythm.

“Would it matter if a defibrillator was not immediately at hand?”

Case Study 1



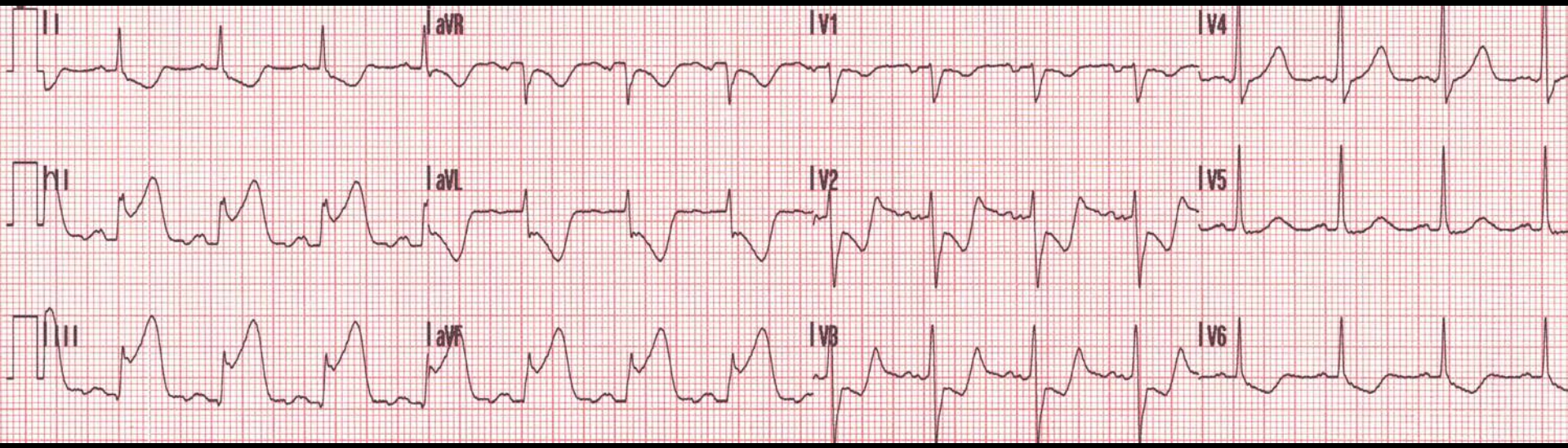
Second 12 lead ECG taken (20 minutes after his first 12 lead) following defibrillation

“What ECG diagnosis can you obtain from this?”

Identify the following 6 ECG infarction sites

Write down your answers

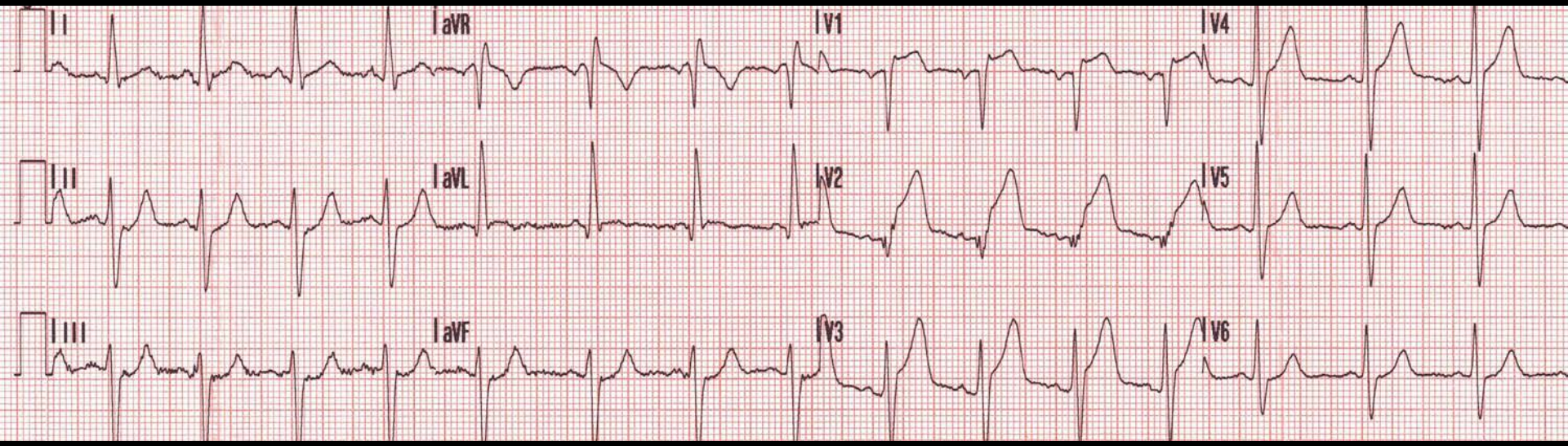
ECG 1



Answer

1. *Antero-lateral MI*
2. *Lateral MI*
3. *Antero-septal MI*
4. *Inferior MI*

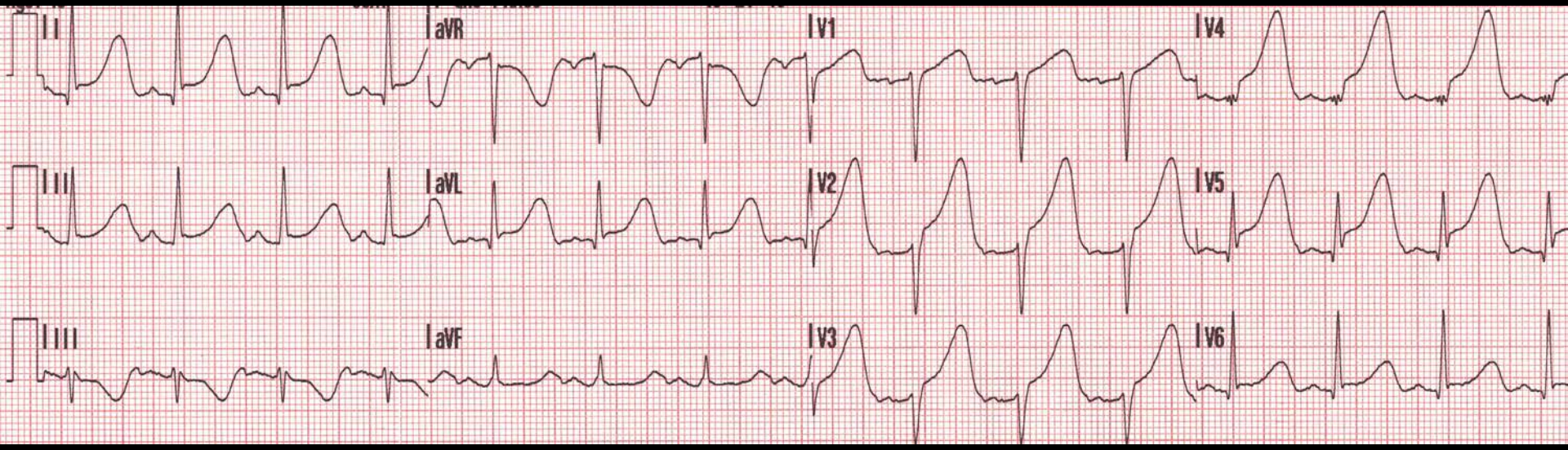
ECG 2



Answer

1. *Antero-lateral MI*
2. *Lateral MI*
3. *Antero-septal MI*
4. *Inferior MI*

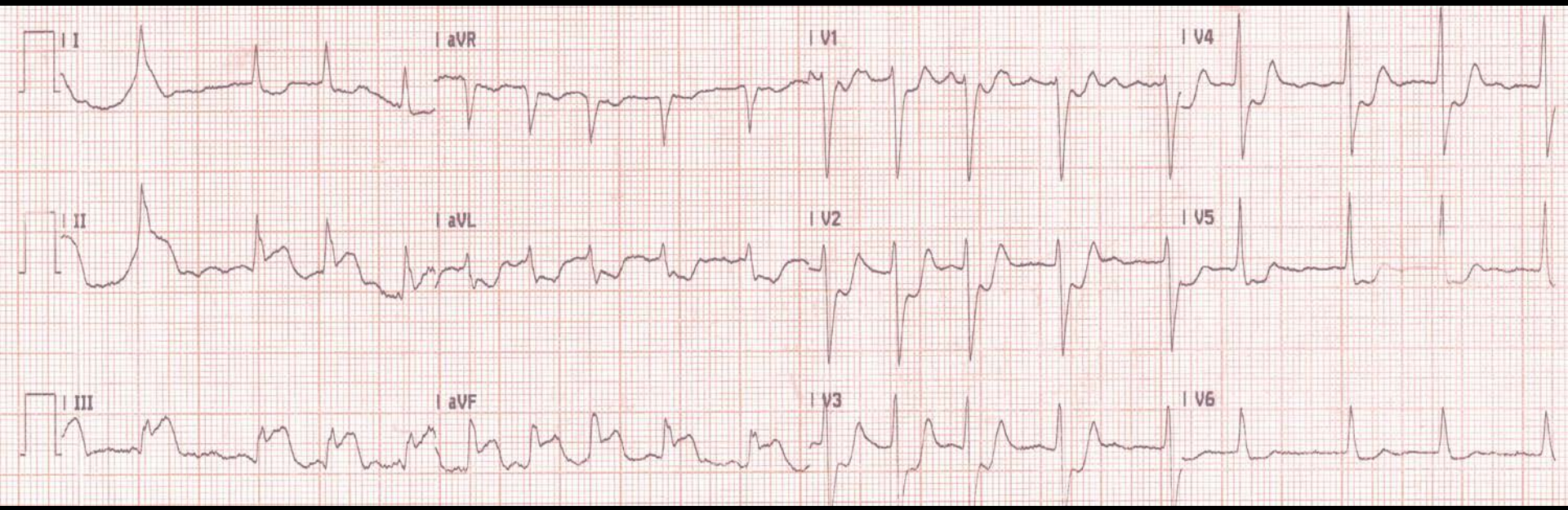
ECG 3



Answer

1. *Antero-lateral MI*
2. *Lateral MI*
3. *Antero-septal MI*
4. *Inferior MI*

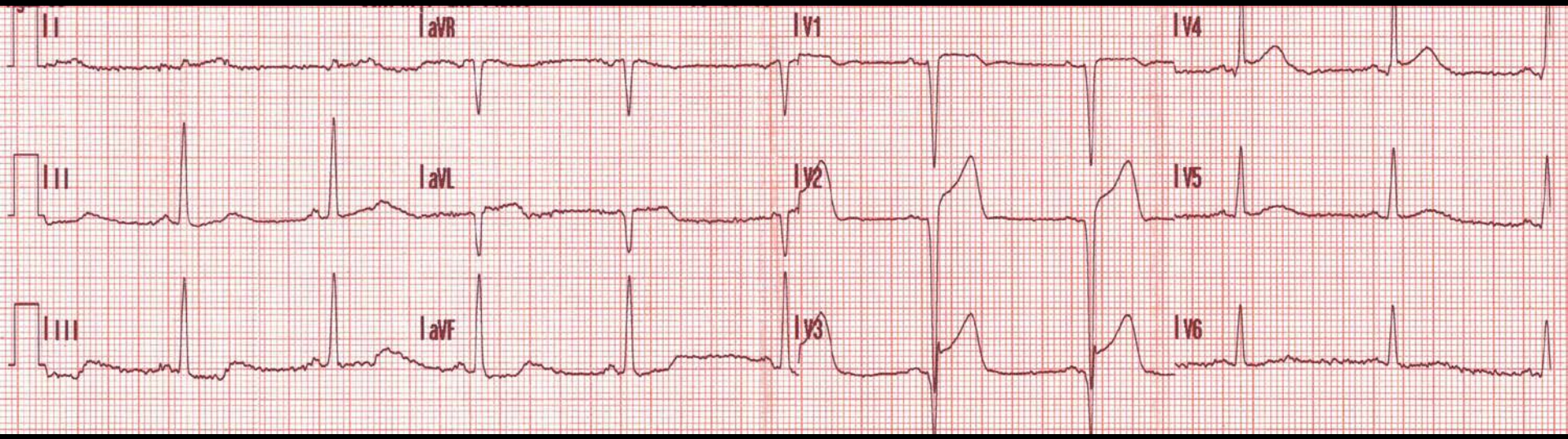
ECG 4



Answer

1. *Antero-lateral MI*
2. *Lateral MI*
3. *Antero-septal MI*
4. *Inferior MI*

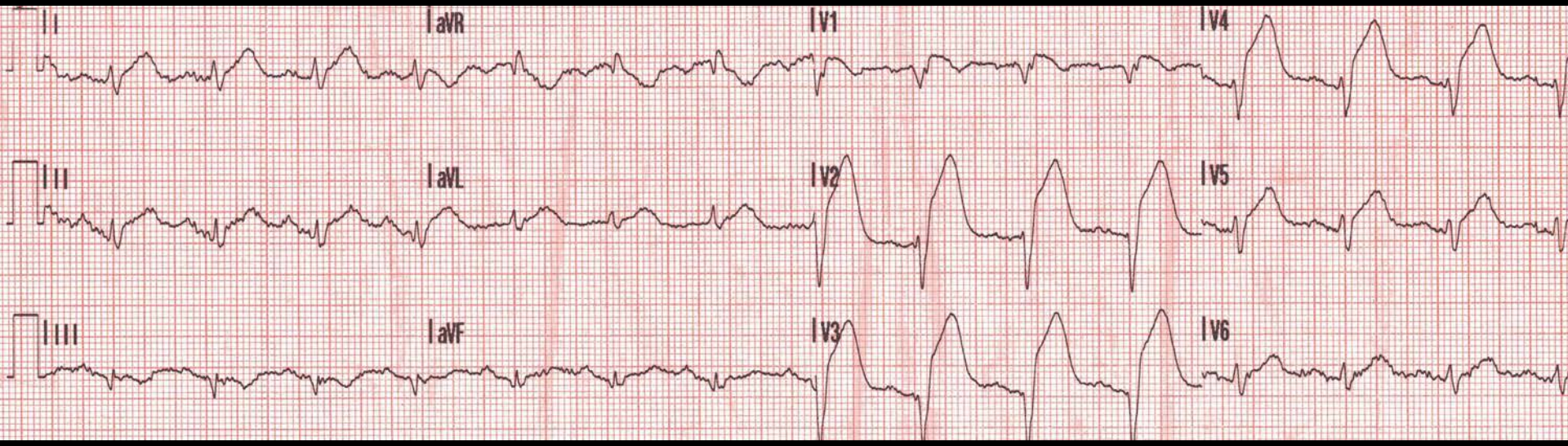
ECG 5



Answer

1. *Antero-lateral MI*
2. *Lateral MI*
3. *Antero-septal MI*
4. *Inferior MI*

ECG 6



Answer

1. *Antero-lateral MI*
2. *Lateral MI*
3. *Antero-septal MI*
4. *Inferior MI*

Answers

- 1 - Inferior
- 2 - Antero-septal
- 3 - Antero-lateral
- 4 - Inferior
- 5 - Antero-septal
- 6 - Antero-lateral

Summary

- A normal ECG does not rule out an AMI
- ST segment depression usually represents ischaemia, although may be seen with total vessel occlusion and infarction
- ST segment elevation is a strong indicator of an AMI

AMI ECG Imitators

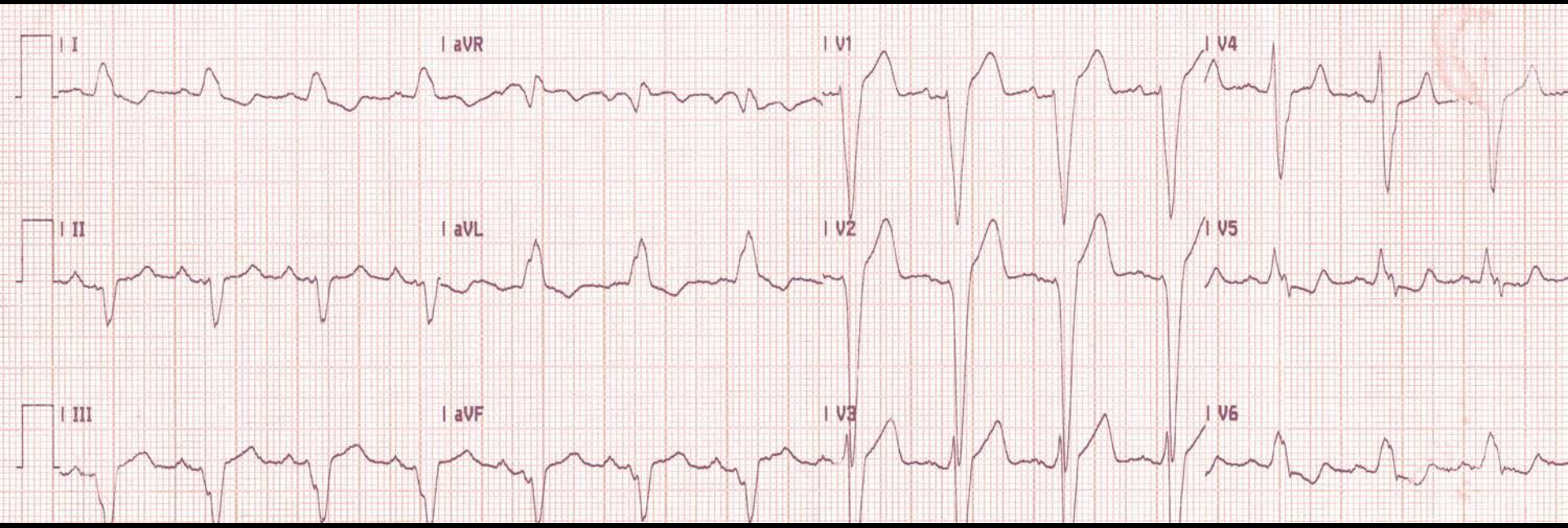
AMI ECG Imitators

"Caution" The following ECGs can resemble ST elevation

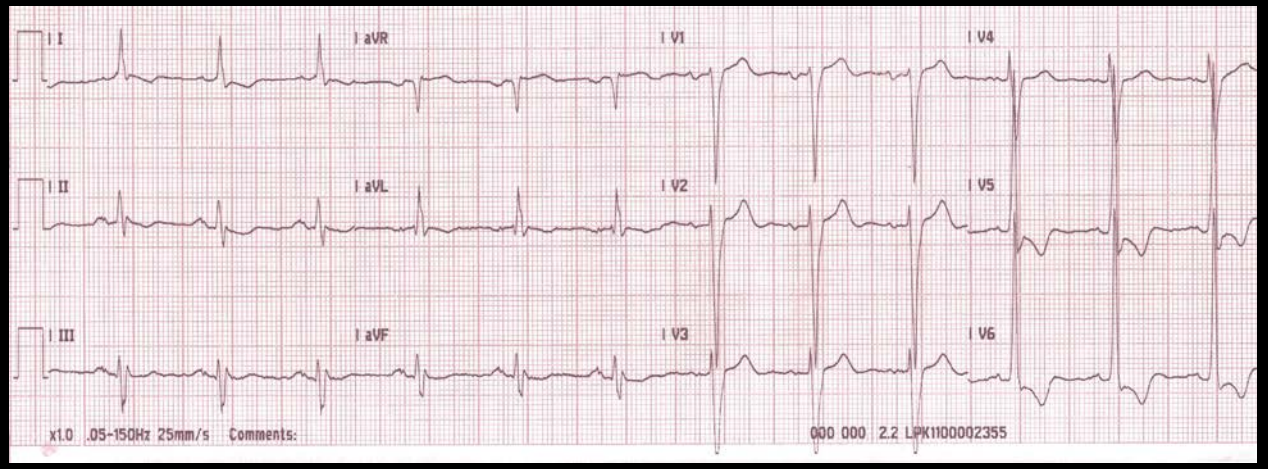
- Bundle Branch Block
- Left Ventricular Hypertrophy
- Paced Rhythm
- Ventricular Rhythms
- Early Repolarisation
- Pericarditis
- Ventricular Aneurysm

This shows the importance of using an ECG along with the clinical findings & not in isolation.

Bundle Branch Block



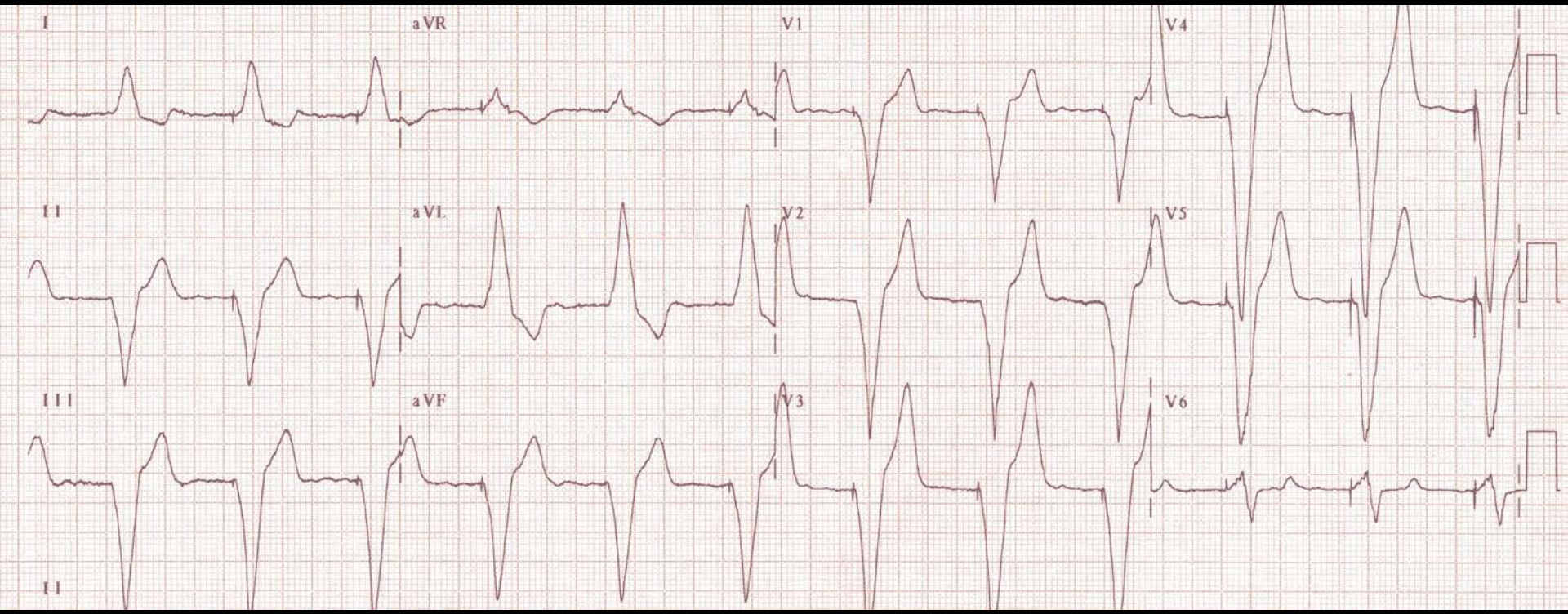
Left Ventricular Hypertrophy



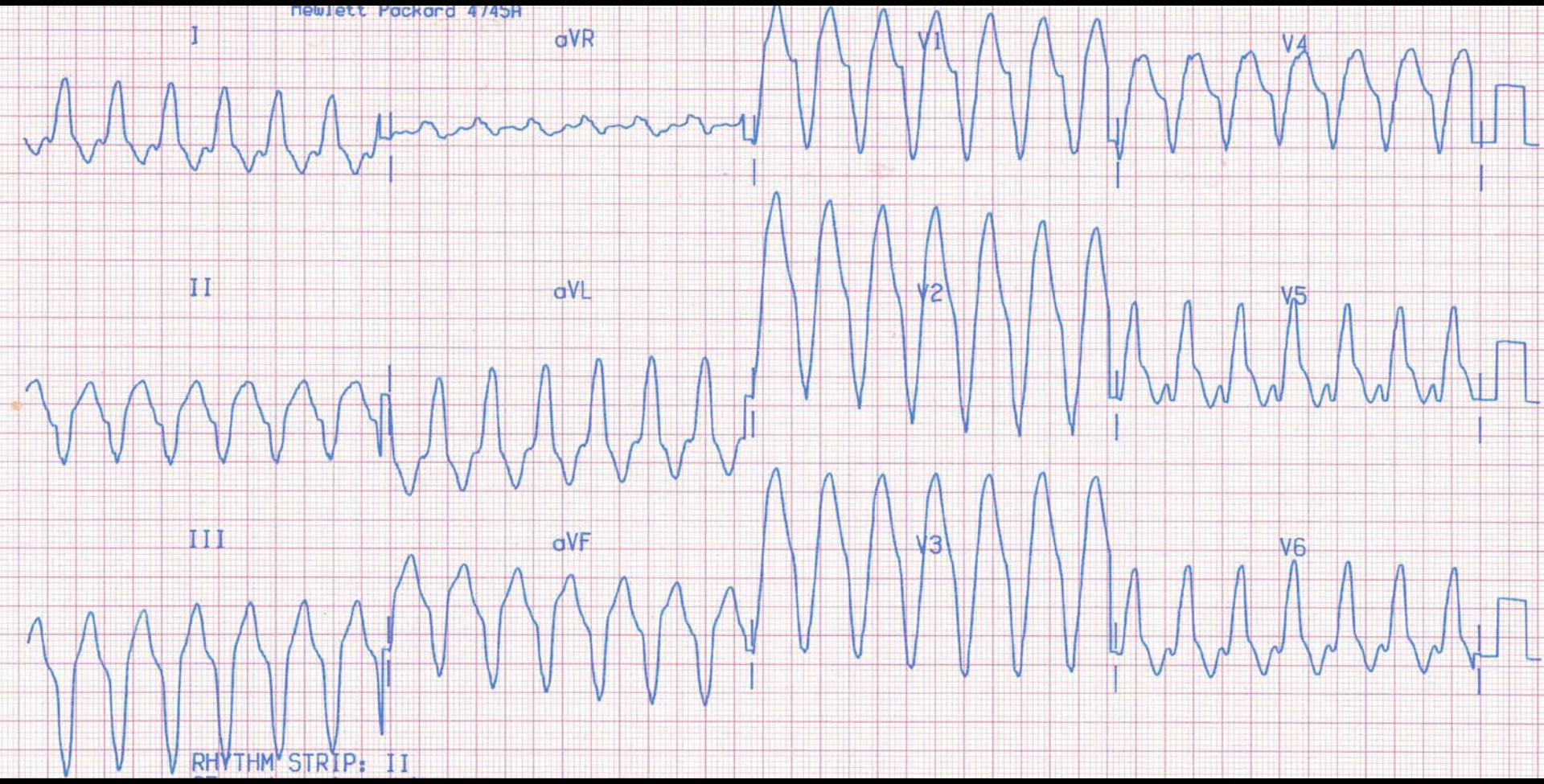
Recognition:

- Compare V1 & V2, determine which has the deeper S wave & measure the depth in mm (1mm = 1 small square)
- Compare V5 & V6, determine which has the taller R wave & measure the height (mm)
- Add together the depth & height (mm). If the sum equals 35 or more, then suspect LVH

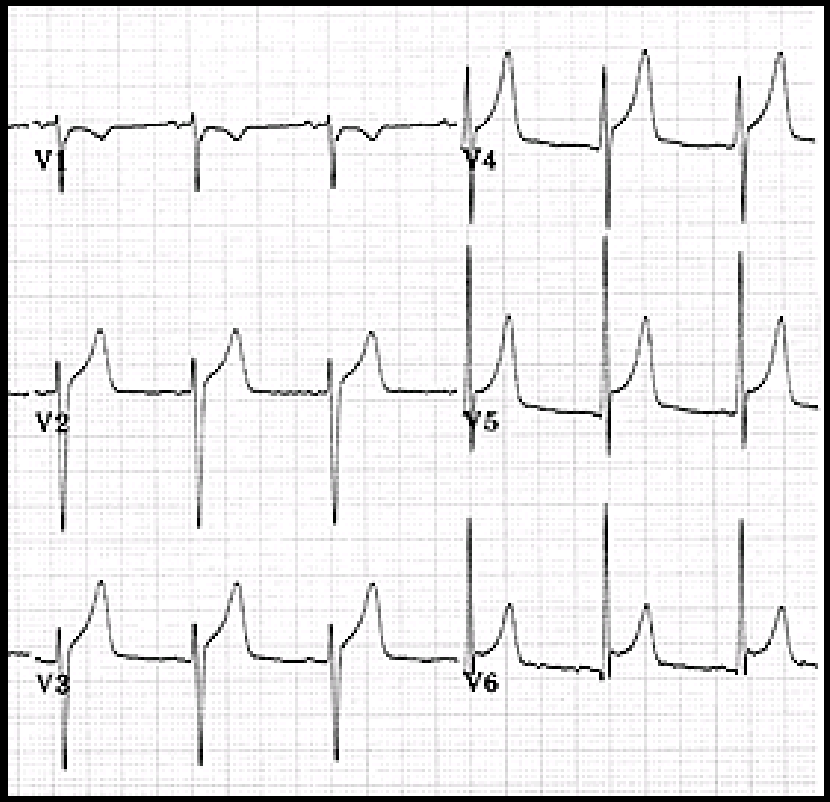
Paced Rhythm



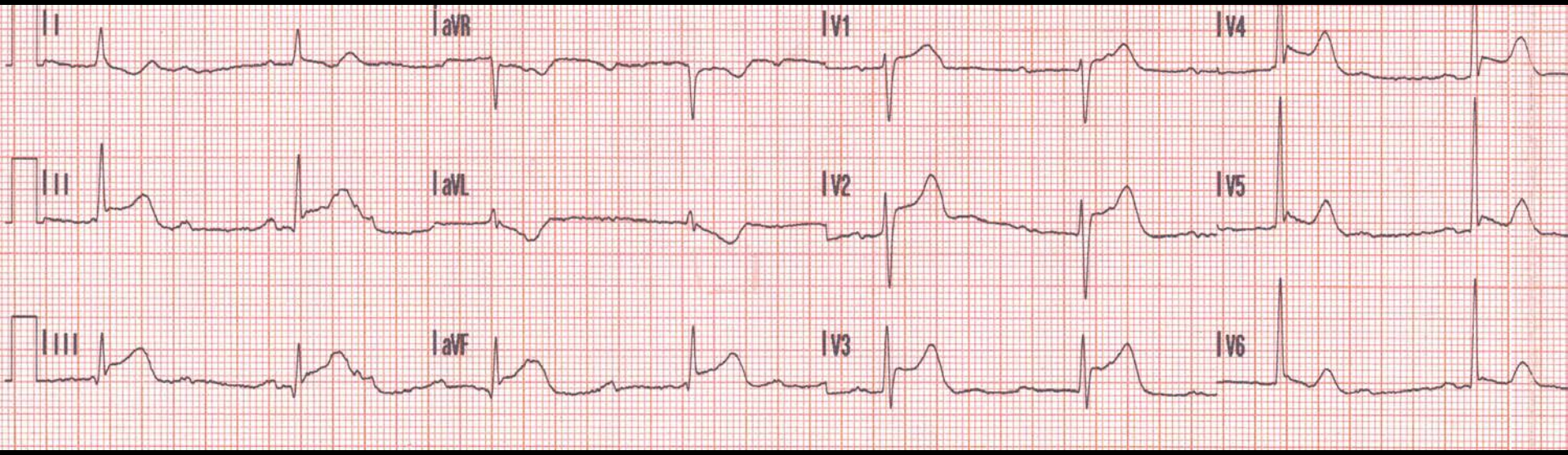
Ventricular Rhythm



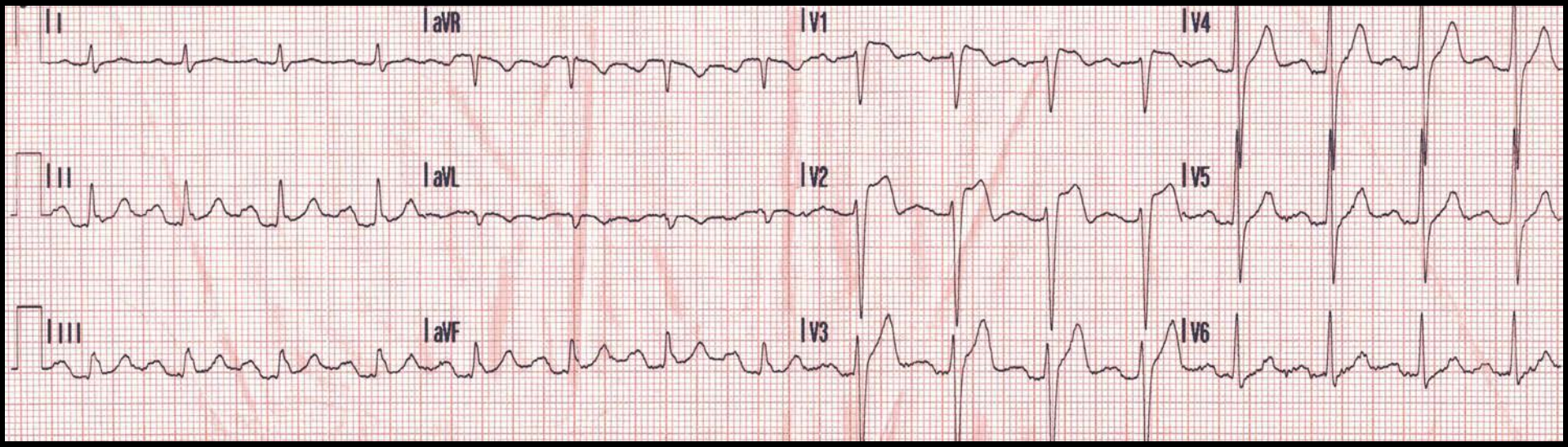
Early Repolarisation



Pericarditis



Ventricular Aneurysm



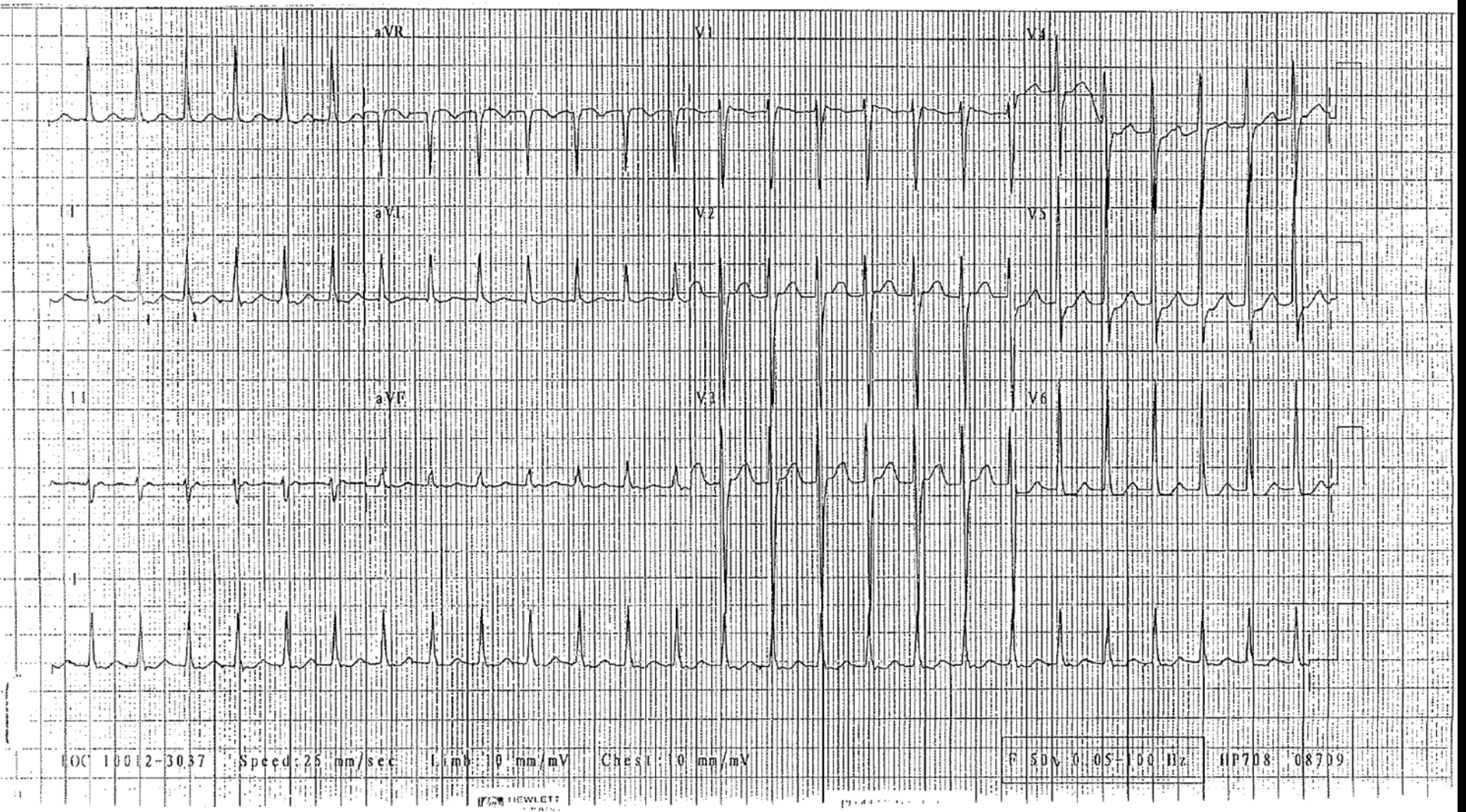
Summary

There are a number of ECGs that can mimic ST Elevation as seen in an AMI. This shows that it is important to evaluate the clinical signs and symptoms first, then follow up with confirmation from the ECG

Case Scenarios

CASE 1

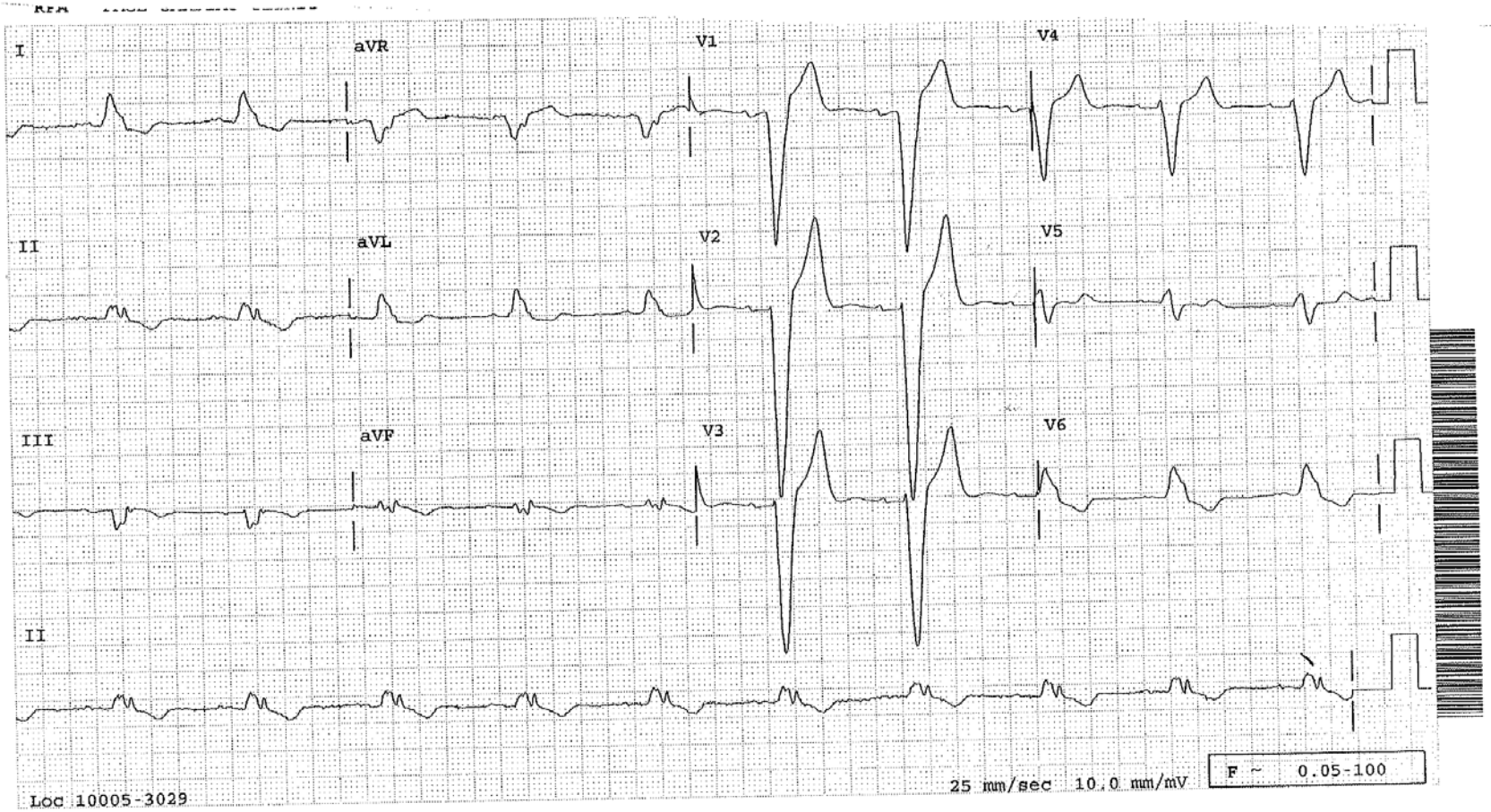
- 28 year old woman
- Recurrent rapid palpitations lasting 5-20 minutes
- ECG done in surgery at time of palpitations


aVR
V1
V4
I
aVL
V2
V5
II
aVF
V3
V6
III
50 mm/sec 1.05-100 Hz
HP708 08709

CASE 2

- 69 yo man
- Past Hx Hypertension 10 years
- Routine ECG done prior to TKR

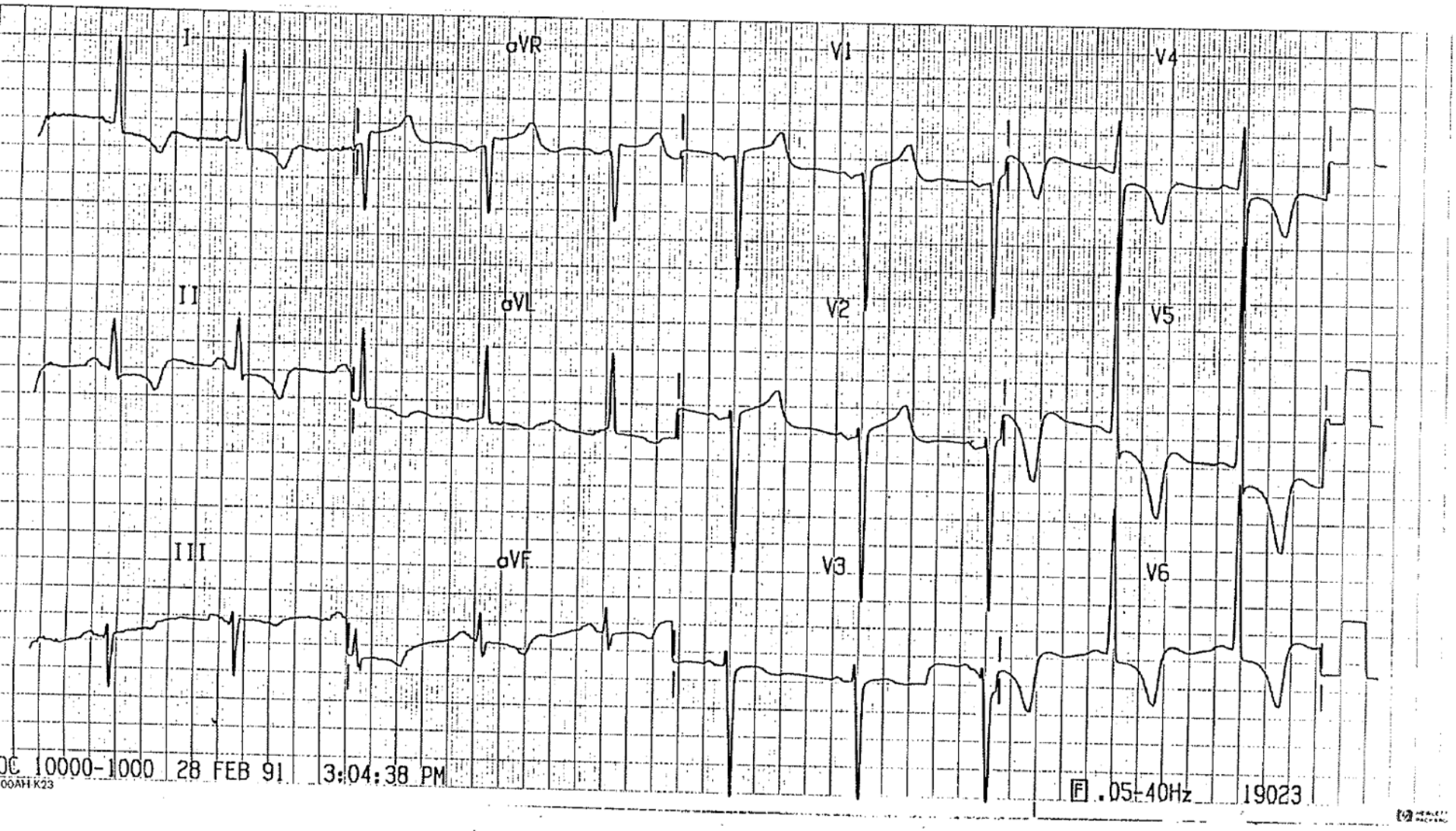
4


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Loc 10005-3029
25 mm/sec 10.0 mm/mV
F ~ 0.05-100

CASE 3

- 19 yo man
- Syncopal episode playing football
- ECG done at review

ECG D

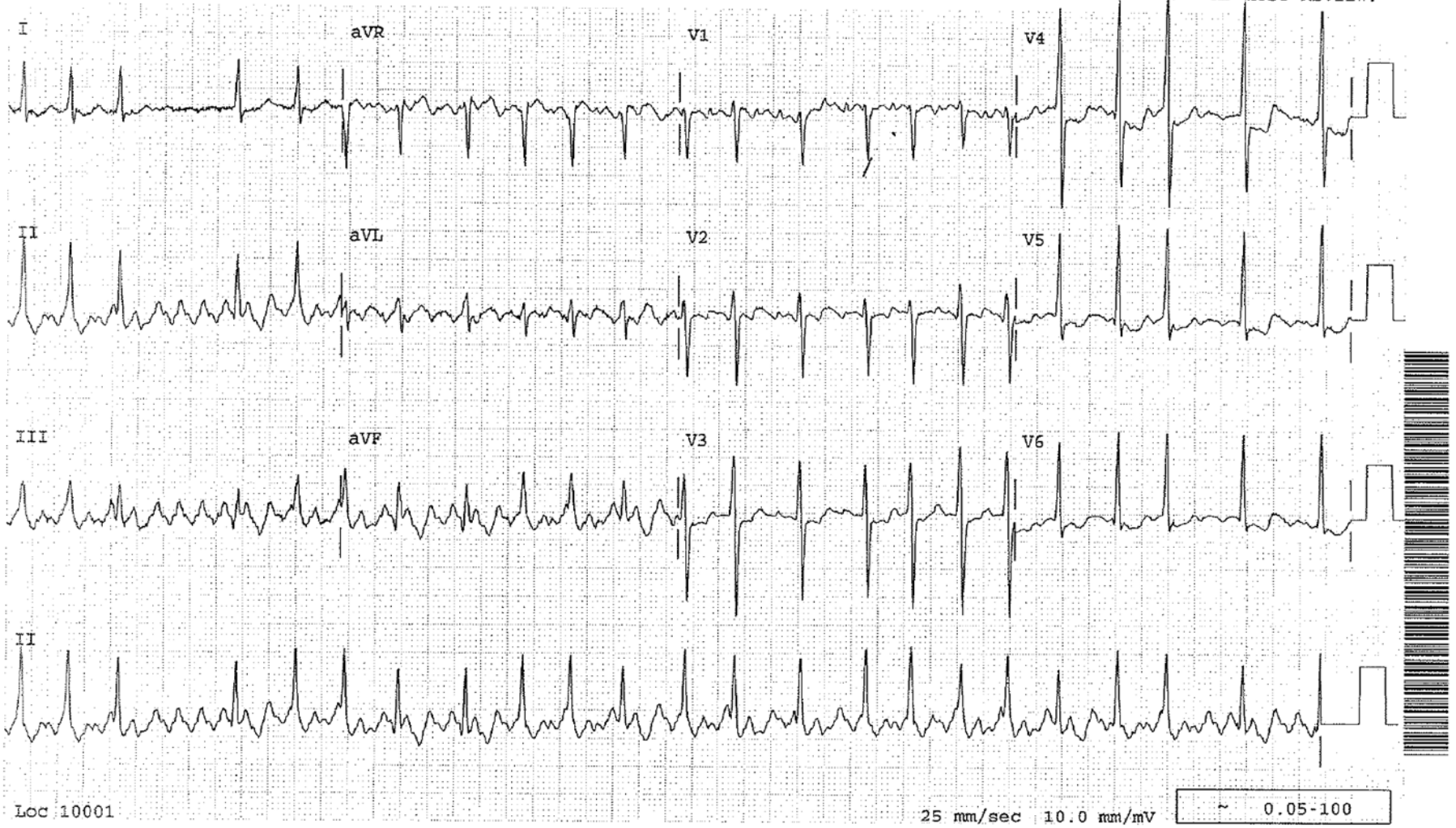

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
10000-1000 28 FEB 91 3:04:38 PM
.05-40Hz
19023

CASE 4

- 65 yo man
- PH aortic valve replacement, complaining of palpitations
- ECG done in surgery

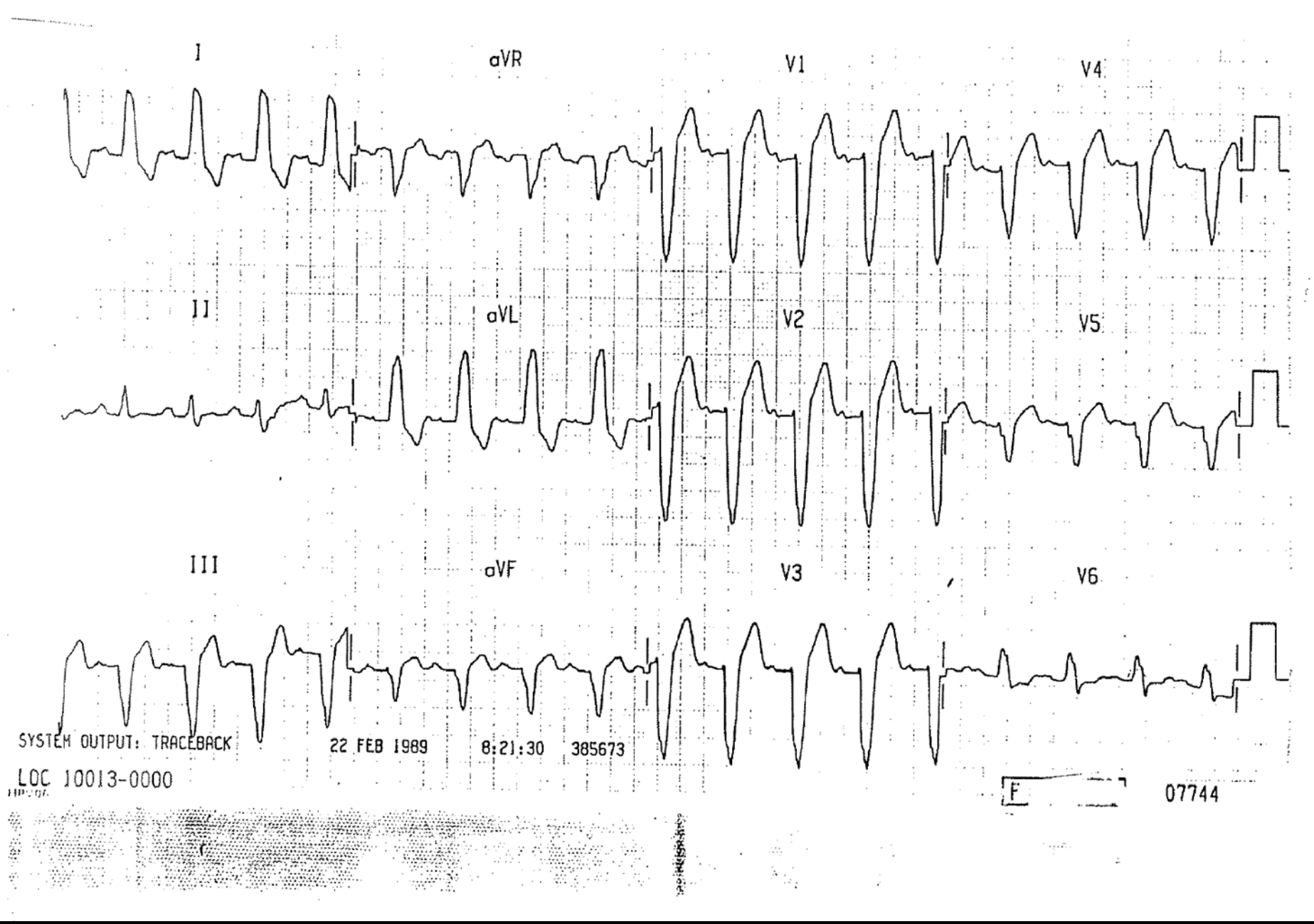
RPA - EMERGENCY DEPARTMENT

PRELIMINARY - MD MUST REVIEW.



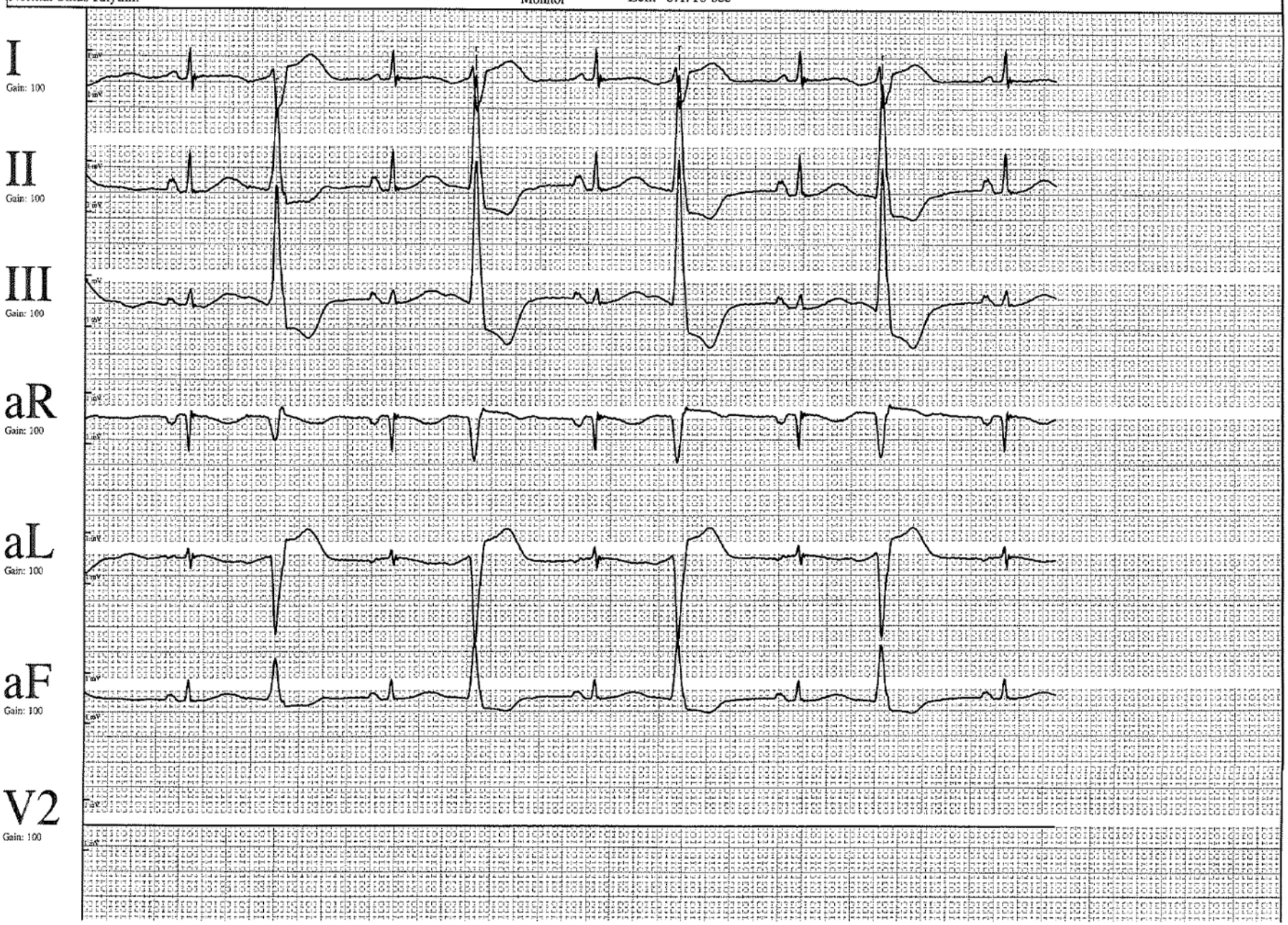
CASE 5

- 80 yo lady
- Presented because of sudden syncopal episode yesterday lasting seconds
- Previously well and now fully recovered
- ECG done in surgery


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
SYSTEM OUTPUT: TRACEBACK
22 FEB 1989
8:21:30
385673
LOC 10013-0000
F
07744

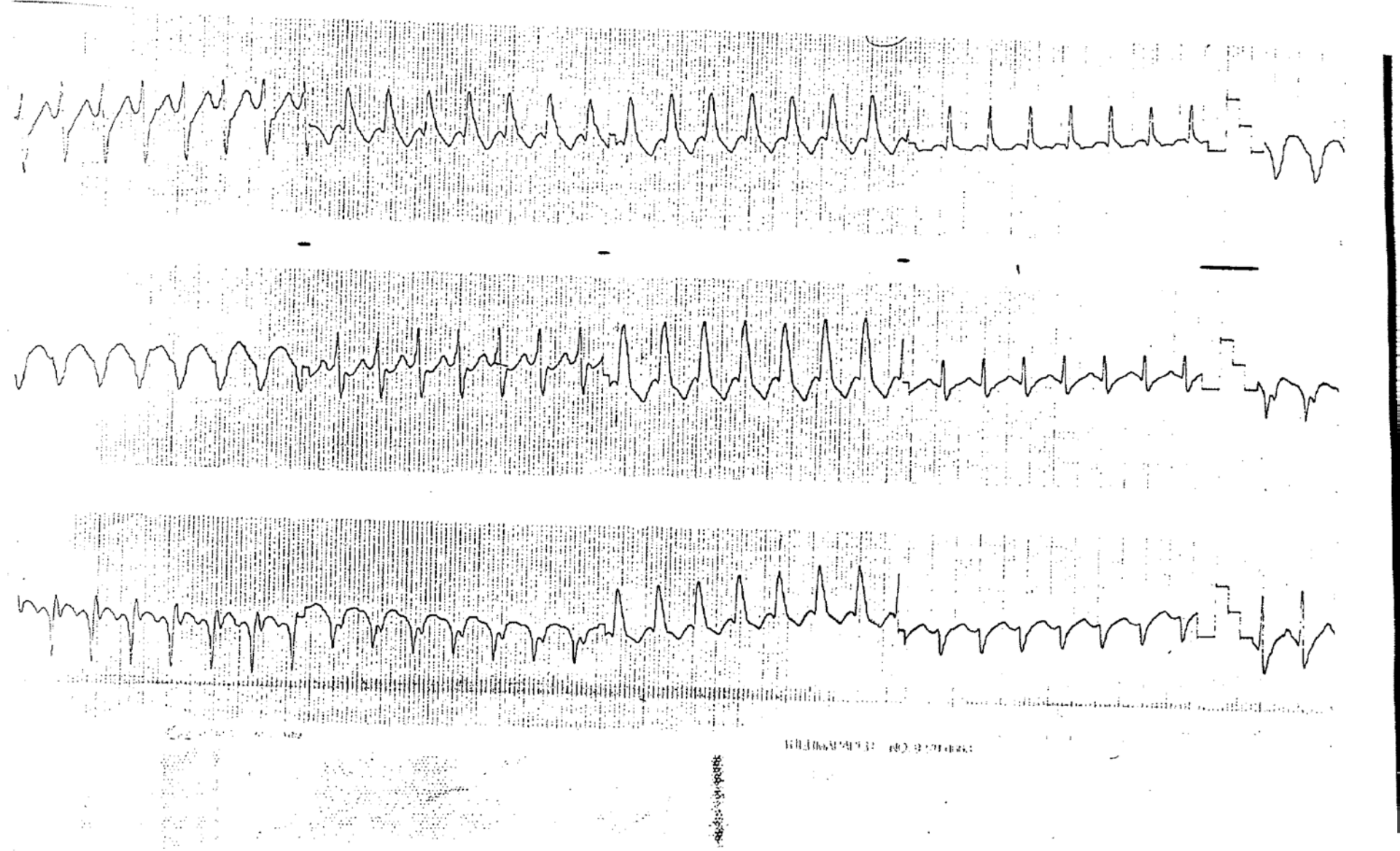
CASE 6

- 54 yo man
- Recently noted thumps in chest
- PH hypertension
- Examination PR 40, BP 150/90
- ECG done by pathology at time of palpitations


I
Gain: 100
II
Gain: 100
III
Gain: 100
aR
Gain: 100
aL
Gain: 100
aF
Gain: 100
V2
Gain: 100

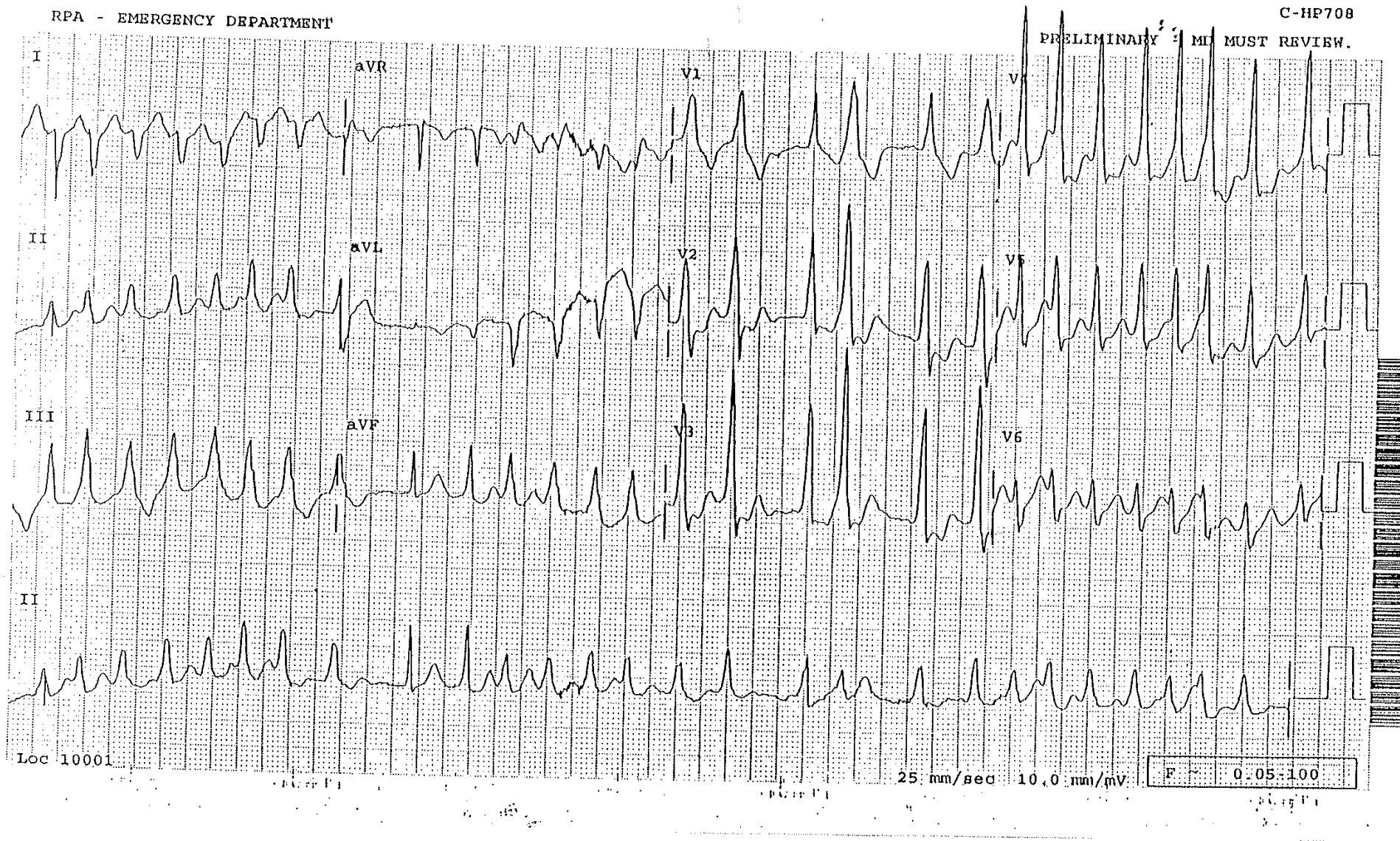
CASE 7

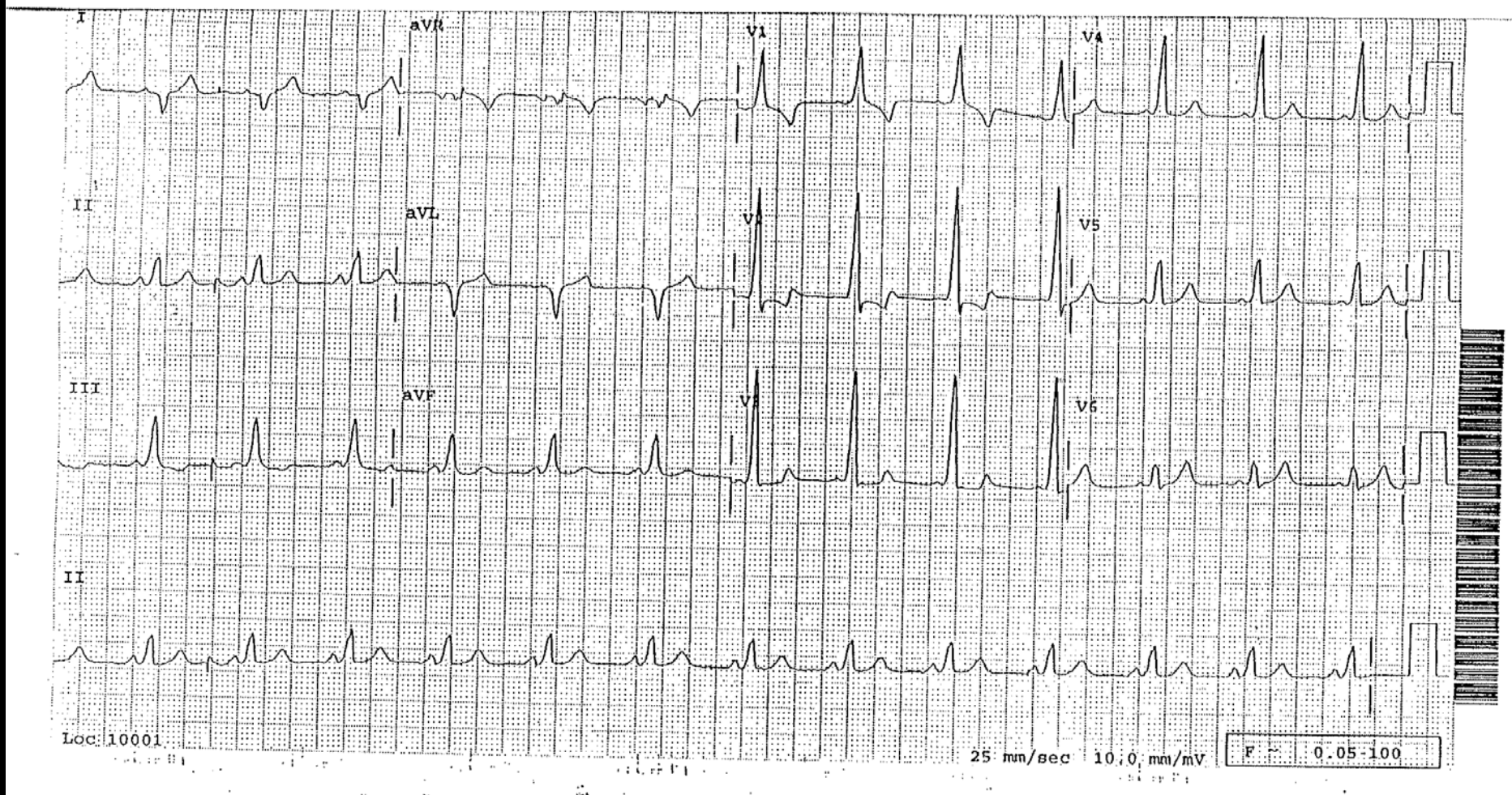
- 56 yo man
- Recent large inferior infarct
- Presents with dizziness, sweatiness and palpitations
- Examination: PR 176, BP 80/50 – looks well



CASE 8

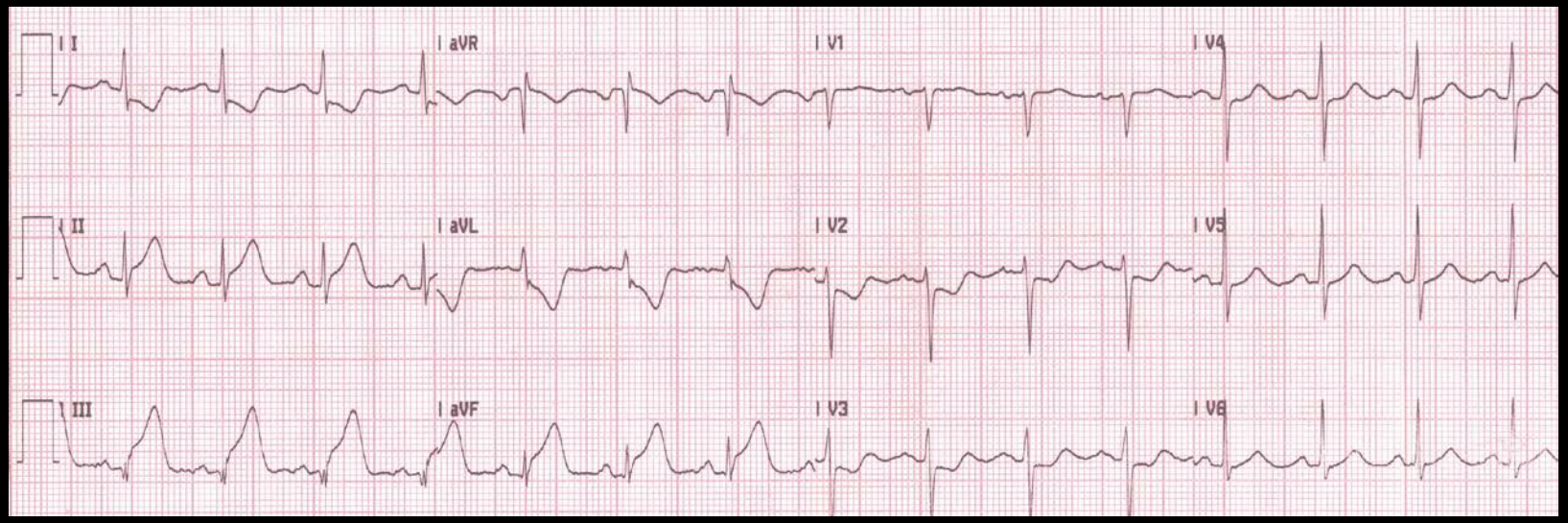
- 17yo boy presents with palpitations and lightheadedness
- Previously well with no prior cardiac history
- HR ~180 irregular BP 100/60
- Reverts in A&E
- Examination normal


RPA - EMERGENCY DEPARTMENT
C-HP708
PRELIMINARY - MD MUST REVIEW.
I
aVR
V1
II
aVL
V2
V5
III
aVF
V3
V6
II
Loc 10001
25 mm/sec 10.0 mm/mV
F - 0.05-100


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Loc 10001
25 mm/sec
10,0 mm/mV
F ~ 0.05-100

CASE 9

Heart Rate - 91 bpm / PR - 0.168s / QRS - 0.080s



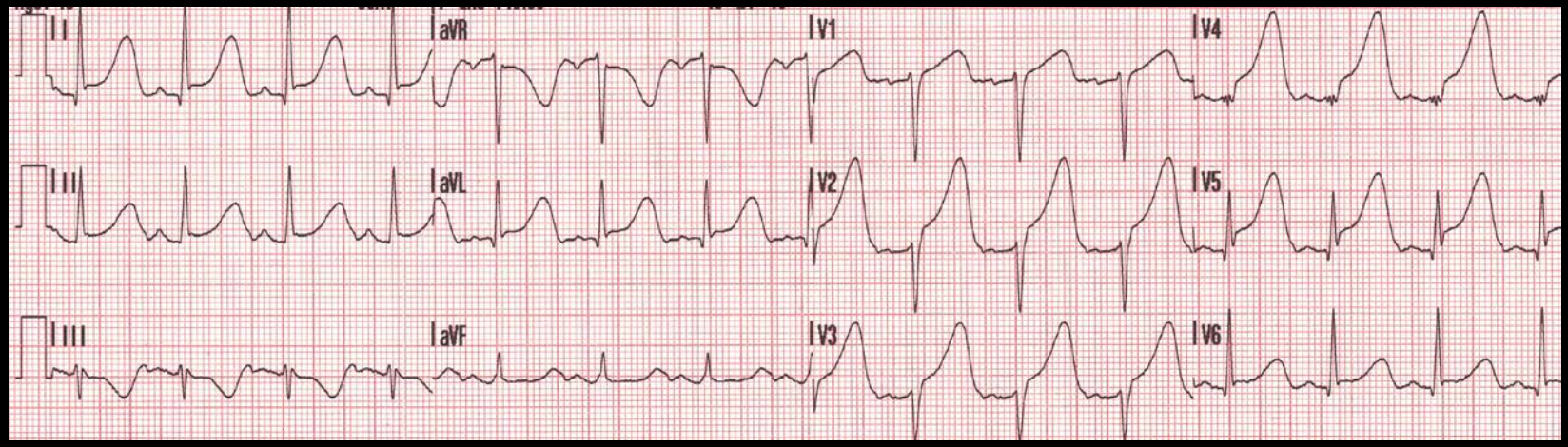
47 year old diabetic lady has had pain in her back, shoulders and right arm for the last 45mins. She has taken analgesia without any relief. She is cold and clammy to touch.

On examination, her blood glucose is 15.7mmols.

BP 135/67.

CASE 10

Heart Rate - 87 bpm / PR - 0.166s / QRS - 0.104s



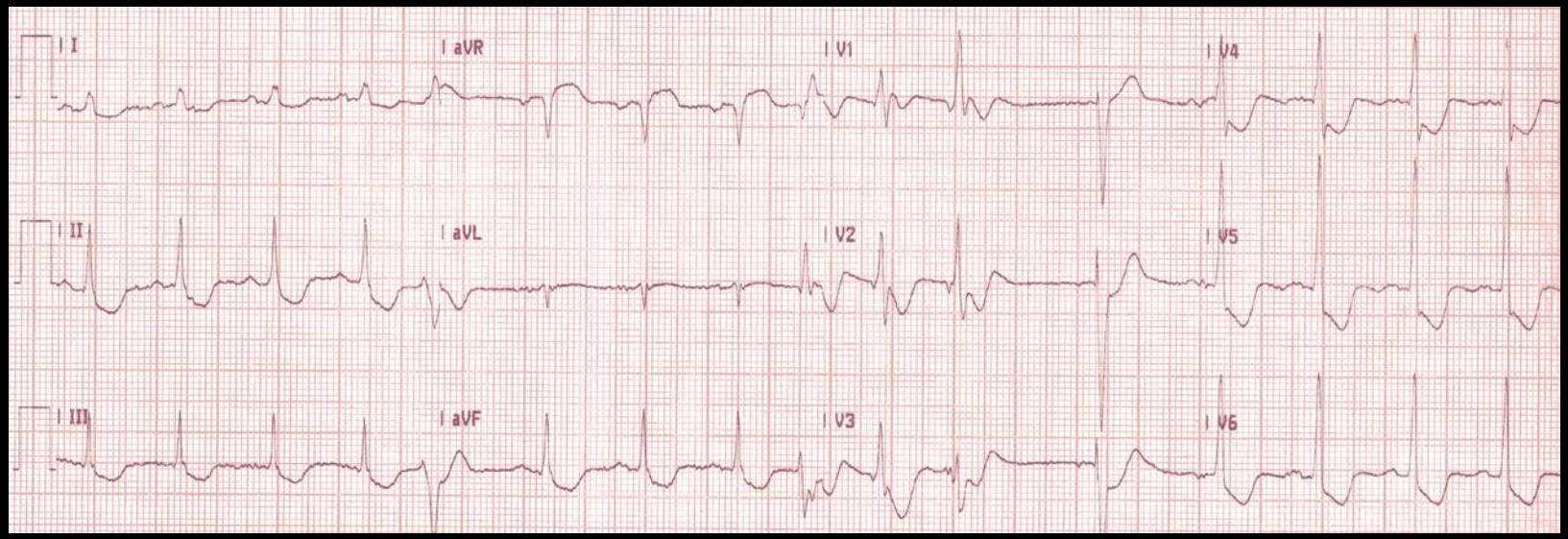
59 year old man has had chest / epigastric pain for 45 mins, associated with vomiting and sweating.

He has no history.

BP 157/80

CASE 11

Heart Rate - 97 bpm / PR - 0.180s / QRS - 0.096s



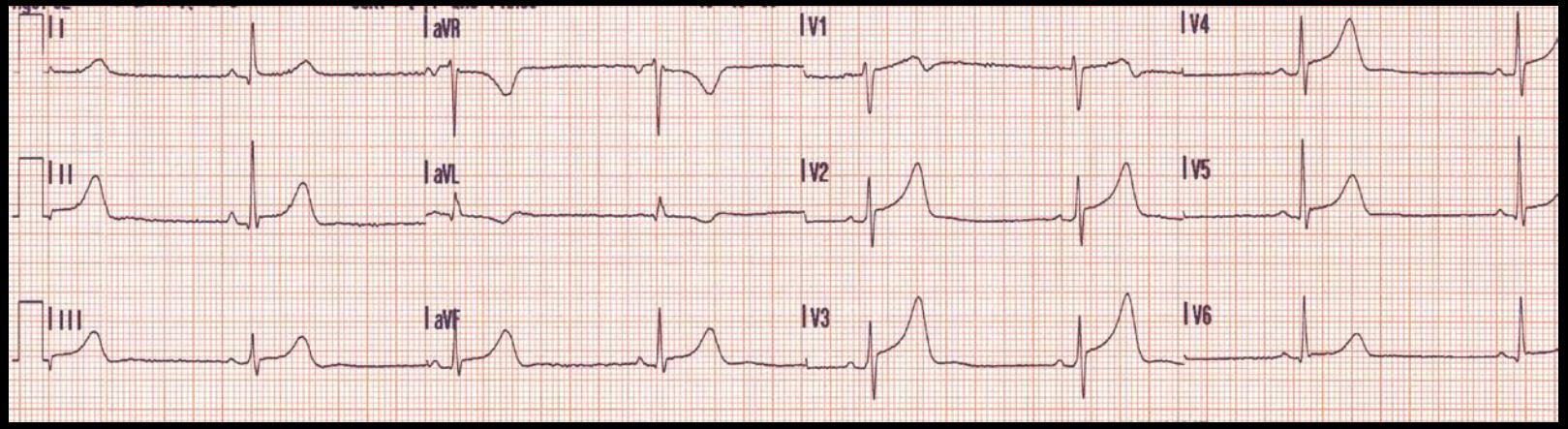
58 year old gentleman has had severe central chest pain for approximately 60 minutes.

He is cold, clammy and nauseous.

BP 135/45

CASE 12

Heart Rate - 42 bpm / PR - 0.128s / QRS - 0.088s



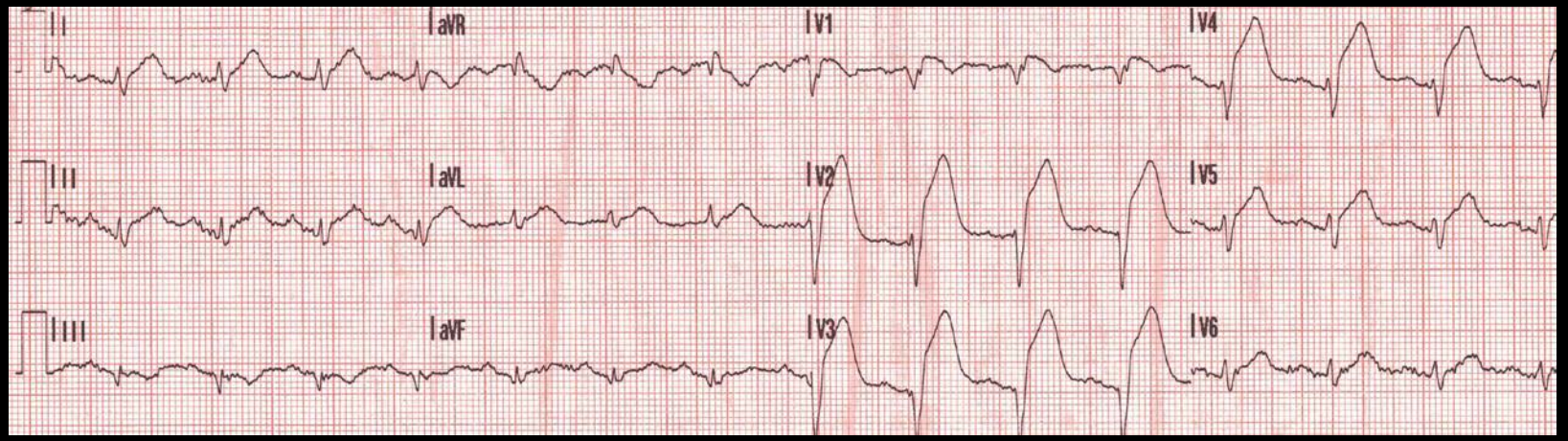
54 year old lady has had intermittent chest pain for the last few days. Today the pain has gradually become more severe over the last 2 hours. She has also become increasingly breathless.

She has no previous medical history.

BP 142/54

CASE 13

Heart Rate - 89 bpm / PR - 0.182s / QRS - 0.114s

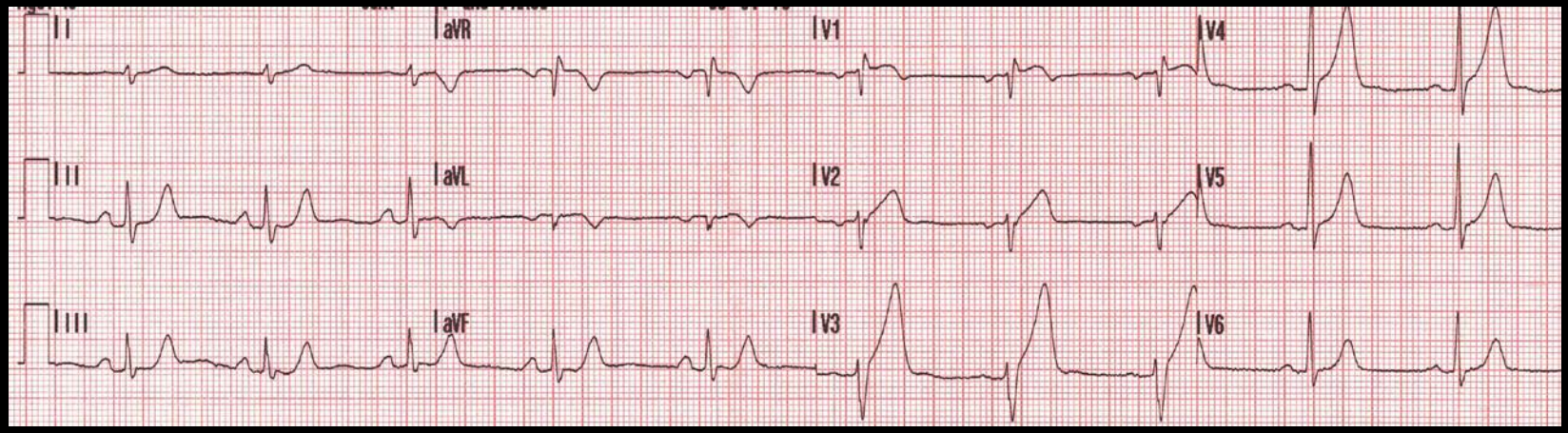


76 year old gentleman has had severe central chest pain for the last 40 minutes. He is grey, clammy and nauseous.

He has a history of an aortic valve replacement and takes Warfarin. BP 156/56

CASE 14

Heart Rate - 61 bpm / PR - 0.168s / QRS - 0.096s



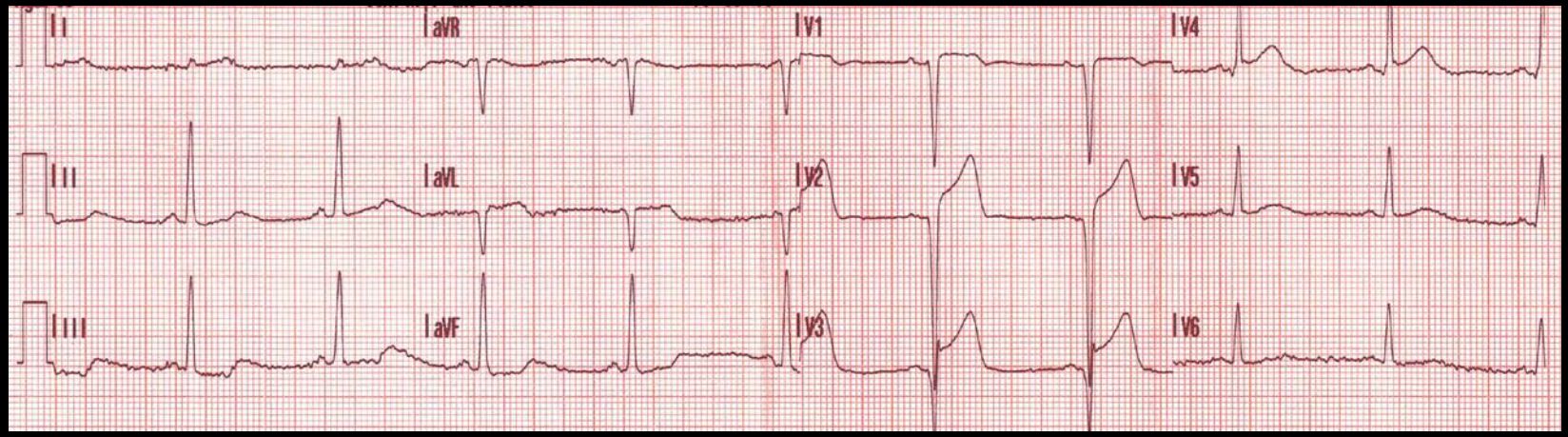
34 year old man has been complaining of chest pain which radiates to his left arm / shoulder for the past hour.

He feels breathless on minimal exertion. He is clammy to touch.

BP 159/67

CASE 15

Heart Rate - 59 bpm / PR - 0.142s / QRS - 0.094s



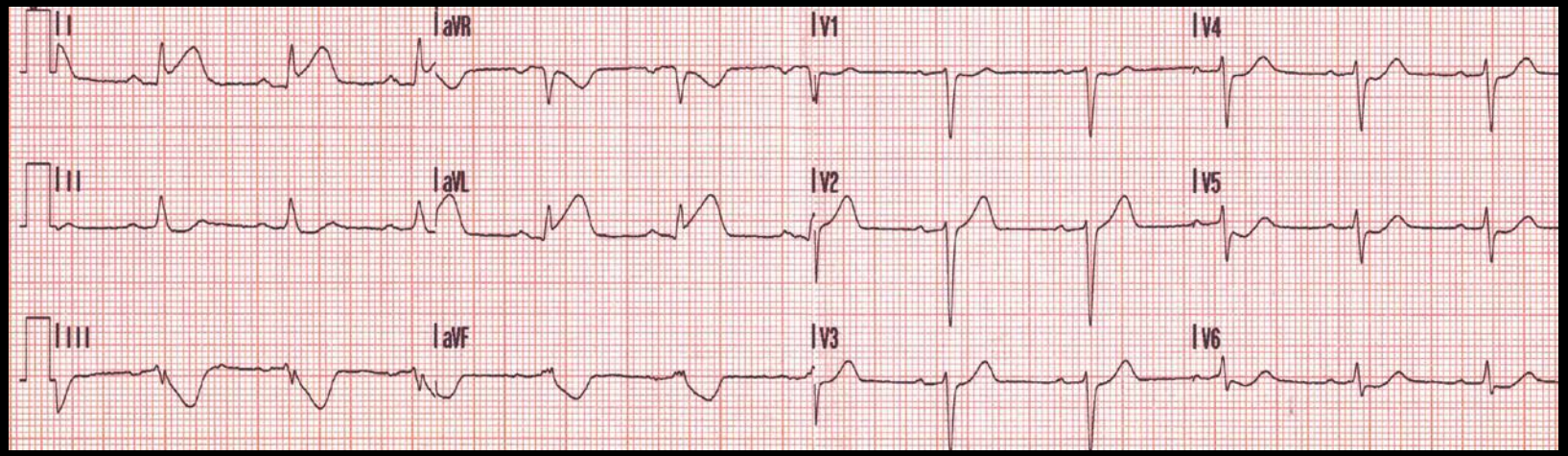
32 year old lady has had severe central chest pain for the last hour. She is pale, cold and clammy. She has vomited twice

There is a strong family history of CHD.

She is unsure of her LMP BP 135/56

CASE 16

Heart Rate - 68 bpm / PR - 0.178s / QRS - 0.098s

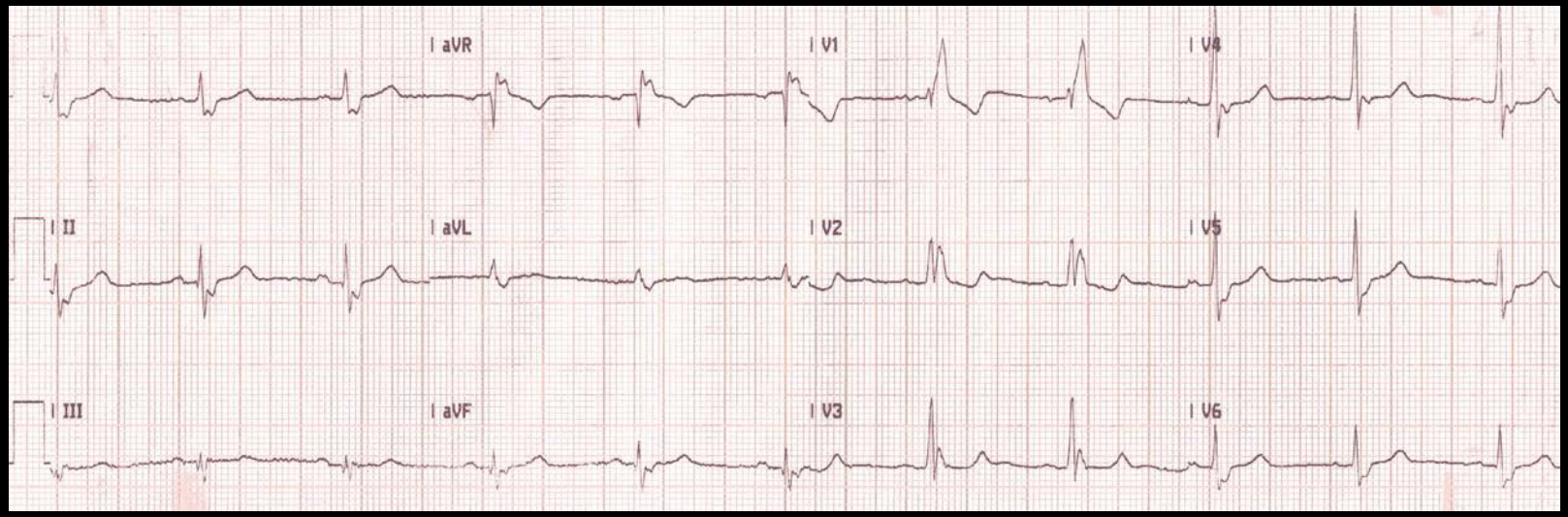


46 year old man was found collapsed at work. He had been complaining of indigestion throughout the morning. Over the past 30 minutes he has developed pins & needles down his left arm. He has also become pale and clammy. He is normally fit and well, with no relevant medical history.

BP 121/45

CASE 17

Heart Rate - 63 bpm / PR - 0.172s / QRS - 0.152s



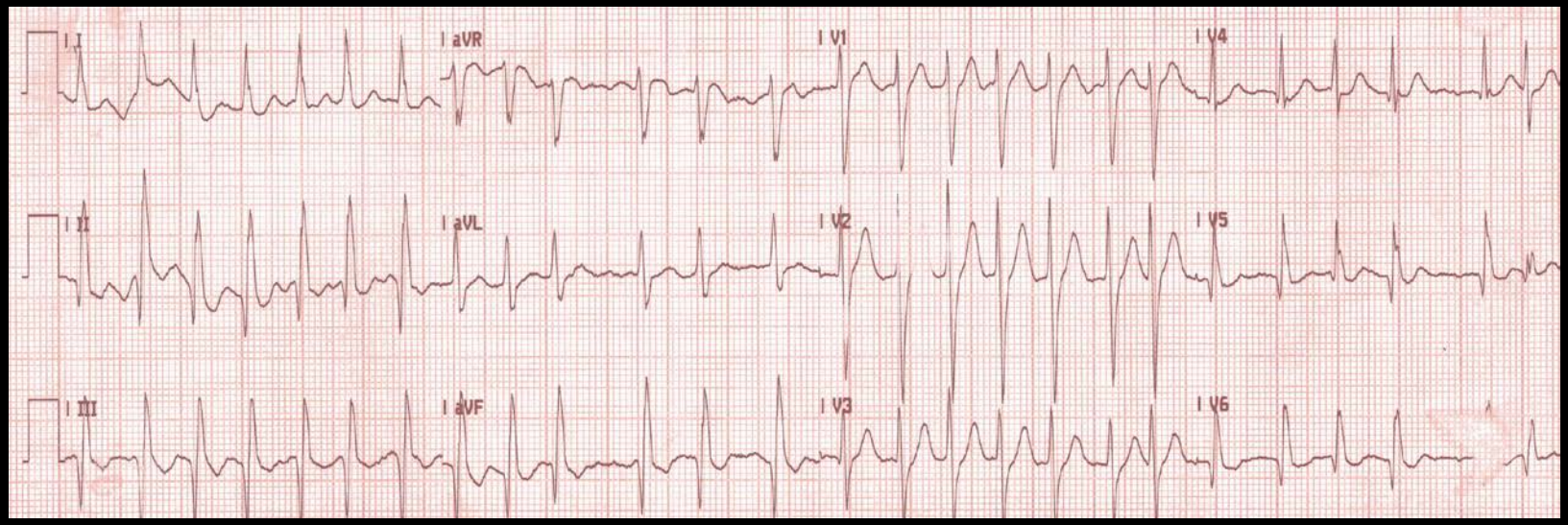
28 year old lady has had intermittent chest pain throughout the day - worse on movement / exertion.

She has a history of asthma.

BP 135/65

CASE 18

Heart Rate - 155 bpm / PR - 0.s / QRS - 0.100s

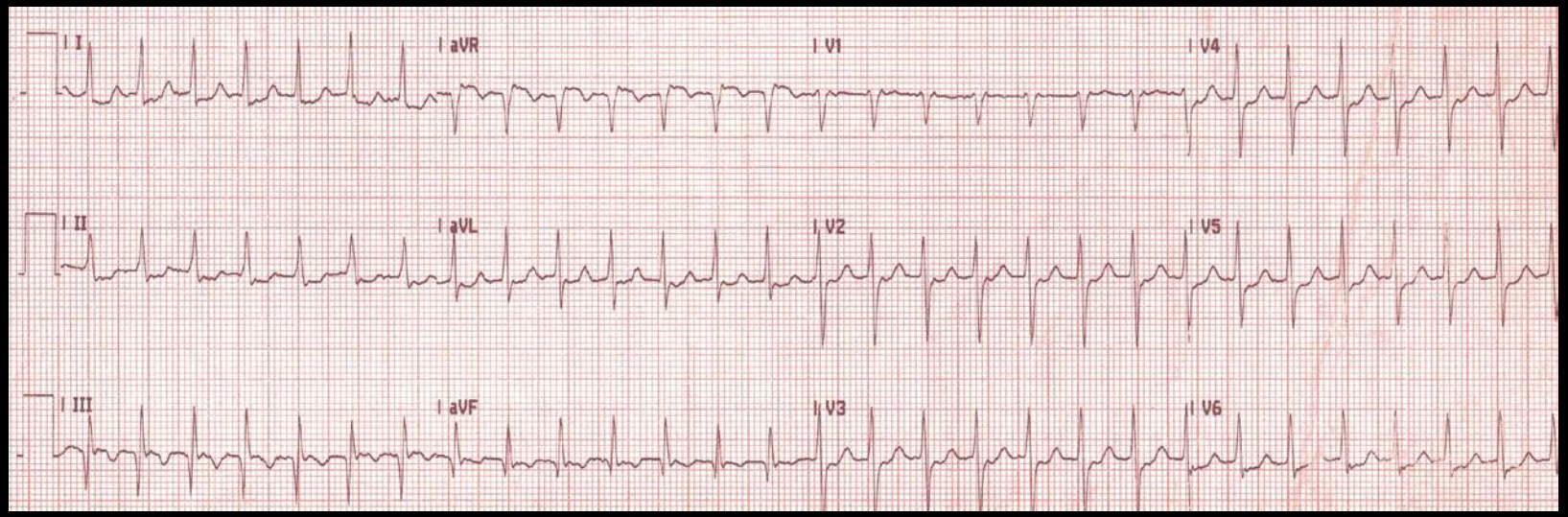


64 year old lady has developed a sudden onset of central chest pain associated with palpitations, sweating and breathlessness.

She has a history of CHD. BP 196/110

CASE 19

Heart Rate - 172 bpm / PR - 0.0s / QRS - 0.100s



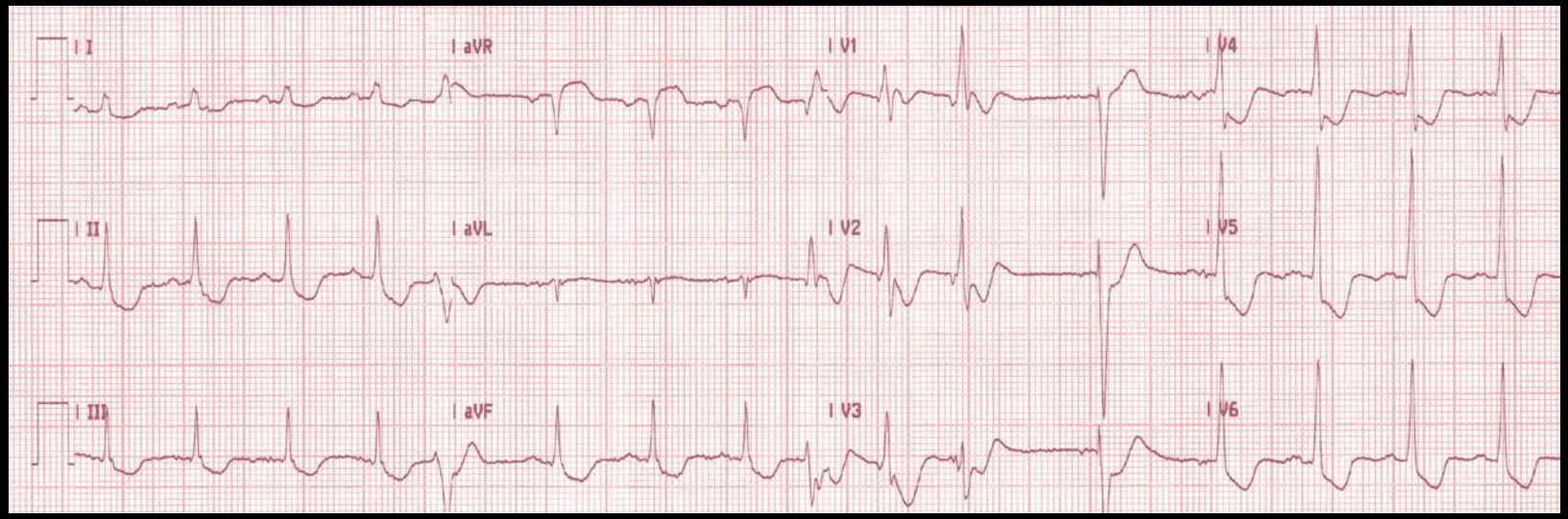
23 year old female feeling dizzy and unwell especially on standing. She is pale, her BM is 10 .4

Normally fit and well with no past medical history

BP 100/50

CASE 20

Heart Rate - 97 bpm / PR - 0.180s / QRS - 0.96s

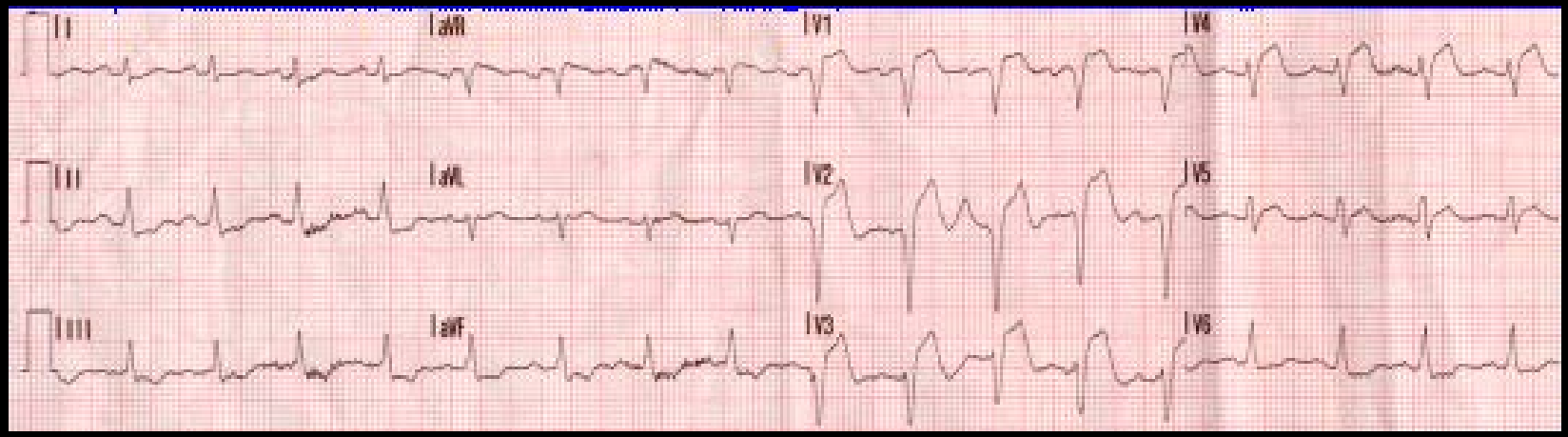


68 year old female has had severe central chest pain for approximately 4 hours not relieved with her GTN.

She is cold, clammy and nauseous. BP 185/95

CASE 21

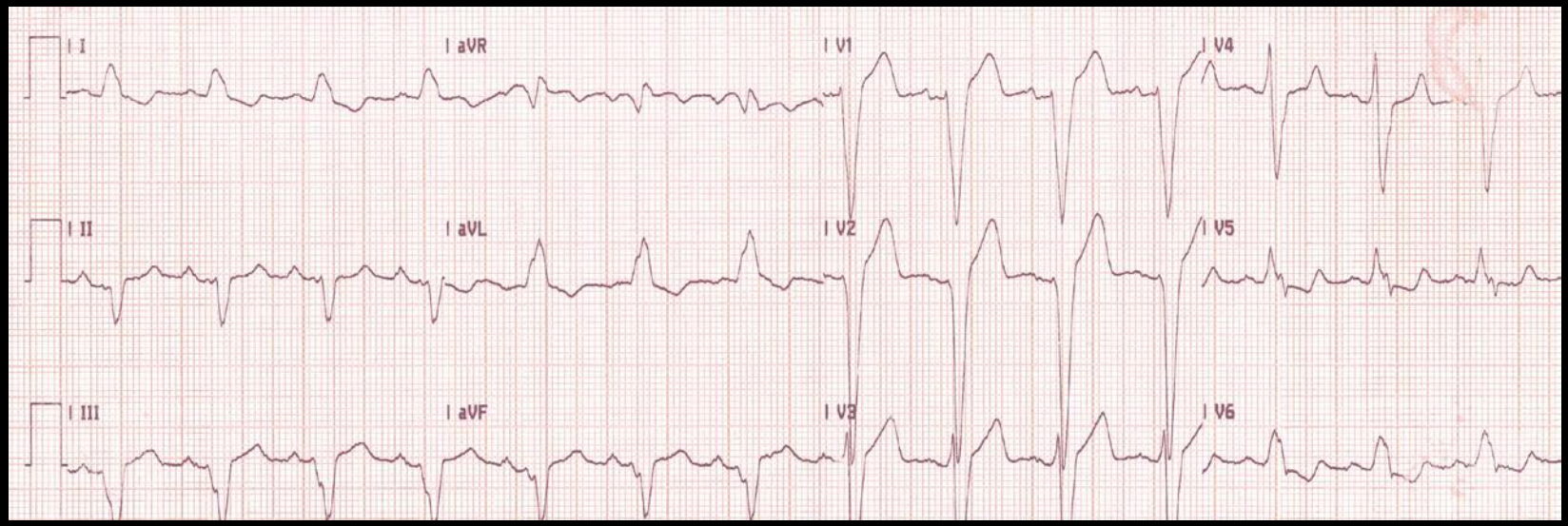
Heart Rate - 104 bpm / PR - 0.182s / QRS - 0.108s



This 58 year old gentleman called for an ambulance after experiencing a gradual onset of severe chest pain, which has now lasted approximately 2hrs. He has a history of asthma which is usually well controlled. On examination, he is cold, sweating profusely and has vomited. BP 146/89

CASE 22

Heart Rate - 85 bpm / PR - 0.152s / QRS - 0.172s

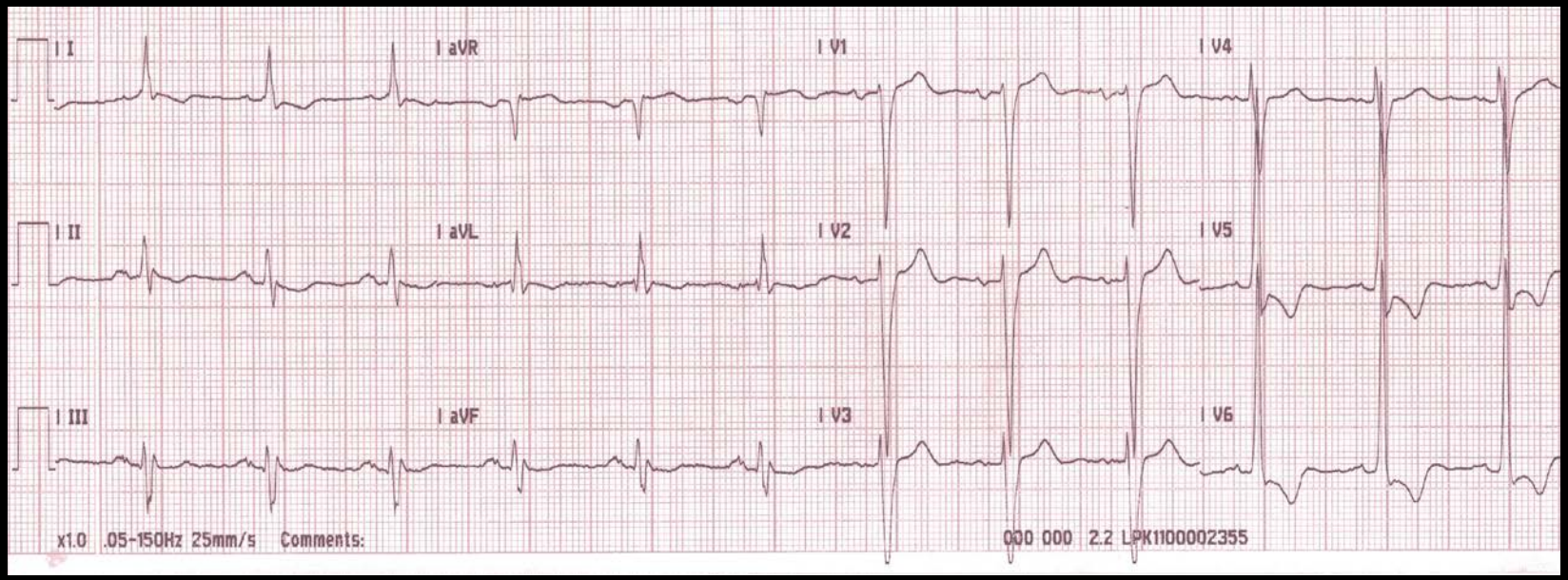


This 58 year old lady has had severe central chest pain for the last 50 minutes. She has vomited and is sweating.

She has no previous medical history. BP 179/76

CASE 23

Heart Rate - 74 bpm / PR - 0.180s / QRS - 0.124s



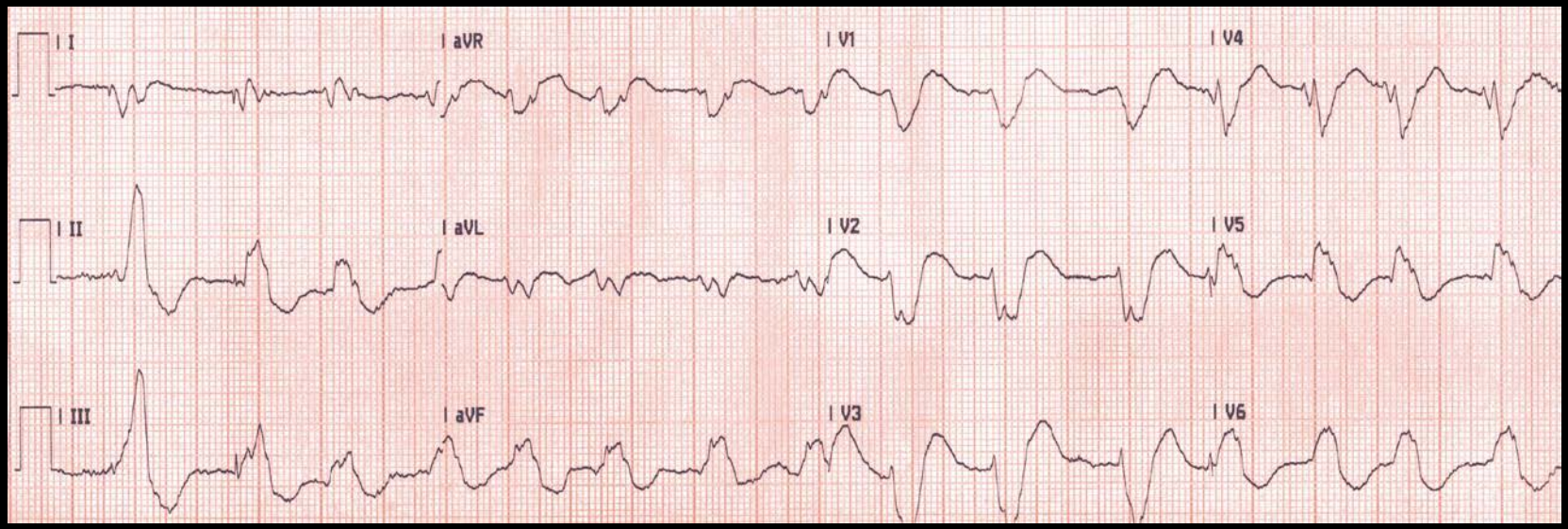
57 year old gentleman has had chest discomfort for the last hour, associated with breathlessness.

He has a long history of uncontrolled hypertension.

BP 197/110

CASE 24

Heart Rate - 95 bpm / PR - 0.0s / QRS - 0.252s



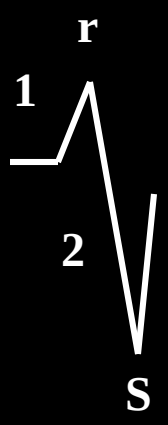
56 year old diabetic gentleman has had some left arm / neck pain for the last 45 minutes.

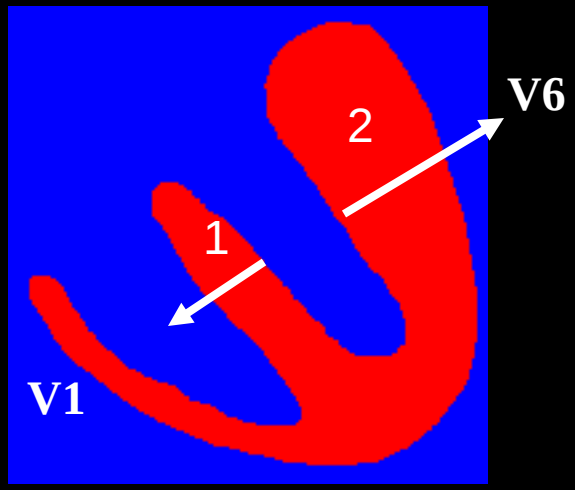
He is grey in colour, and is peripherally cyanosed. He is sweating profusely.

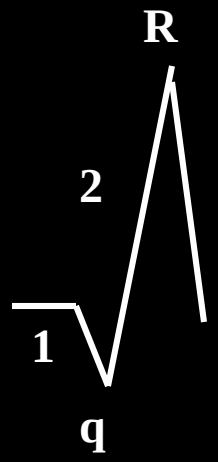
BP 149/54

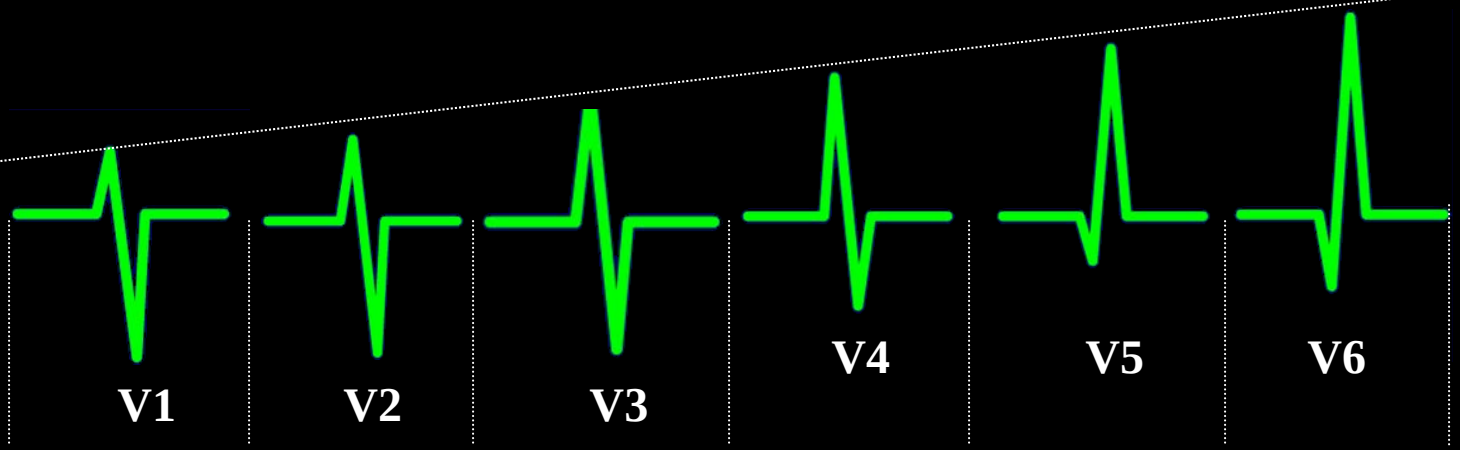
Thank You

R Wave Progression





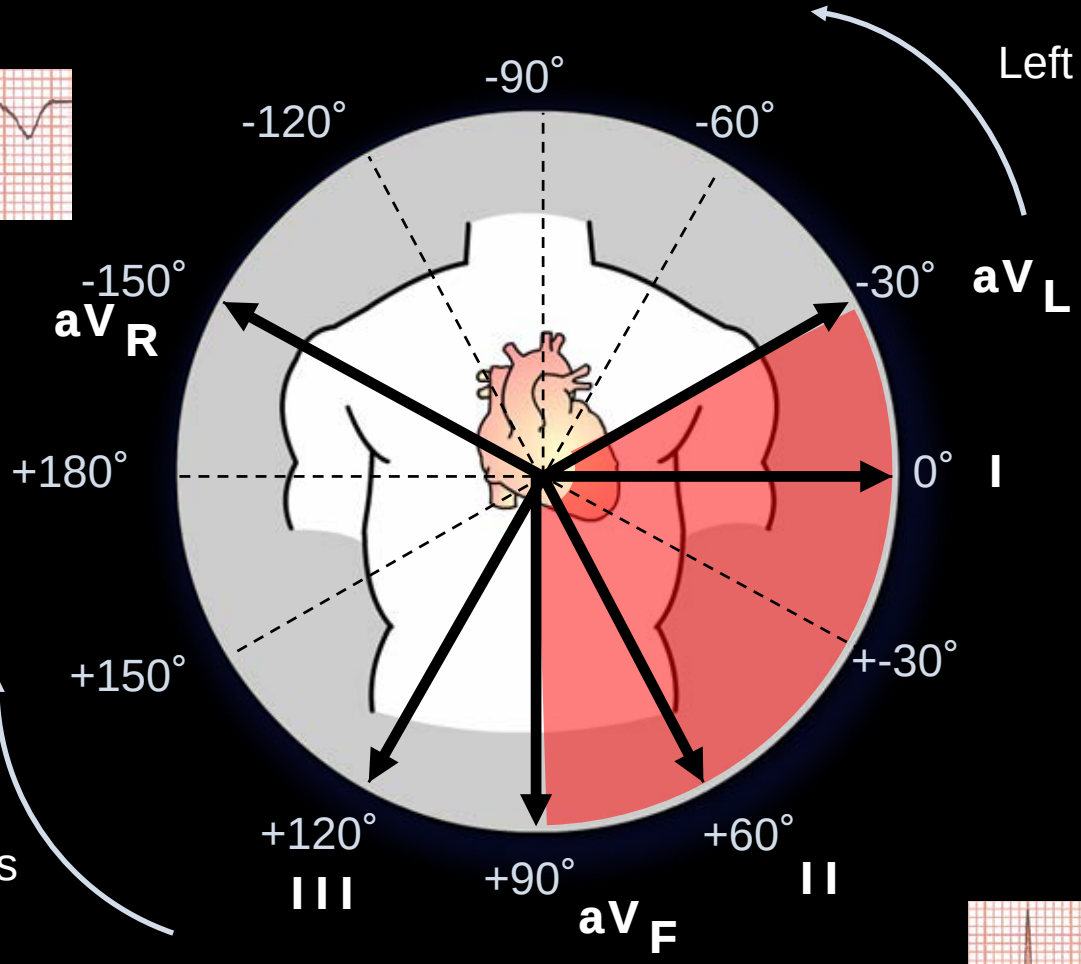




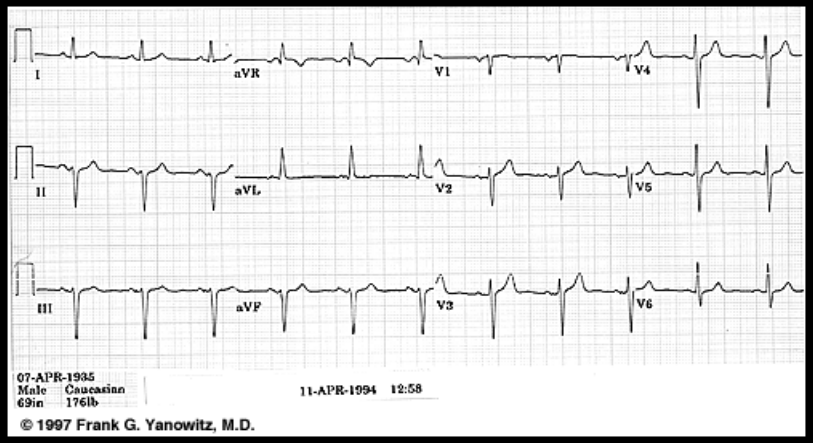
Left Anterior Fascicular Block (LAFB)... the most common intraventricular conduction defect

- Left axis deviation in frontal plane, usually -45 to -90 degrees
- rS complexes in leads II, III, aVF
- Small q-wave in leads I ***and/or*** **aVL**
- **R-peak time in lead aVL >0.04s, often with slurred R wave downstroke**
- **QRS duration usually <0.12s unless coexisting RBBB**
- **Usually see poor R progression in leads V1-V3 and deeper S waves in leads V5 and V6**
- **May *mimic* LVH voltage in lead aVL, and *mask* LVH voltage in leads V5 and V6**

Limb leads


-90°
-120°
-60°
Left axis
-150°
aV R
-30°
aV L
+180°
0°
I
+150°
+-30°
Right axis
+120°
III
+90°
aV F
+60°
II

- In this ECG, note -75 degree QRS axis, rS complexes in II, III, aVF, tiny q-wave in aVL, poor R progression V1-3, and late S waves in leads V5-6. QRS duration is normal, and there is a slight slur to the R wave downstroke in lead aVL



Left Posterior Fascicular Block (LPFB).... Very rare intraventricular defect!

Right axis deviation in the frontal plane (usually > +100 degrees)

rS complex in lead I

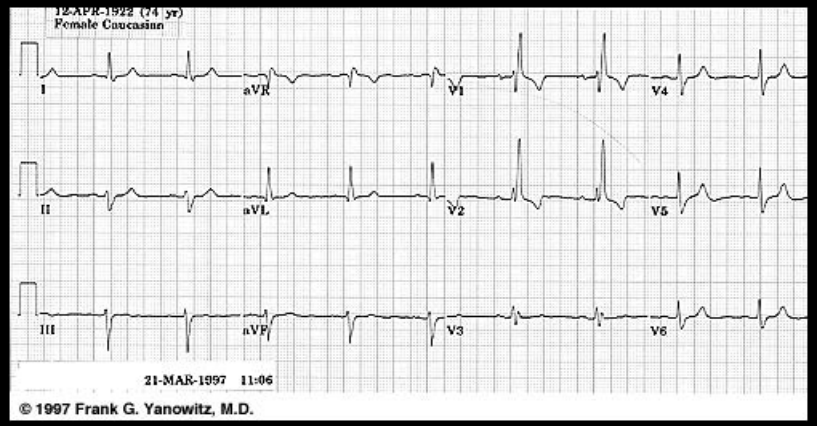
qR complexes in leads II, III, aVF, with R in lead III > R in lead II

QRS duration usually <0.12s unless coexisting RBBB

Must first exclude (on clinical grounds) other causes of right axis deviation such as cor pulmonale, pulmonary heart disease, pulmonary hypertension, etc., because these conditions can result in the identical ECG picture!

Bifascicular Blocks

- RBBB plus either LAFB (common) ***or***LPFB (uncommon)
- Features of RBBB plus frontal plane features of the fascicular block (axis deviation, etc.)
- The above ECG shows classic RBBB (note rSR' in V1) ***plus*** LAFB (note QRS axis = -45 degrees, rS in II, III, aVF; and small q in aVL).



Nonspecific Intraventricular Conduction Defects (IVCD)

- QRS duration
  >0.10s indicating slowed conduction in the ventricles
- Criteria for specific bundle branch or fascicular blocks not met
- Causes of nonspecific IVCD's include

1. Ventricular hypertrophy (especially LVH)
2. Myocardial infarction (so called ***periinfarction blocks***)
3. Drugs, especially class IA and IC antiarrhythmics (e.g., quinidine, flecainide)
4. Hyperkalemia

True posterior MI

- ECG changes are seen in anterior precordial leads V1-3, but are the mirror image of an anteroseptal MI

1. Increased R wave amplitude and duration (i.e., a "pathologic R wave" is a mirror image of a pathologic Q)
2. R/S ratio in V1 or V2 >1 (i.e., prominent anterior forces)
3. Hyperacute ST-T wave changes: i.e., ST depression and large, inverted T waves in V1-3
4. Late normalization of ST-T with symmetrical upright T waves in V1-3

- Acute inferoposterior MI (note tall R waves V1-3, marked ST depression V1-3, ST eleva