



**Basic EKG and Rhythm
Interpretation**

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Objectives:

1. Describe the basic conduction system within the heart
2. Learn basic rhythm strip analysis
3. Learn basic EKG morphology
4. Be able to recognize normal and abnormal rhythms and EKGs

Course Outline

- Part 1
 - Basic ECG and Arrhythmias
- Part 2
 - “Heart block” and Pacemakers
- Part 3
 - Ischemia, Injury and Infarct

Conduction System of the Heart

- Sinoatrial node (SA node): a small group of cells that function as the natural pacemaker of the heart (at 60-100 bpm)
- Atrioventricular node (AV node): a small group of cells that:
 - Slows the conduction impulse from atria to ventricles to allow for ventricular filling
 - Functions as the backup pacemaker if SA node fails (40-60 bpm)
 - Screens rapid atrial impulses to protect the ventricles from dangerously fast rates

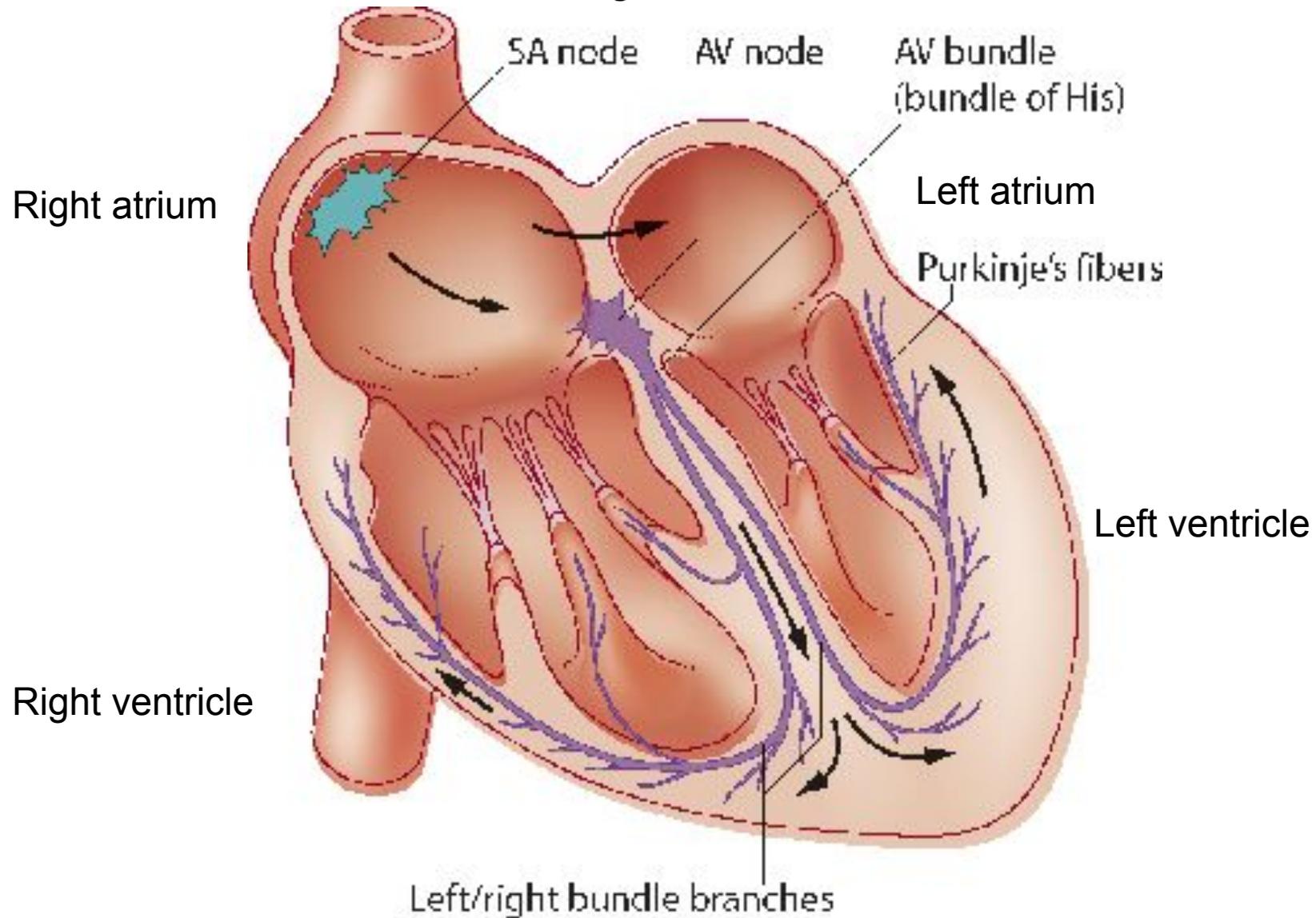
Conduction System of the Heart

- Bundle of His: short bundle of nerve fibers at the bottom of the AV node, leading to the bundle branches
- Bundle branches: bundles of nerve fibers located along the septum that carry the impulse into the right and left ventricles
 - Right bundle branch: travels along the right side of the septum and carries impulse to the RV
 - Left bundle branch: travels along the left side of the septum and carries impulse to the LV
- Purkinje Fibers: hair-like fibers that spread across endocardial surface of both ventricles and rapidly carry impulse to the ventricular muscle cells

Conduction System of the Heart

1. Impulse originates in SA node and spreads through both atria simultaneously
2. Impulse is delayed in AV node so atria have time to contract and contribute to ventricular filling before ventricles contract
3. Impulse travels through Bundle of His, down both bundle branches into the ventricles and through the Purkinje fibers to the ventricular myocardium

Conduction System of the Heart



What am I looking for?

- 1. What is the rate? (fast, slow or normal)
- 2. What is the rhythm? (regular or irregular)
- 3. Is there a P wave before every QRS complex? (is it sinus rhythm or not)
- 4. Is the QRS complex wide or narrow?

Rhythm Strips

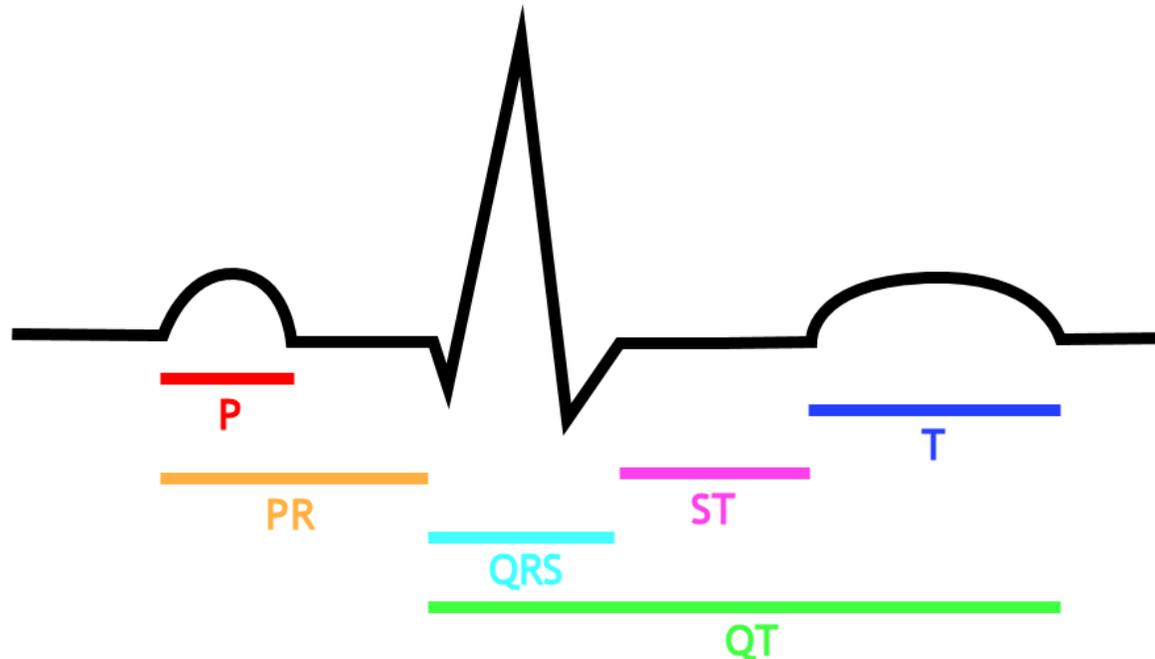
- Focus only on the rate and rhythm
- Evaluate each strip for:
 - Heart rate
 - Rhythm: regular/irregular
 - Location and morphology of P waves
 - QRS status
- *Cannot diagnose acute MI on rhythm strip!



EKG (electrocardiogram)

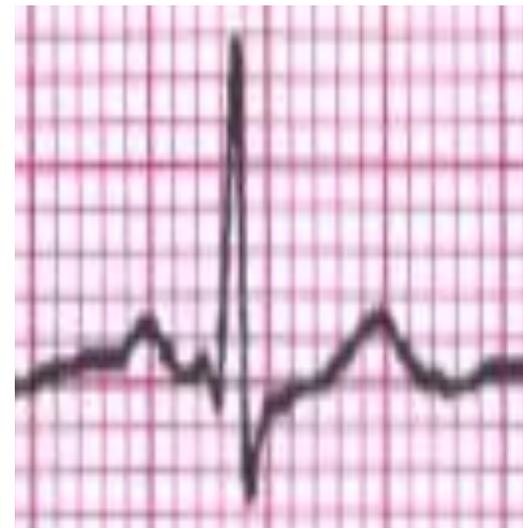
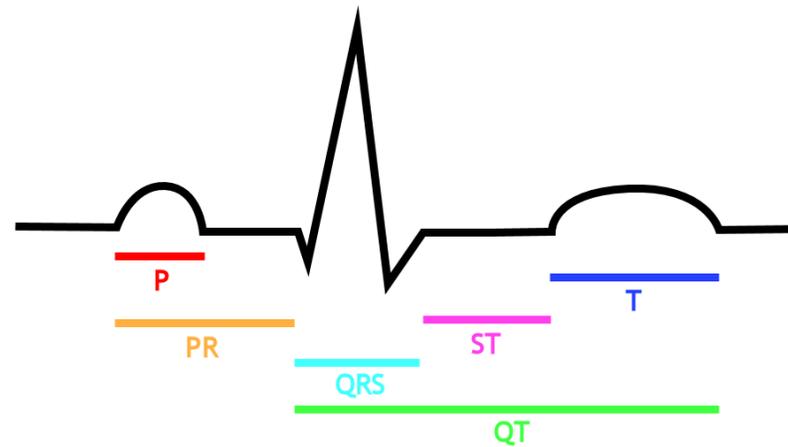
A picture of the electrical conduction through the heart

- P wave (atrial depolarization)
- QRS complex (ventricular depolarization)
 - Q wave: first negative deflection from baseline
 - R wave: positive deflection from baseline
 - S wave: negative deflection following an R wave
- T wave (ventricular repolarization)



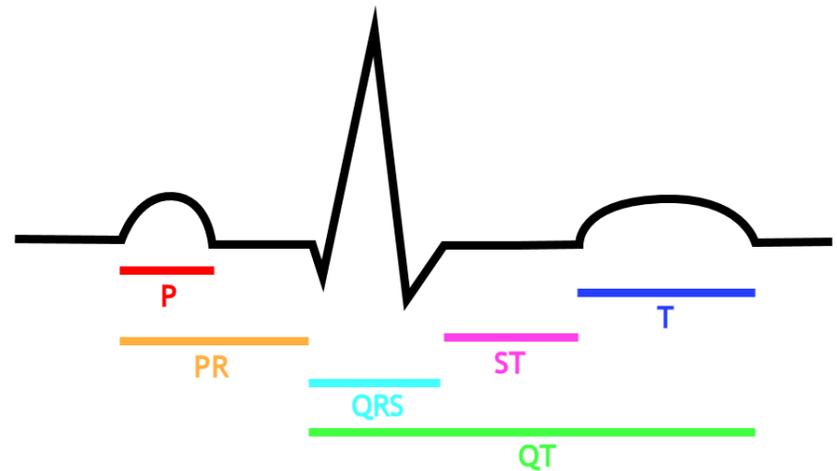
Intervals

- **PR Interval:** AV conduction time; the time for impulse to travel SA node → atria → AV node → ventricles
 - Measured from beginning of P wave to beginning of QRS.
 - Normal= 120-200 ms (0.12-0.20 sec)
 - >200 ms: AV block
- **QRS Duration:** time for conduction to travel through LV and RV
 - Measured from beginning to end of QRS complex (QRS width)
 - Normal= < 120 ms (0.12 sec)



Intervals

- ST segment: early repolarization phase; should be at baseline; elevation or depression indicates injury, ischemia or infarct
 - From end of S wave to beginning of T wave
 - More to come on this later...
- QT Interval: the time for both ventricular depolarization and repolarization
 - Dependent upon rate

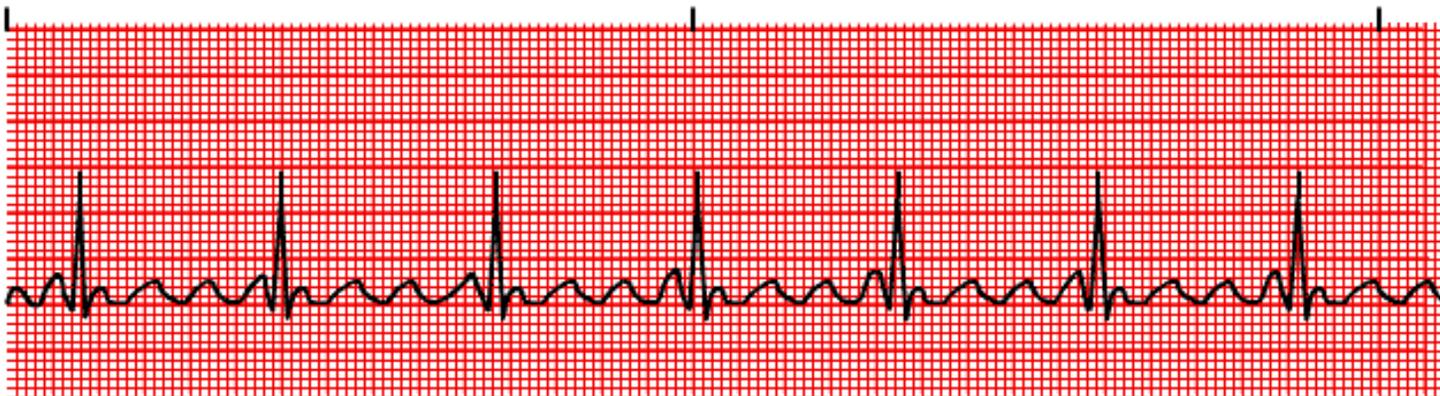


Rate

- How fast the heart is going
 - How many times the heart beats in 1 minute (bpm)
 - A “beat” is a ventricular contraction or a QRS complex.
- Only reliable if rhythm is regular; if irregular then rate is just an estimation

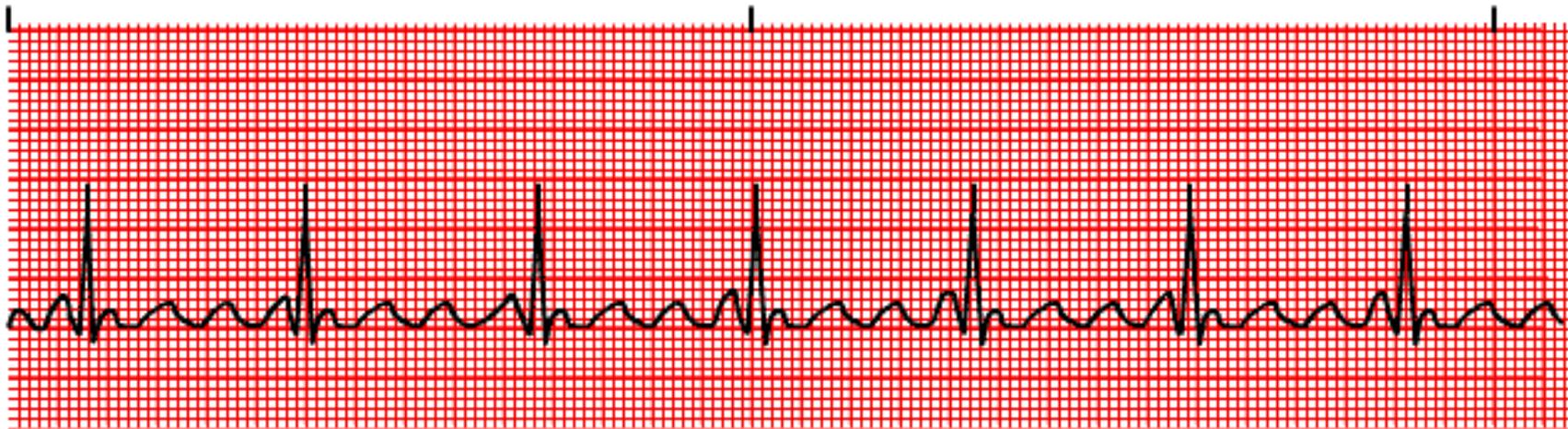
Rate

- ON RHYTHM STRIP:
 - If paper speed is 25 mm/sec (standard), the vertical lines at top edge of paper represent 3 second intervals
 - 1 small box = 0.04 sec
 - There are 5 small boxes within each large box
 - 1 large box = 0.20 sec



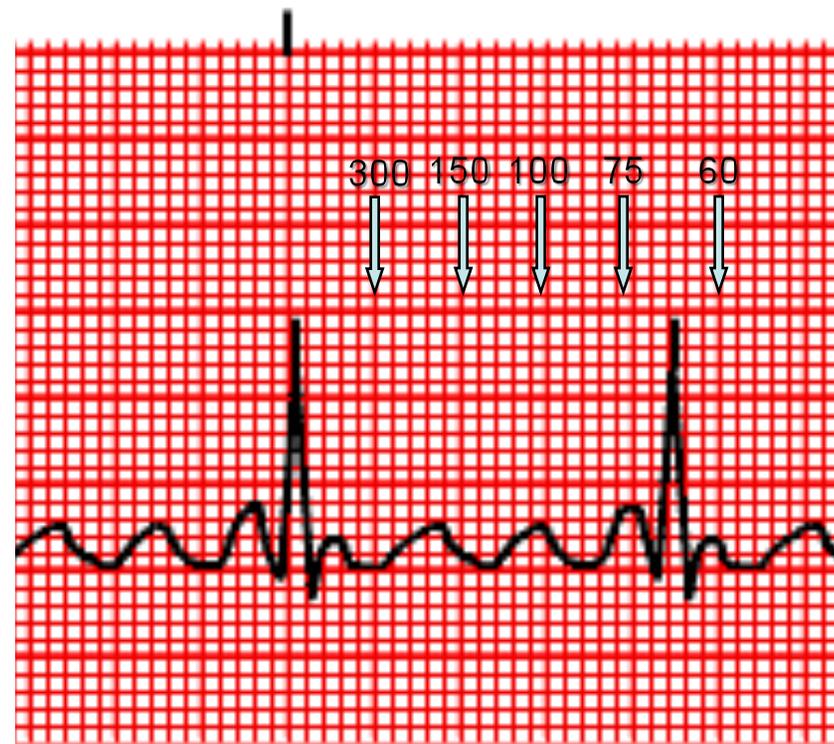
Rate

- ON RHYTHM STRIP:
 - Count the number of QRS complexes in a 6 second strip and multiply by 10



Rate

- ON EKG:
 - Measured between two consecutive QRS waves (R-R interval)
 - Rule of 300's:
 - Count the # of large boxes between R waves and divide into 300
 - Find an R wave on a dark line. The first big box would be 300, the second 150, 100, 75, 60 bpm.*



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*This applies only to EKGs printed at 25 mm/sec (standard)

Rhythm

- Regular: equal distance between R waves
- Irregular: varying distances between R waves
 - Regularly irregular: R waves occur in a pattern
 - Irregularly irregular: totally irregular without any pattern
- Mark out R-R intervals on a separate piece of paper and hold over EKG to see if all R-R's map out

Arrhythmias...

What you need to know:

1. Normal or Abnormal?
2. Name the Arrhythmia
3. Treat the Patient with the Arrhythmia

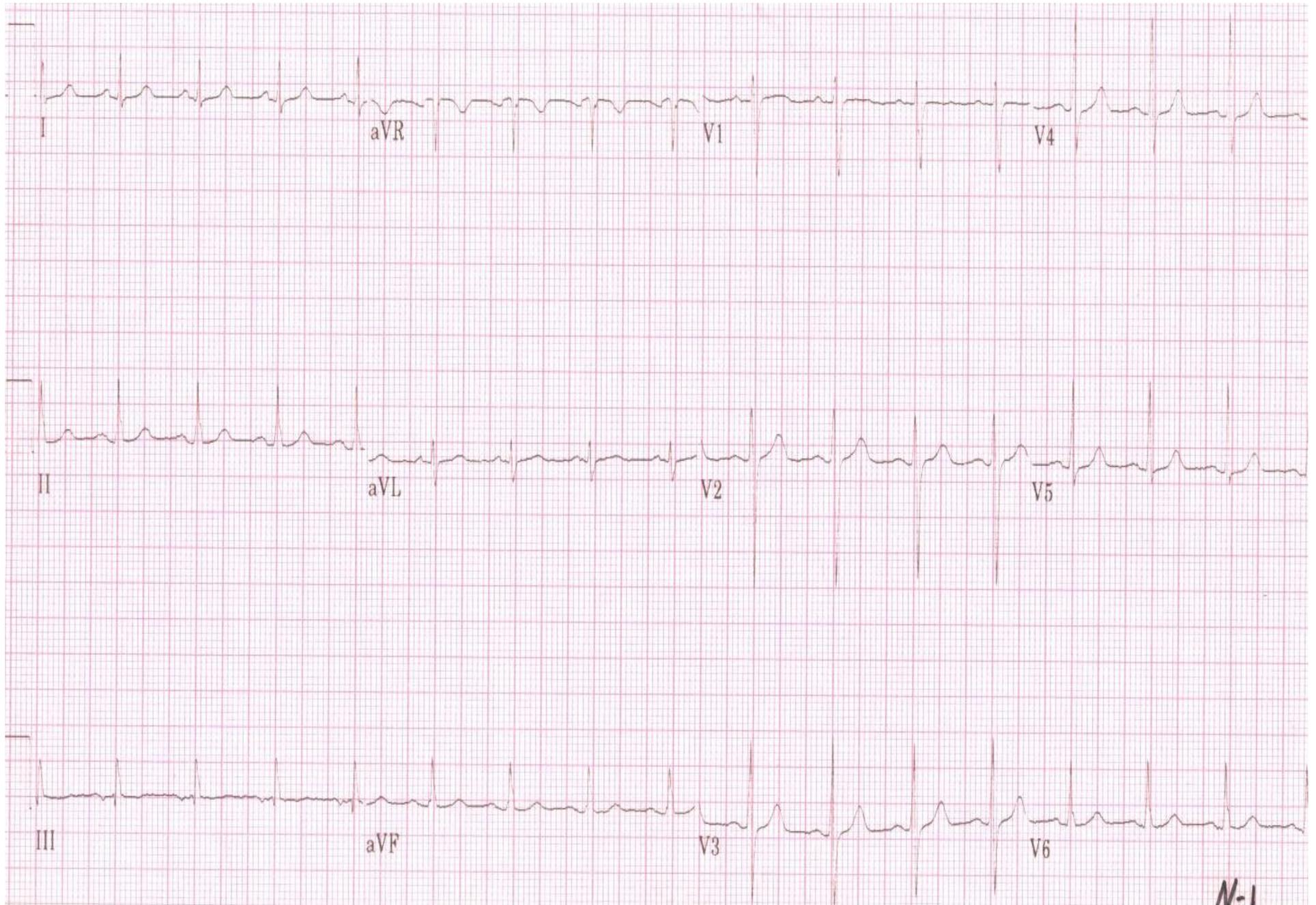
Basic Rhythms and Arrhythmias

- Normal Sinus Rhythm
- Sinus Tachycardia
- Sinus Bradycardia
- Sinus Arrhythmia
- Sinus Arrest
- Ectopy (PACs, PVCs)
- Supraventricular Tachycardia (SVT)
- Atrial Fibrillation (AF)
- Atrial Flutter
- Ventricular Tachycardia (VT)
- Torsades de Pointes
- Ventricular Fibrillation (VF)

Normal Sinus Rhythm

- Rate: 60-100 bpm
- Rhythm: regular
- P -> QRS -> T
- Intervals: All normal





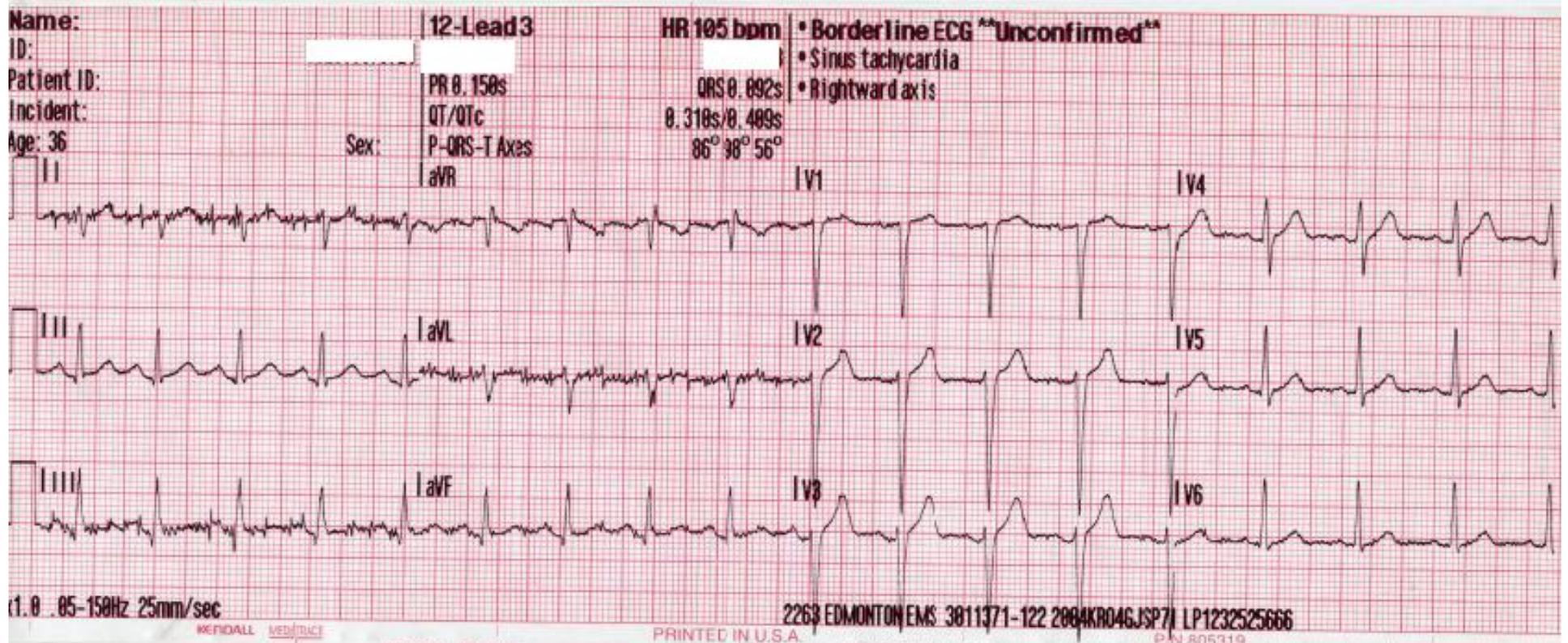
N-1

Sinus Tachycardia

- Rate: >100 bpm
- Rhythm: regular
- P \rightarrow QRS \rightarrow T
- Intervals: All normal



Sinus Tachycardia

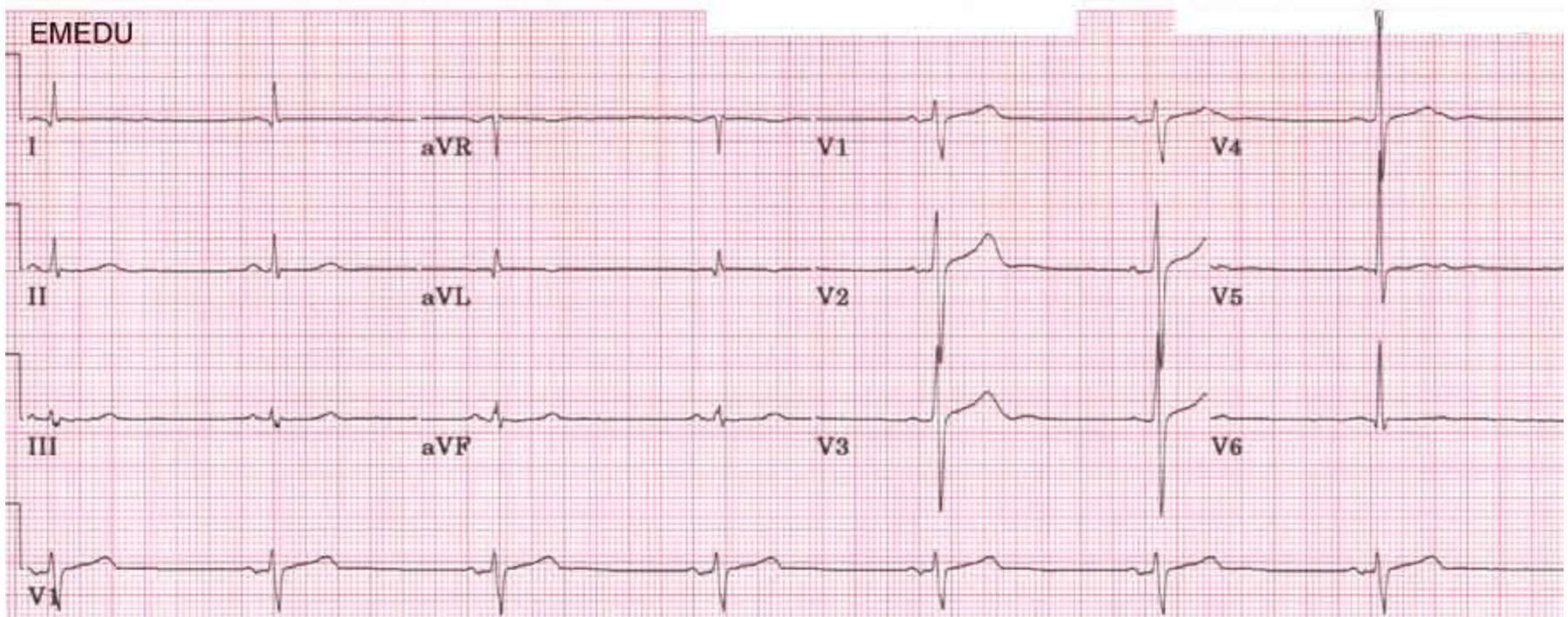


Sinus Bradycardia

- Rate: <60 bpm
- Rhythm: Regular
- P -> QRS -> T
- Intervals: All normal



Sinus Bradycardia

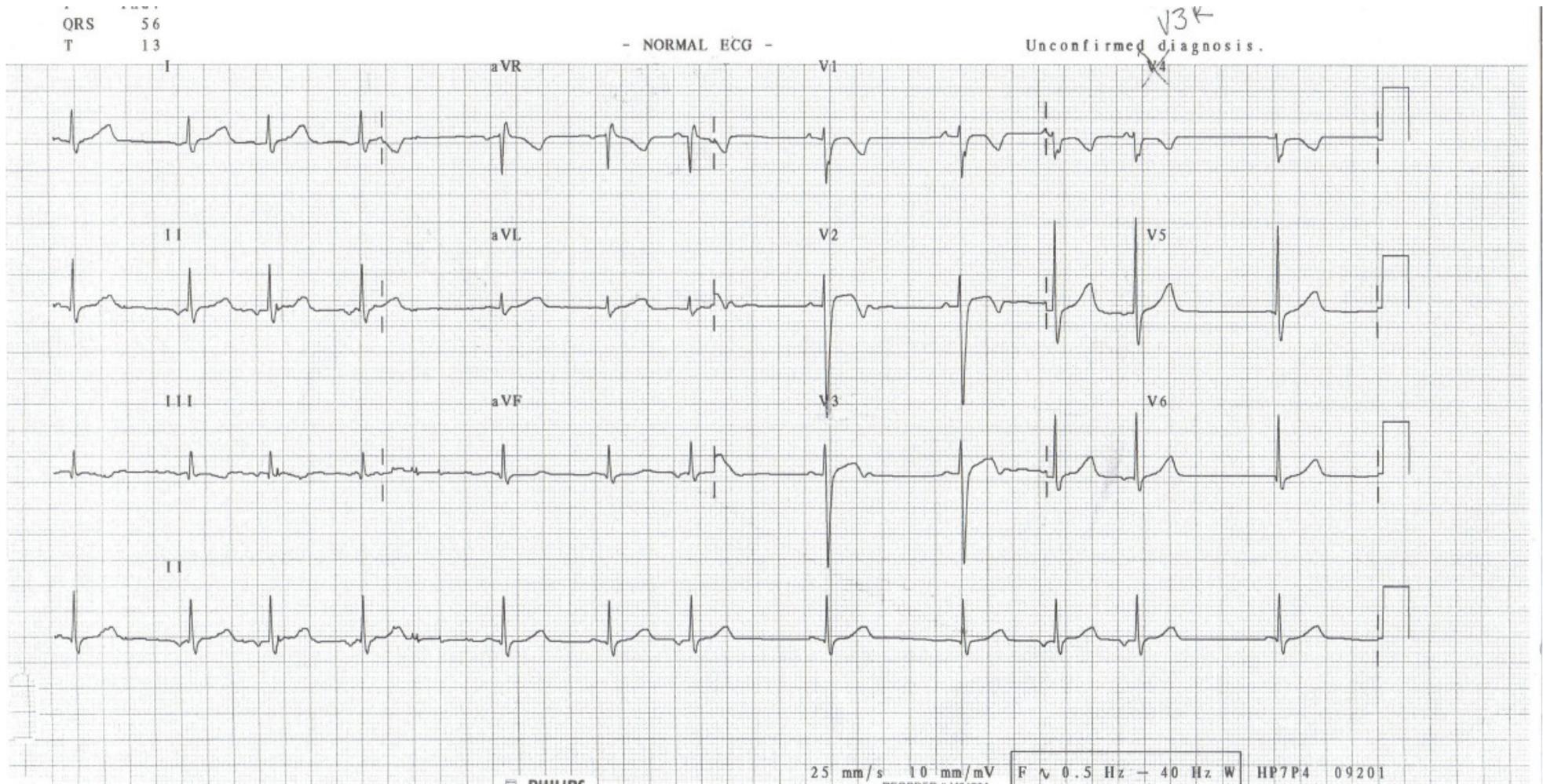


Sinus Arrhythmia

- Rate: Any rate, but usually 60-100 bpm
- Rhythm: irregular
- P -> QRS -> T
- Intervals: All normal



Sinus Arrhythmia



Sinus Pause/Arrest

- A period of time where there is no heart beat (flat line)
 - Somewhat interchangeable, but technically...
 - Just one impulse fails to form: sinus pause
 - More than one impulse in a row fails to form: sinus arrest
- Rate: can be normal or bradycardia
- Rhythm: irregular due to absence of sinus node discharge (evaluate baseline rhythm independently)



Ectopy

- Premature atrial contractions (PACs)
 - Irritable focus in atria fires before next sinus impulse is due
 - A compensatory pause will follow an ectopic beat
 - Rate: Normal
 - Rhythm: Irregular because of the PAC, otherwise baseline rhythm is regular

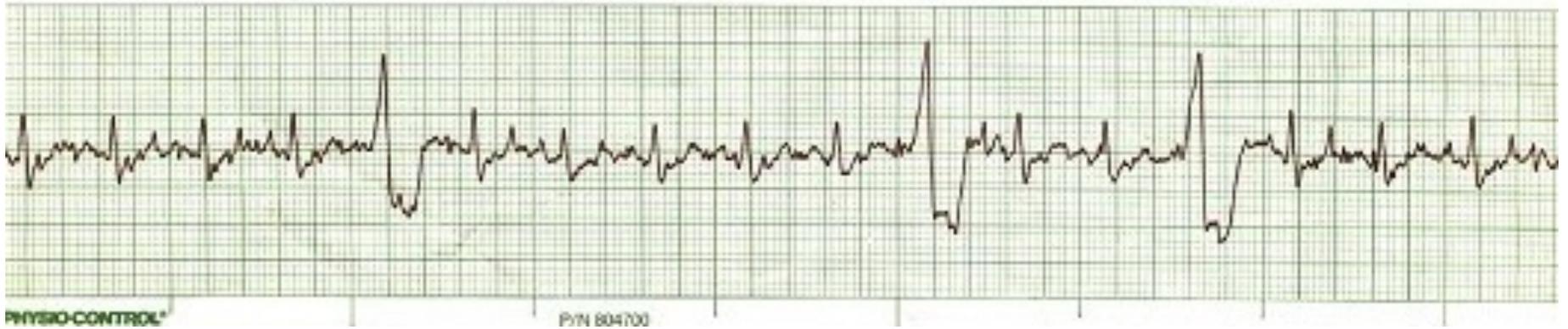


Ectopy

- Premature ventricular contractions (PVCs)
 - Early beat followed by compensatory pause
 - Rhythm: Irregular because of the PVC, otherwise baseline rhythm is regular
 - QRS: Wide



PVCs



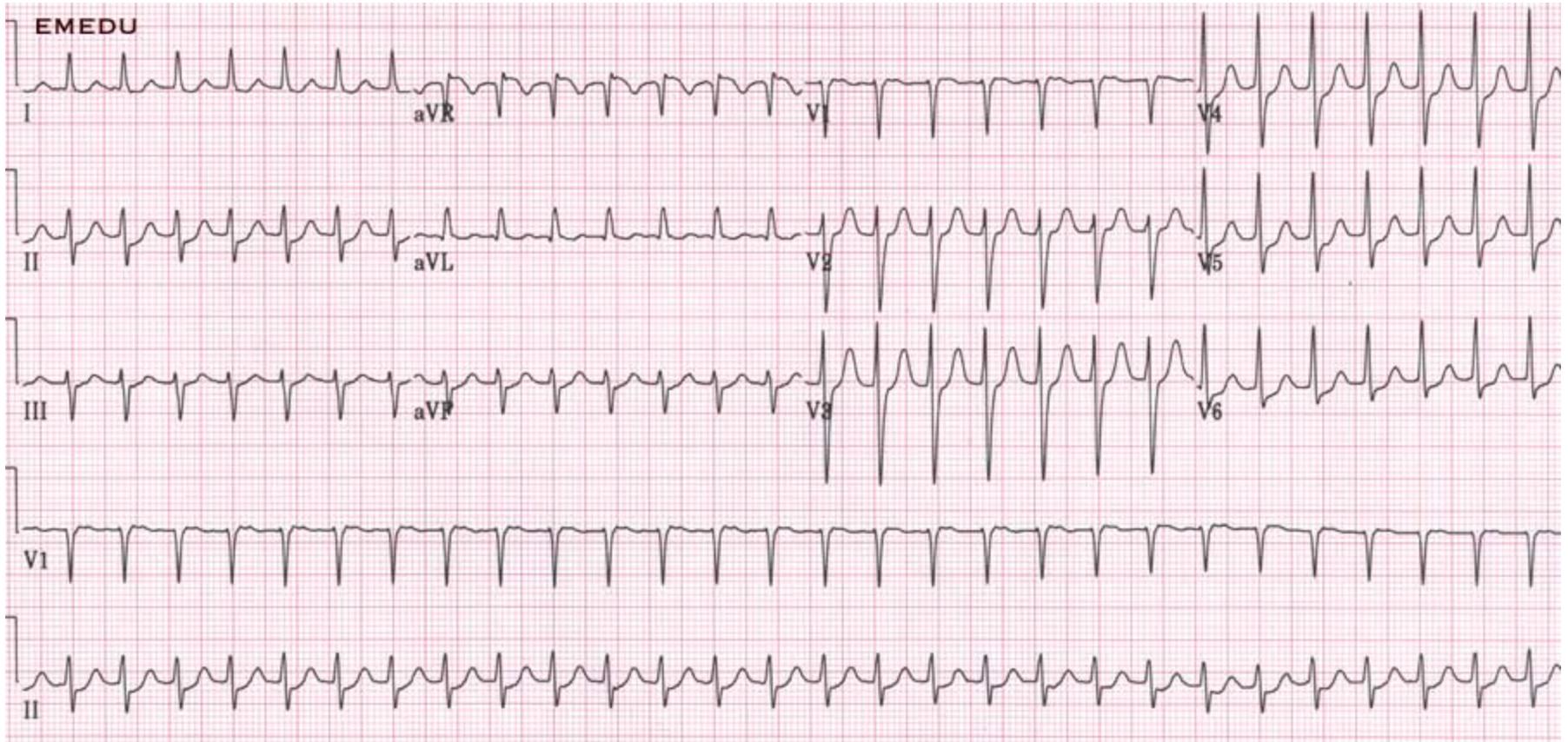
More Advanced Arrhythmias

- Supraventricular Tachycardia (SVT)
- Atrial Fibrillation (AF)
- Atrial Flutter
- Torsades de Pointes
- Ventricular Tachycardia (VT)
- Ventricular Fibrillation (VF)

Supraventricular Tachycardia (SVT)

- Narrow QRS tachycardia that originates above the ventricles; exact mechanism unknown
- Rate: 150-250+
- Rhythm: Regular
- P waves: Not visible
- QRS: Normal (narrow)

SVT



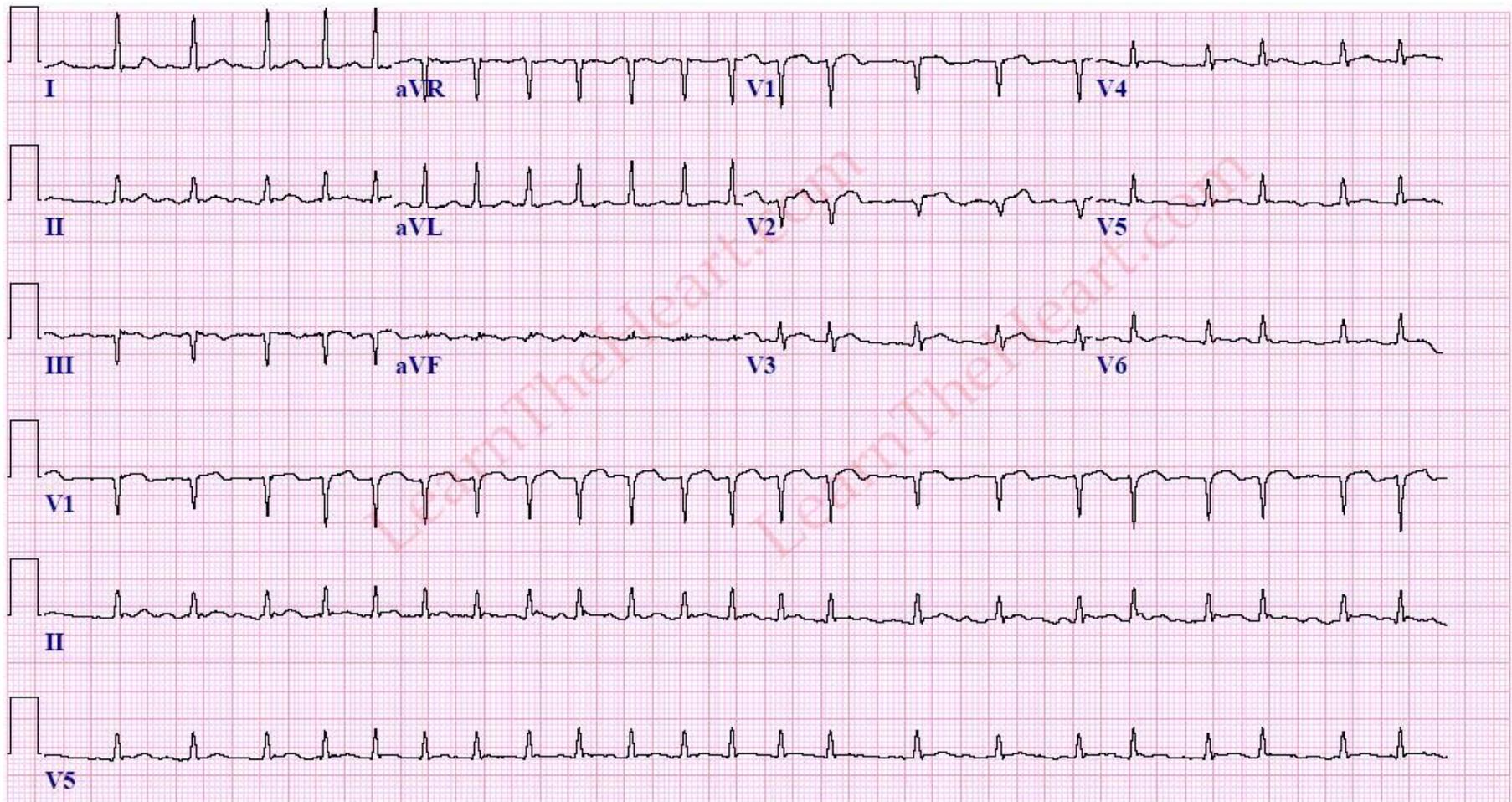
Atrial Fibrillation (A-fib, AF)

- Rate: Atrial rate so fast it can't be counted
Rhythm: Irregularly irregular (chaotic)
- P-waves: Not present; with no formed atrial impulses visible
- PR: not measurable
- QRS: usually normal

Atrial Fibrillation (A Fib, AF)



Atrial Fibrillation (A-fib, AF)



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EID: Unconfirmed EDT: ORDER:

ROYAL PERTH HOSPITAL

Adult

28

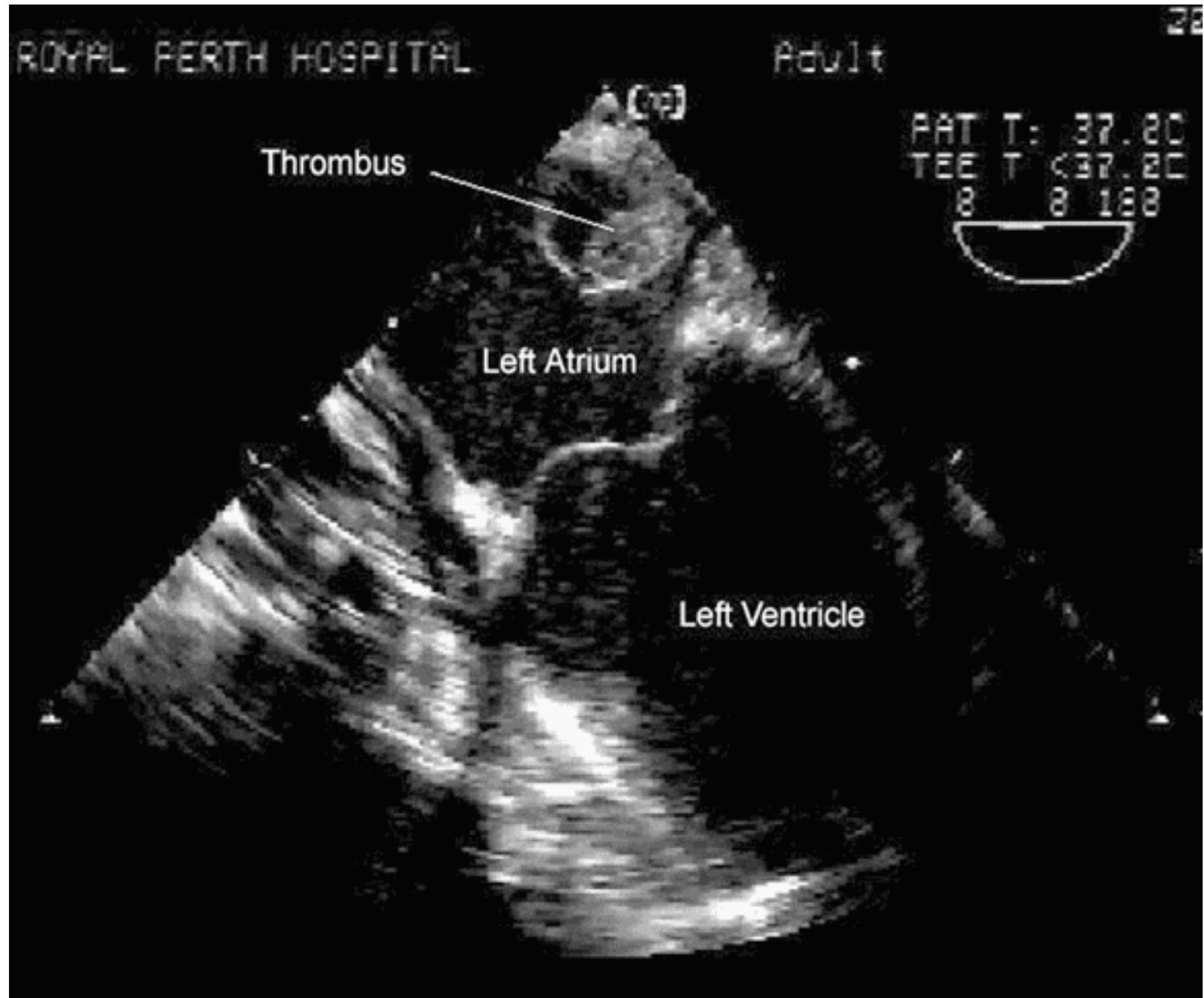
Thrombus



Left Atrium

Left Ventricle

PAT T: 37.2C
TEE T: 37.2C
8 8 188



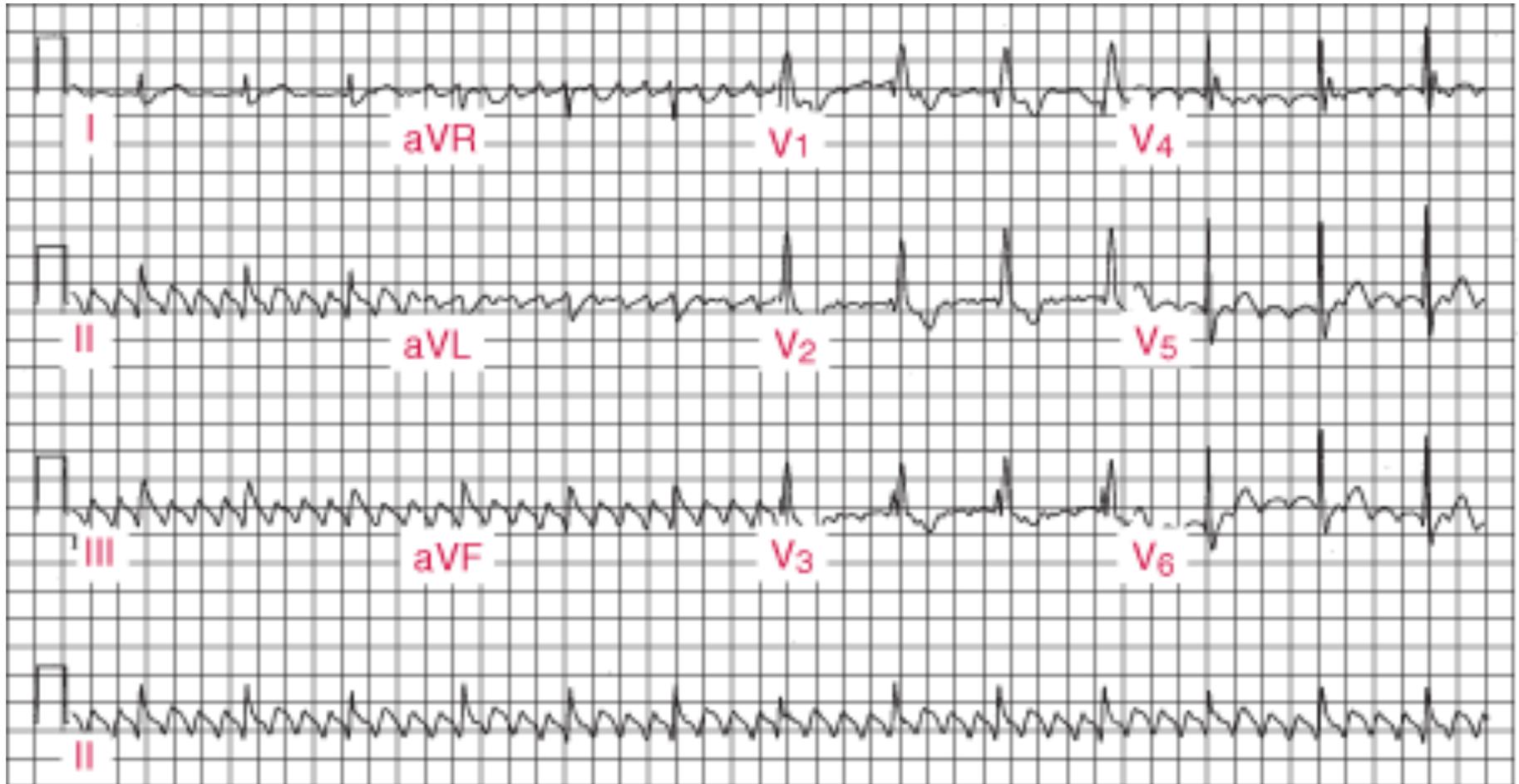
Atrial Flutter

- Rate: Atrial rate usually 300 bpm (250-350)
- 4:1 (V rate: 75 bpm), 3:1 (100 bpm), 2:1 (150 bpm), 1:1 (300 bpm)
- Rhythm: Usually regular, can be irregular, depending on AV conduction
- P-wave: sawtooth pattern
- PR: not measurable
- QRS: normal

Atrial Flutter



Atrial Flutter



Multifocal Atrial Tachycardia (MAT)

- Regularity No
- Rate Approximately 150's
- P waves Different appearing (3 different)
- PRI Variable
- QRS < . 12 seconds
- Causes of MAT: pulmonary disease (especially during acute exacerbations), Dig toxicity, hypoxia, electrolyte imbalances, CHF, nicotine, alcohol, caffeine
- Treatment involves treating the underlying cause (sepsis, pulmonary disease) but Calcium Channel Blockers are sometimes effective

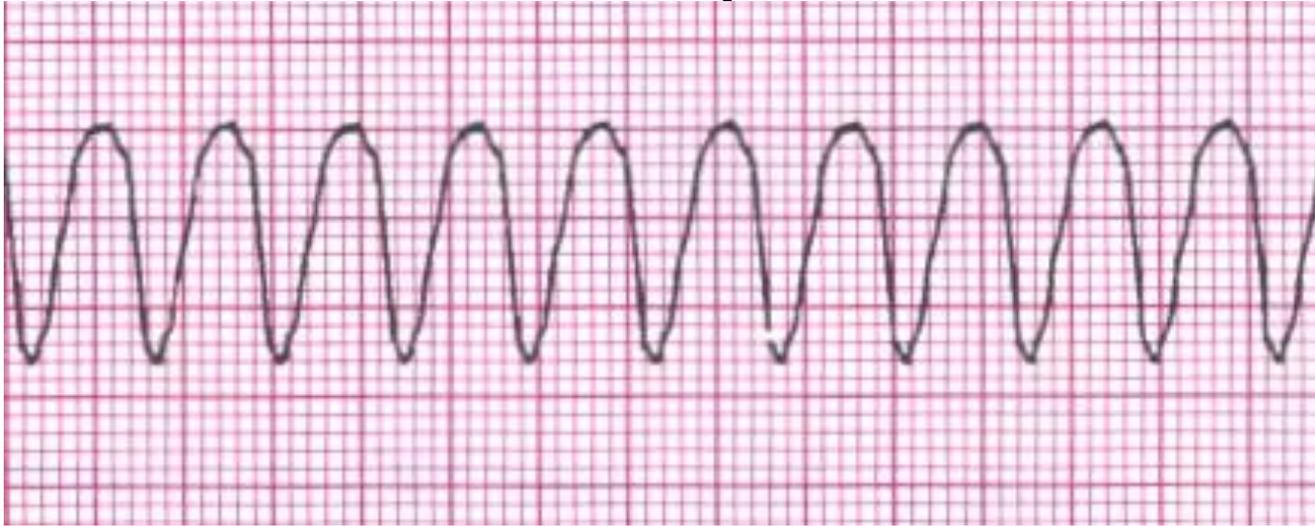
MAT



Ventricular Tachycardia (V Tach, VT)

- Ectopic focus in ventricle
- Rate: 140 – 250, may start at lower rate
- Rhythm: usually regular, may be slightly irregular
- P-wave: Not usually present, however, can occasionally see P waves.
- PR: not measurable
- QRS: wide > 0.12 sec
- ACLS protocol to manage (CPR/SHOCK!)

Ventricular Tachycardia (V Tach, VT)



Idioventricular Rhythm

Regularity	Yes
Rate	20-40 bpm
P waves	none
QRS	WIDE

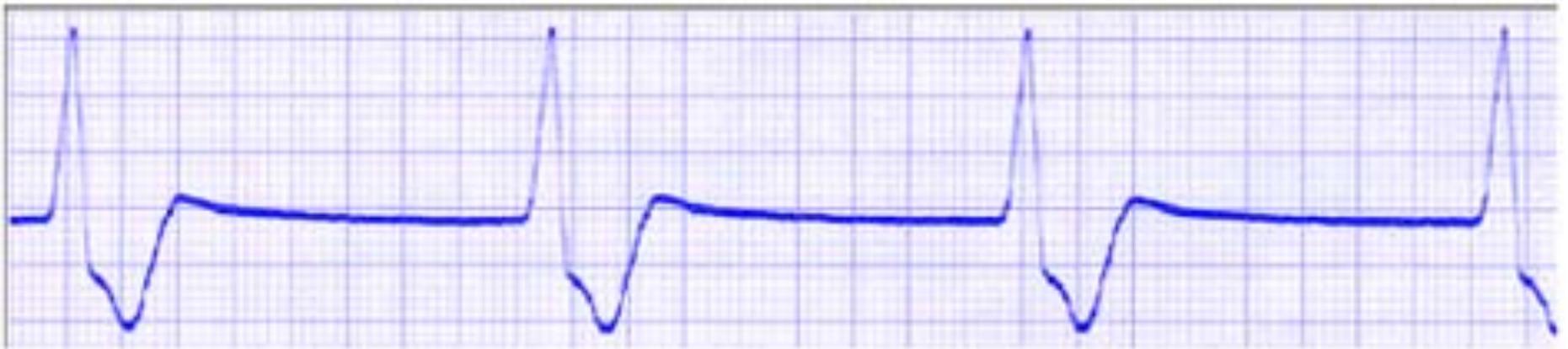
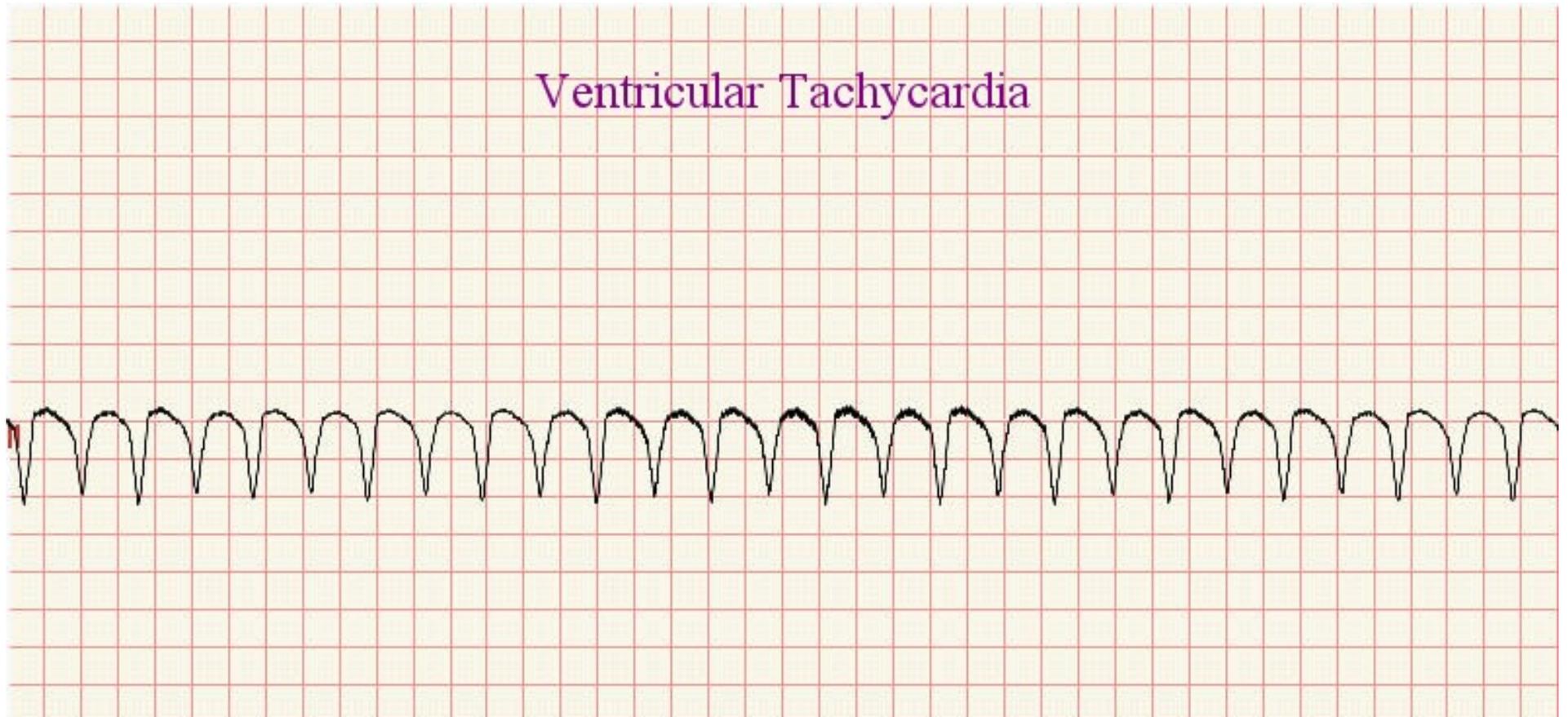


Figure S-7

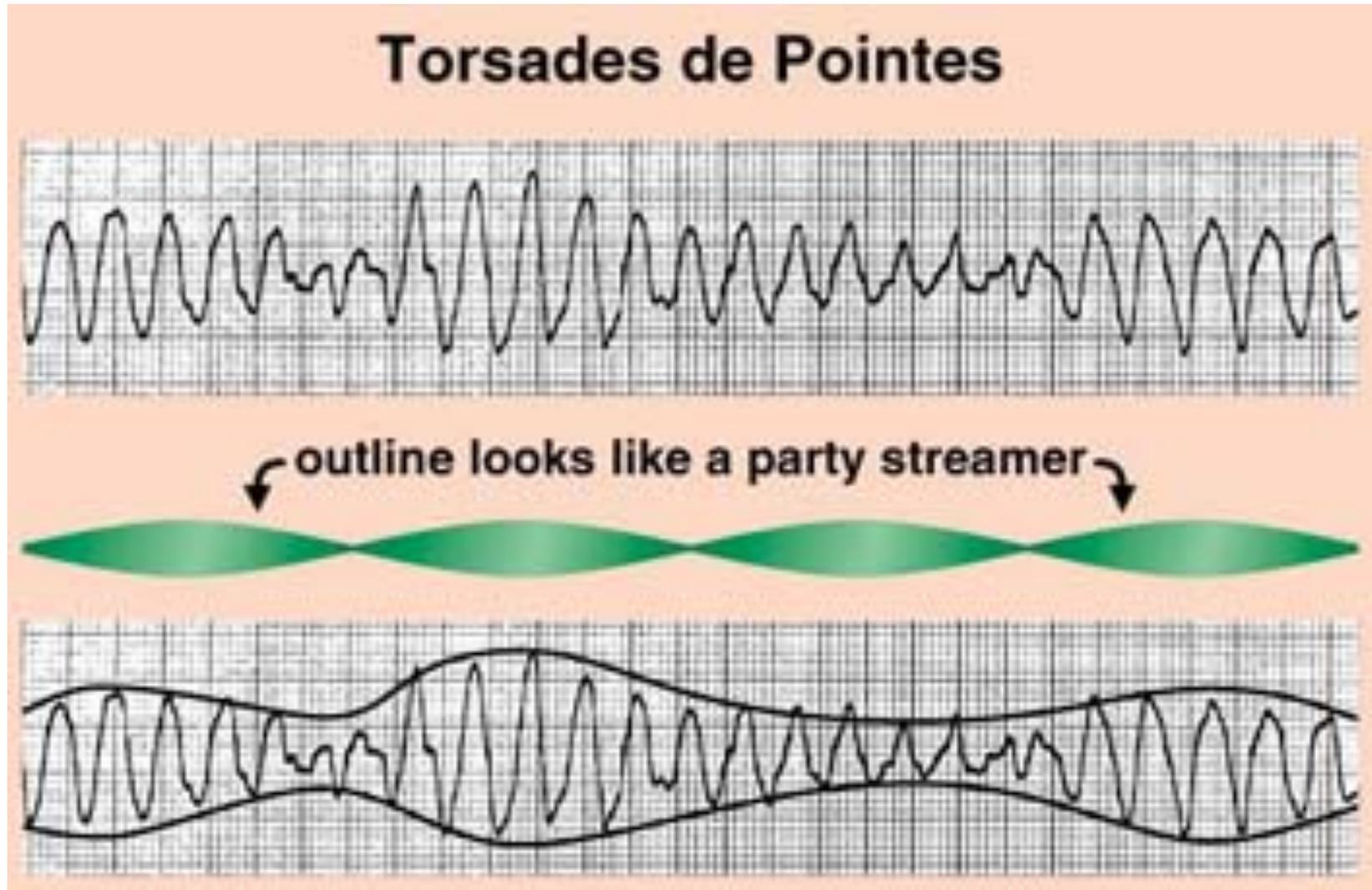
Ventricular Tachycardia

Regularity	Yes
Rate	> 100 bpm
P waves	Can't always see them
QRS	Wide



Torsades de Pointes

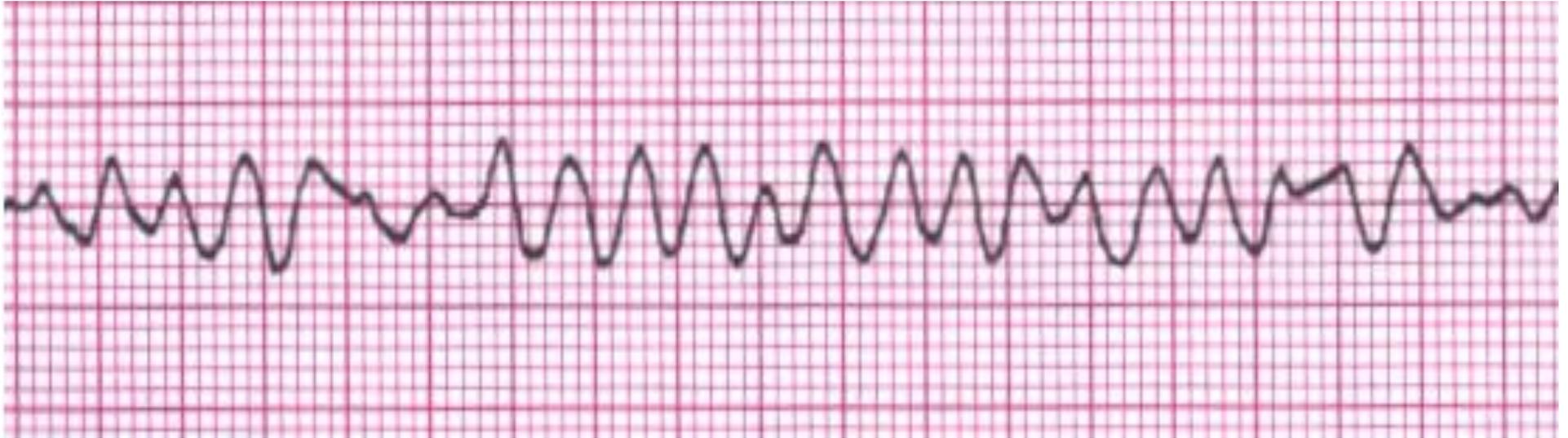
Multifocal Ventricular Tachycardia



Ventricular Fibrillation (V Fib, VF)

- Chaotic electrical activity in ventricles resulting in the ventricles quivering; Total loss of cardiac output
- Rate: Zero
- Rhythm: Chaotic
- P-waves: None
- QRS: None
 - Treat per ACLS protocol (CPR/SHOCK!)

Ventricular Fibrillation (V Fib, VF)



In Summary....

1. Is it fast or slow?
2. Is it regular or irregular?2.
5. Is there a P wave before every QRS complex?

Part 2 – Heart Blocks

Heart Blocks

- A blockage at any level of the electrical conduction system of the heart
- 1st degree heart block
- 2nd degree heart block
 - Type I (Wenkebach)
 - Type II
- 3rd degree (complete) heart block

1st degree heart block

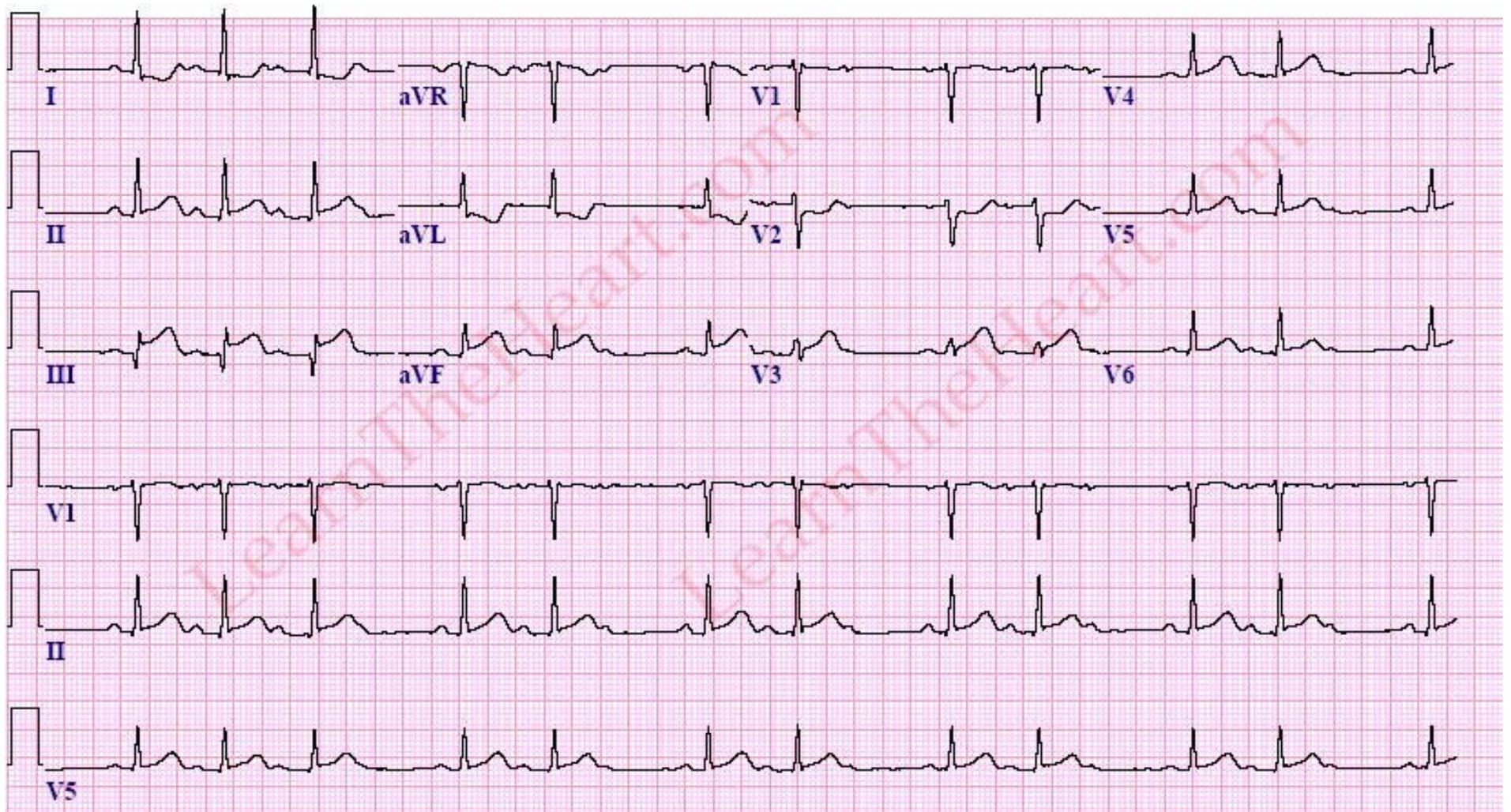
- AV node conducts the electrical activity more slowly than normal
- PR interval > 200 ms.
- Often seen with bradycardia; usually an incidental finding on a routine EKG



2nd Degree Heart Block

- Disturbance, delay, or interruption of atrial impulse conduction to the ventricles through the atrioventricular node (AVN).
- Type I (Wenckebach, Mobitz I)
 - progressive prolongation of the PR interval until ultimately, the atrial impulse fails to conduct, a QRS complex is not generated, and there is no ventricular contraction





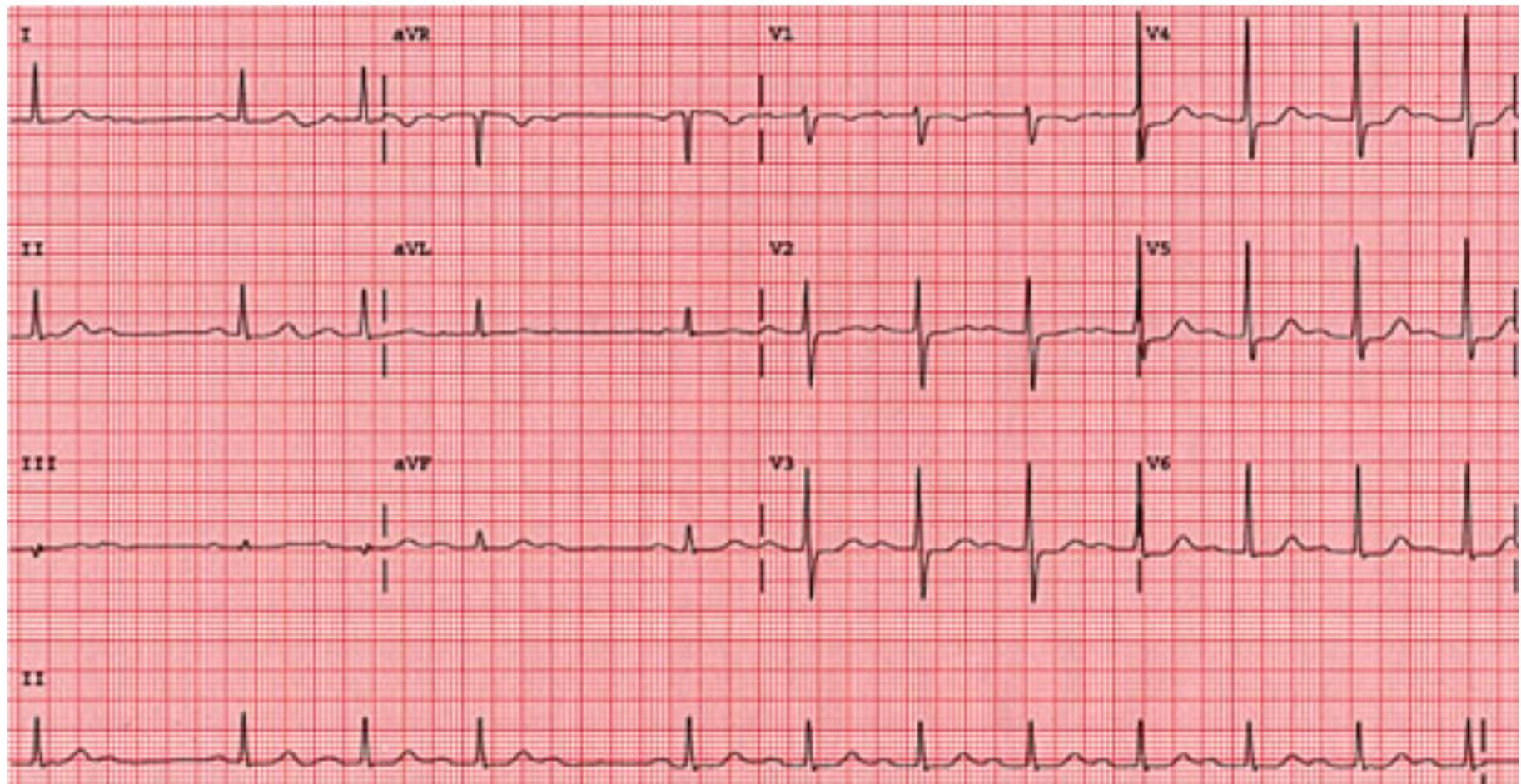
25mm/s 10mm/mV 150Hz 005C 12SL 250 CID: 10

EID:615 EDT: 08:58 14-FEB-2004 ORDER:

2nd Degree Heart Block

- Type II (Mobitz II)
 - an unexpected nonconducted atrial impulse, without prior measurable lengthening of the conduction time. Thus, the PR and R-R intervals between conducted beats are constant.

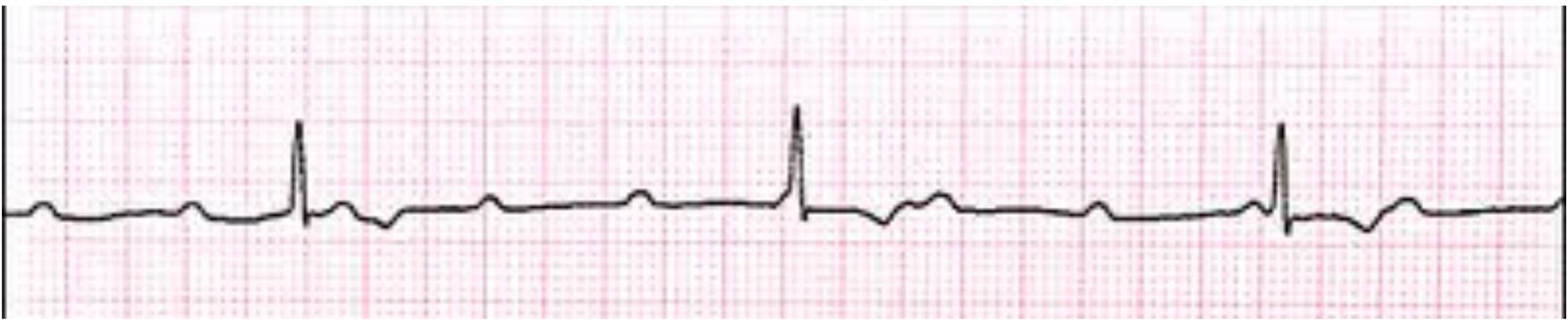
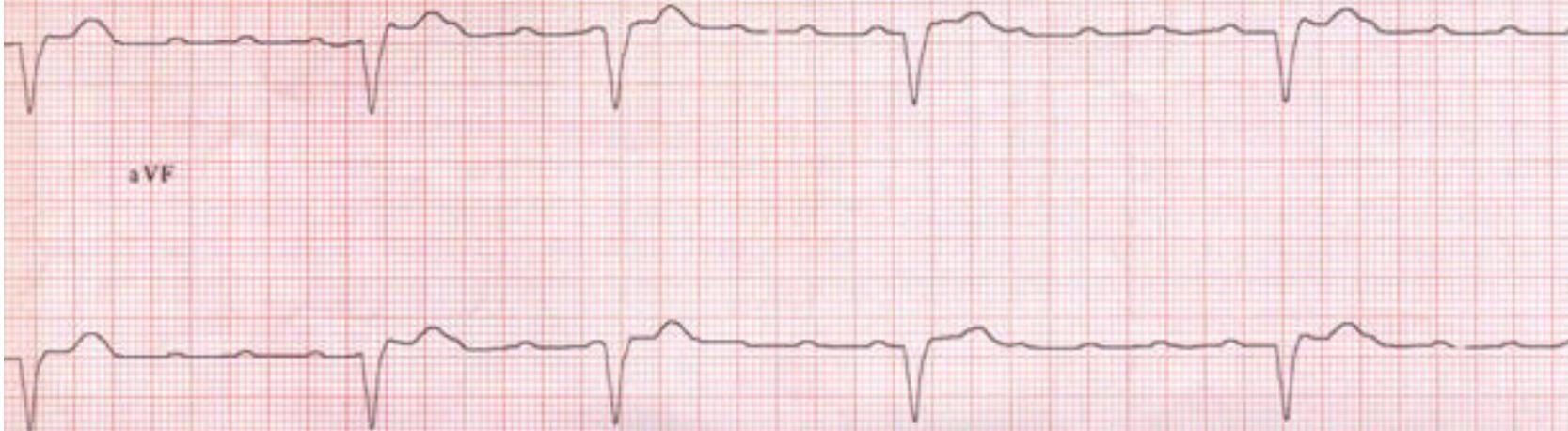




3rd Degree Heart Block

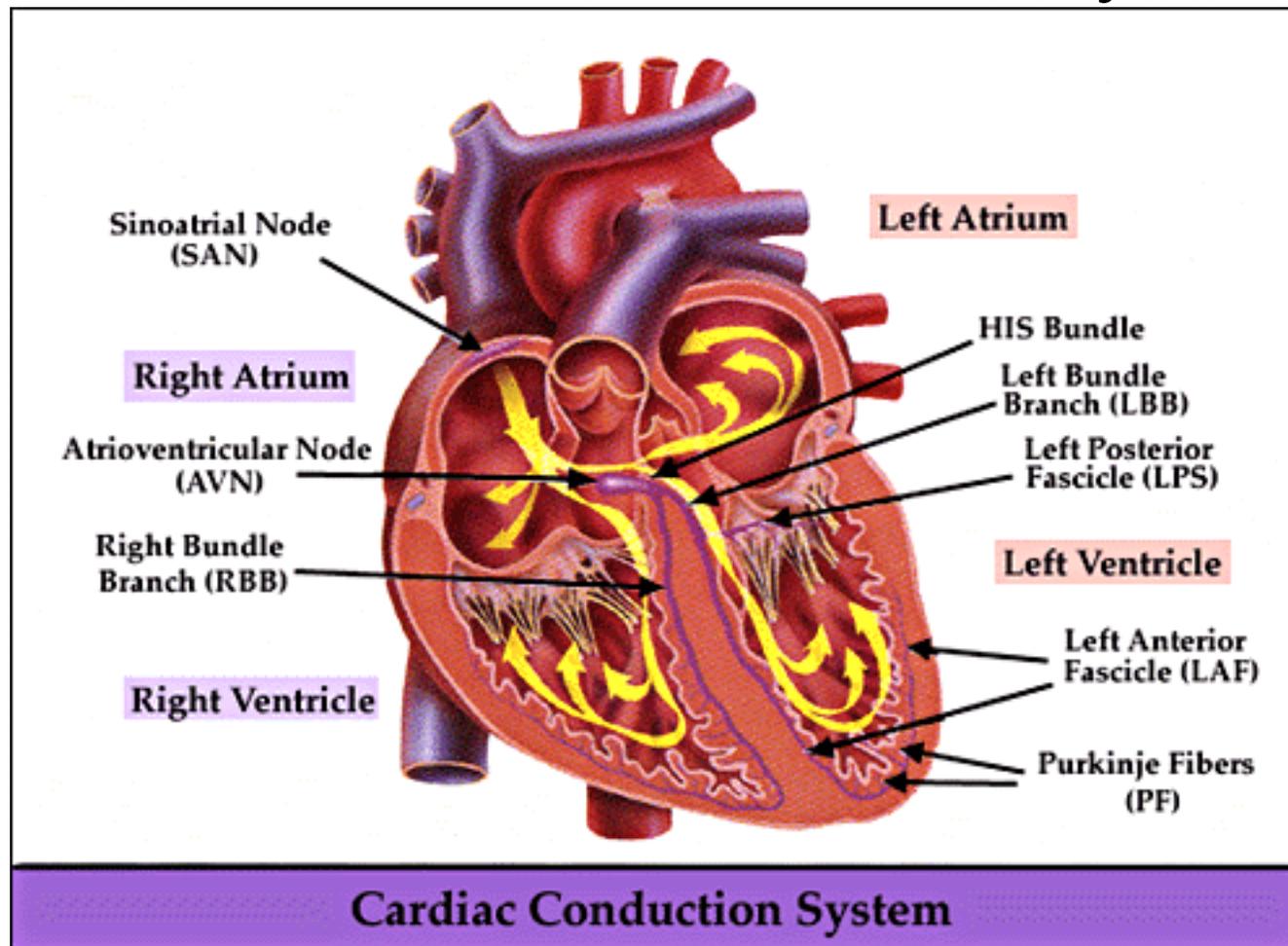
- “Complete” heart block
- Complete separation of atria from ventricles
- The P waves with a regular P to P interval represents the first rhythm.
- The QRS complexes with a regular R to R interval represent the second rhythm. The PR interval will be variable, as the hallmark of complete heart block is no apparent relationship between P waves and QRS complexes.

II F_v 0.5 Hz - 40 Hz W



Moving on to bundle branch blocks

- A reminder of the conduction system...



Bundle Branch Blocks

- A condition in which there's a delay or obstruction along the pathway that electrical impulses travel to the ventricles
- The blockage may occur on the pathway that sends electrical impulses to the left or the right side of your heart.

Bundle Branch Blocks

- Wide QRS complex (≥ 120 ms)
- Left bundle branch block (LBBB): wide, purely positive QRS deflection in V5, V6

A bit about devices...

- Pacemakers- Used to treat bradyarrhythmias
- Pacemakers have two functions: pace or sense
- If pacing in the ventricle will make a wide QRS complex

Paced Rhythms

Chamber Paced

A = Atrium

V = Ventricle

D = Dual (A +V)

O = None

Chamber Sensed

A = Atrium

V = Ventricle

D = Dual (A +V)

O = None

Response to Sensing

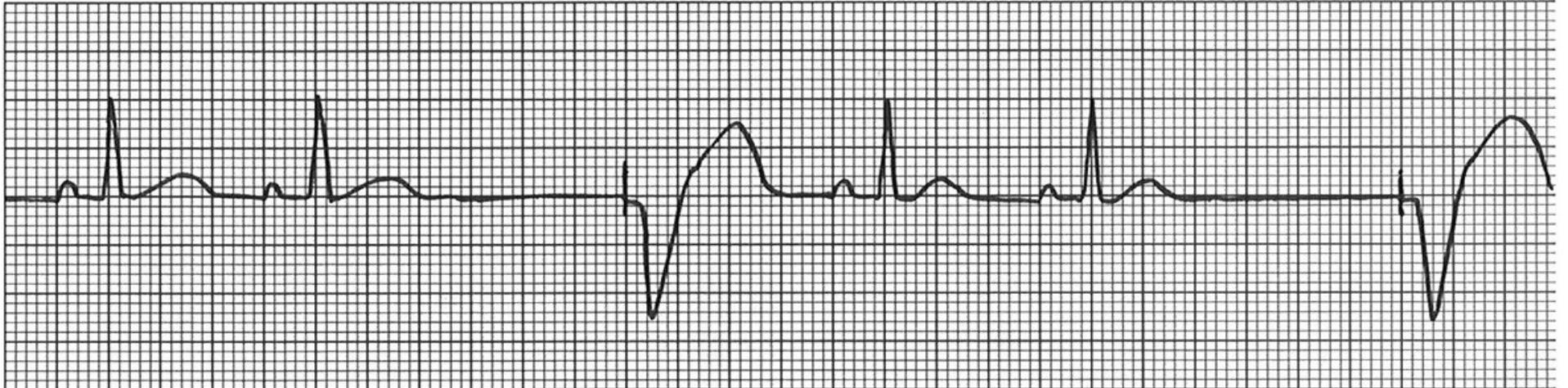
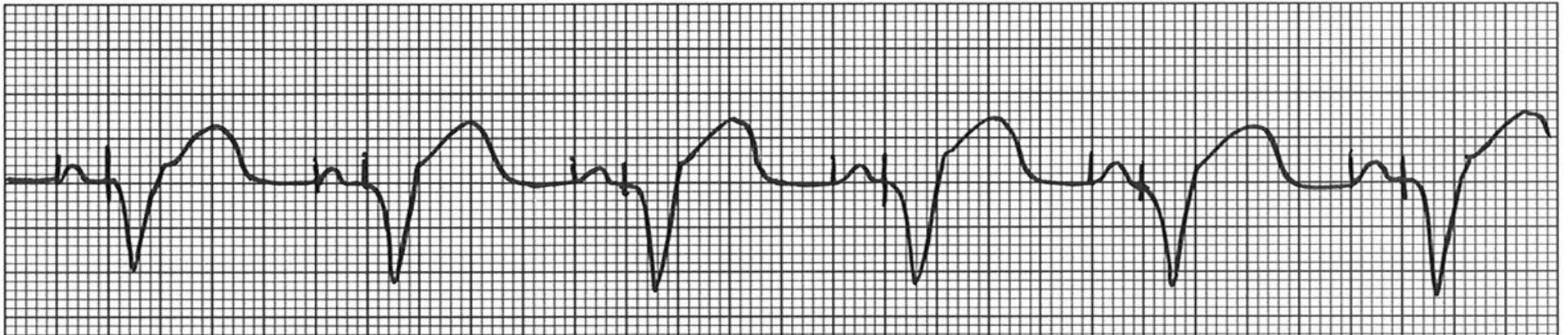
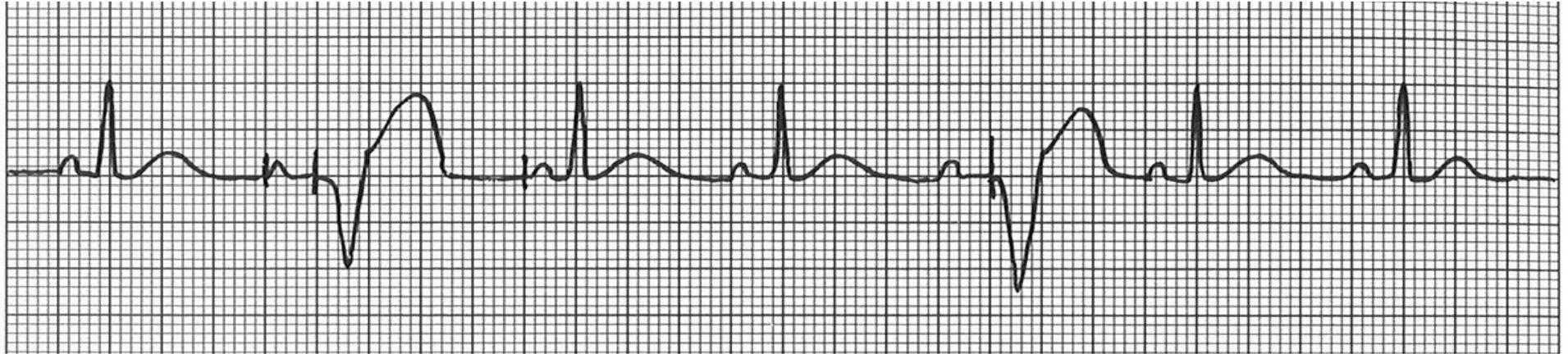
T = Triggered

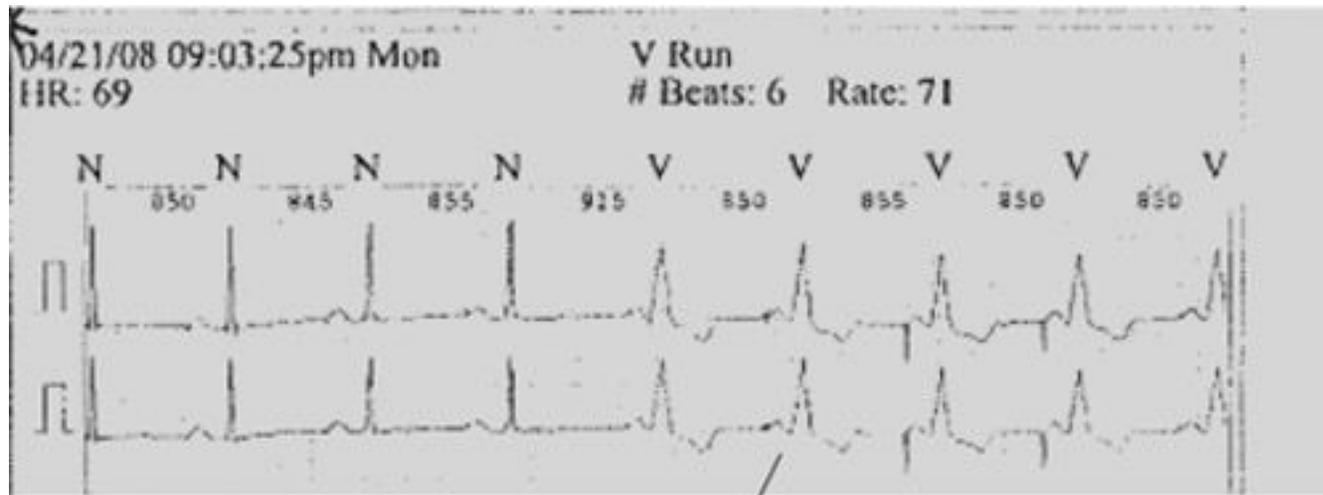
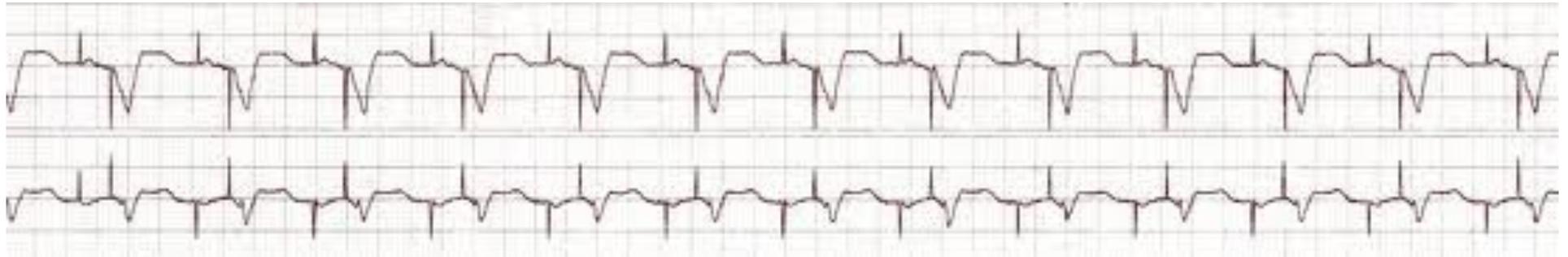
I = Inhibited

D = Dual (D+I)

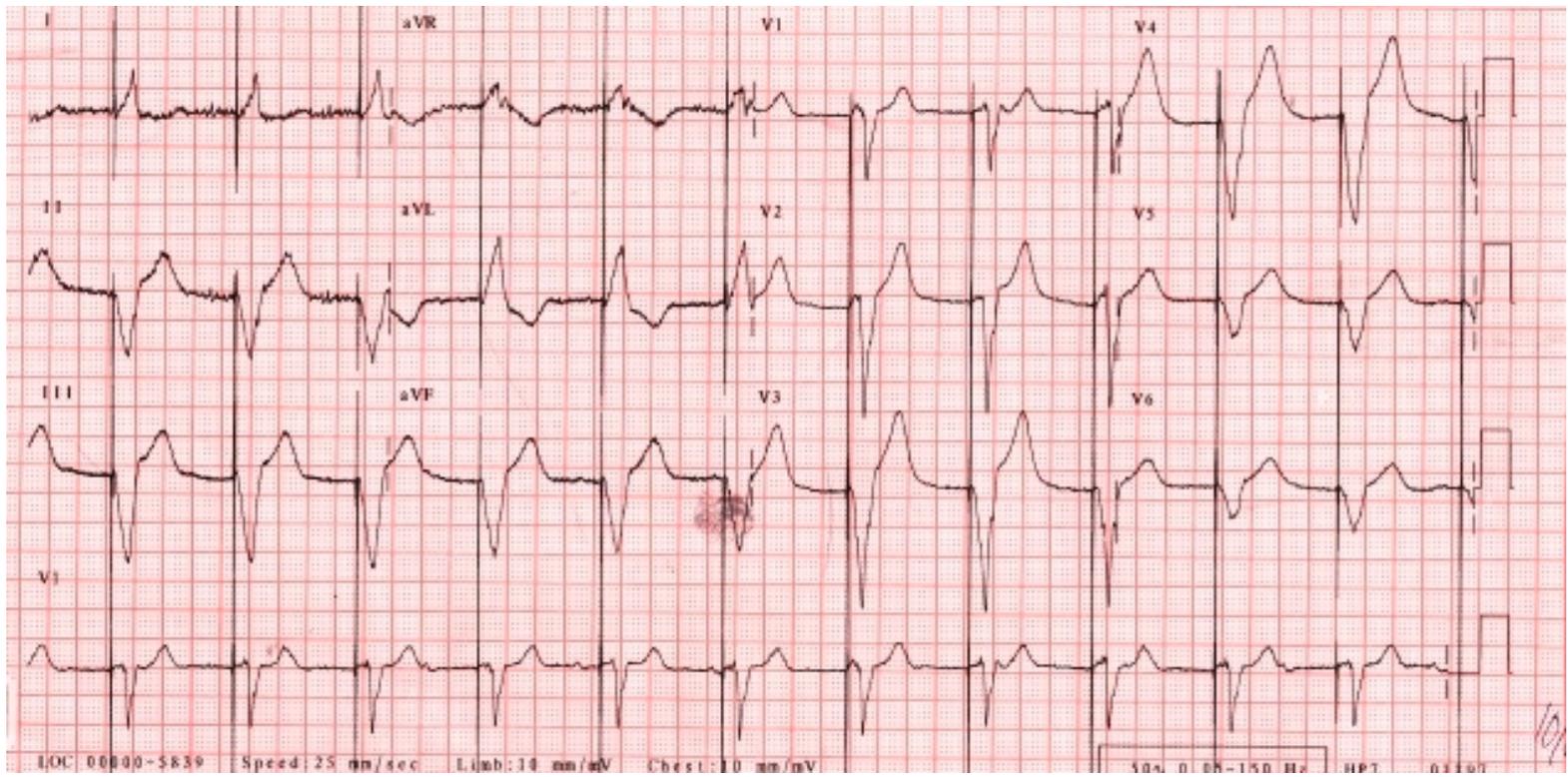
O = None

What Type of Pacemaker Is It?



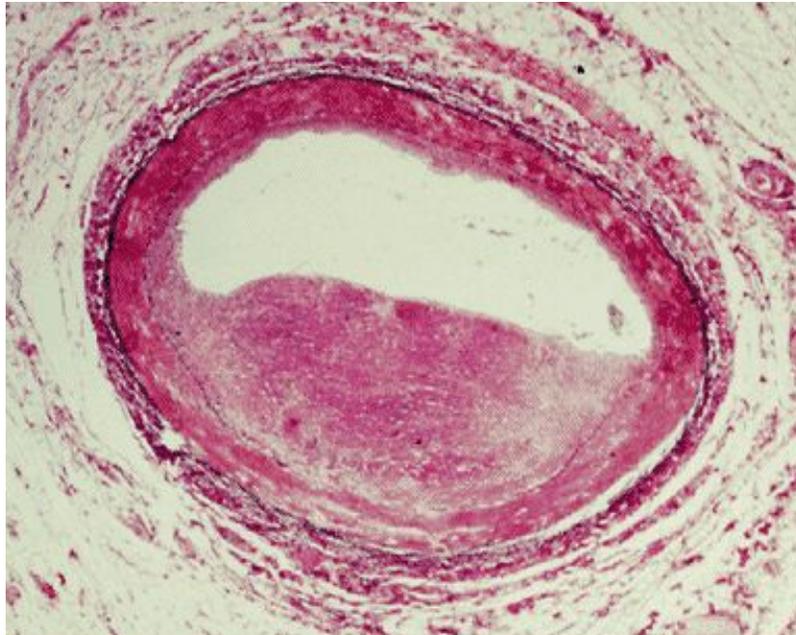


Atrio Ventricular pacing at 5V and 1ms for impedance check. This recording was triggered by patient with her usual symptoms of chest pounding.



Part 3 – Ischemia, Injury or Infarct

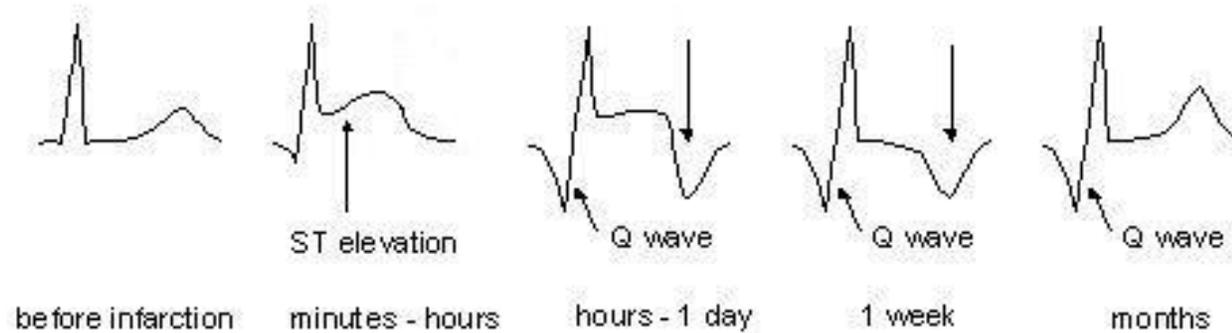
Coronary Atherosclerosis



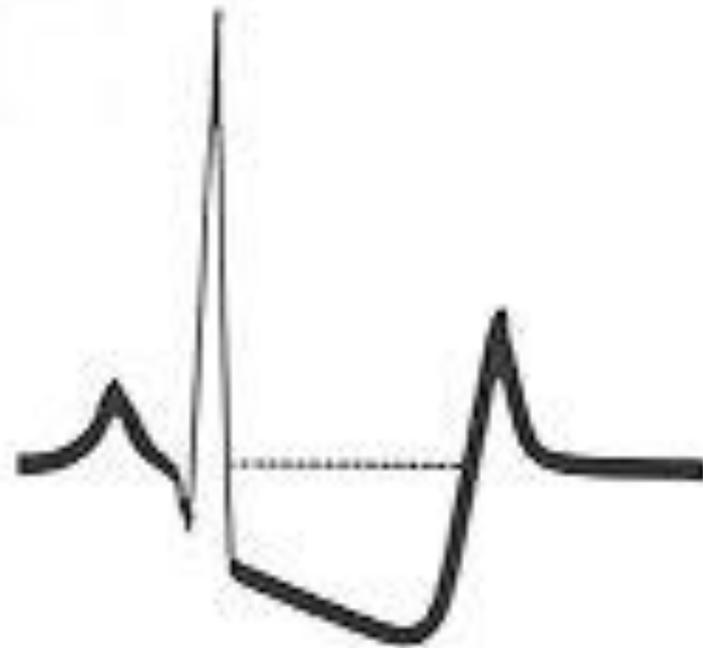
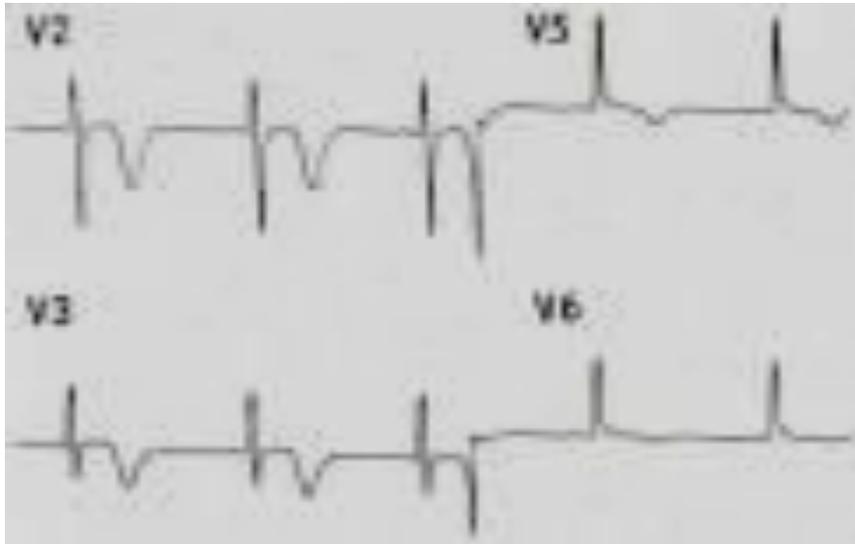
Ischemia, Injury or Infarct

- Ischemia- diminished blood flow to the heart muscle
 - ST segment depression and/or T-wave inversion.
- Injury- due to prolonged ischemia and lack of blood flow to the myocardium
 - ST segment elevation and/or tall, peaky T-waves over area of injury.
 - Can be reversed with prompt intervention and reperfusion
- Infarction- myocardial cells in the infarcted zone are dead and cannot be reperfused
 - Acute: ST elevation, Q waves may be present
 - Old: Significant Q waves present
 - Greater than $\frac{1}{4}$ amplitude of the R-wave **OR**
 - Greater than 0.04 seconds wide (one small box)

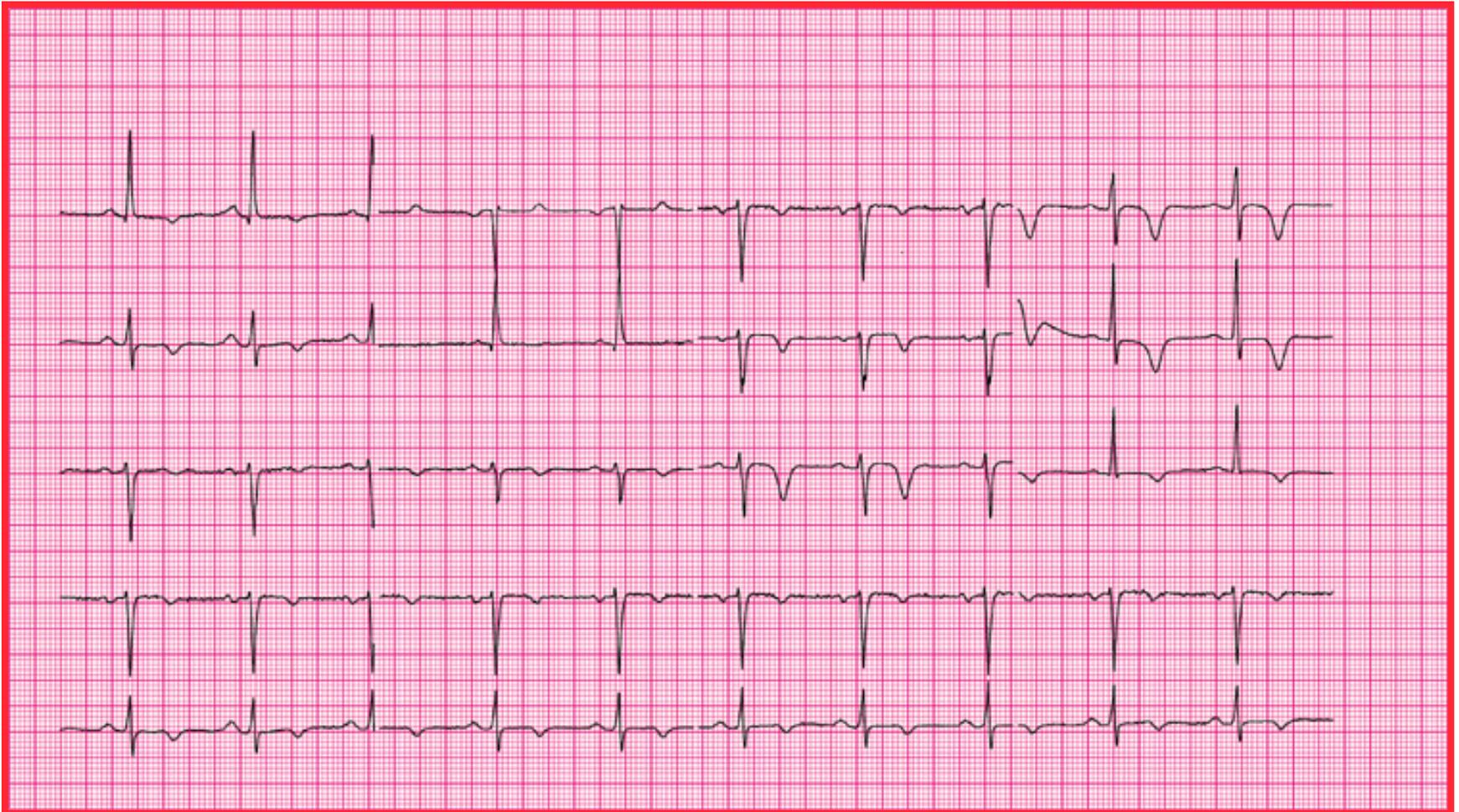
Time Passing



Ischemia

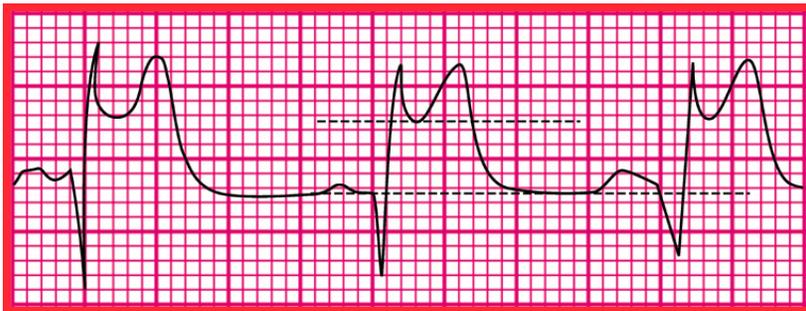
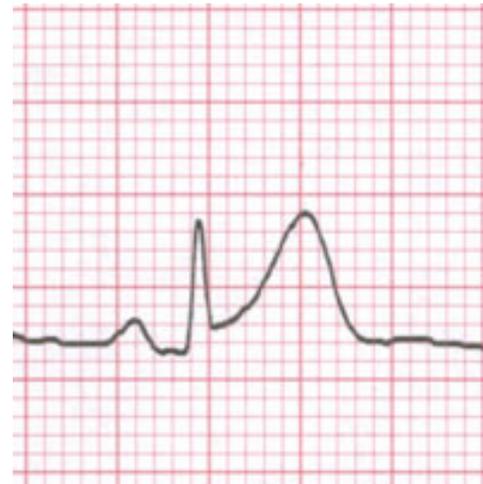


12 Lead EKG Practice

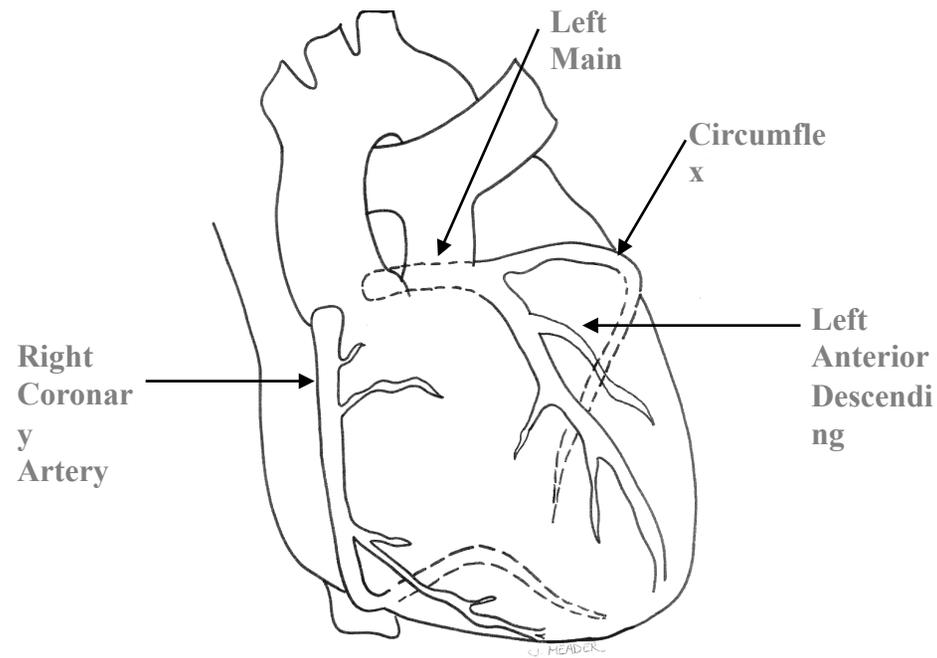


ST elevation with AMI

- Look for ST elevation $>$ 1mm in two or more anatomically contiguous leads



Coronary Circulation:



Right Coronary Artery (RCA)

- Left Ventricle
- Inferior Wall
- Posterior Wall
- Right Ventricle
- SA Node (55%)
- AV Node (90%)

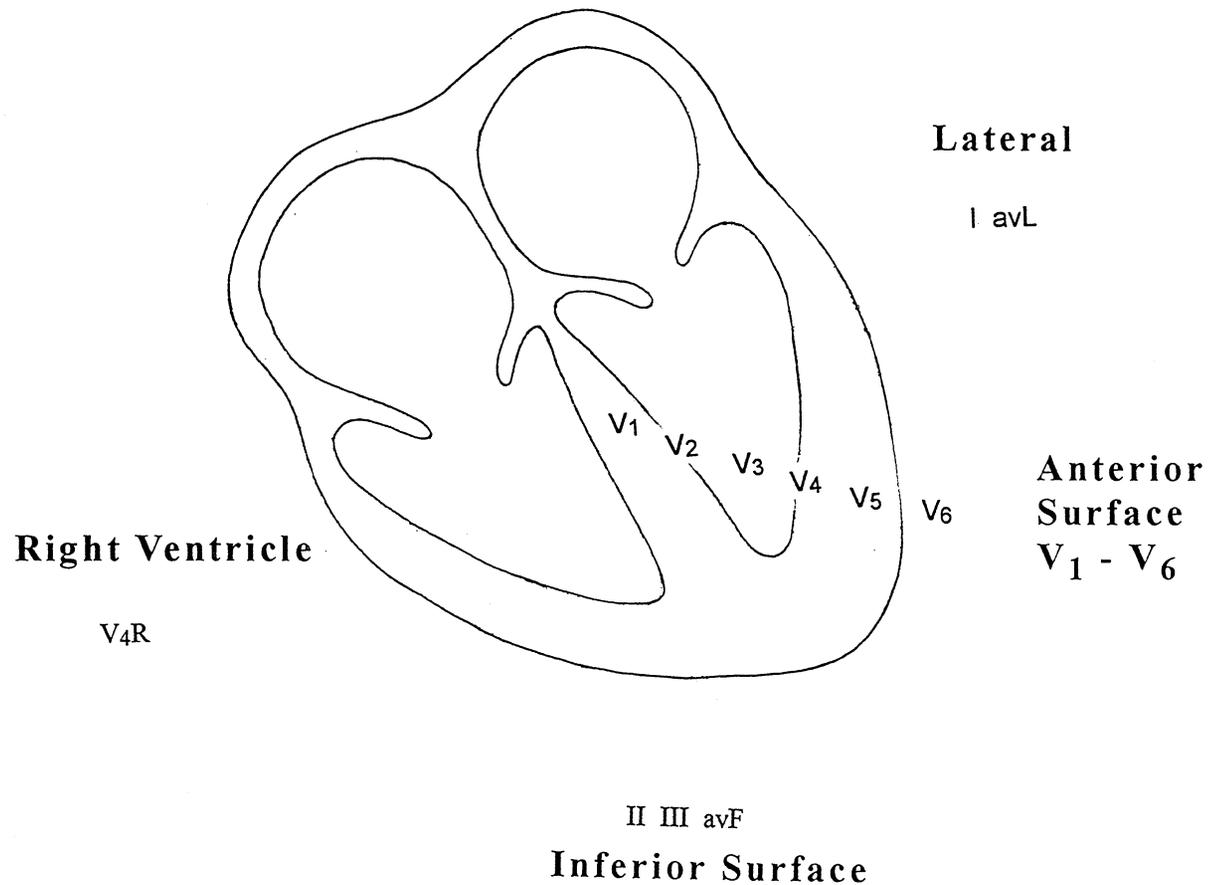
Left Main Coronary Artery

- | | |
|---------------------------|------------------|
| Left Anterior Descending | Circumflex |
| - Left Ventricle | - Left Ventricle |
| - Anterior Wall | - Lateral wall |
| - Interventricular Septum | |

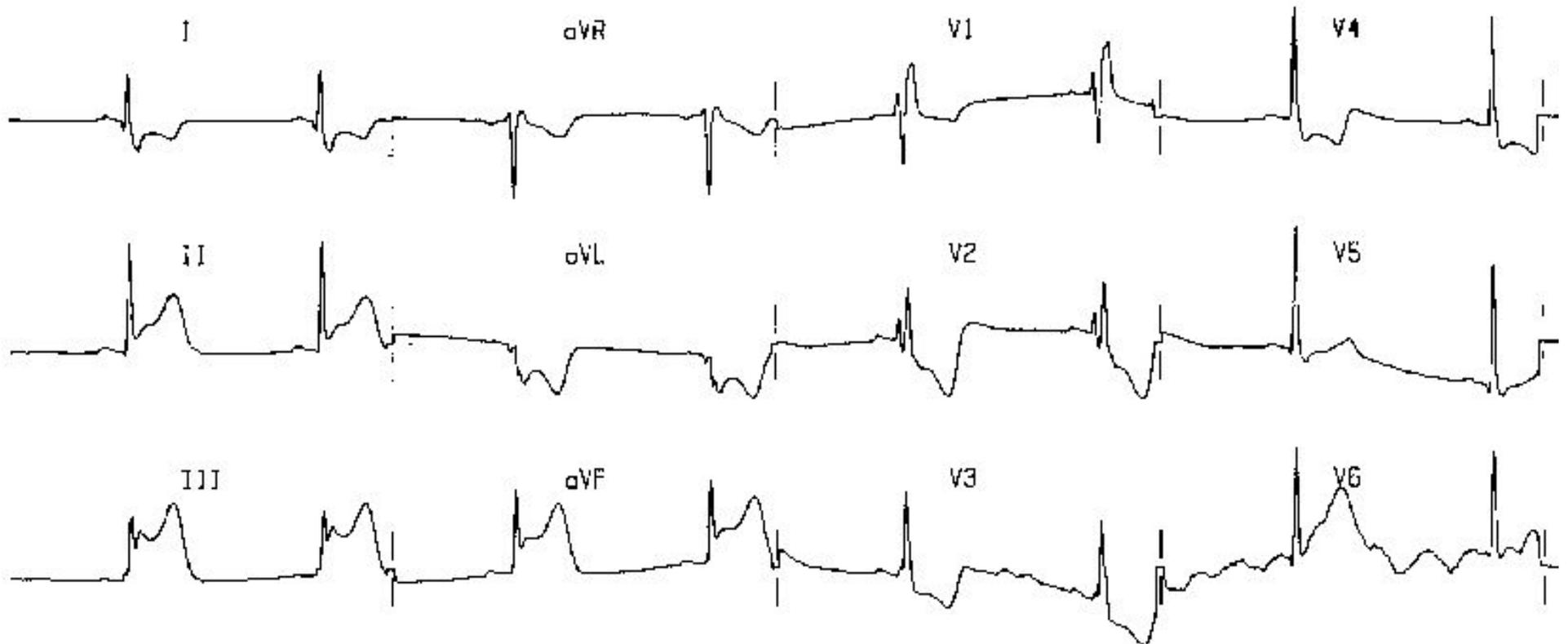
Leads tell location:

- Septal
 - V1-V2
- Anterior
 - V3-V4
- Inferior
 - II, III, AVF
- Lateral
 - I, AVL, V5-V6

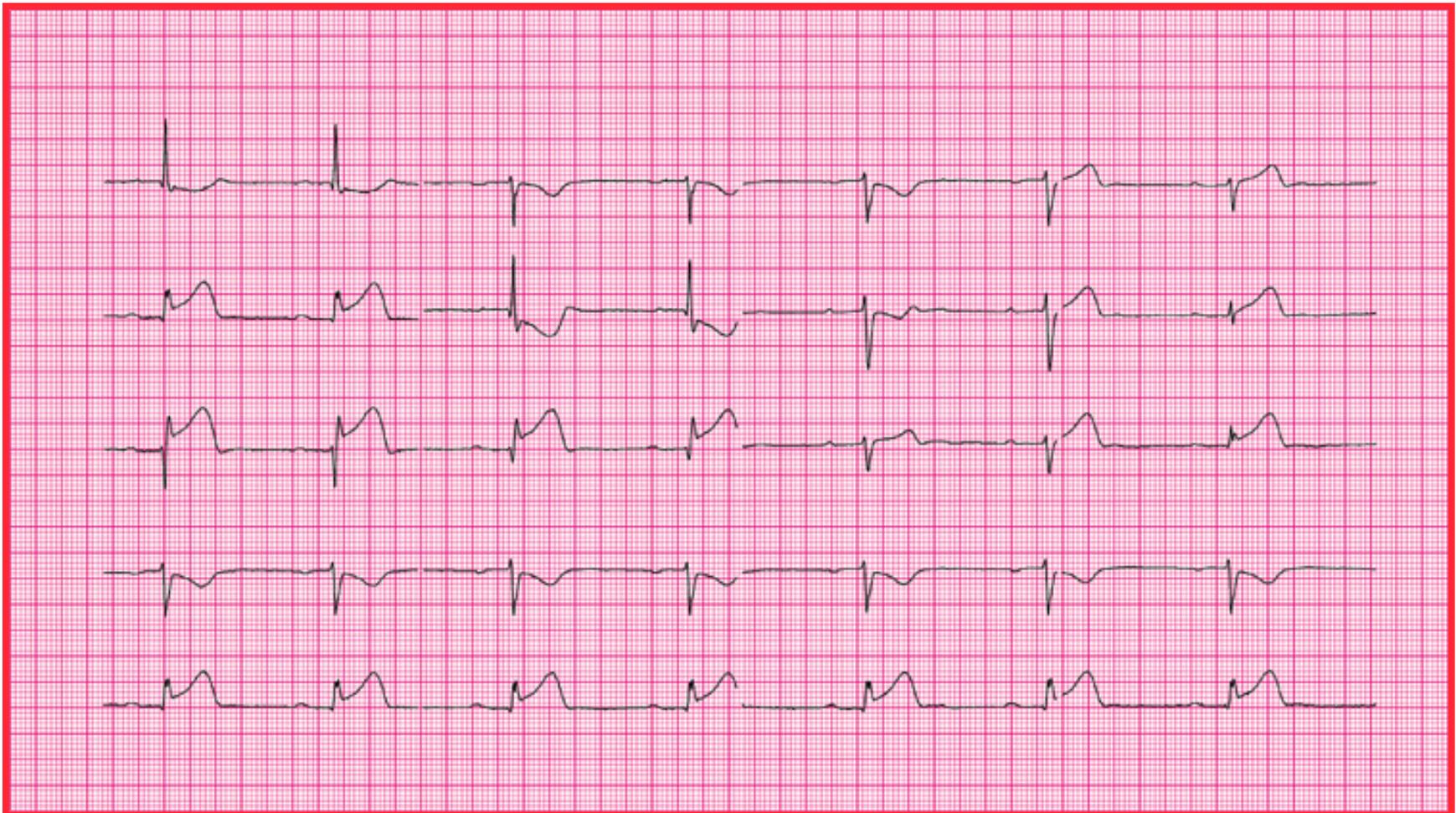
Localization of an MI:



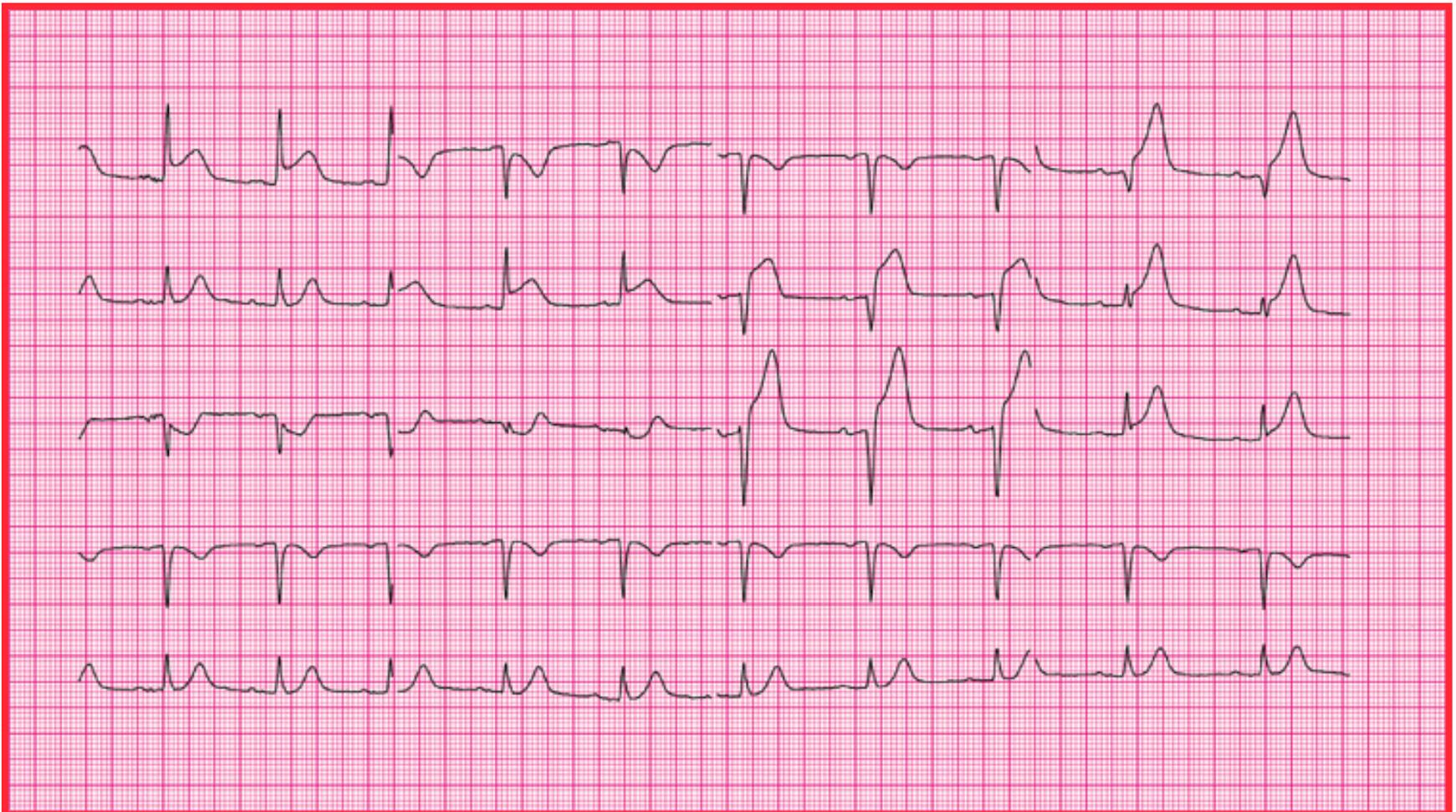
Inferior MI with reciprocal changes in lateral leads



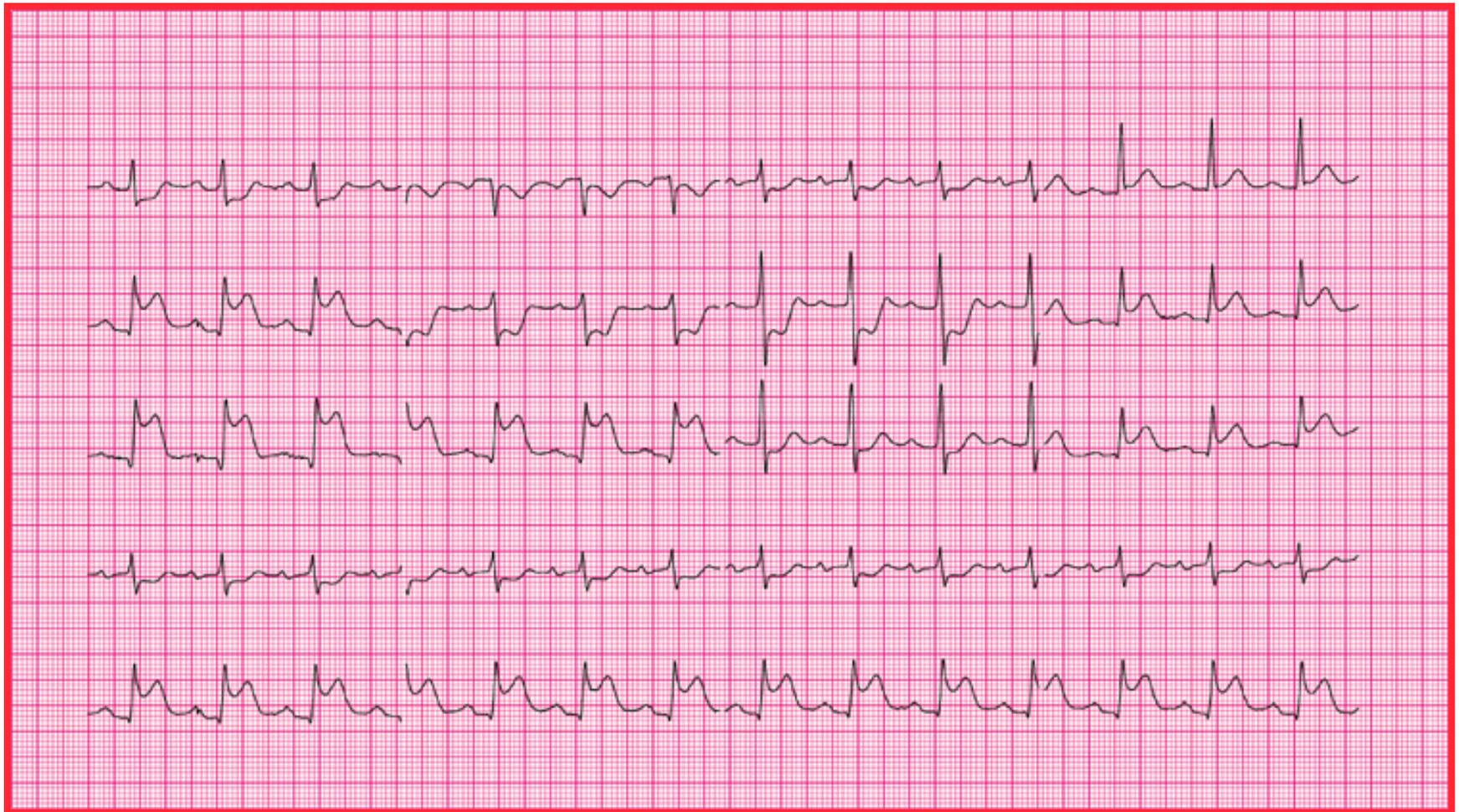
12 Lead EKG Practice



12 Lead EKG Practice

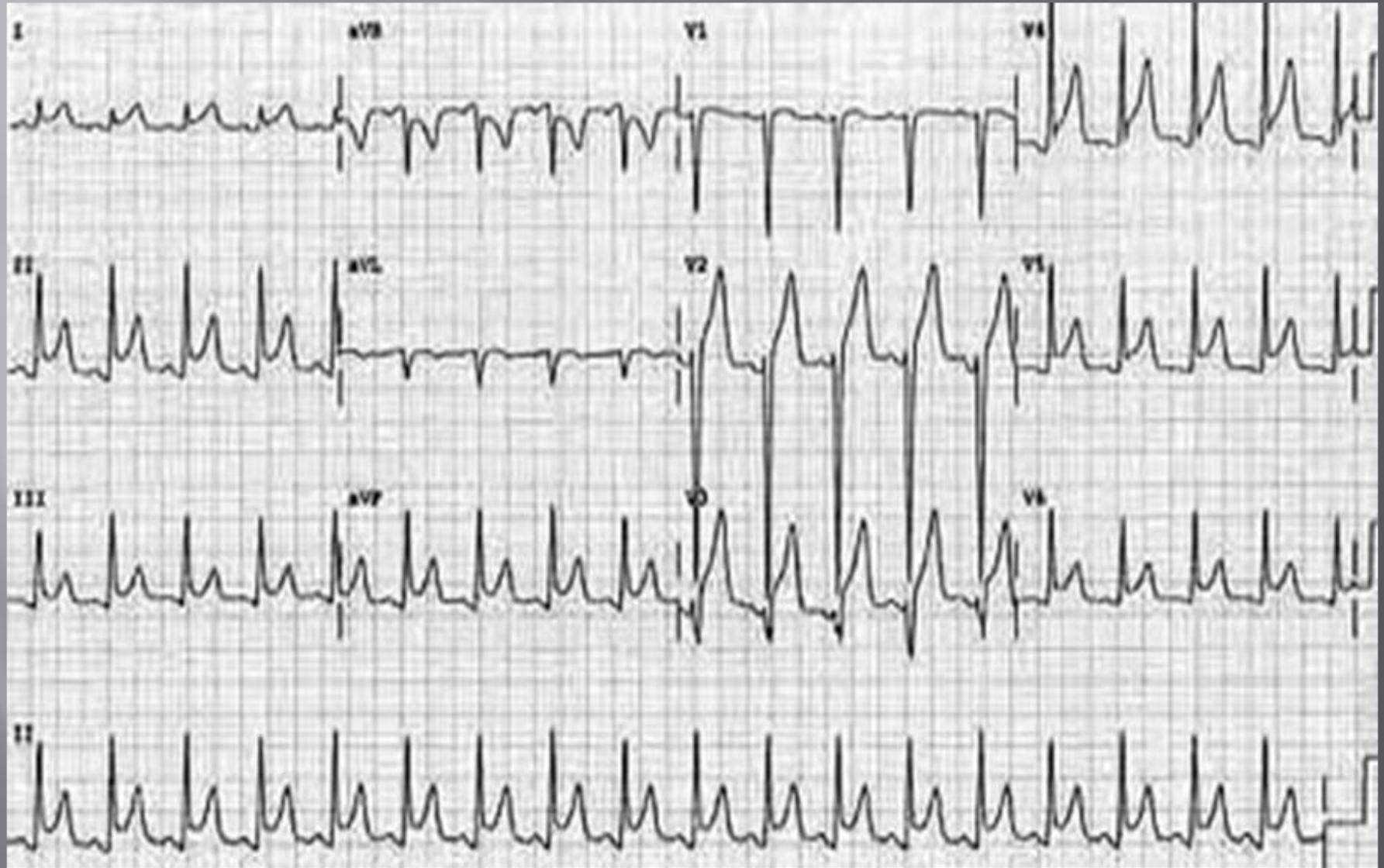


12 Lead EKG Practice

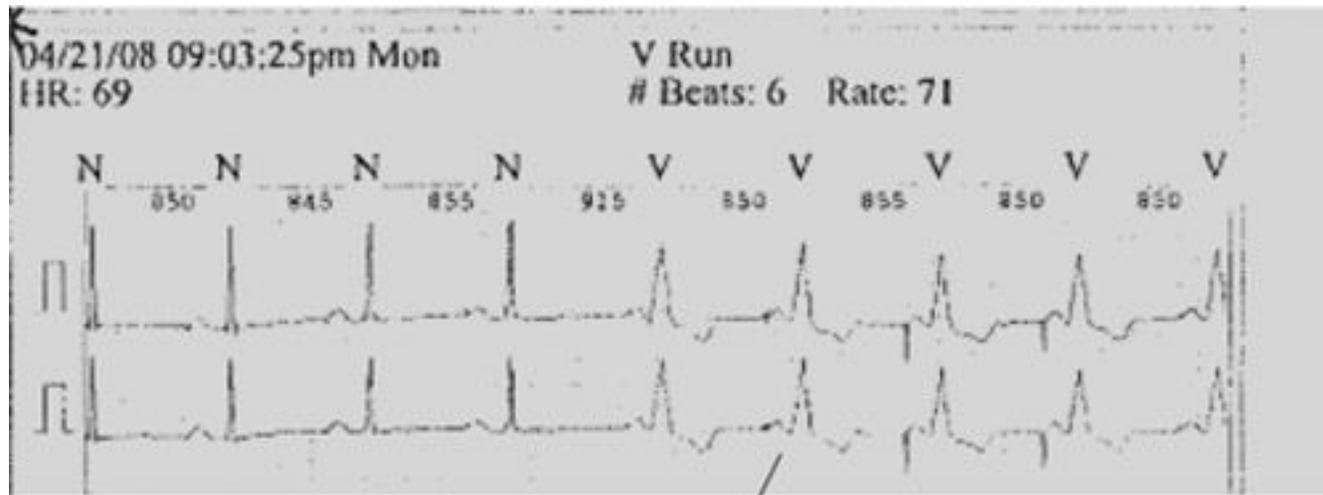
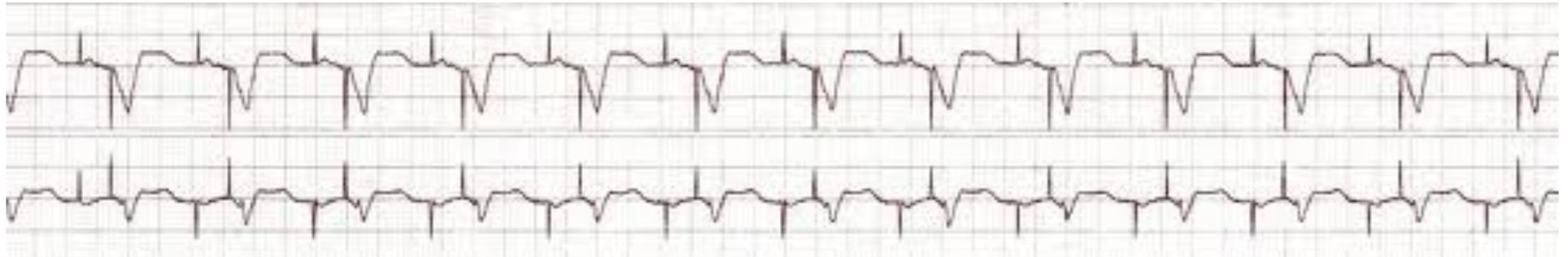


Pericarditis:

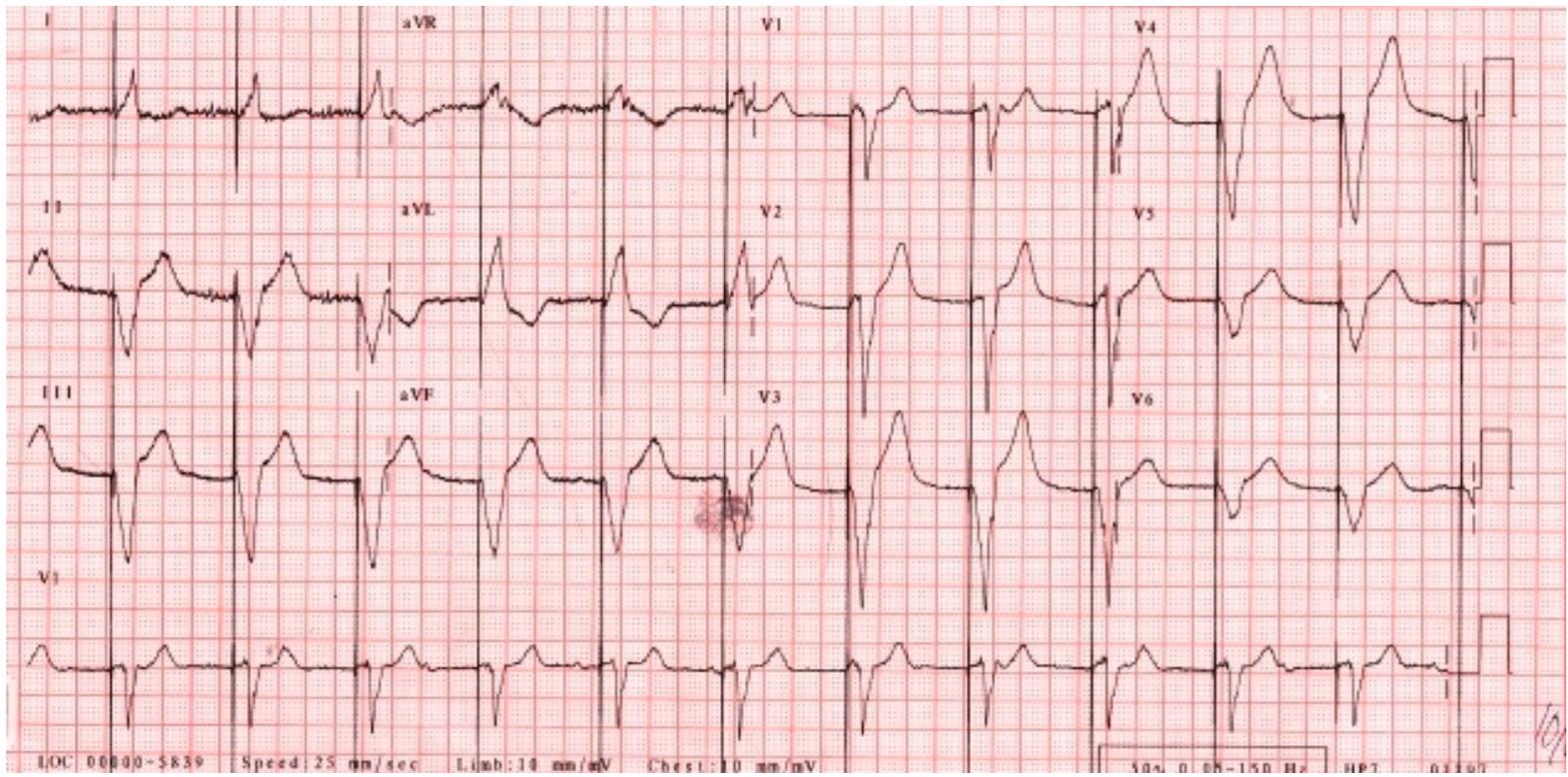
- Patients present with s/s of MI
- Sharp, pleuritic, and **POSITIONAL**-relieved by leaning forward
- Often accompanied by fever and palpitations
- Treated with ASA or NSAID
- **EKG shows DIFFUSE ST elevation in all leads except aVR**



Pericarditis



Atrio Ventricular pacing at 5V and 1ms for impedance check. This recording was triggered By patient with her usual symptoms of chest pounding.



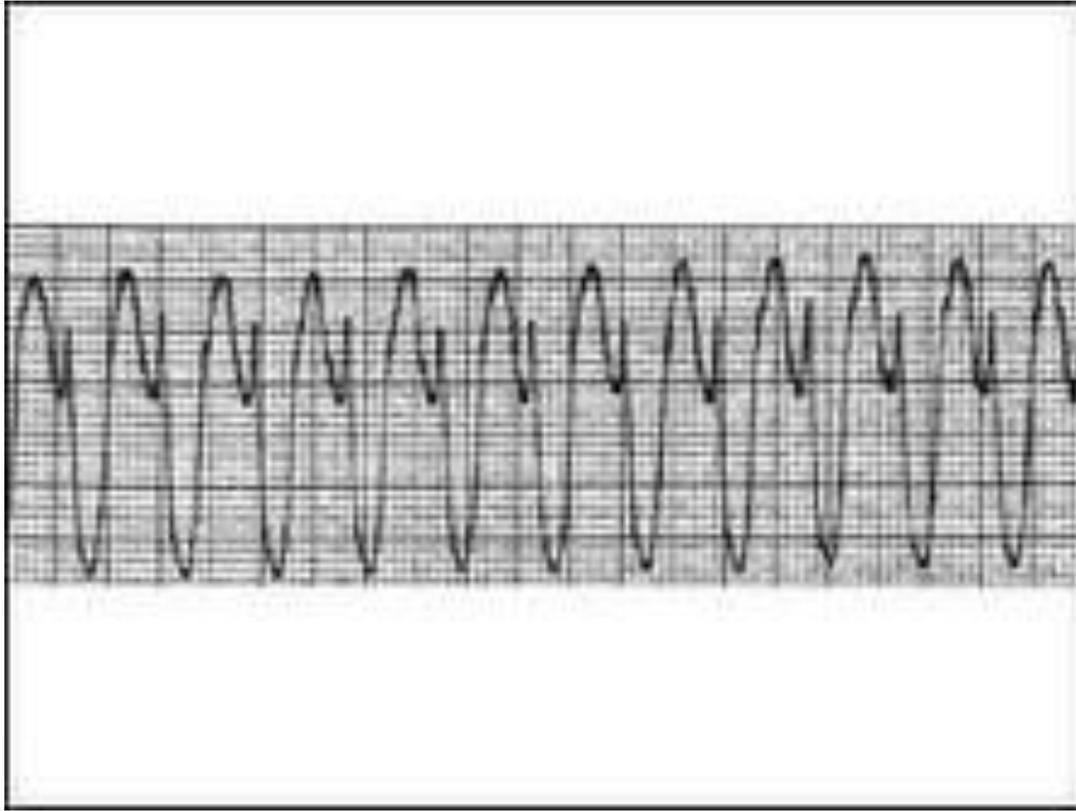
Cases....

- A 59 year-old female patient is sitting in the lobby when she begins to feel her heart race. You get her back to a patient room and hook her up to the heart monitor.
- This is what you see....



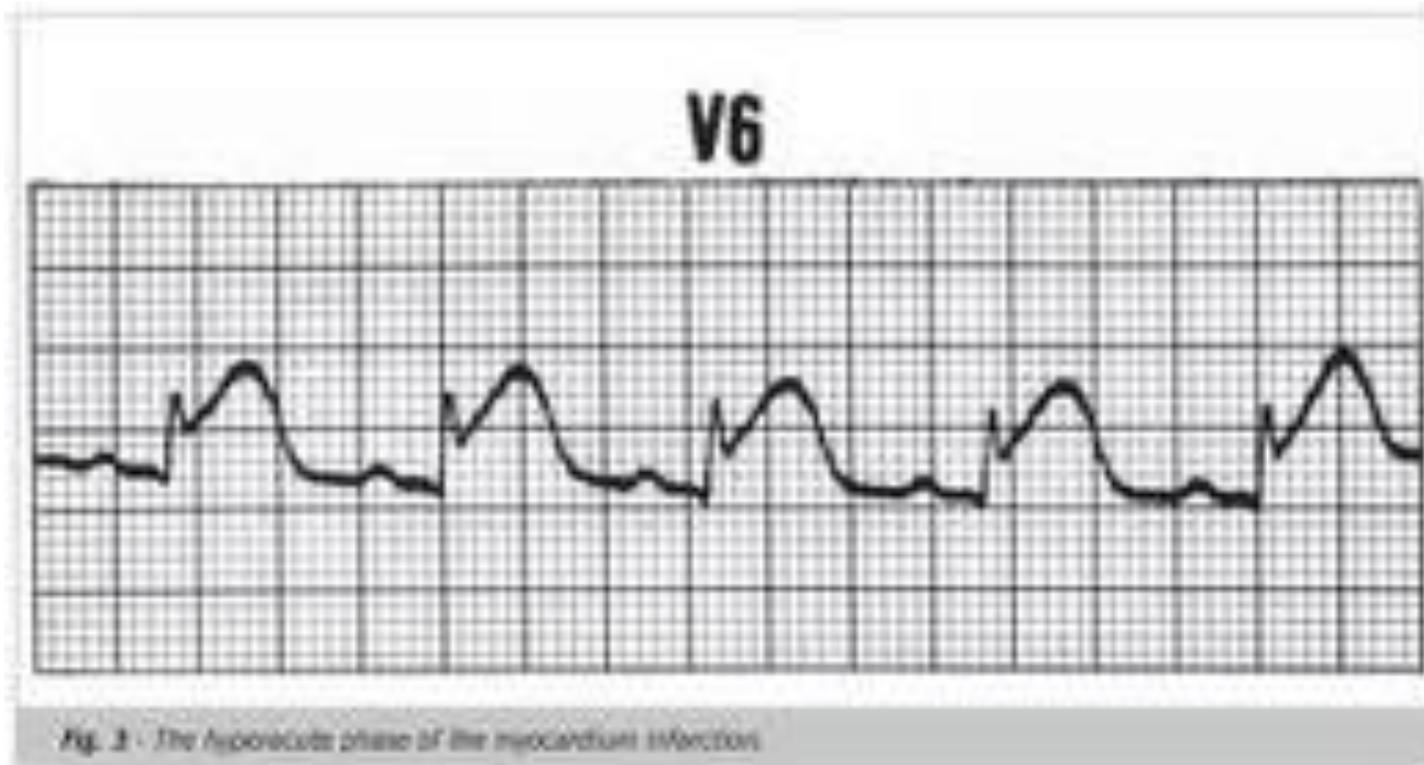
- What is the rhythm?

- A 73 year-old male diabetic patient is in the lobby waiting to see his internist. He clutches his chest and slumps onto the floor. As a member of the Code Blue Team you respond and after swift completion of your ABC's (airway, breathing, circulation- ACLS protocol!) you hook him up to the monitor.
- This is what you see.....

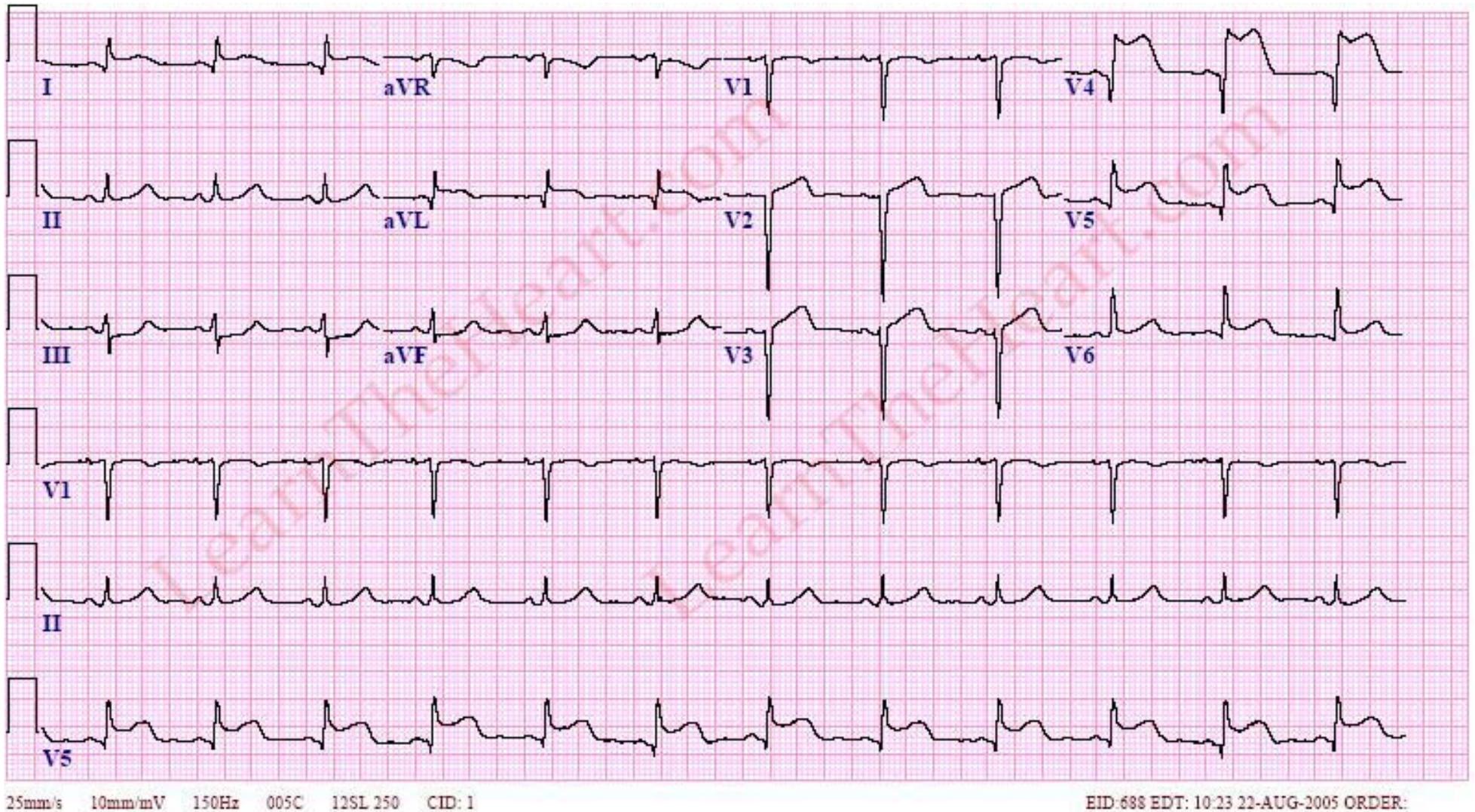


- What is the rhythm?
- What do you do next?

- You now see this on the monitor.....



- What is the rhythm?
- What else to you see?
- What do you do next?



- What do you see?
- What do you do next?

- A 32 year-old male patient comes into the clinic complaining of his heart racing. He has just come up from the Wellness Center downstairs and says he finished his “No Explode” energy drink just prior to beginning his workout. You swiftly take him back to a patient room and hook up the monitor.
- This is what you see.....

- A 65 year-old male patient comes into the clinic to be evaluated for a syncopal episode. He admits to frequent episodes of lightheadedness and feeling like he could pass out. You hook him up to the monitor this is what you see.....



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- What do you see?
- What is the underlying rhythm?