

# EKG Essentials

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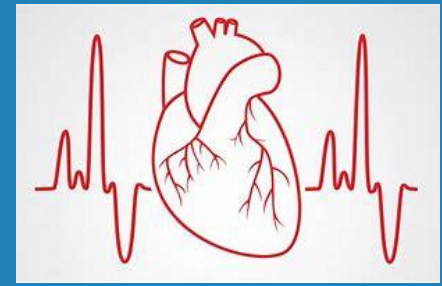


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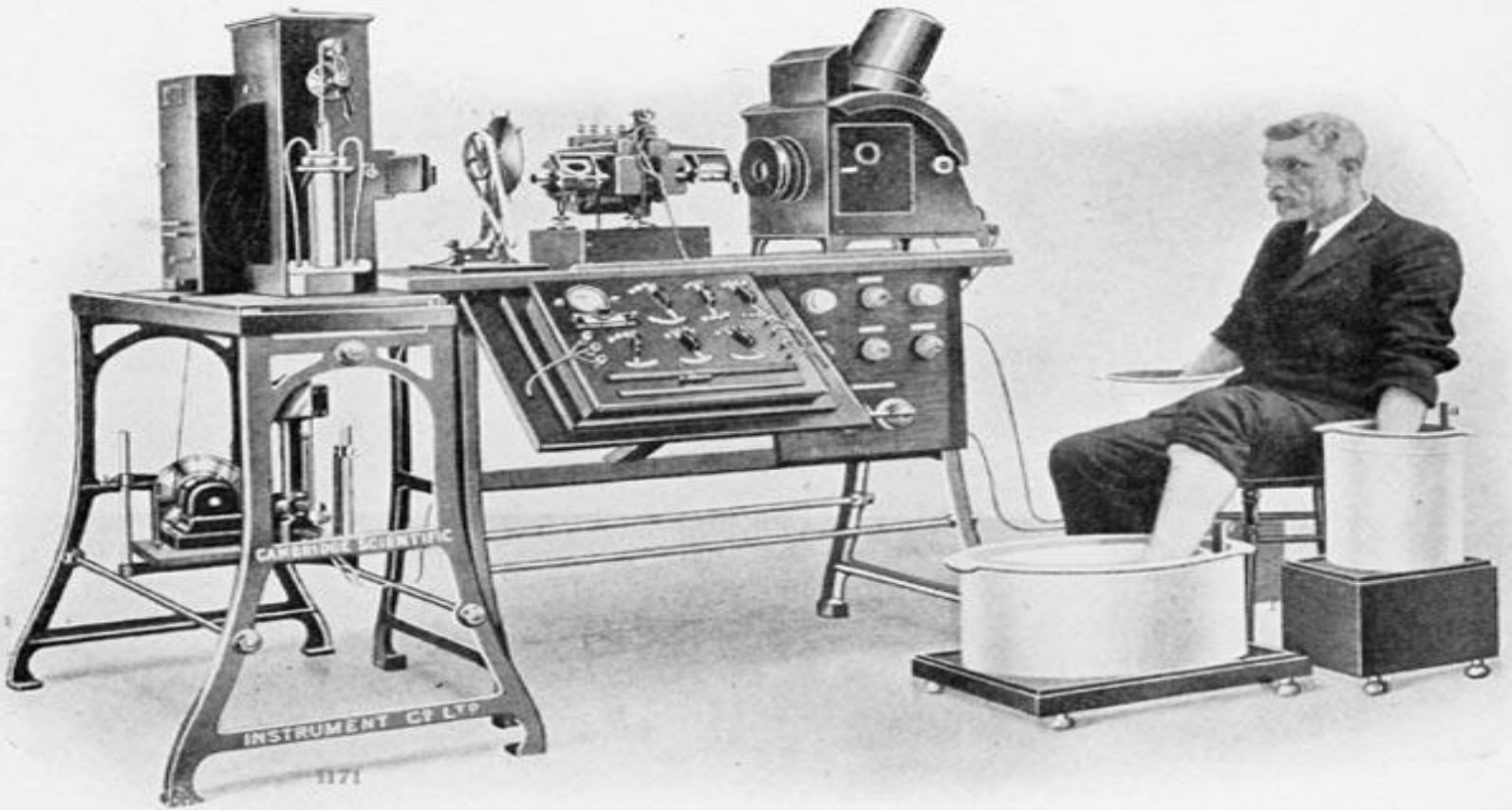
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# Learning Objectives



1. Describe what an EKG is and measures.
2. Describe the proper lead placement for a 12-Lead EKG.
3. Identify basic EKG waveform morphology.
4. Identify 4 basic brady and tachy EKG dysrhythmias and lethal rhythms.



PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSSED IN JARS OF SALT SOLUTION

1842-Italian scientist Carlo Matteucci discovers electricity is associated with the heart.

1876- Irish scientist analyzes the electrical pattern of a frog's heart.

1895-William Einthoven invents the EKG.

# EKG INSTRUMENTS



# What is an ECG/EKG?



- The electrocardiogram (EKG/ECG) is a representation of the electrical events of the cardiac cycle.
- Each event has a distinctive waveform
- The waveforms give insight into a patient's cardiac pathophysiology.

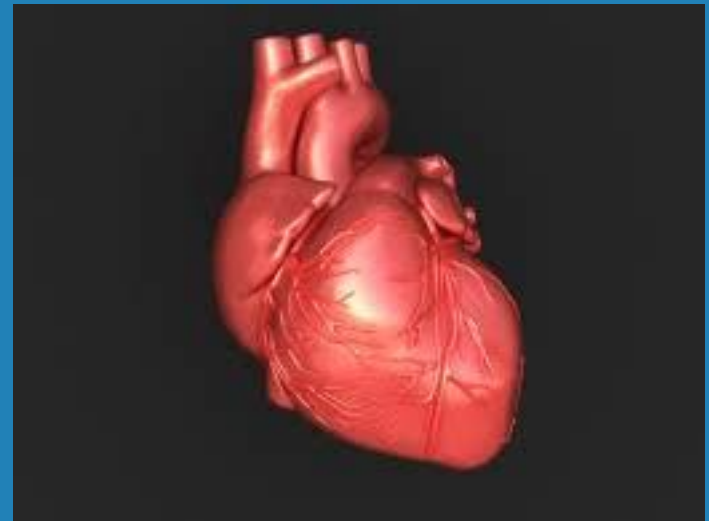
# REVIEW OF the HEART

## Purpose

- **Pumps blood**

## Basic Anatomy

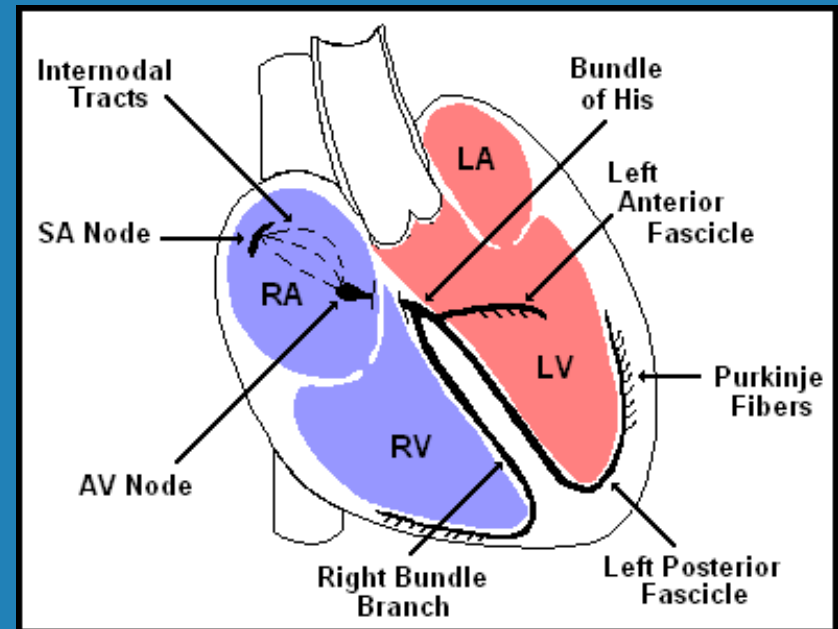
- **4 chambers**
- **2 sides**
- **4 valves**
- **Pacemakers: SA, AV**



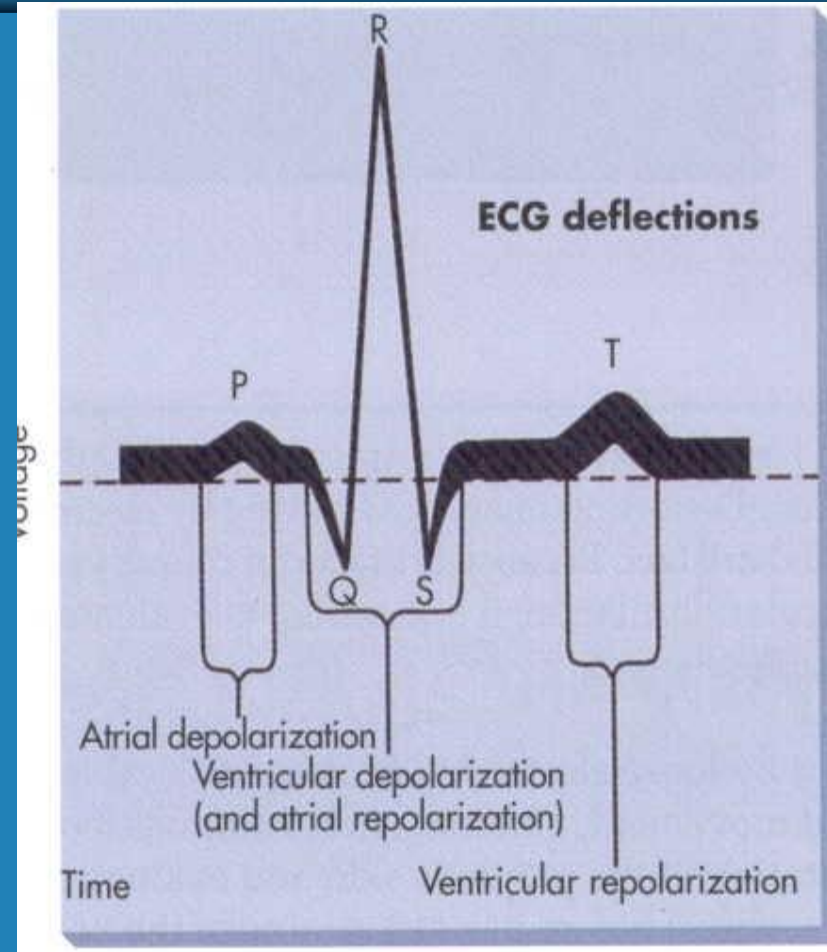
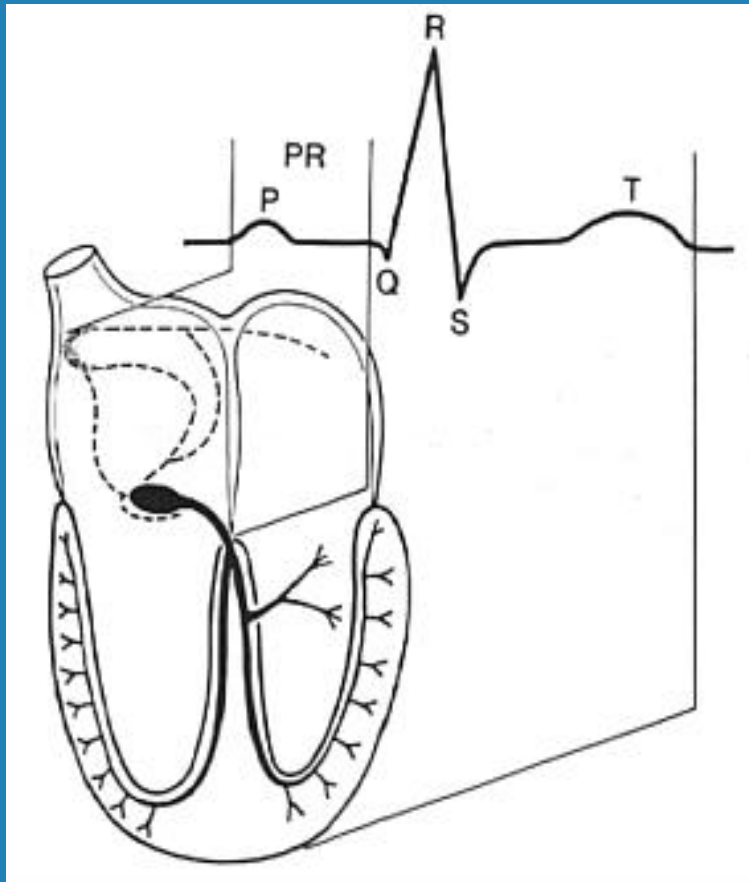





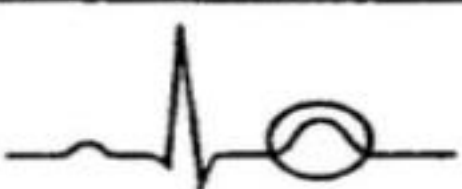

# THE CONDUCTING SYSTEM

- SA Node
- Inter-nodal pathway
- AV Node
- Bundle of HIS
- Bundle Branches
- Purkinje Fibers
- Cardiac muscle cells

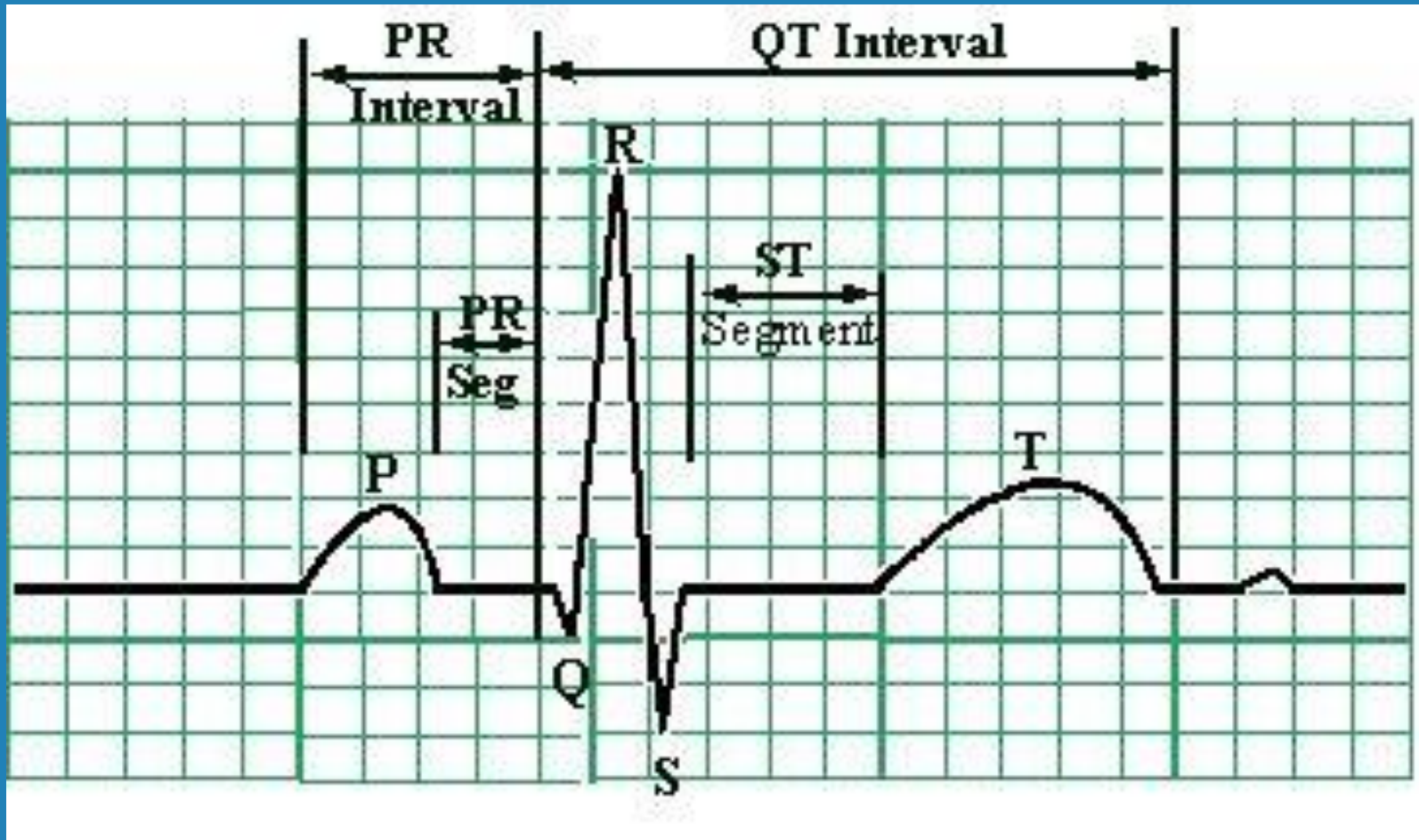


# Waveforms



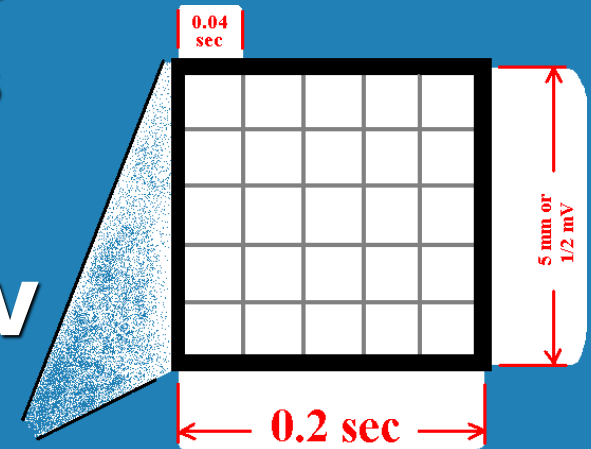
Electrical Activity	Graphic Depiction	Associated Pattern
Atrial Depolarization		P Wave
Delay at AV Node		PR Segment
Ventricular Depolarization		QRS Complex
Ventricular Repolarization		T Wave
No electrical activity		Isoelectric Line

# CARDIAC CYCLES



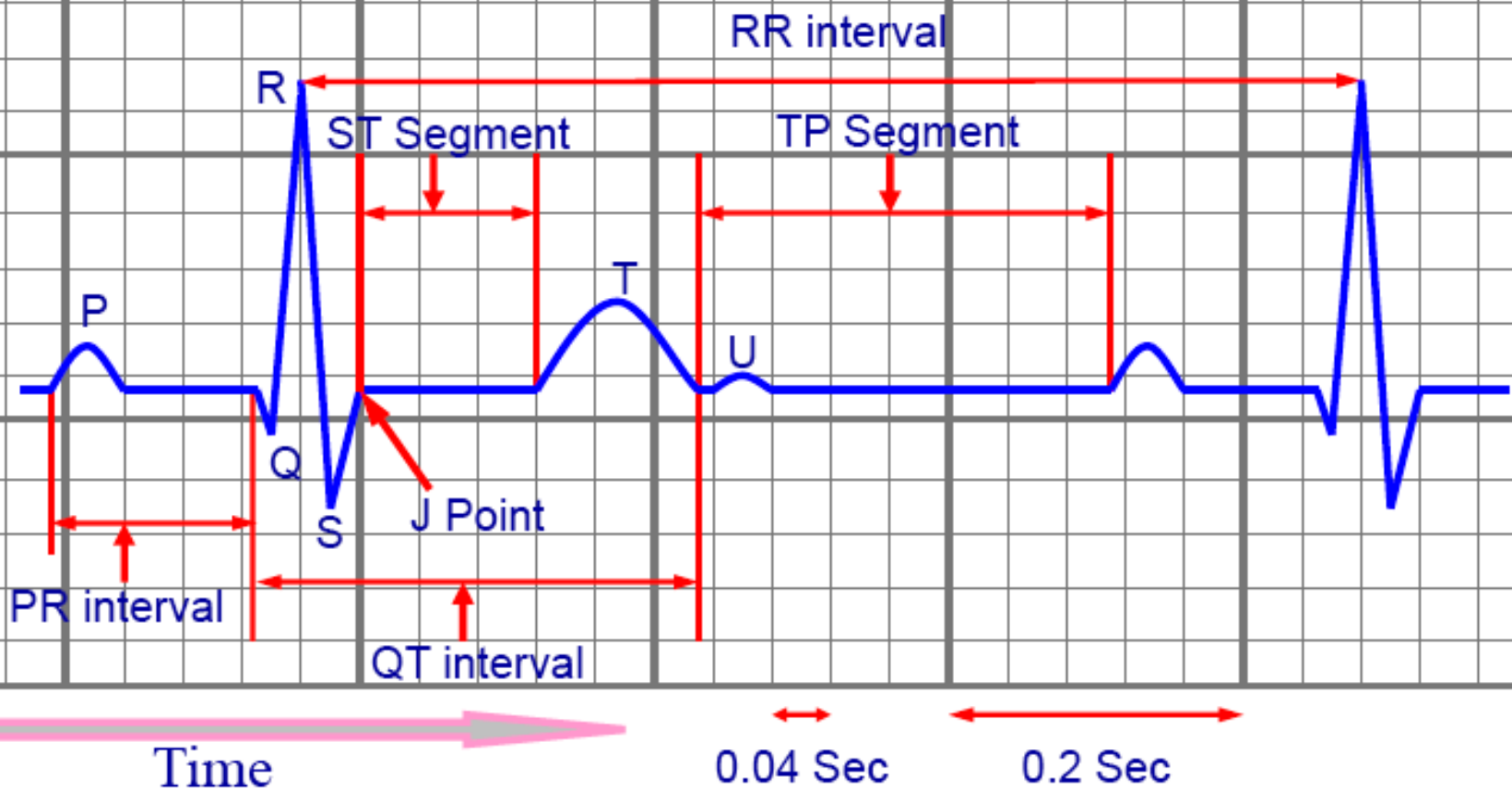
# The ECG Paper

- **Horizontally**
  - One small box - 0.04 s
  - One large box - 0.20 s
- **Vertically**
  - One large box - 0.5 mV



0.1 mv ↑

Voltage

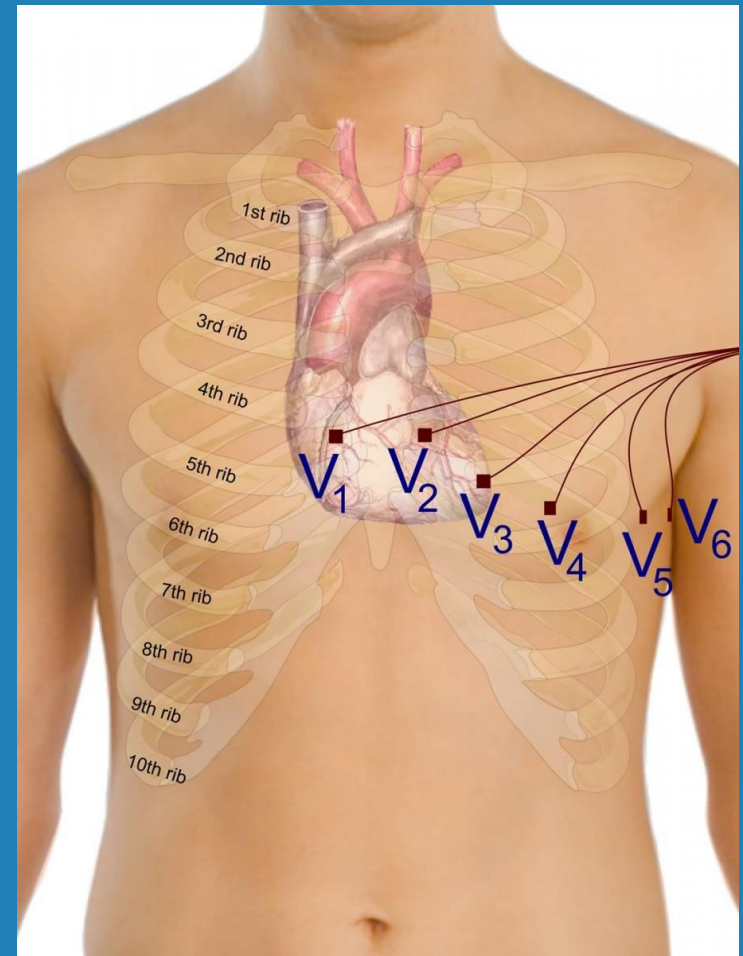


- PR interval 0.12 – 0.20 sec
- QRS duration 0.08 – 0.10 sec

- QT interval 0.4 – 0.43 sec
- RR interval 0.6 – 1.0 sec

# Placement 12-LEAD ECG

- **Proper skin prep**
- **Placement of the limb electrodes**
- **Placement of the chest electrodes**



# EKG Leads

The standard EKG has 12 leads:

3 Standard Limb Leads

3 Augmented Limb Leads

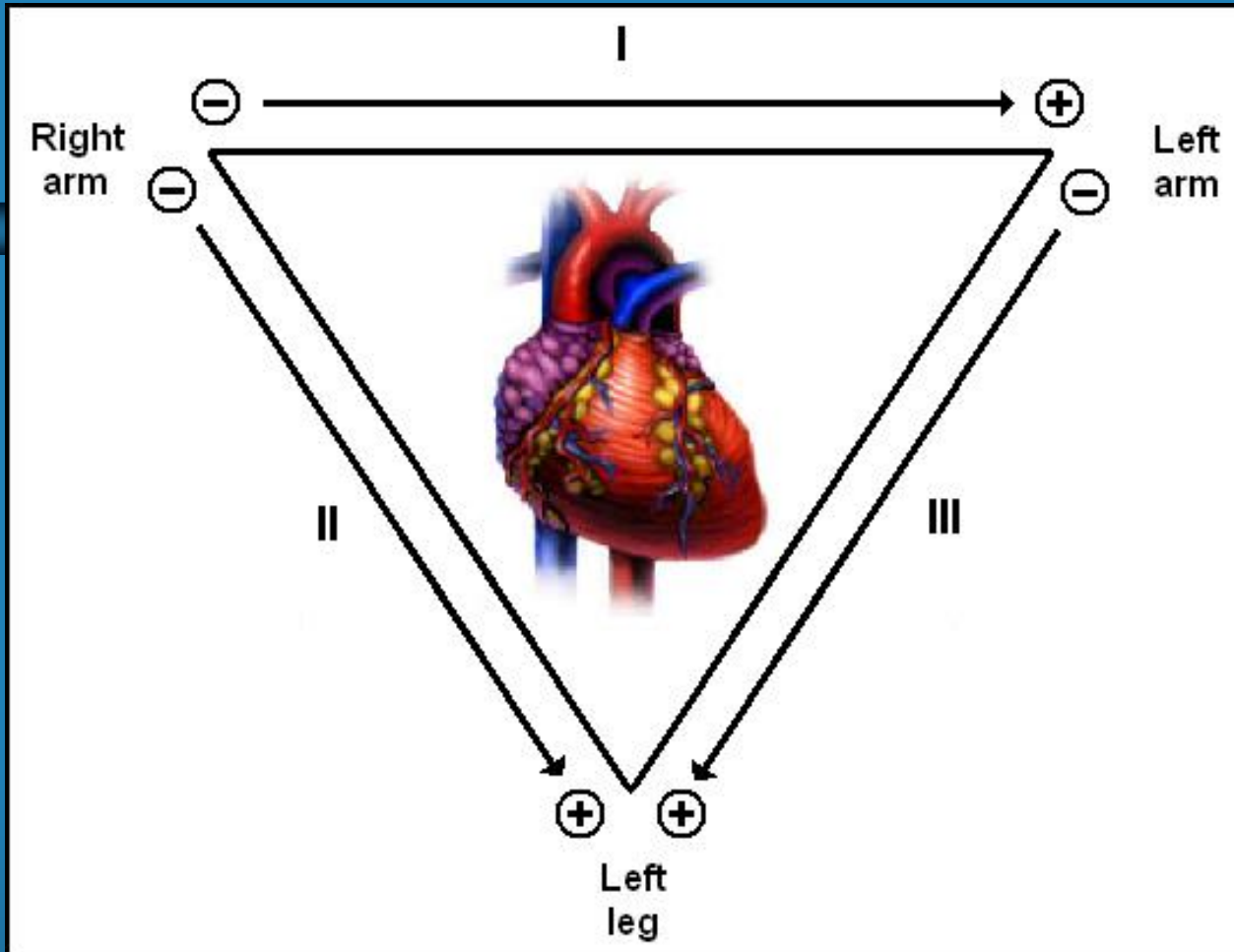
6 Precordial Leads

1. Bipolar Leads: Two different points on the body

2. Unipolar Leads: One point on the body and a virtual reference point with zero electrical potential, located in the center of the heart

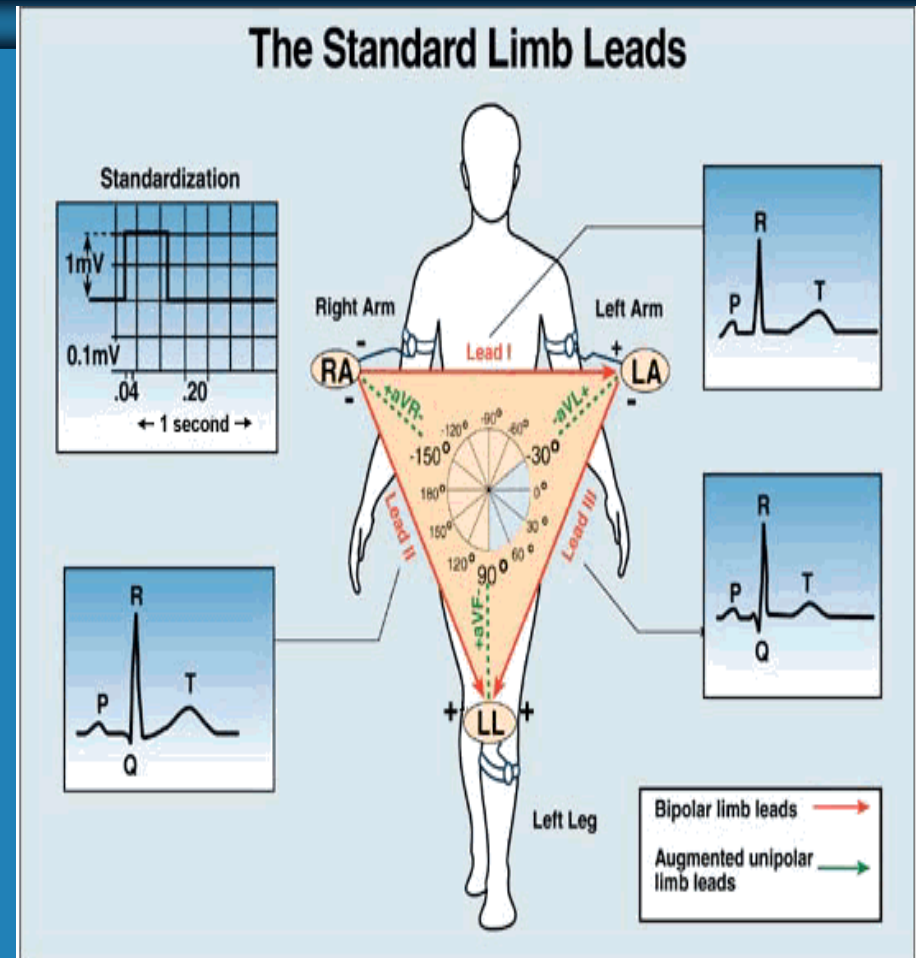


# Standard Limb Leads



# LIMB LEADS

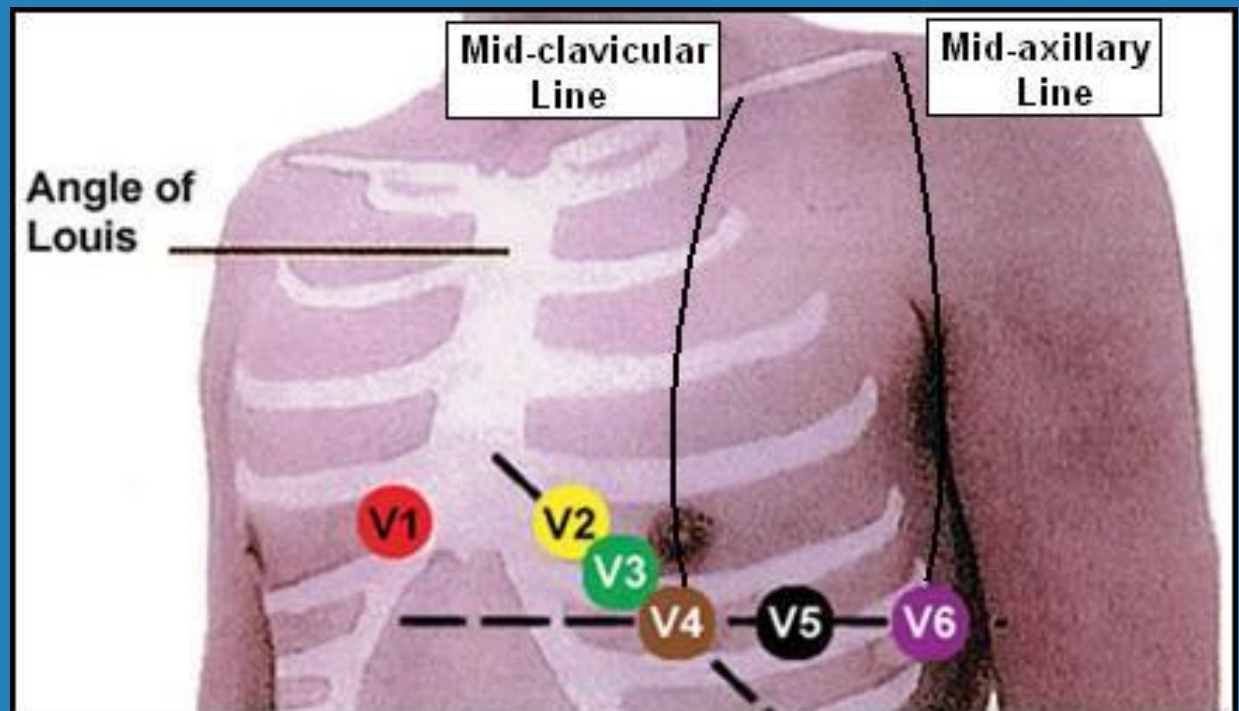
- **Bipolar leads**  
**I II III**
- **Augment leads**  
**Avr Avl Avf**



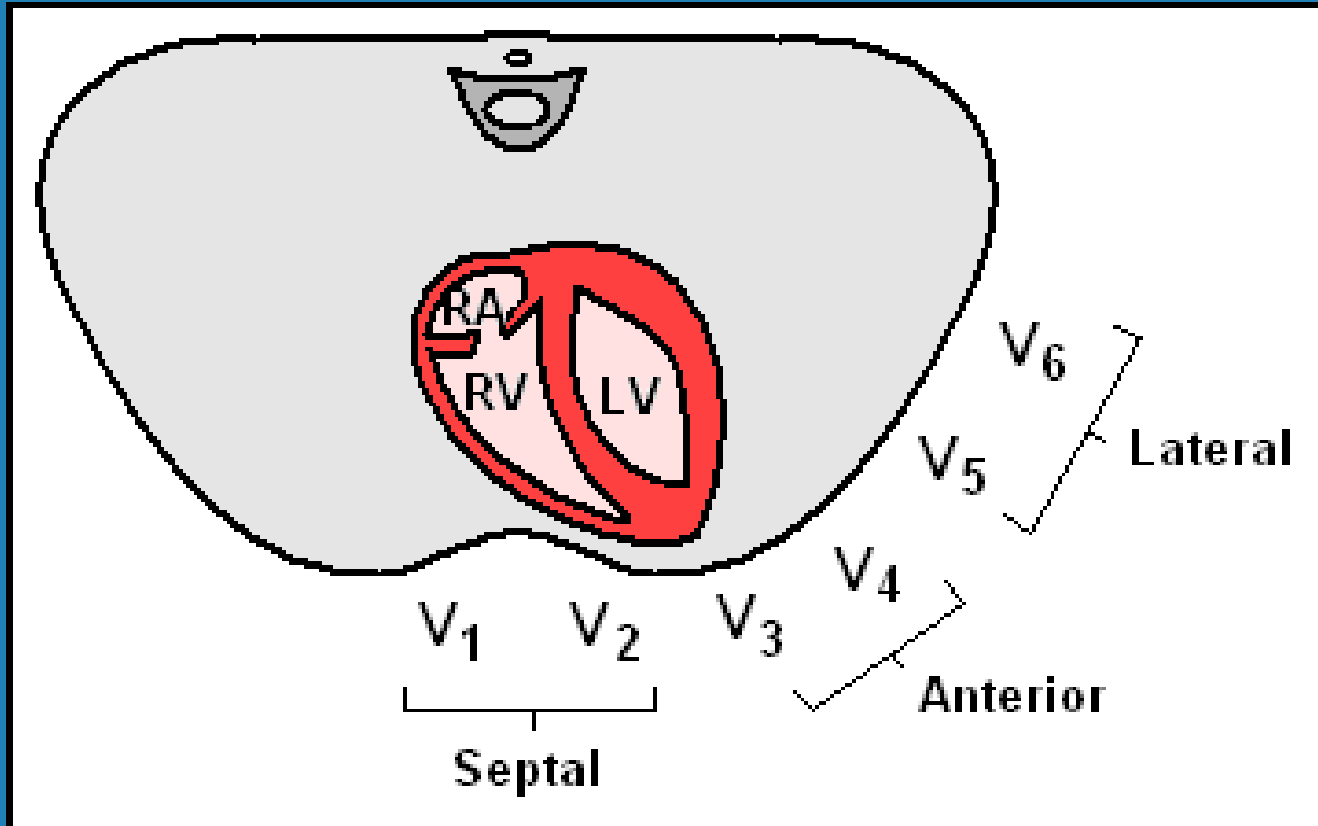
# Precordial CHEST LEADS

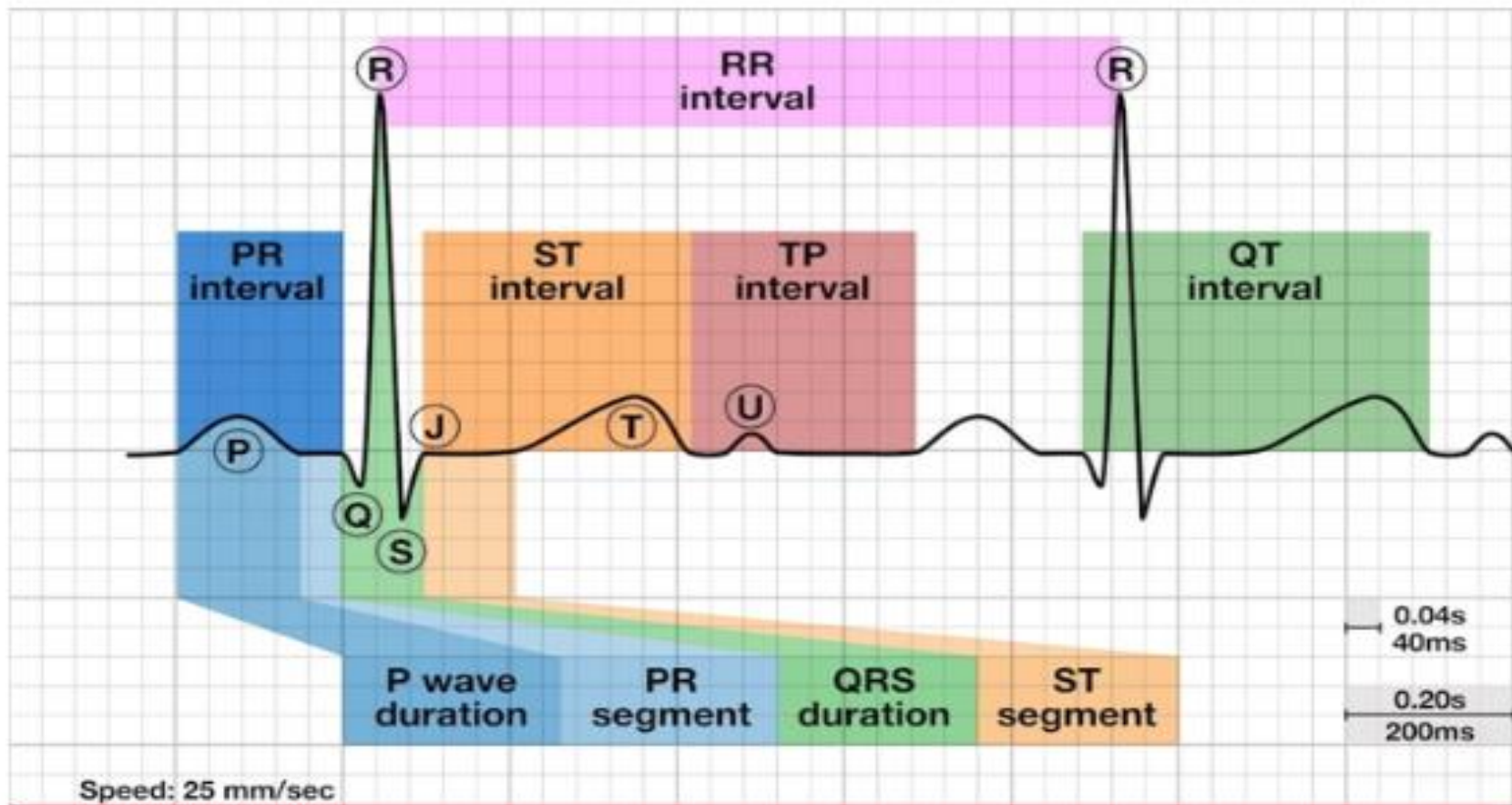
- **6 UNIPOLAR LEADS**

- **V1**
- **V2**
- **V3**
- **V4**
- **V5**
- **V6**



# Precordial Leads

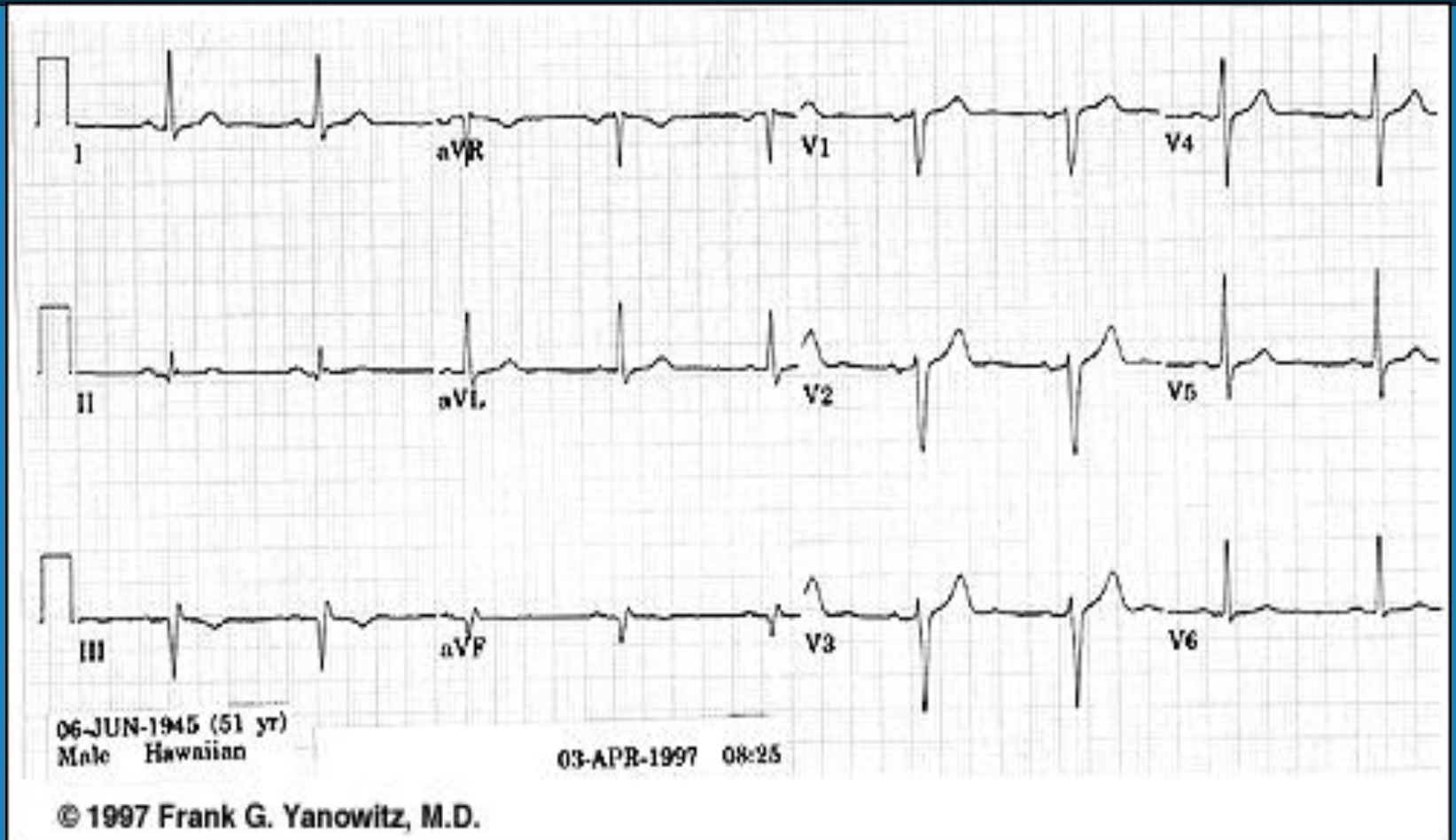




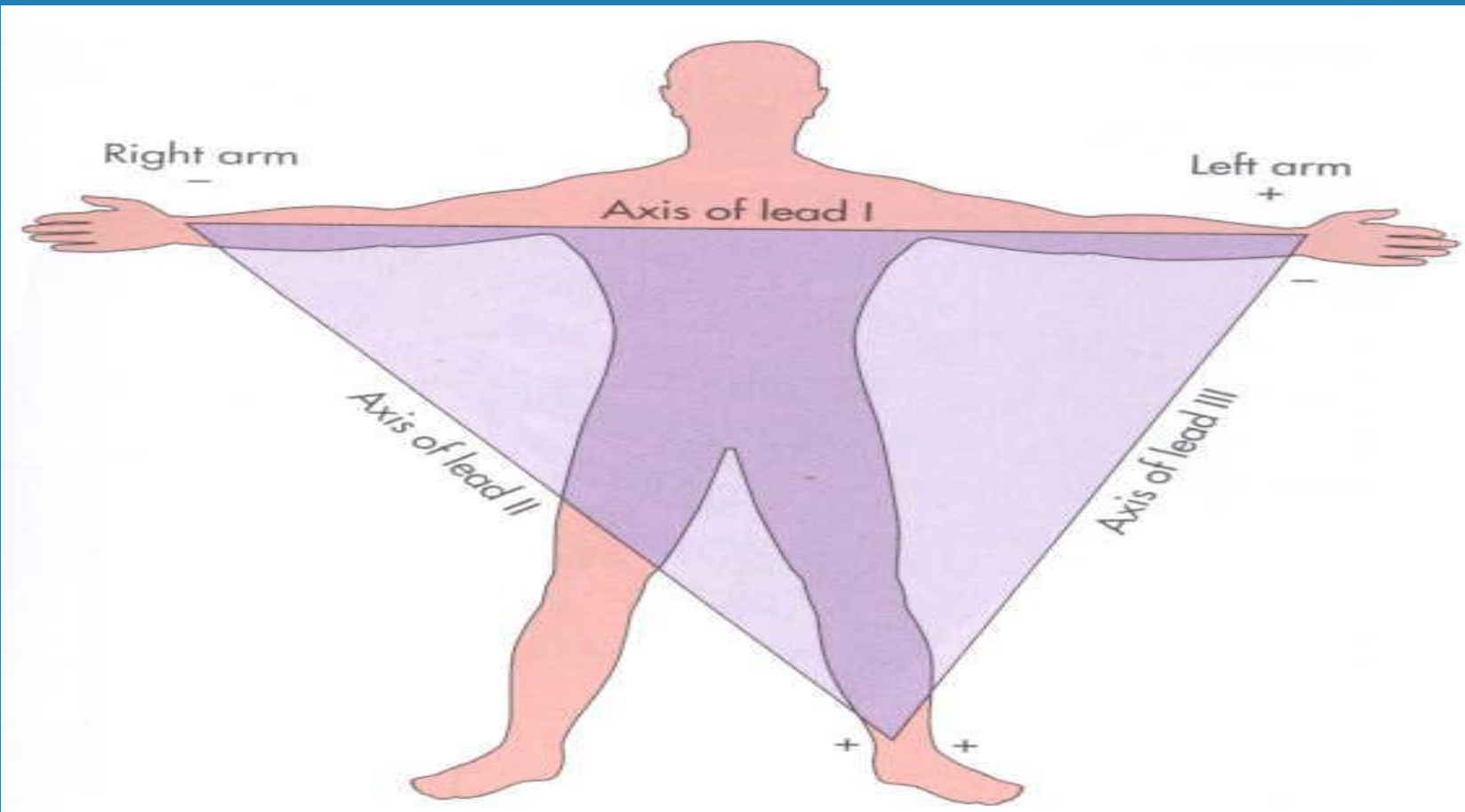
In regards to what things mean...

- The P wave reflects atrial firing
- The QRS reflects the ventricle firing
- The T wave reflects ventricle recovery
- The U wave (not always seen) represents small fiber recovery (Purkinje fiber repolarization).

# 12-LEAD ECG LAYOUT



# EINTHOVENS TRIANGLE



# Anatomic Groups (Septum)

I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral



# Anatomic Groups (Anterior Wall)

I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

# Anatomic Groups (Lateral Wall)

<b>I</b> Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
<b>II</b> Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
<b>III</b> Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

# Anatomic Groups (Inferior Wall)

I Lateral	aVR None	V <sub>1</sub> Septal	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septal	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

# Anatomic Groups (Summary)

<b>I</b> Lateral	<b>aVR</b> None	<b>V<sub>1</sub></b> Septal	<b>V<sub>4</sub></b> Anterior
<b>II</b> Inferior	<b>aVL</b> Lateral	<b>V<sub>2</sub></b> Septal	<b>V<sub>5</sub></b> Lateral
<b>III</b> Inferior	<b>aVF</b> Inferior	<b>V<sub>3</sub></b> Anterior	<b>V<sub>6</sub></b> Lateral

# WHAT YOU NEED TO LOOK FOR

- **Rate**
- **Rhythm**
- **Regularity**
- **R to R**





# How to Calculate Rate

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- **Rule of 300**
- **10 Second Rule**

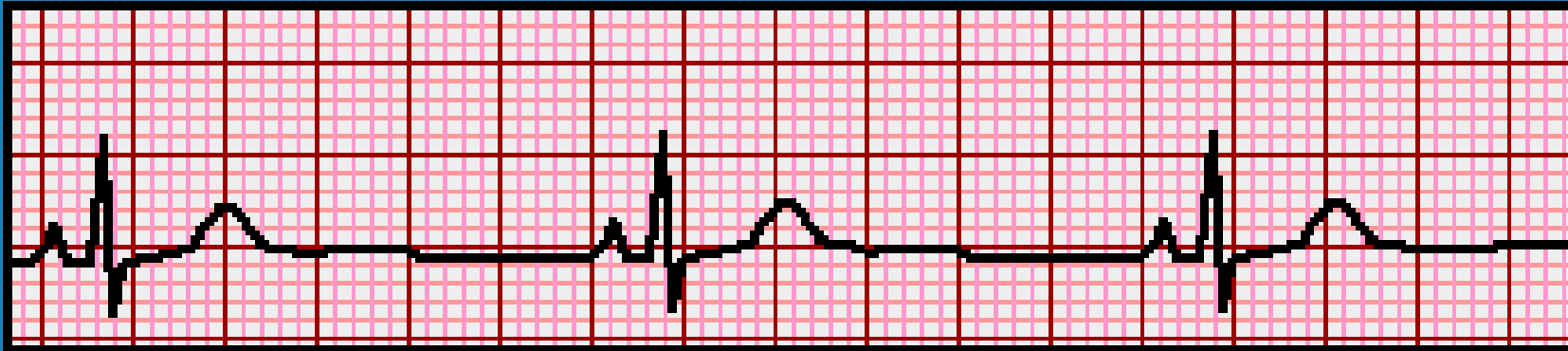


# Rule of 300

Take the number of “big boxes” between neighboring QRS complexes, and divide this into 300. The result will be approximately equal to the rate.

This method only works for regular rhythms.

# What is the heart rate?

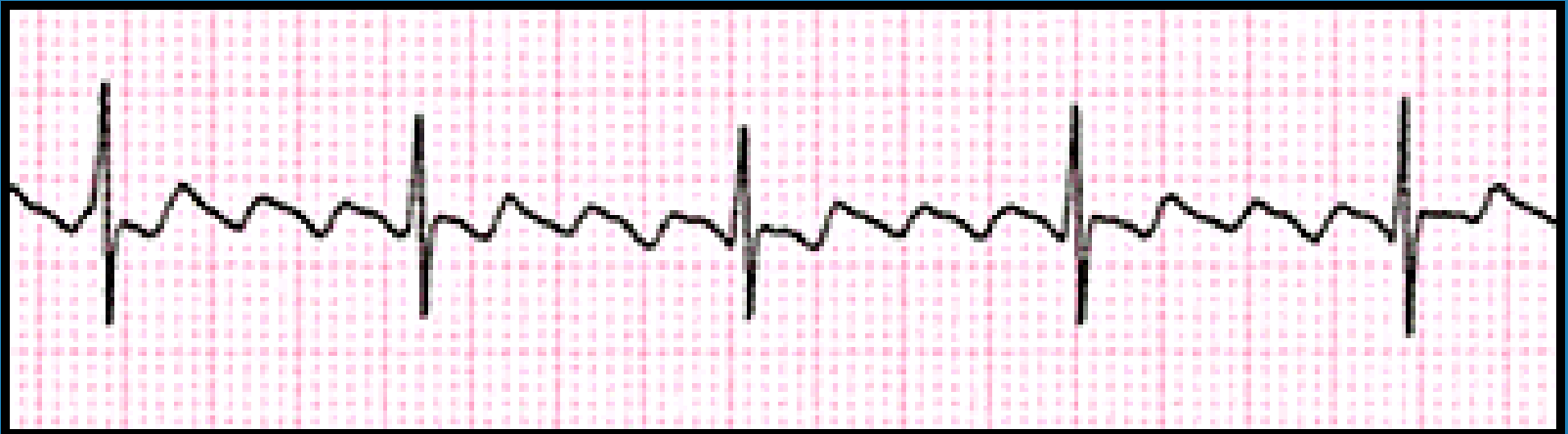


[www.uptodate.com](http://www.uptodate.com)

$$(300 / 6) = 50 \text{ bpm}$$



# What is the heart rate?



[www.uptodate.com](http://www.uptodate.com)

$$(300 / \sim 4) = \sim 75 \text{ bpm}$$

# What is the heart rate?



$$(300 / 1.5) = 200 \text{ bpm}$$



# The Rule of 300

**It may be easiest to memorize  
the following table:**

# of big boxes	Rate
1	300
2	150
3	100
4	75
5	60
6	50



# 10 Second Rule

**EKGs record 10 seconds of rhythm per page, so simply count the number of beats present on the EKG and multiply by 6 to get the number of beats per 60 seconds.**

**This method works well for irregular rhythms.**

# What is the heart rate?



The Alan E. Lindsay ECG Learning Center ; <http://medstat.med.utah.edu/kw/ecg/>

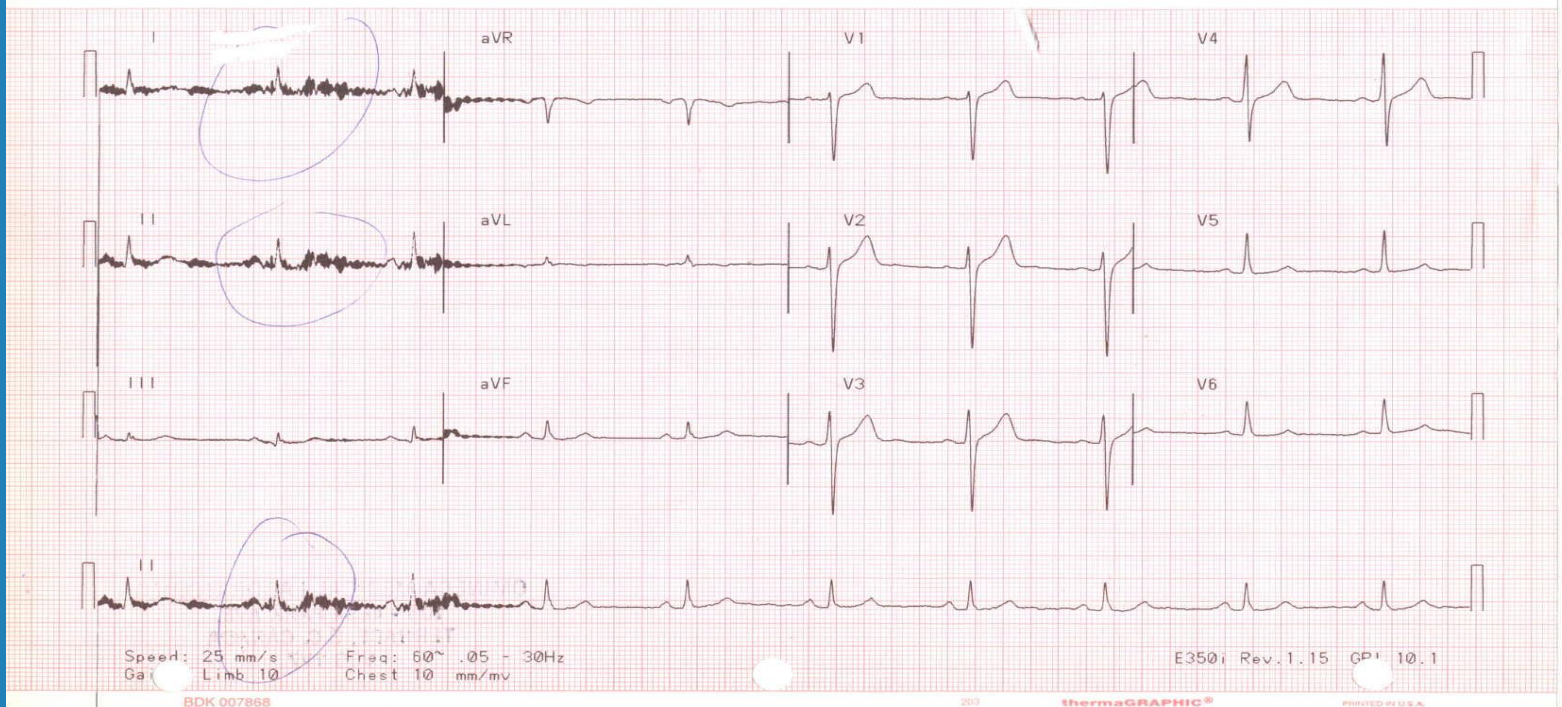
$33 \times 6 = 198 \text{ bpm}$

# ELECTRICAL INTERFERENCE

Name: [REDACTED]  
ID: [REDACTED]  
Date: 09/24/02 Time: 11:22  
Age: 51 Sex: MALE  
Hgt: 72 IN Vgt: 215 LBS  
Med1:  
Med2:  
Ccl1:  
Ccl2:  
Cmnt:

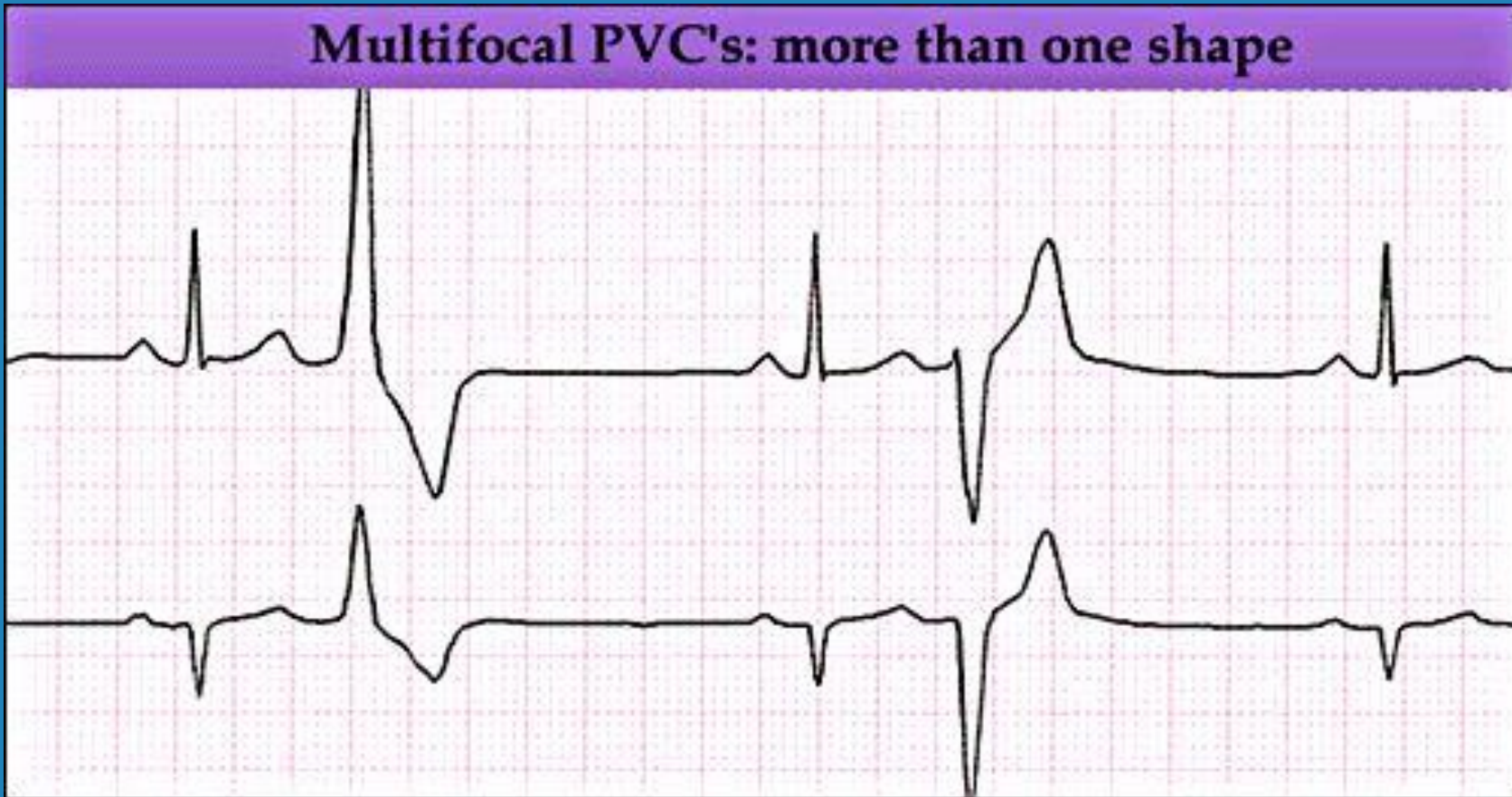
Vent rate: 59  
--Durations--  
P : 108  
QRS: 114  
--Intervals--  
PR : 164  
QT : 422  
QTc: 421  
--Axes--  
P : 65  
QRS: 45  
T : 54

SINUS BRADYCARDIA  
DEMAND VENTRICULAR PACING  
ST-T changes in inferior leads  
MAY BE RELATED TO THE ELECTRONIC PACEMAKER ACTIVITY  
SUMMARY: ABNORMAL \*\* UNCONFIRMED ANALYSIS \*\*



# ECTOPIC BEATS

Multifocal PVC's: more than one shape



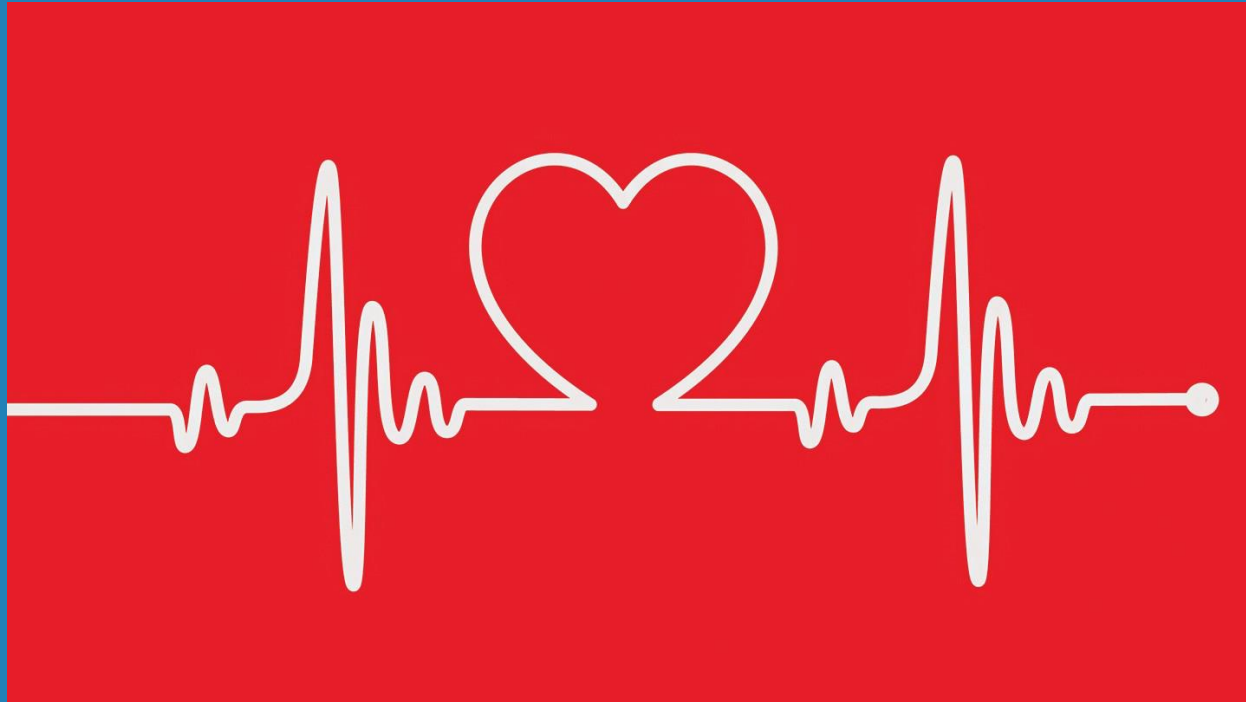
# ECTOPIC BEATS

Triplet PVC's: occur in groups of three





# And the Beat Goes On



# When the Master has Problems

**The SA Node  
can:**

- **fire too slowly**
- **fire too quickly**

***Sinus***

***Bradycardia***

***Sinus***

***Tachycardia***

*Sinus Tachycardia may be an appropriate response to stress.*

# BASIC CRITICAL VALUES

- **Bradycardia – HR  $\leq$  40 bpm**
- **Tachycardia HR  $\geq$  120 bpm**
- **PVC's - 4 or more in a row**
- **ST Elevation /STEMI**

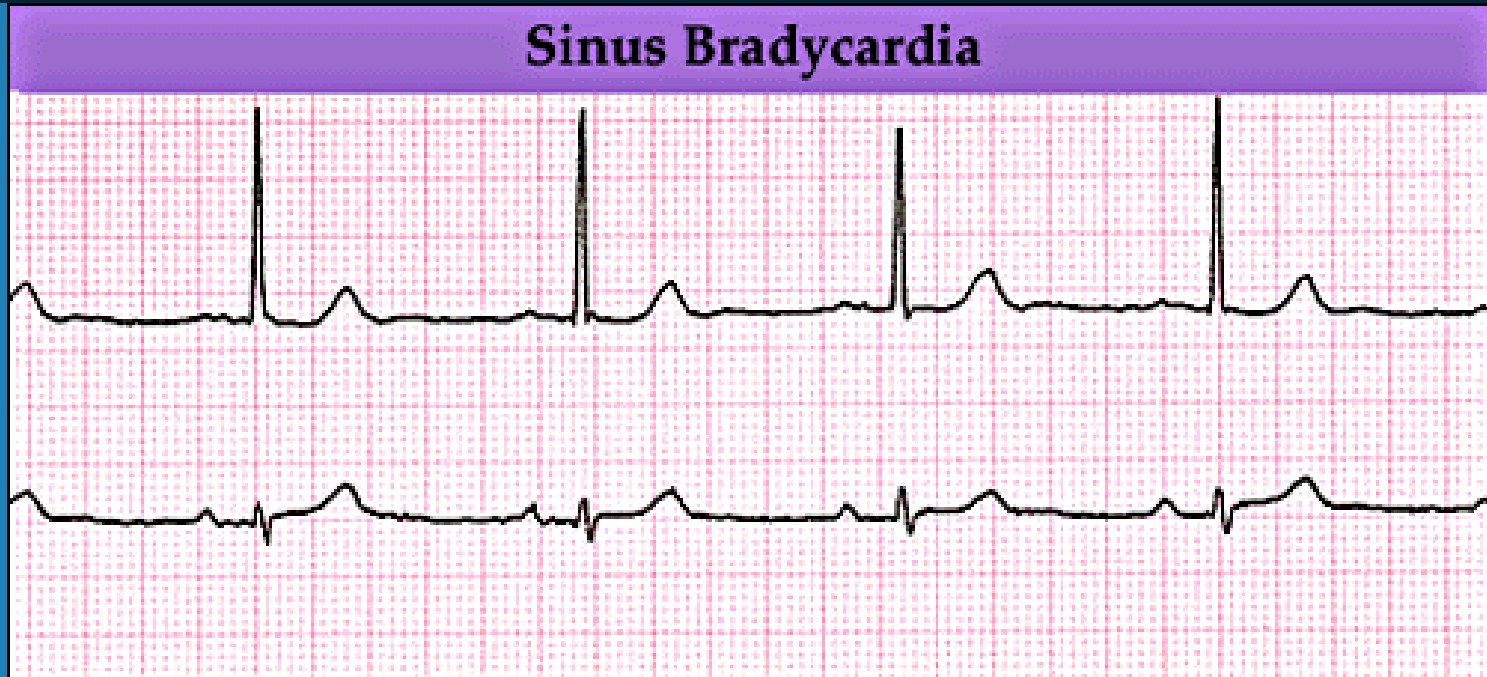


# **Classification- BRADY**

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- **Sinus Bradycardia**
- **Junctional Rhythm**
- **Sino Atrial Block**
- **Atrioventricular block**

# Sinus Bradycardia



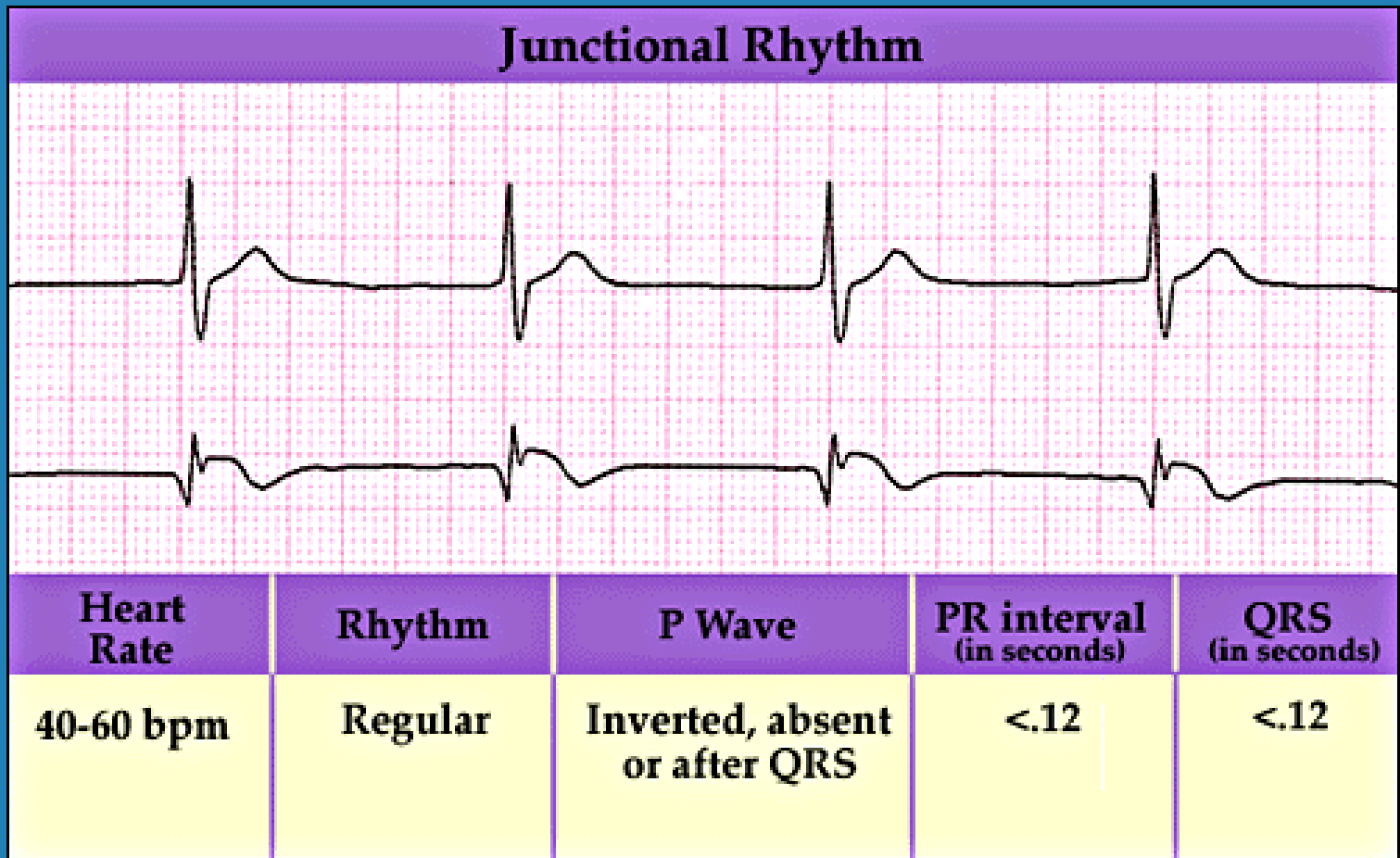
Heart Rate	Rhythm	P Wave	PR interval (in seconds)	QRS (in seconds)
<60 bpm	Regular	Before each QRS, identical	.12 to .20	<.12

# Rhythm #1



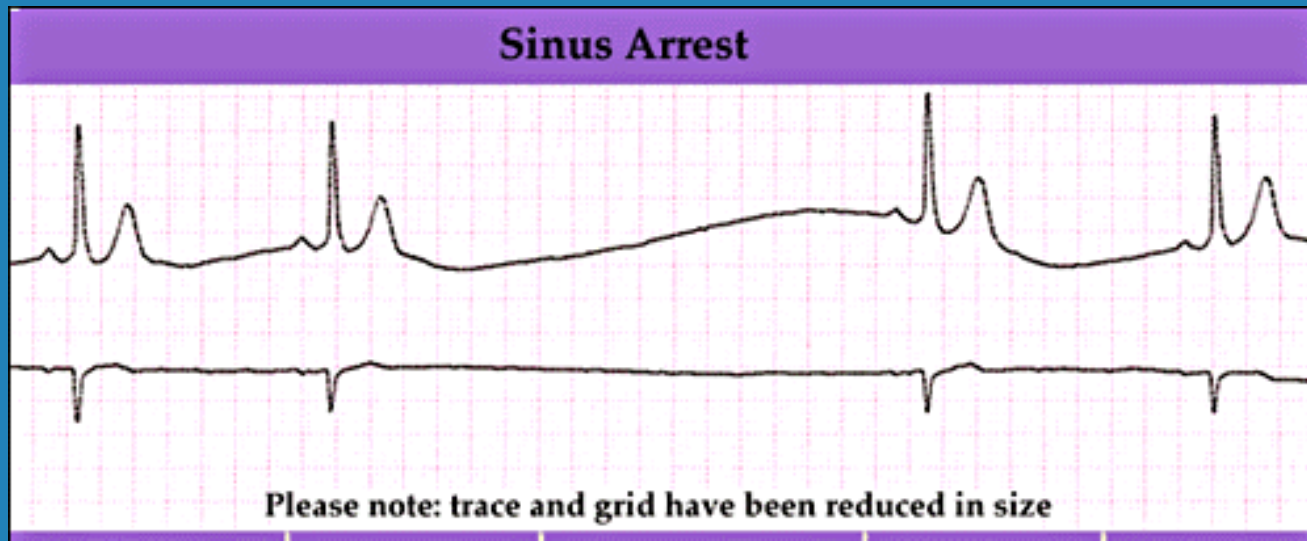
- Rate? 30 bpm
- Regularity? regular
- P waves? normal
- PR interval? 0.12 s
- QRS duration? 0.10 s
- Interpretation? *Sinus Bradycardia*

# Junctional Rhythm



# SA Block

- Sinus impulses are blocked within the SA junction
- Between SA node and surrounding myocardium
- Absent complete cardiac cycle
- Occurs irregularly and unpredictably
- Present : Young athletes, Digitalis, Hypokalemia, Sick Sinus Syndrome







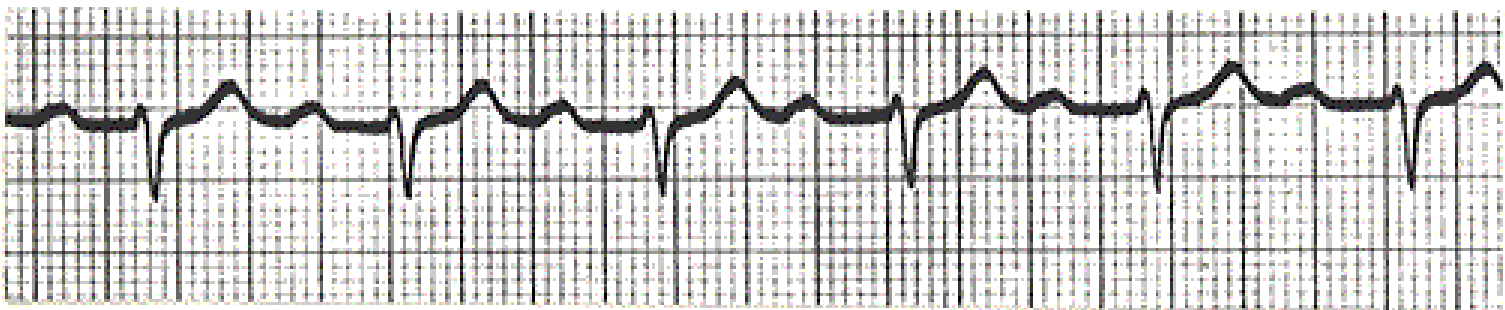
# AV Block

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- **First Degree AV Block**
- **Second Degree AV Block**
- **Third Degree AV Block**

# First Degree AV Block

- Delay in the conduction through the conducting system
- Prolong P-R interval
- All P waves are followed by QRS
- Associated with: Rheumatic Carditis, Digitalis, Beta Blocker, excessive vagal tone, ischemia, intrinsic disease in the AV junction or bundle branch system.



**1st degree AV block (PR = 280 ms)**

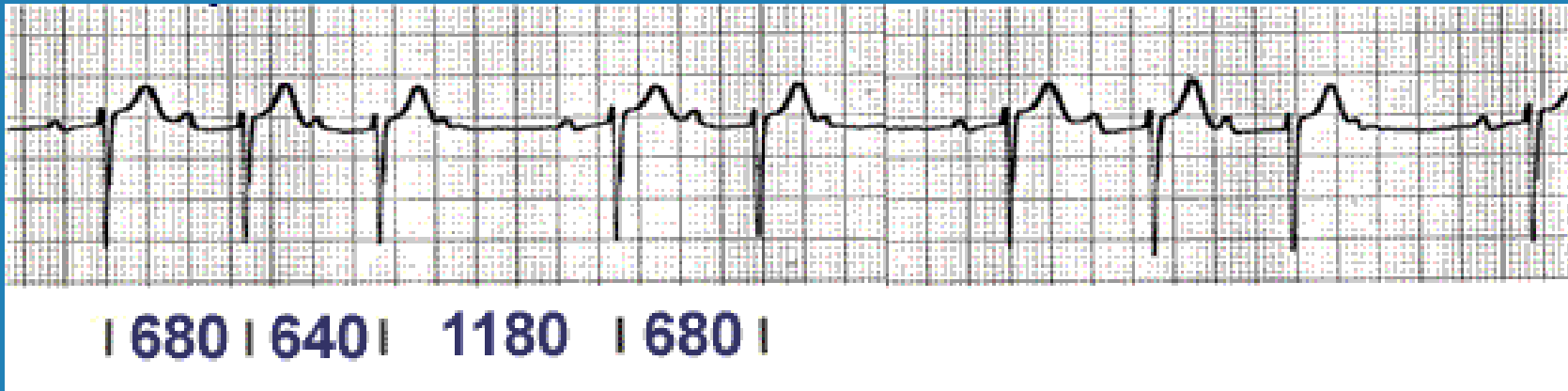


# **Second Degree AV Block**

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- **Intermittent failure of AV conduction**
- **Impulse blocked by AV node**
- **Types:**
  - **Mobitz type 1 (Wenckebach Phenomenon)**
  - **Mobitz type 2**

# Mobitz type 1 (Wenckebach Phenomenon)

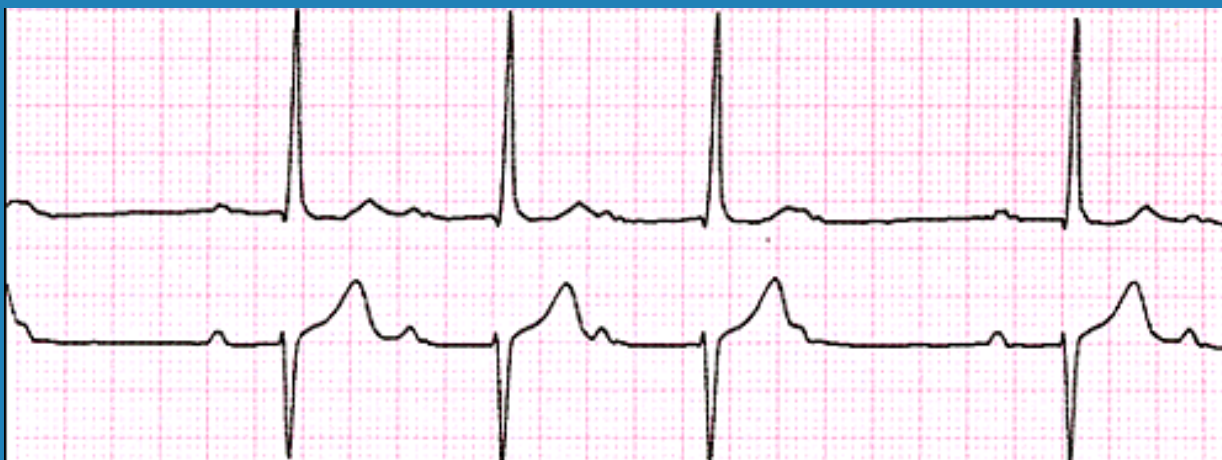


Classic Wenckebach  
Decreasing RR intervals until pause/wink

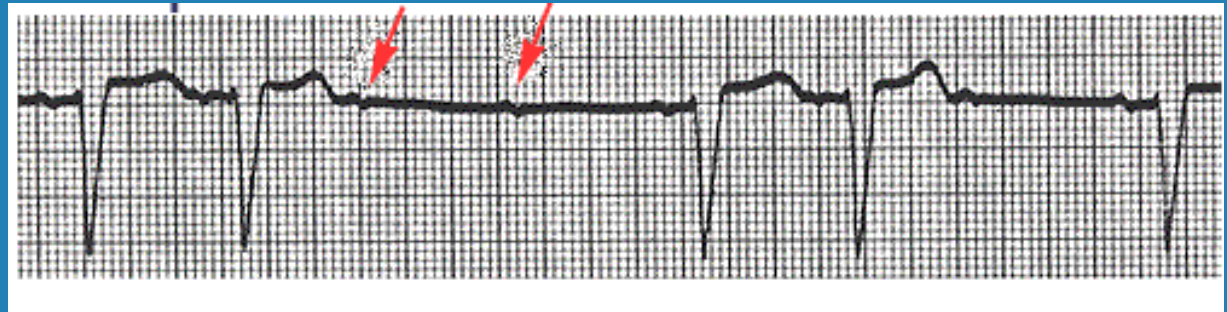
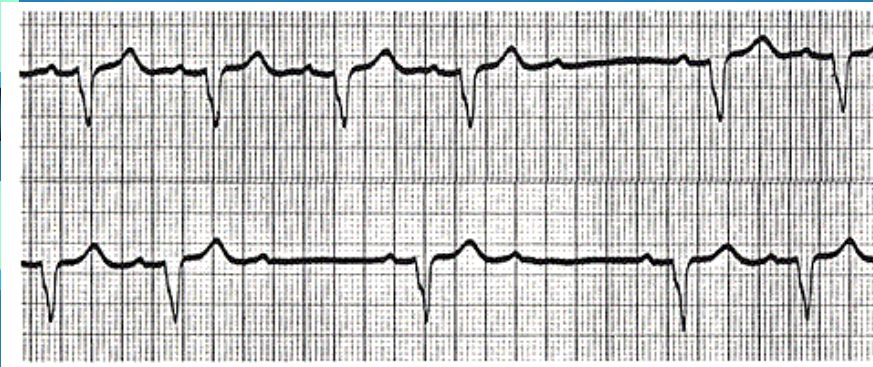
# Mobitz Type 1 (Wenckebach)



3:2 2nd Degree AV block (Type I)

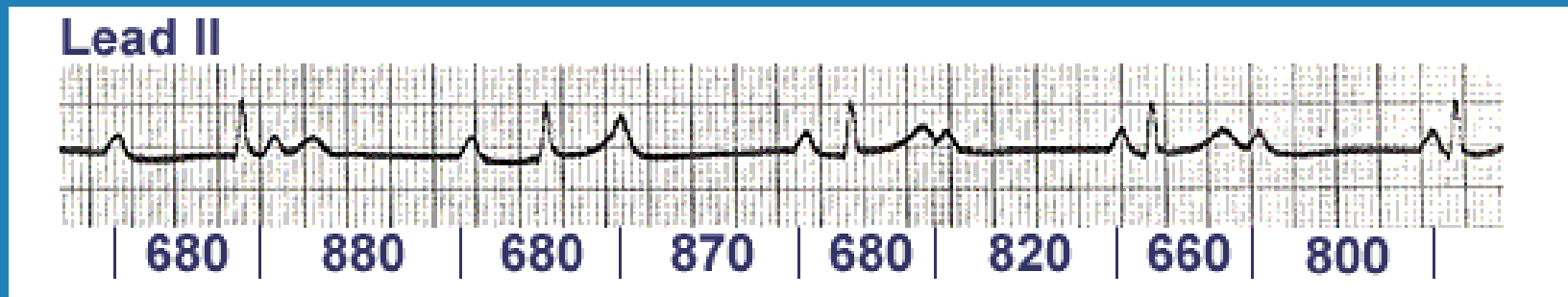
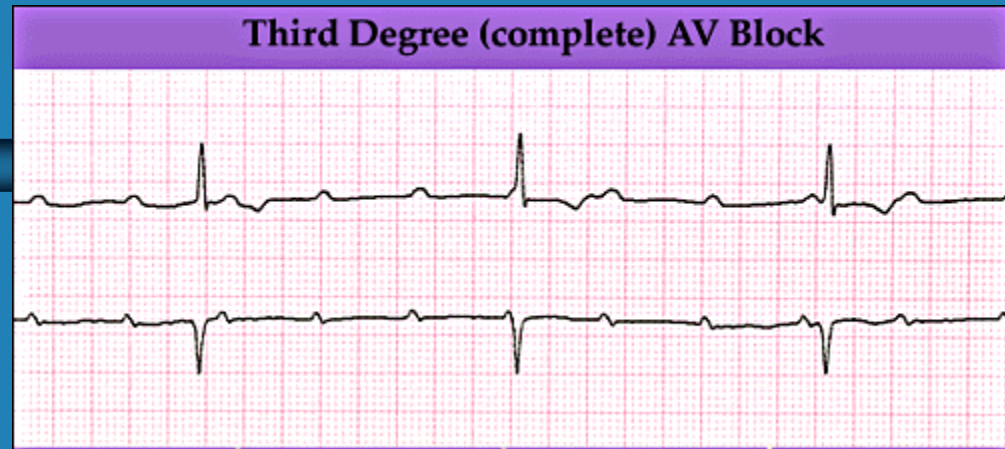


## • Mobitz type 2



- Usually a sign of bilateral bundle branch disease.
- One of the branches should be completely blocked;
- Most likely blocked in the right bundle
- P waves may be blocked somewhere in the AV junction

# Third Degree Heart Block



- Complete heart block evidenced by the AV dissociation
- The PP intervals vary because of sinus arrhythmia



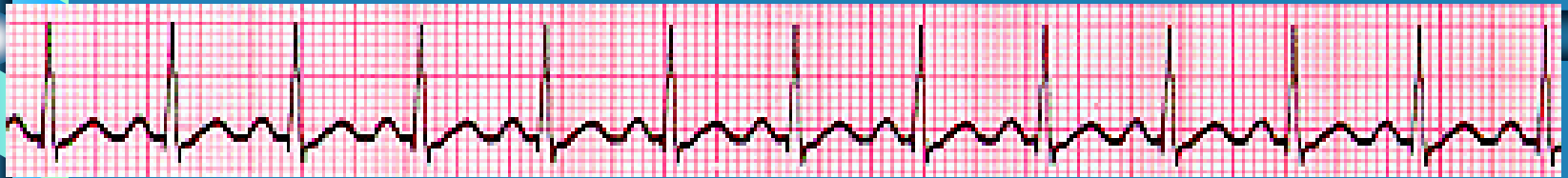
# Classification- TACHY

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- **Sinus Tachycardia**
- **Atrial Flutter**
- **Atrial Fibrillation**
- **Ventricular Flutter**
- **PSVT**
- **V-Tach**
- **Ventricular Fibrillation**



# Rhythm #1



- Rate? 130 bpm
- Regularity? regular
- P waves? normal
- PR interval? 0.16 s
- QRS duration? 0.08 s

Interpretation?

*Sinus Tachycardia*

# Rhythm #2



- Rate?
- Regularity?
- P waves?
- PR interval?
- QRS duration?
- Interpretation?

70 bpm

occasionally irreg.

2/7 different contour

0.14 s (except 2/7)

0.08 s

*NSR with PACs*

# Rhythm #3



- Rate? 60 bpm
- Regularity? occasionally irreg.
- P waves? none for 7<sup>th</sup> QRS
- PR interval? 0.14 s
- QRS duration? 0.08 s (7<sup>th</sup> wide)
- Interpretation? *Sinus Rhythm with 1 PVC*

# Rhythm #4



- Rate? 70 bpm
- Regularity? regular
- P waves? flutter waves
- PR interval? none
- QRS duration? 0.06 s
- Interpretation? *Atrial Flutter*

# Rhythm #5



- Rate? 100 bpm
- Regularity? irregularly irregular
- P waves? none
- PR interval? none
- QRS duration? 0.06 s
- Interpretation? *Atrial Fibrillation*

# Rhythm #6



- Rate?
- Regularity?
- P waves?
- PR interval?
- QRS duration?
- Interpretation?

74 → 148 bpm

Regular → regular

Normal → none

0.16 s → none

0.08 s

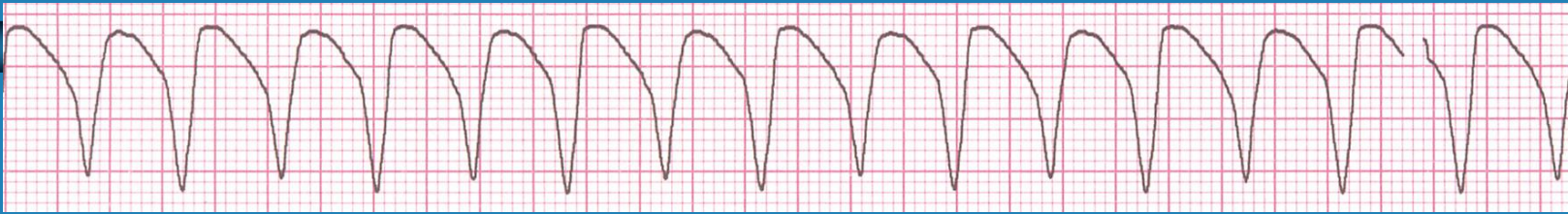
*Paroxysmal  
Supraventricular  
Tachycardia (PSVT)*

# SVT



- **Deviation from NSR**
  - The heart rate suddenly speeds up, often triggered by a PAC and the P waves are lost.
  - Generally  $> 150$  bpm

# Rhythm #7



- Rate? 160 bpm
- Regularity? regular
- P waves? none
- PR interval? none
- QRS duration? wide (> 0.12 sec)

Interpretation?

*Ventricular Tachycardia*



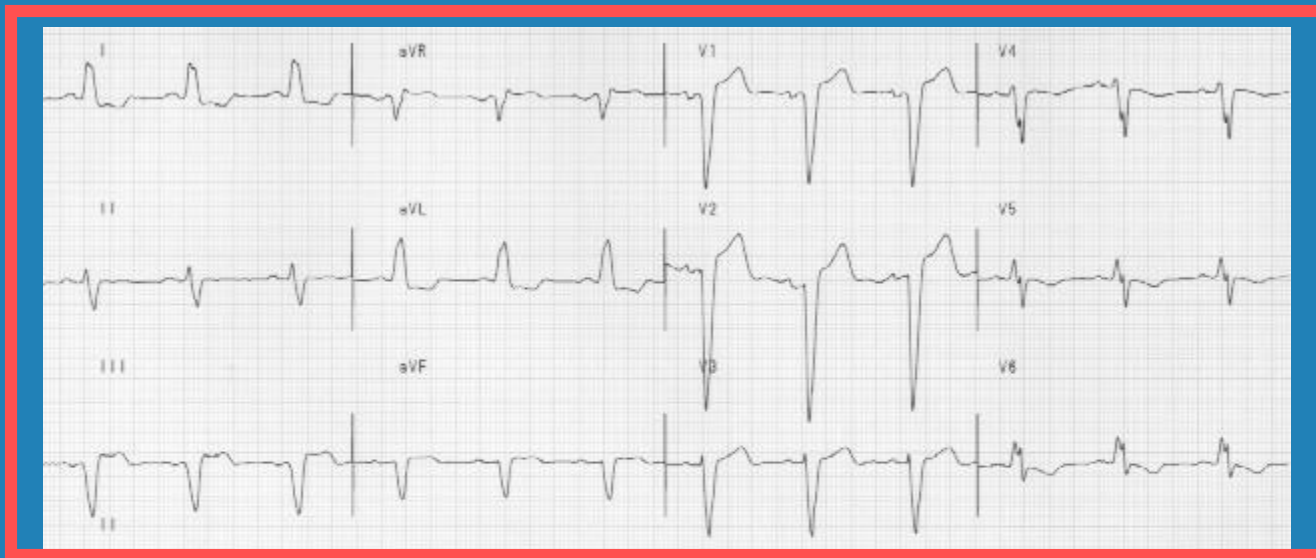
# Rhythm #8



- Rate? none
- Regularity? irregularly irreg.
- P waves? none
- PR interval? none
- QRS duration? wide, if recognizable
- Interpretation? *Ventricular Fibrillation*

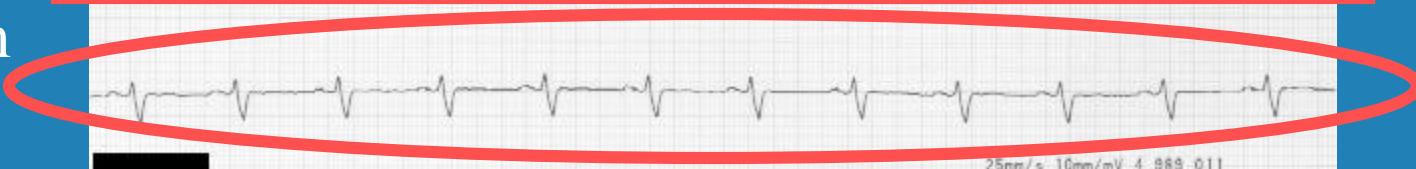
# Diagnosing a MI

To diagnose a myocardial infarction, you need to go beyond looking at a rhythm strip and obtain a 12-Lead ECG.



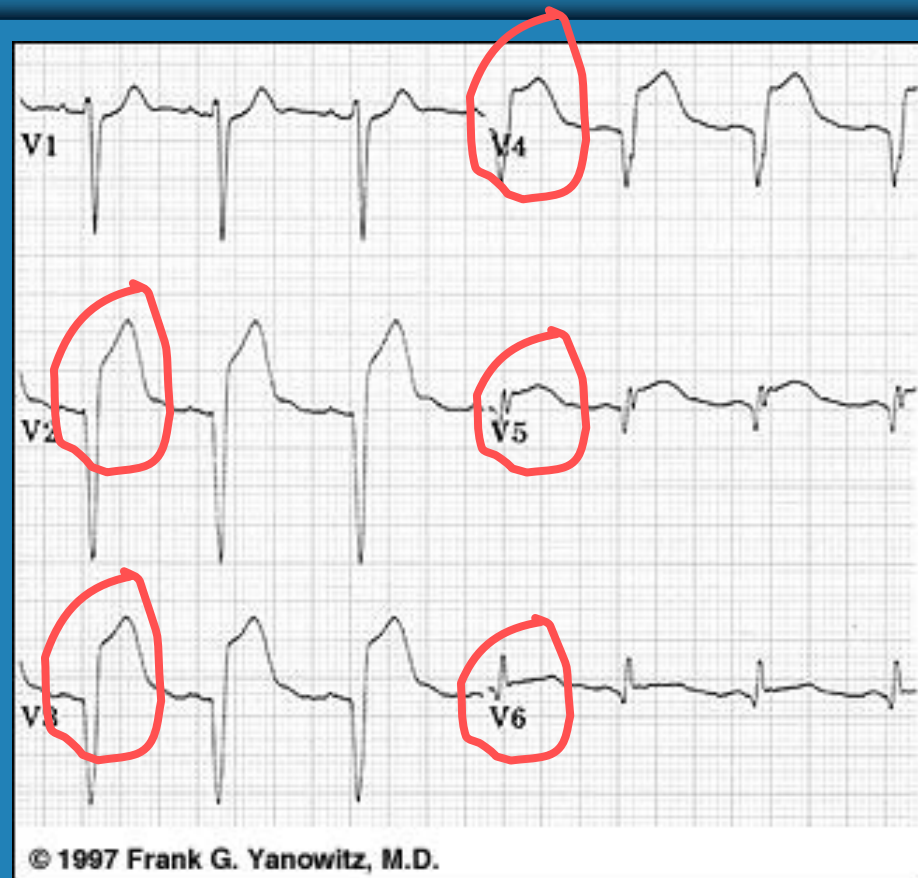
12-Lead  
ECG

Rhythm  
Strip



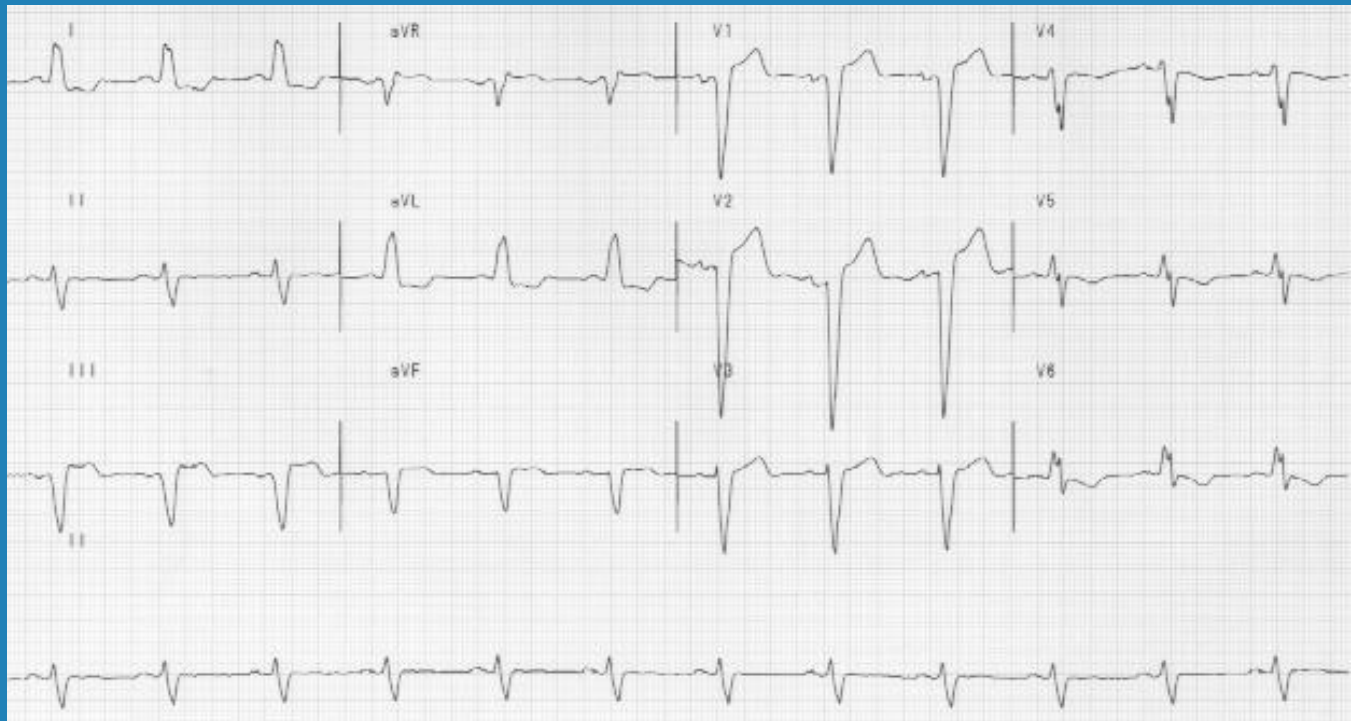
# ST Elevation (cont)

**Elevation of the ST segment (greater than 1 small box) in 2 leads is consistent with a myocardial infarction.**



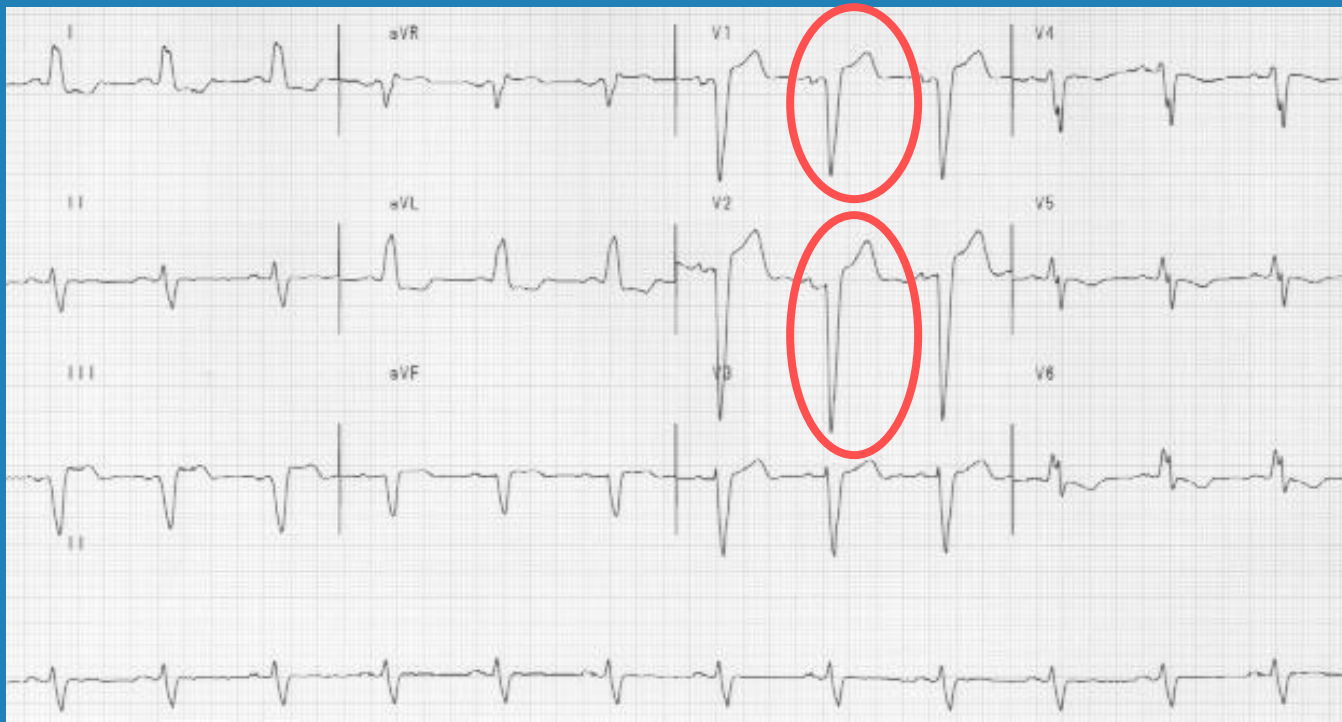
# Putting it all Together

Do you think this person is having a myocardial infarction. If so, where?

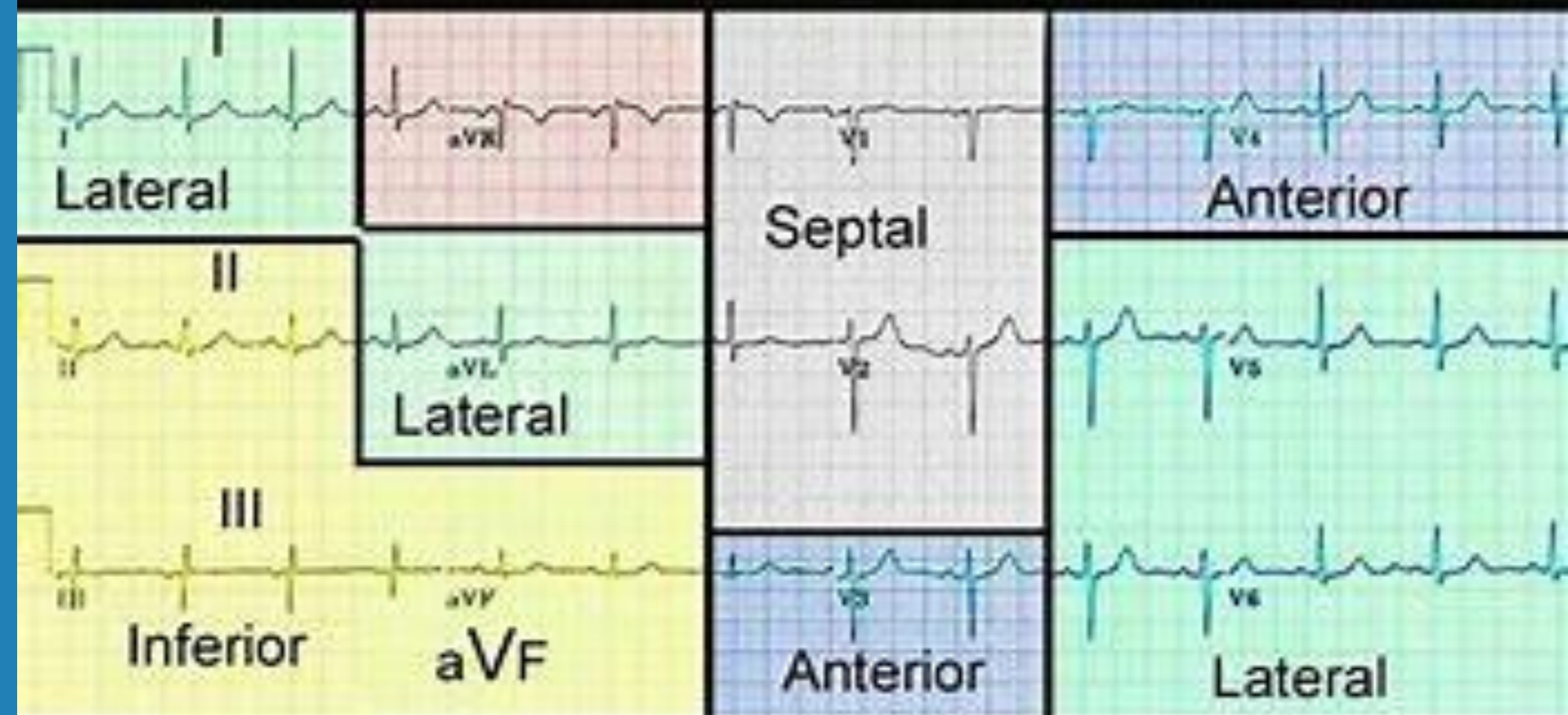


# Interpretation

**Yes**, this person is having an acute anterior wall myocardial infarction.



# Best Mnemonic for ECG Leads

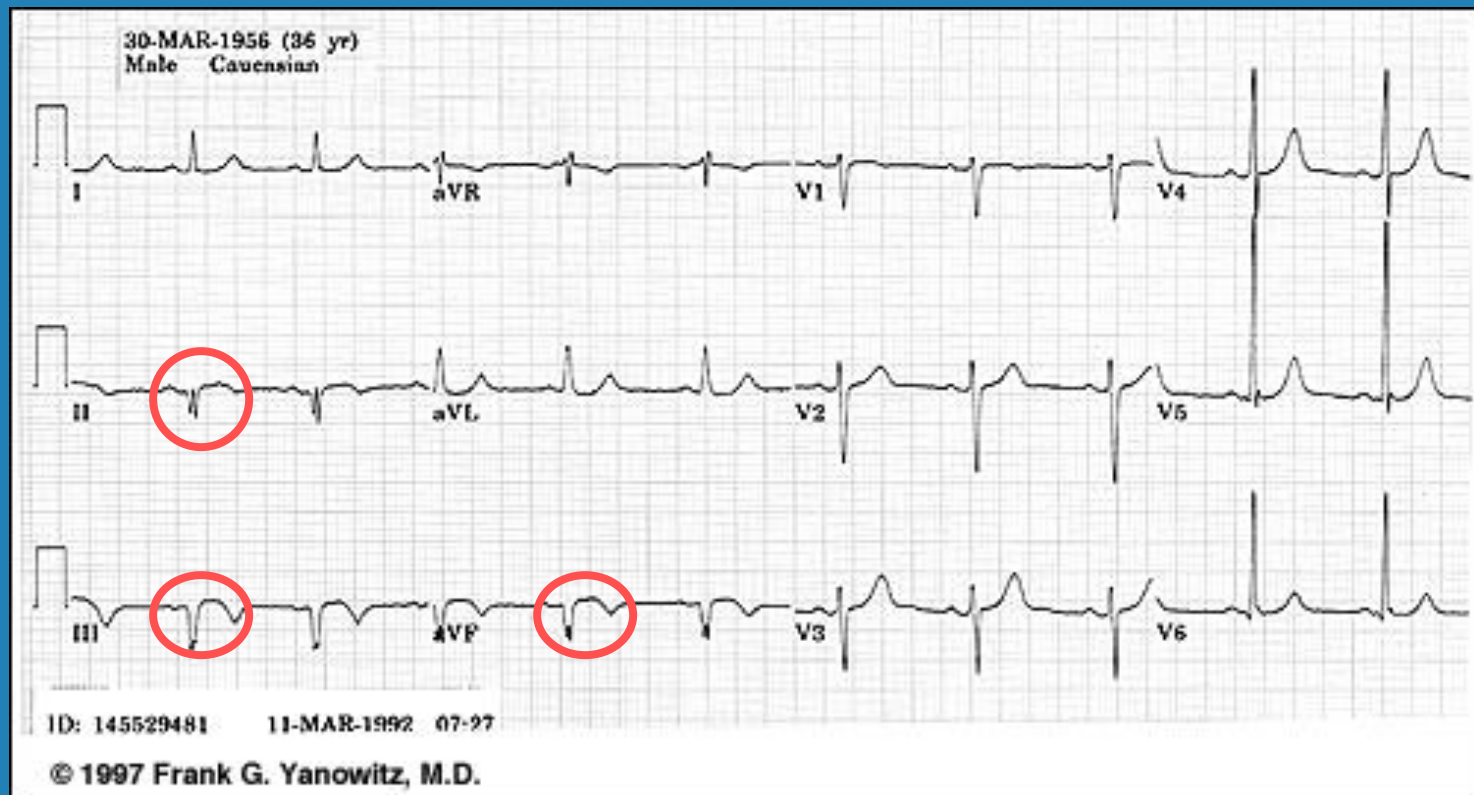


Inferior Leads (yellow)	II III aVF
Lateral Leads (green)	I aVL V5 V6
Anterior Leads (blue)	V3 V4
Septal Leads (grey)	V1 V2

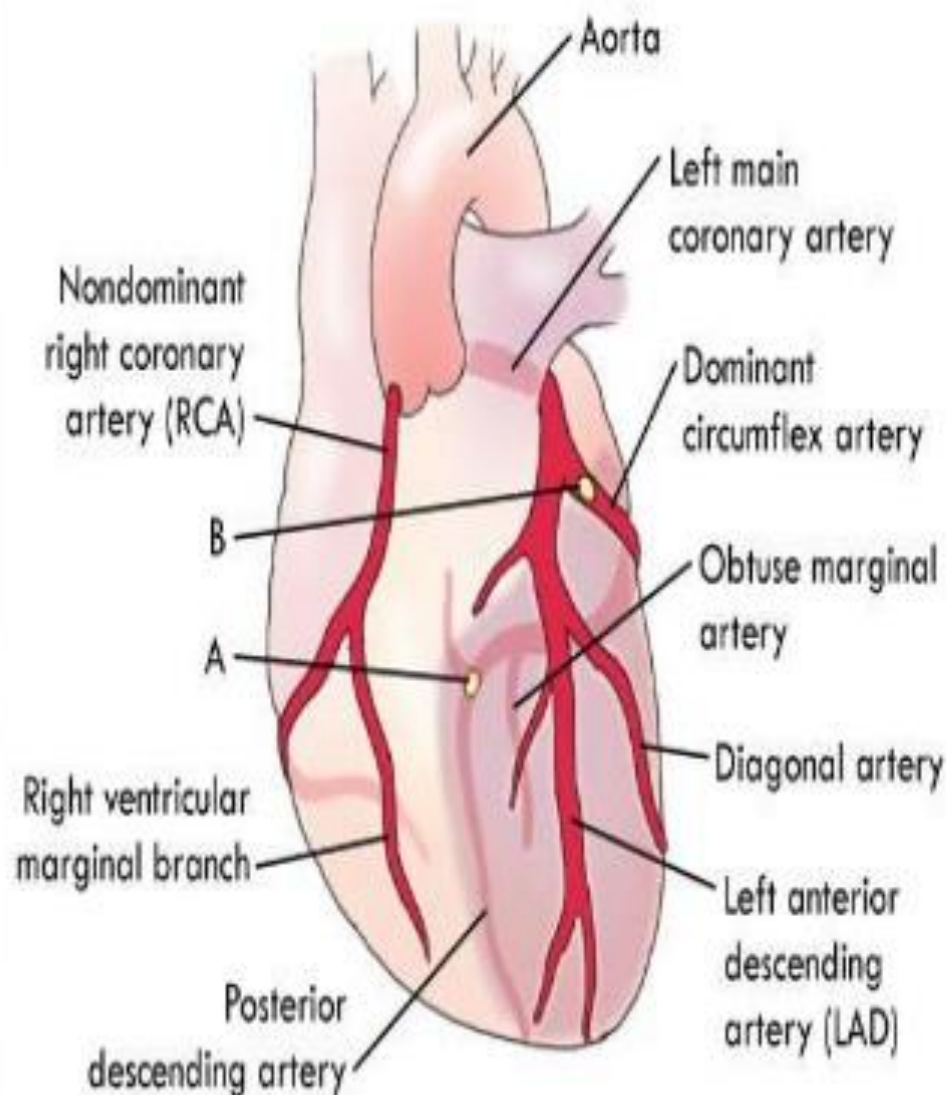
By Medical Cases  
[www.facebook.com/amitorra.kr](http://www.facebook.com/amitorra.kr)

# Inferior Wall MI

**This is an inferior MI. Note the ST elevation in leads II, III and aVF.**



# Inferior Wall MI II, III, aVF



I Lateral	aVR	V <sub>1</sub> Septum	V <sub>4</sub> Anterior
II Inferior	aVL Lateral	V <sub>2</sub> Septum	V <sub>5</sub> Lateral
III Inferior	aVF Inferior	V <sub>3</sub> Anterior	V <sub>6</sub> Lateral

B





# LETS SUMMARIZE

- **What is an ECG?**
- **Proper skin prep**
- **Correct electrode placement**
- **Recognize basic critical values**
- **Identify steps of rhythm reading:**
- **R's: rate, regularity, rhythm, R-R**

# Have a Heart to Heart

- **How will you better care for YOUR heart?**

