# EKG Interpretation

*Collegio A. Volta*
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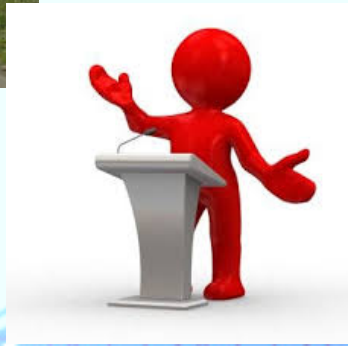
SOCIETA' SCIENTIFICA DI MEDICINA INTERNA
FADOI
FEDERAZIONE DELLE ASSOCIAZIONI DEI DIRIGENTI OSPEDALIERI INTERNISTI





# NOW WE CAN START...

# WHAT IS EKG?

- Electrocardiography (ECG or EKG from Greek: kardia, meaning heart is the process of recording the electrical activity of the heart over a period of time using electrodes placed on a patient's body. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle depolarizing during each heartbeat.

- In a conventional 12 lead ECG, ten electrodes are placed on the patient's limbs and on the surface of the chest. The overall magnitude of the heart's electrical potential is then measured from twelve different angles ("leads") and is recorded over a period of time (usually 10 seconds).

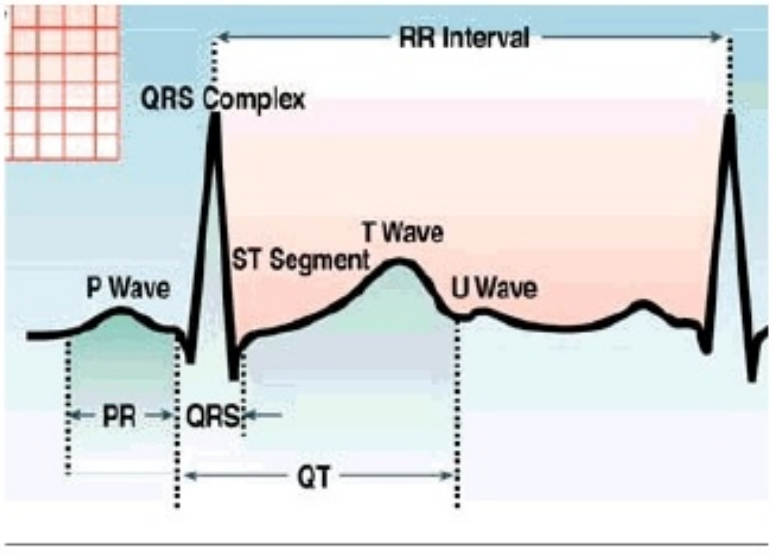
# Why EKG…?

- **Rate**: Fast or slow?
- **Rhythm**: Sinus or not? Narrow complexes or wide?
- **Intervals**: PR and QT normal or prolonged?
- **P wave**: Normal sinus axis? Atrial enlargement?
- **QRS**: Axis shift? Q waves? Ventricular hypertrophy? Bundle branch
- block?
- **The ST segment**: Elevation or depression?
- **The T wave**: Upright or inverted?

# The Normal Conduction System

## Conduction System

- The heart has a conduction system separate from any other system
- The conduction system makes up the PQRST complex we see on paper
- An arrhythmia is a disruption of the conduction system
- Understanding how the heart conducts normally is essential in understanding and identifying arrhythmias

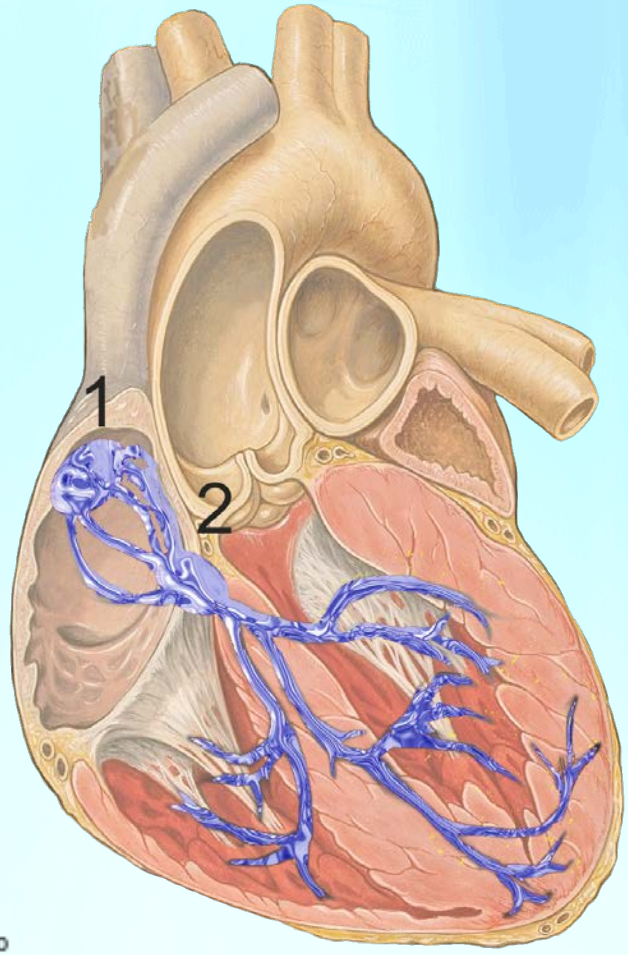


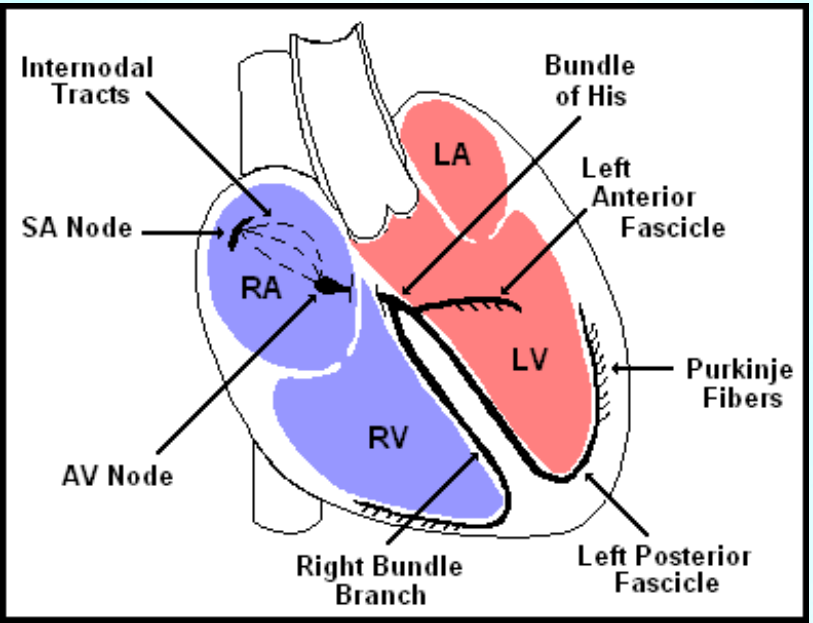
# Cardiac Conduction

- The normal conduction pathway:

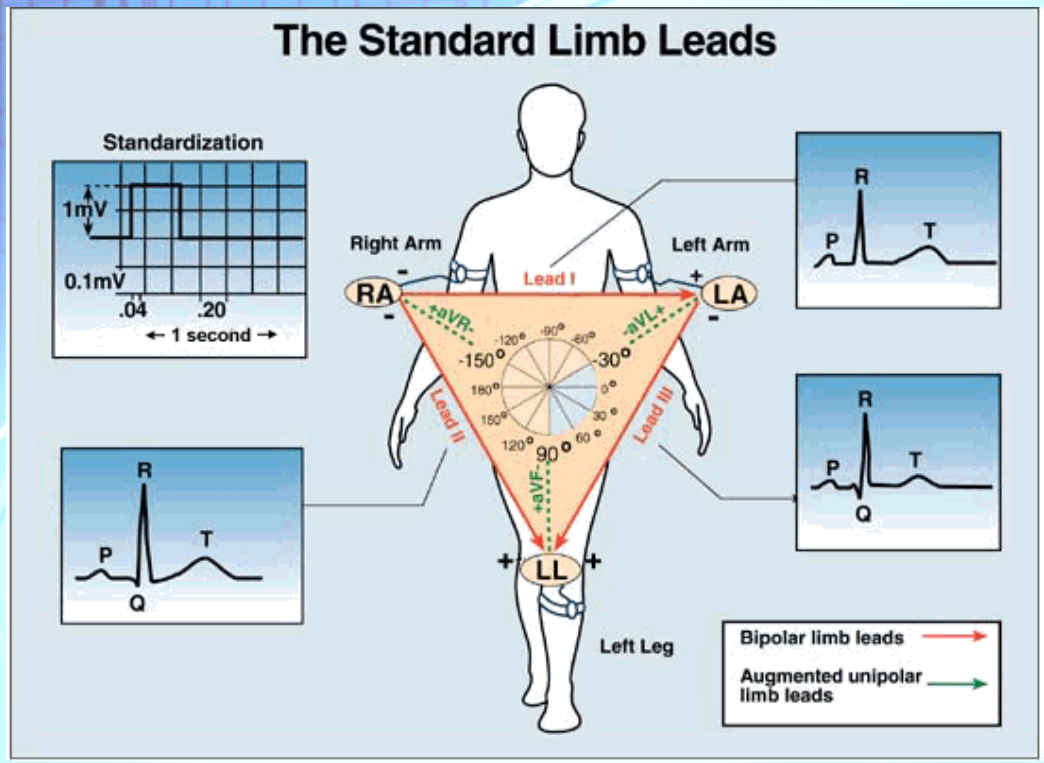
SA Node → AV Node → Bundle of His → Right & Left Bundle Branches → Purkinje Fibers → Myocardial Contraction

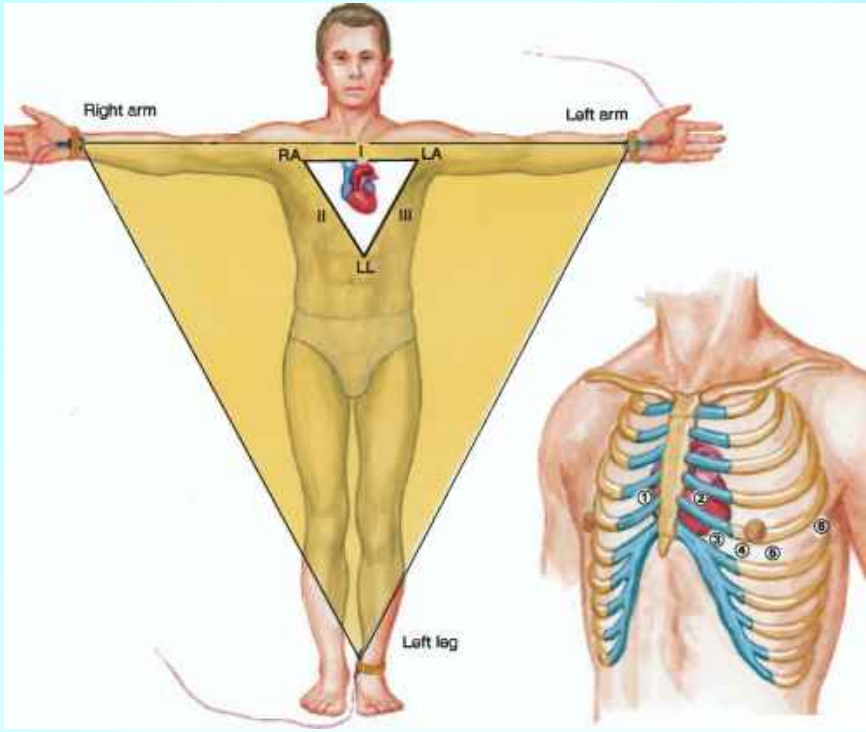
ECG

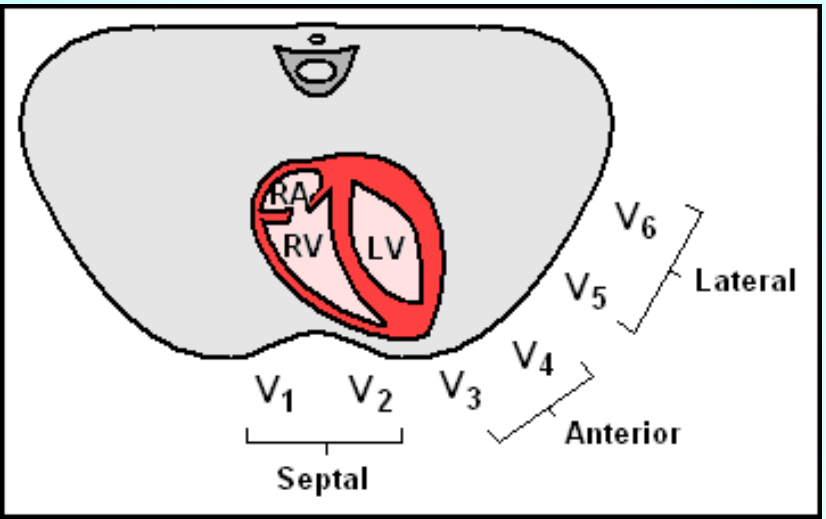


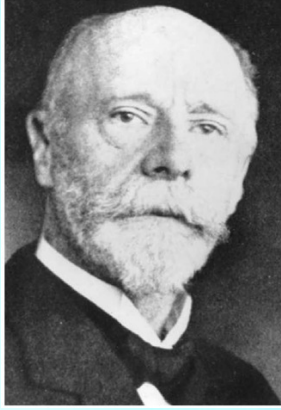

# Lead Placement



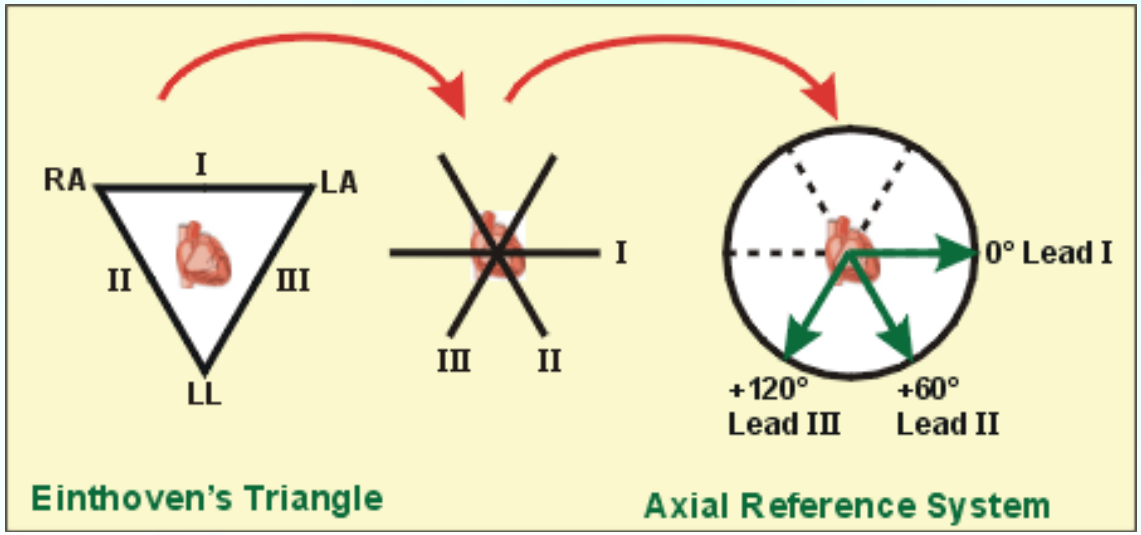



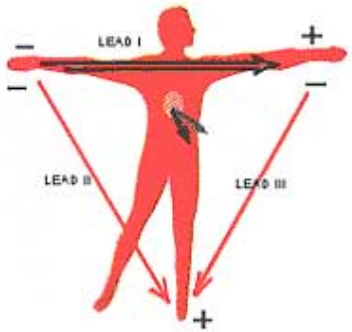



# Einthoven's law



- An equilateral triangle used as a model of the standard limb leads used in electrocardiography.
- In the electrocardiogram the potential of any wave or complex in lead II is equal to the sum of its potentials in leads I and III.

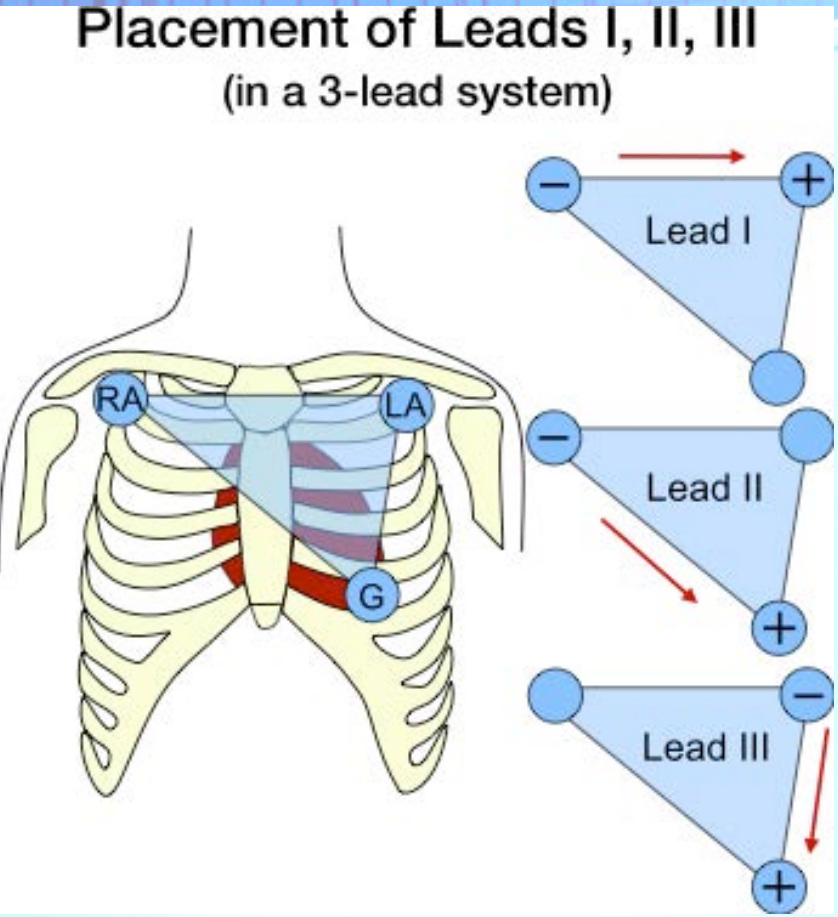


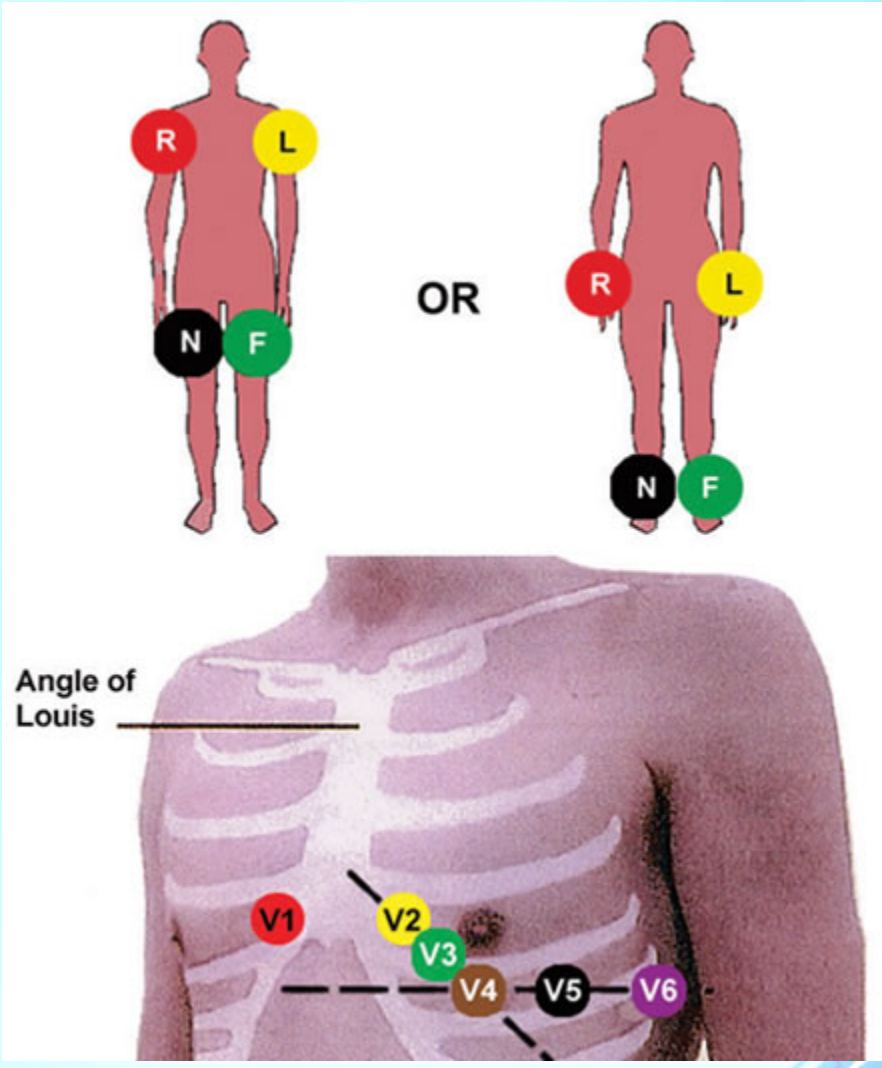



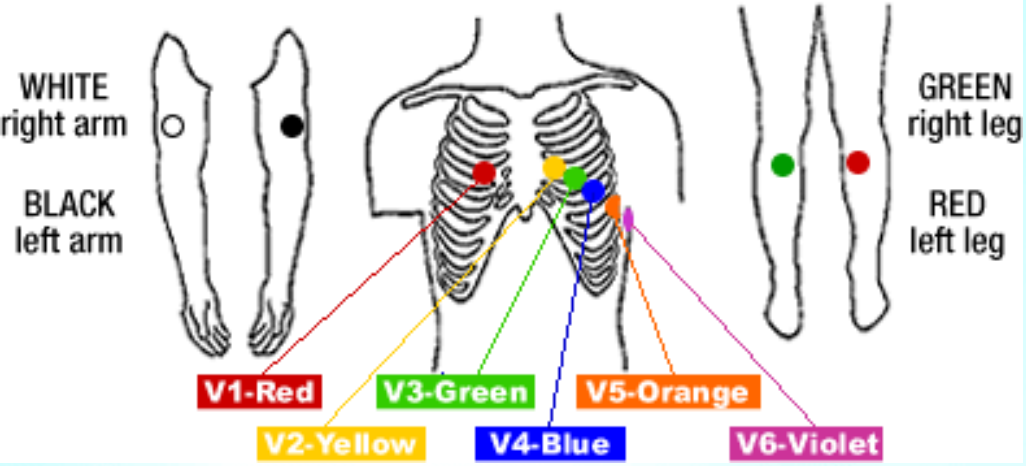

Lead I measures the voltage from Right arm to Left arm

Lead II measures the voltage from Right arm to Left foot

Lead III measures the voltage from Left arm to Left foot

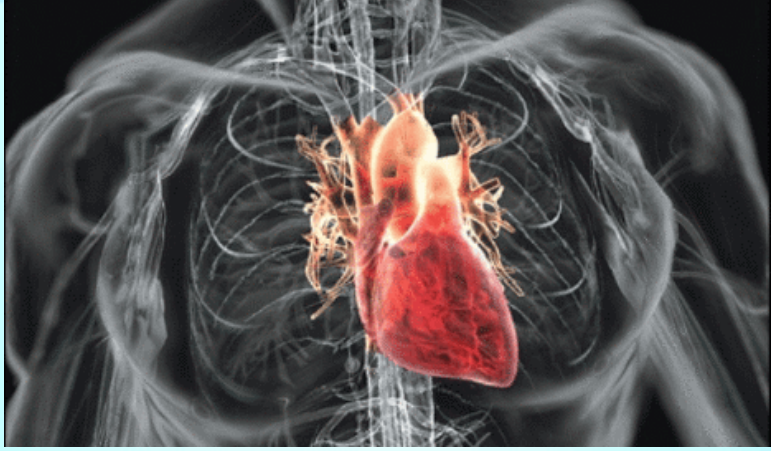

Placement of Leads I, II, III
(in a 3-lead system)
Lead I
Lead II
Lead III
RA
LA
G

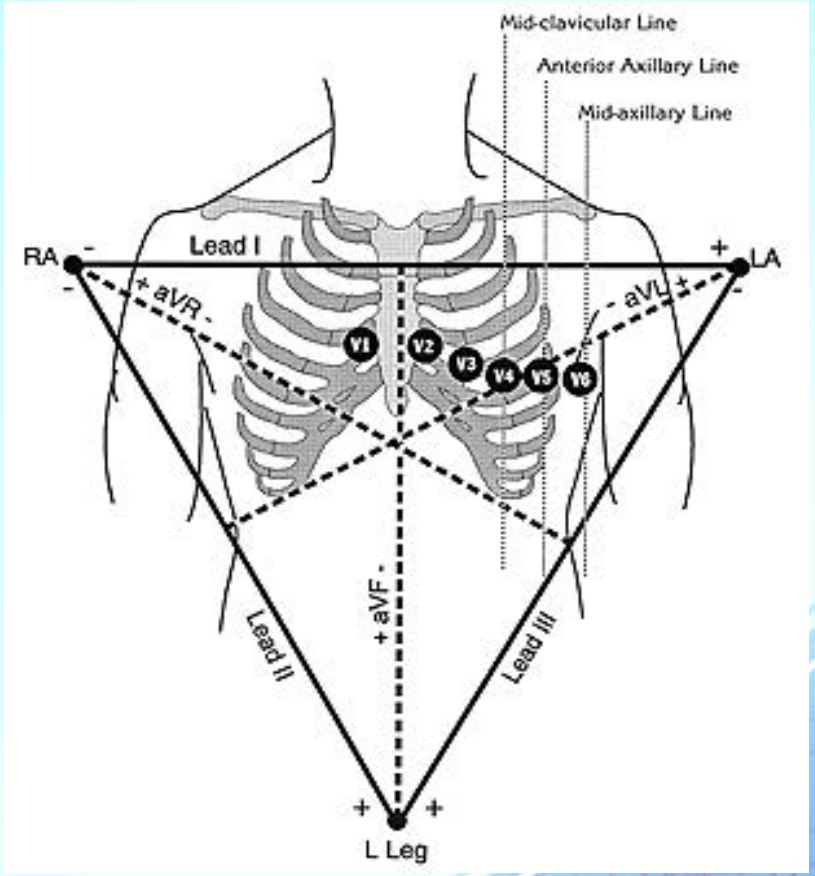

R
L
N
F
OR
R
L
N
F
Angle of Louis
V1
V2
V3
V4
V5
V6


WHITE
right arm
BLACK
left arm
GREEN
right leg
RED
left leg
V1-Red
V3-Green
V5-Orange
V2-Yellow
V4-Blue
V6-Violet

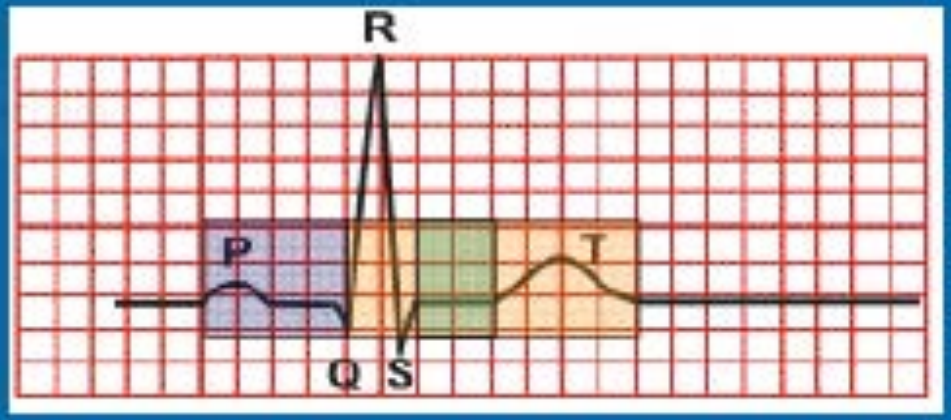
# EKG Distributions

- Anteroseptal: V1, V2, V3, V4
- Anterior: V1–V4
- Anterolateral: V4–V6, I, aVL
- Lateral: I and aVL
- Inferior: II, III, and aVF
- Inferolateral: II, III, aVF, and V5 and V6



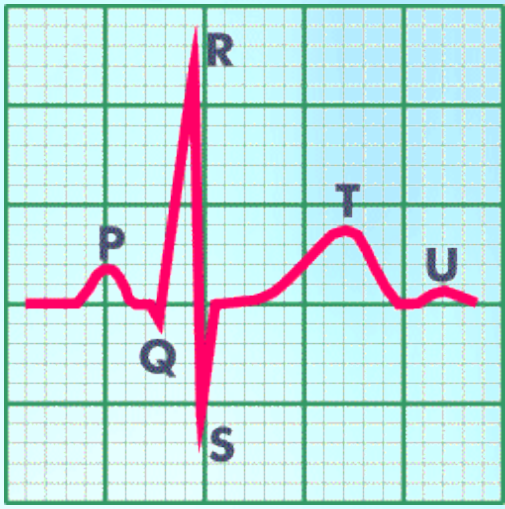


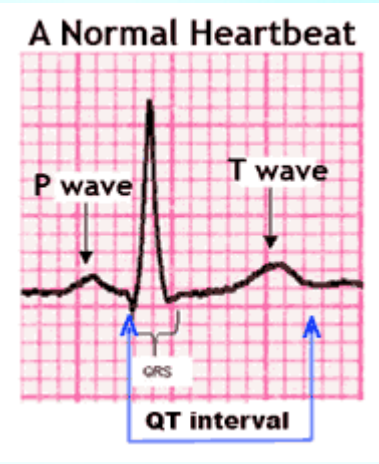
# Waveforms

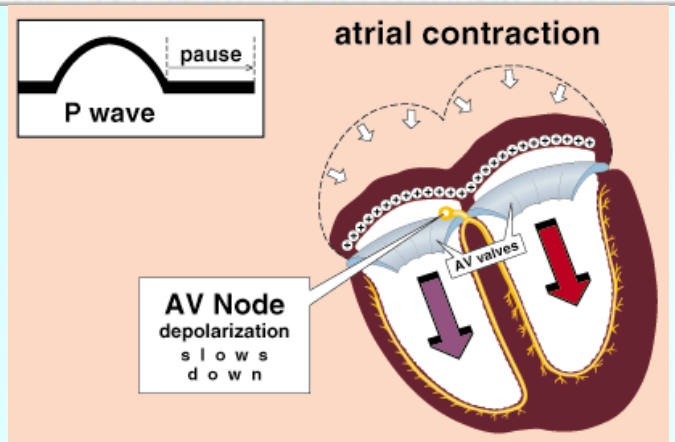


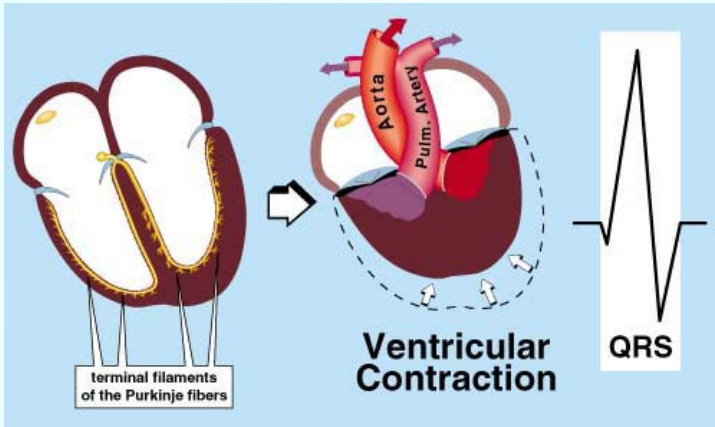

**P wave:** atrial depolarization (right-left)
**QRS:** ventricular depolarization (septum-LV-RV)
**T wave:** ventricular repolarization

**PR interval:** efficiency of atrial and AV nodal conduction
**ST segment:** "quiet time" between ventricular depolarization and repolarization
**QT interval:** efficiency of ventricular depolarization and repolarization



# EKG PAPER

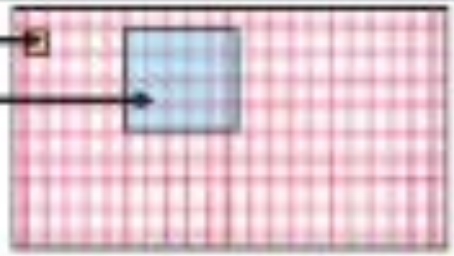
One small box = 0.04 sec = 40 ms

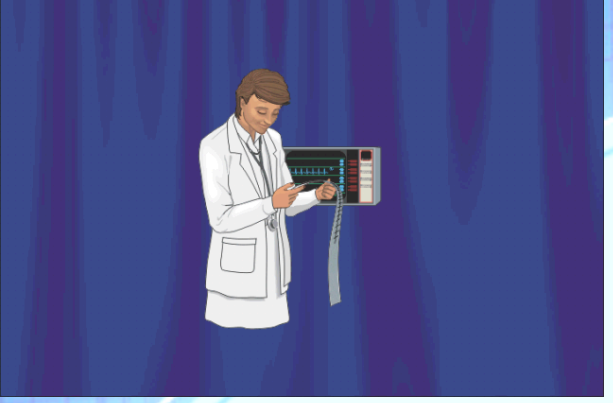
One large box = 0.2 sec = 200 ms

Paper speed 1500 mm/min

One beat per 0.2 sec = 300 bpm

Heart Rate = 1500/RR (mm) ***OR*** 300/ # large boxes between two R waves





# Interpretation…


**Develop a systematic approach to reading EKGs and use it every time**

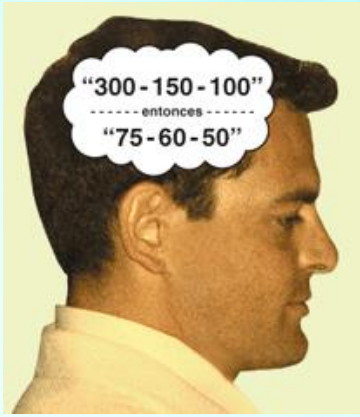
**The system we will practice is:**

- Rate
- Rhythm (including intervals and blocks)
- Axis
- PR, QRS and ST intervals examination

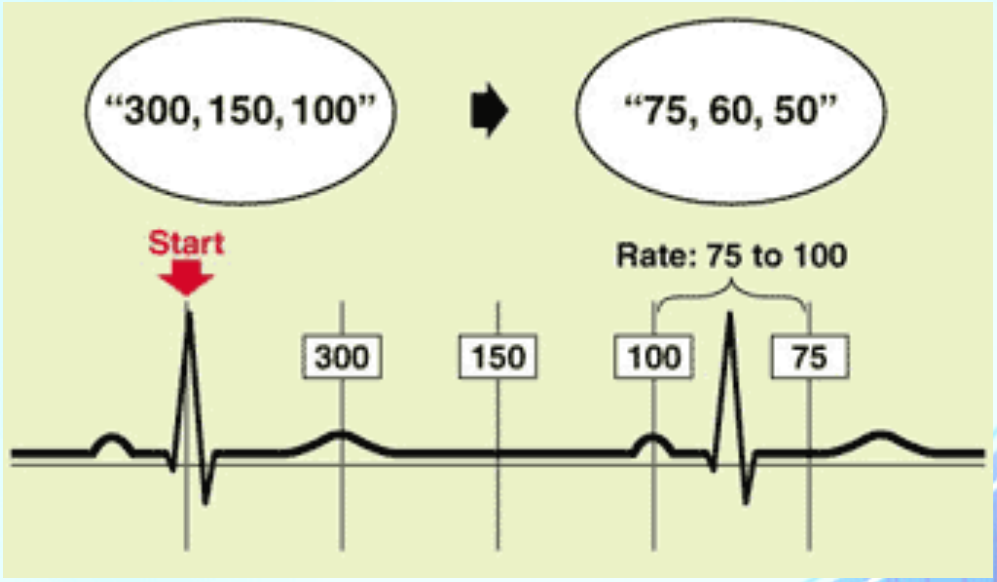
# RATE

Rule of 300- Divide 300 by the number of boxes between each QRS = rate

- HR of 60-100 per minute is normal
- HR > 100 = tachycardia
- HR < 60 = bradycardia

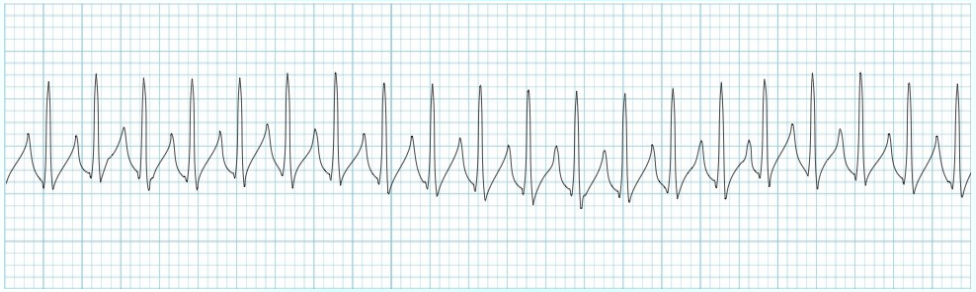


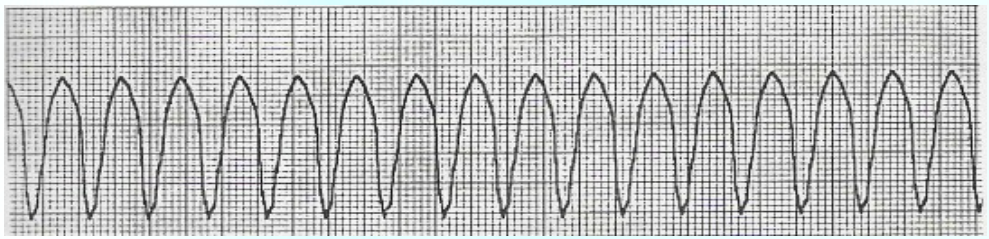

| Number of big boxes | Rate |
|---|---|
| 1 | 300 |
| 2 | 150 |
| 3 | 100 |
| 4 | 75 |
| 5 | 60 |
| 6 | 50 |



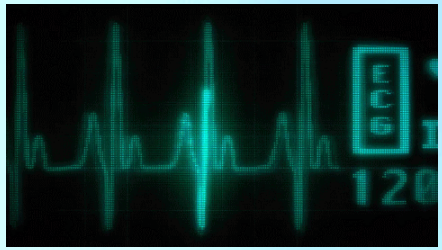
# Differential Diagnosis of Tachycardia

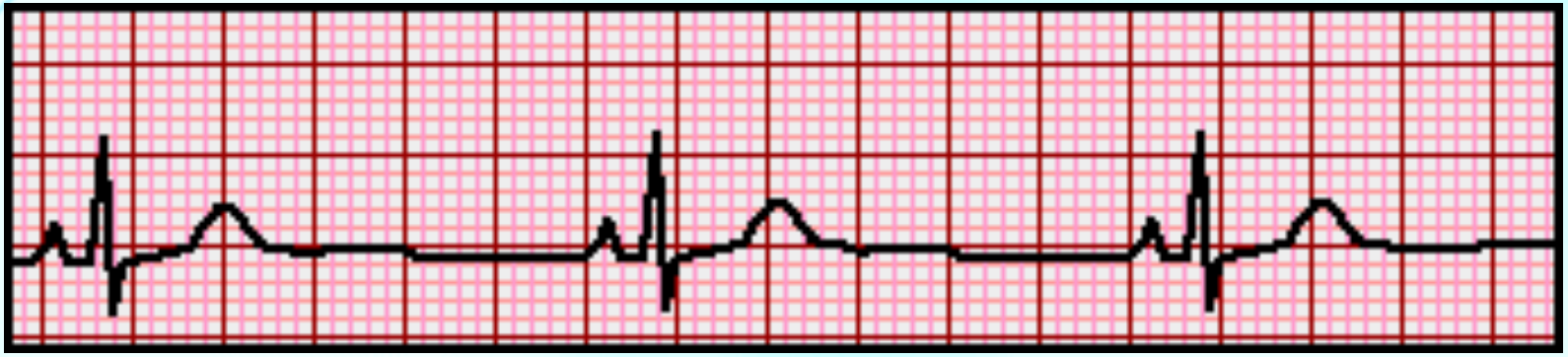
| Tachycardia | Narrow Complex | Wide Complex |
|---|---|---|
| Regular | ST<br>SVT<br>Atrial flutter | ST w/ aberrancy<br>SVT w/ aberrancy<br>VT |
| Irregular | A-fib<br>A-flutter w/ variable conduction<br>MAT | A-fib w/ aberrancy<br>A-fib w/ WPW<br>VT |





# What is the heart rate?

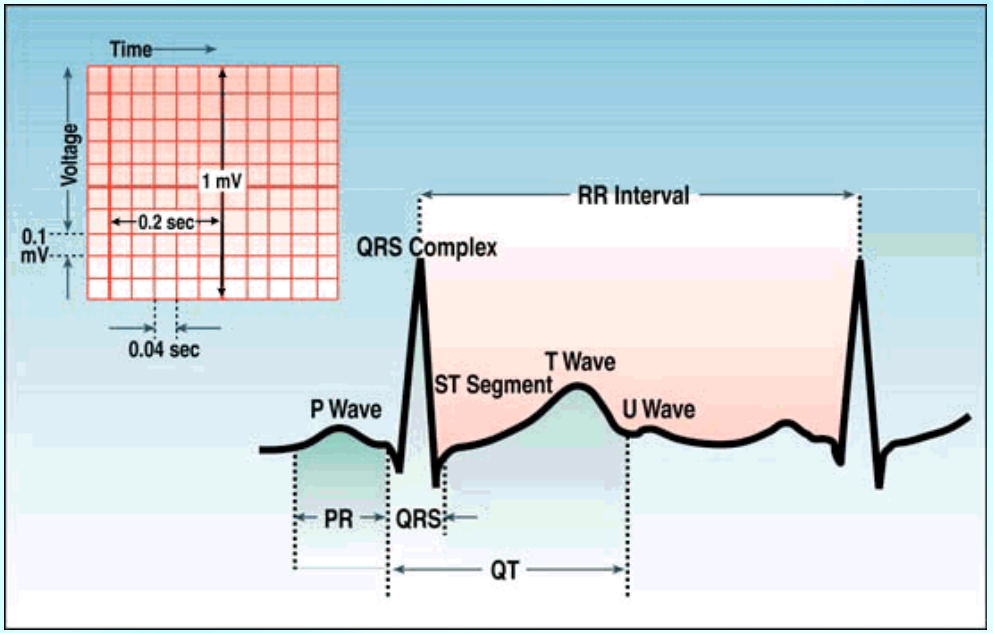


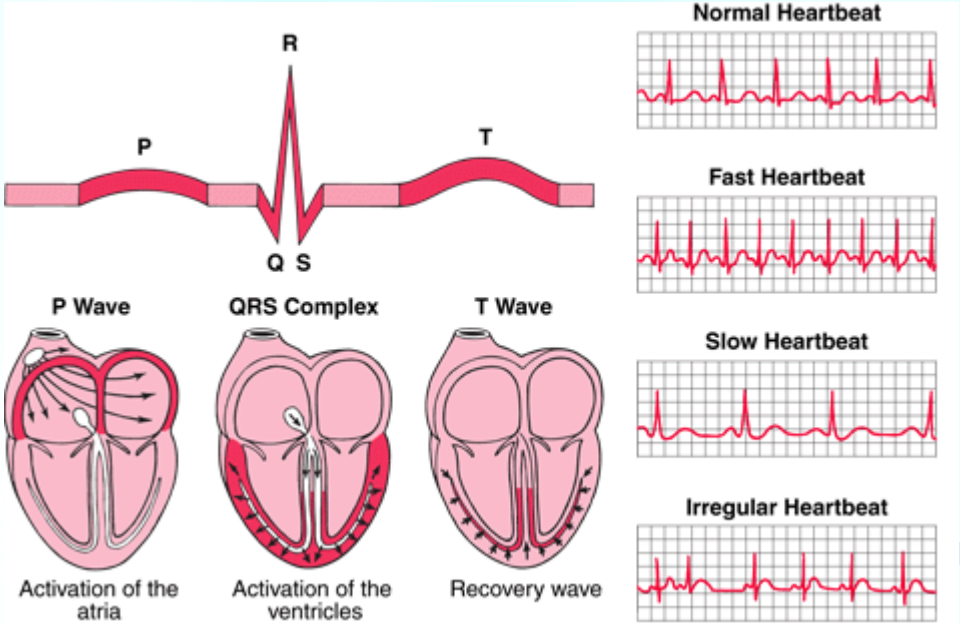



**(300 / 6) = 50 bpm**

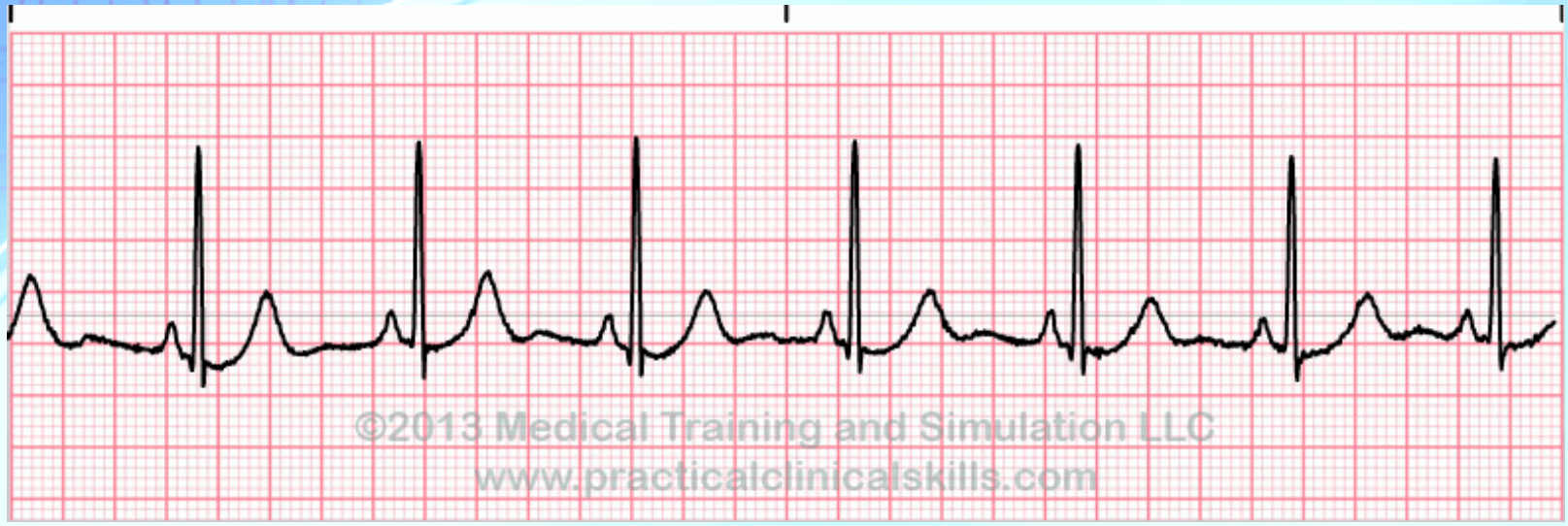
# Rhythm

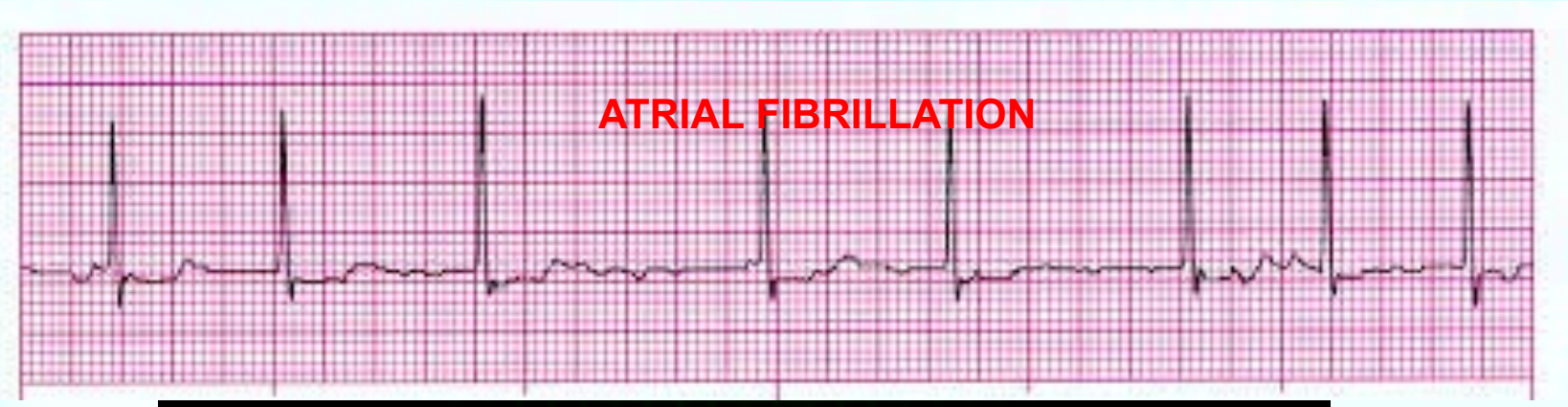
- Regular
- Irregular
- Normal Sinus Rhythm
  - Originating from SA node
  - P wave before every QRS
  - P wave in same direction a



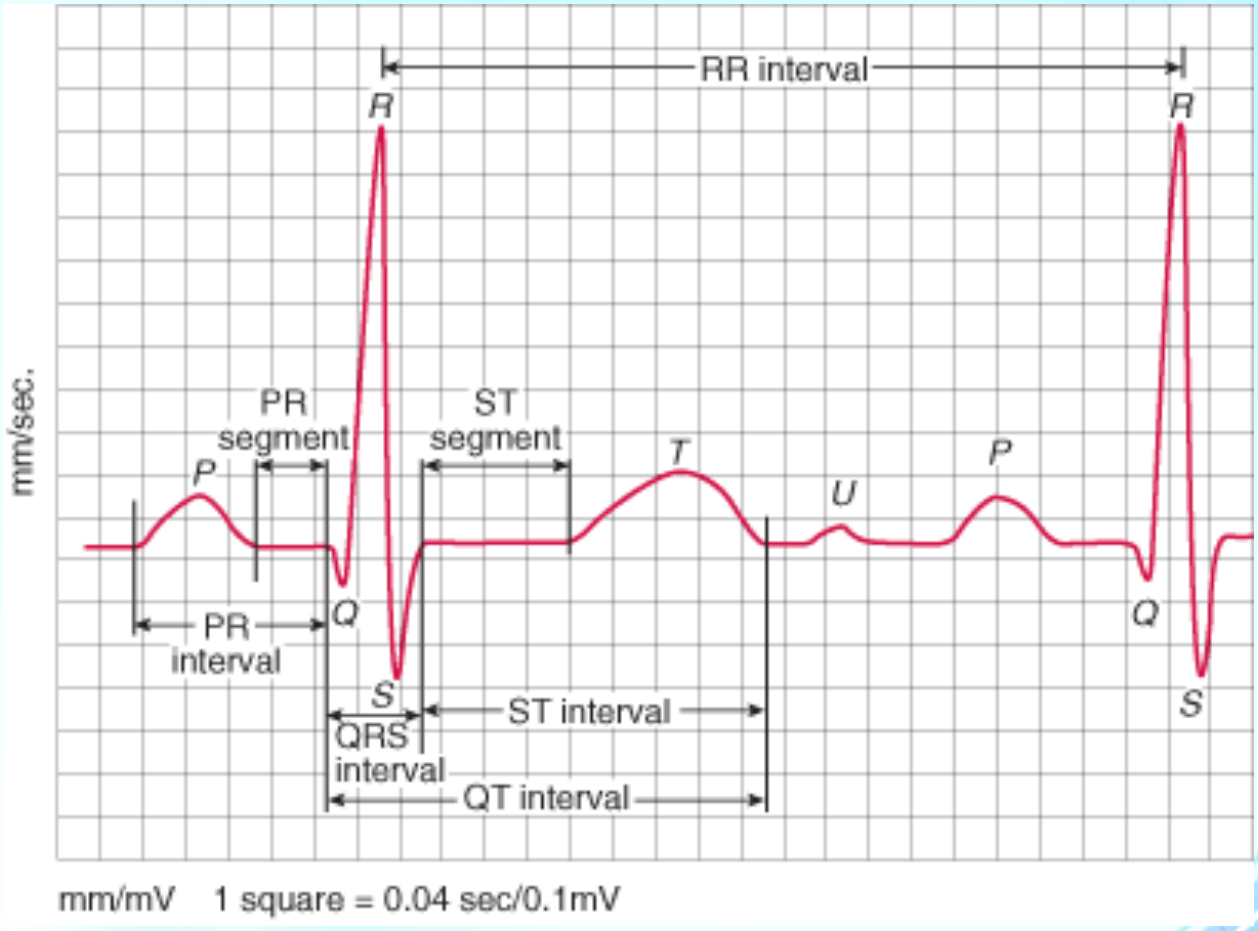
# Normal sinus rhythm




# Normal Intervals

- **PR**
  - 0.20 sec (less than one large box)
- **QRS**
  - 0.08 – 0.10 sec (1-2 small boxes)
- **QT**
  - 450 ms in men, 460 ms in women
  - Based on sex / heart rate
  - Half the R-R interval with normal HR



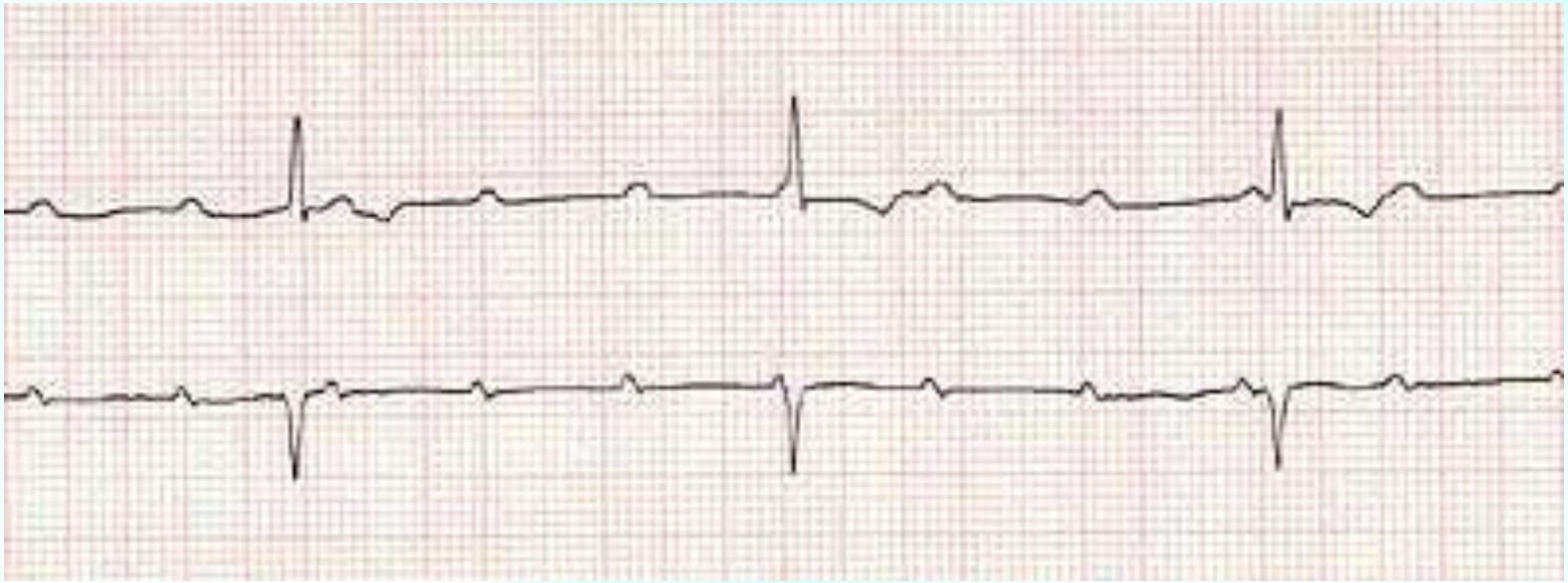
# Blocks

- AV blocks
  - First degree block
    - PR interval fixed and > 0.2 sec
  - Second degree block, Mobitz type 1
    - PR gradually lengthened, then drop QRS
  - Second degree block, Mobitz type 2
    - PR fixed, but drop QRS randomly
  - Type 3 block
    - PR and QRS dissociated

# What is this rhythm?

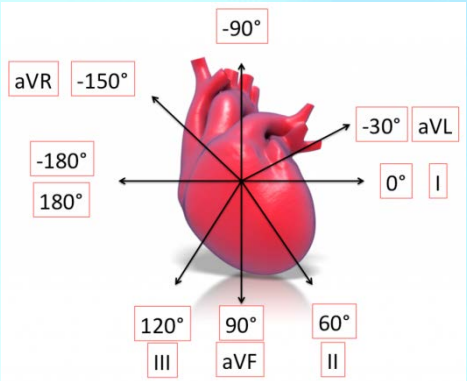

First degree AV block → PR is fixed and longer than 0.2 sec

# 3rd degree heart block (complete)



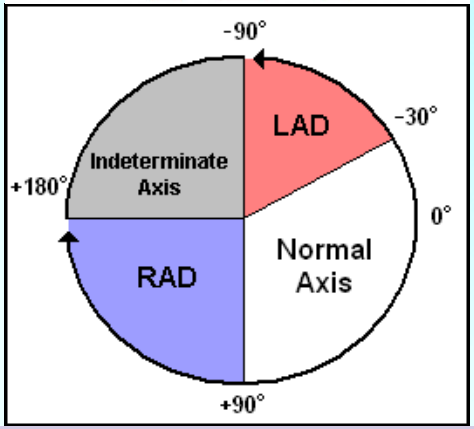
# The QRS Axis

- Represents the overall direction of the heart's activity
- Axis of –30 to +90 degrees is normal

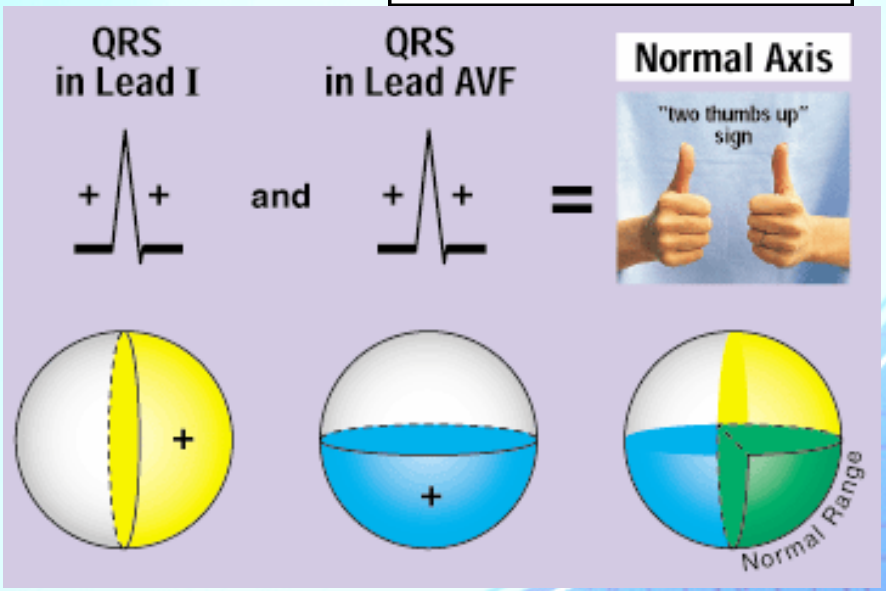



## The Quadrant Approach:

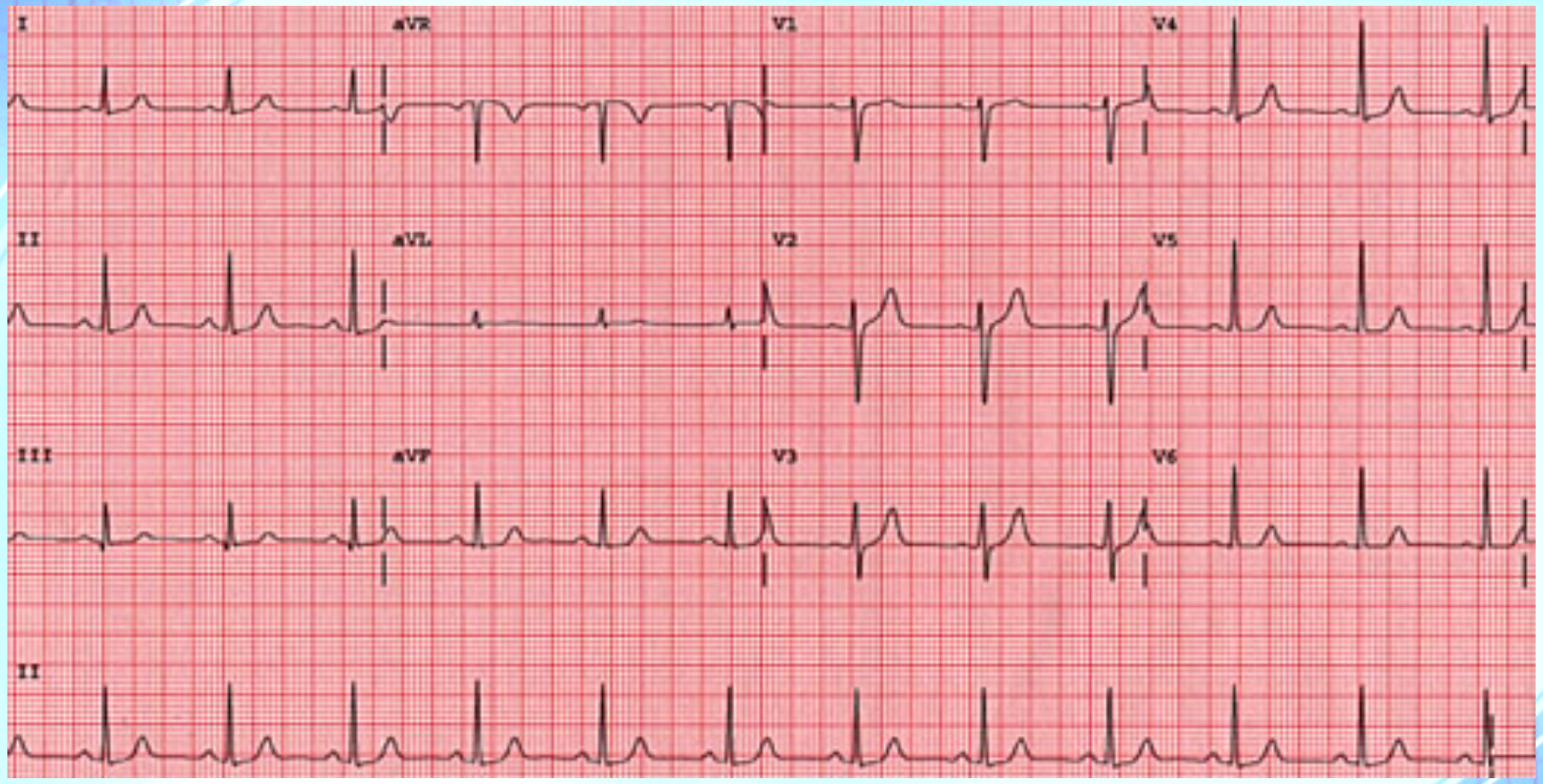
- QRS up in I and up in aVF = Normal




| | | Lead aVF | |
|---|---|---|---|
| | | Positive | Negative |
| Lead I | Positive | Normal Axis | LAD |
| | Negative | RAD | Indeterminate Axis |

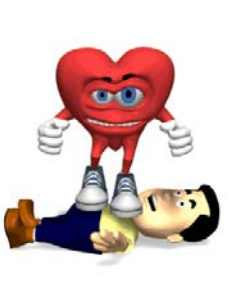


# What is the axis?

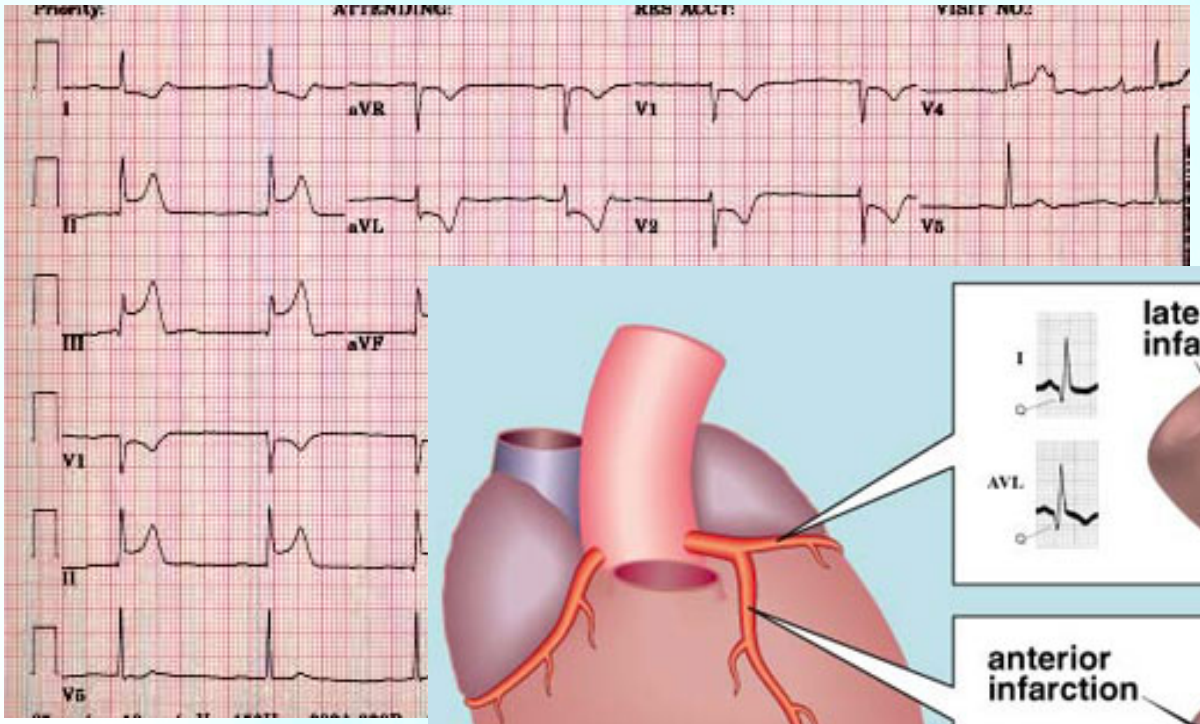



Normal- QRS up in I and aVF

# Ischemia



- Usually indicated by **ST changes**
  - Elevation = Acute infarction
  - Depression = Ischemia
- Can manifest as T wave changes

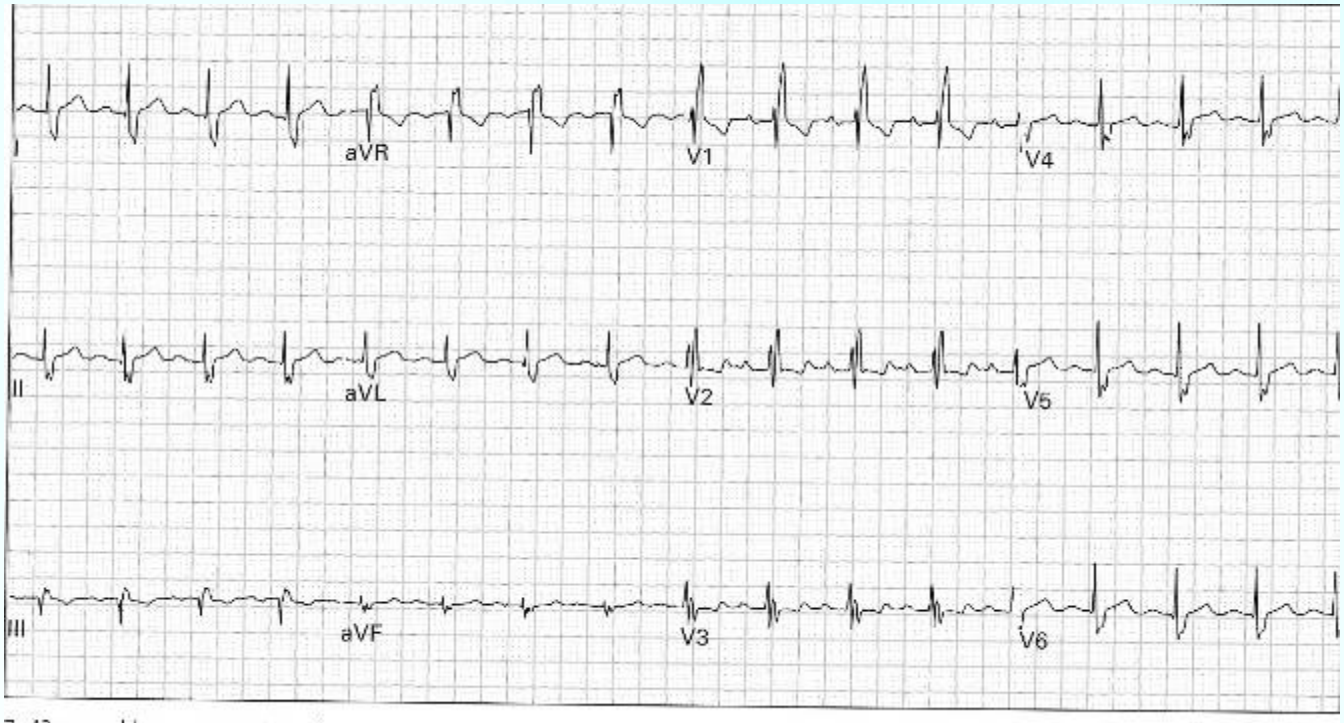






Acute inferior MI wi

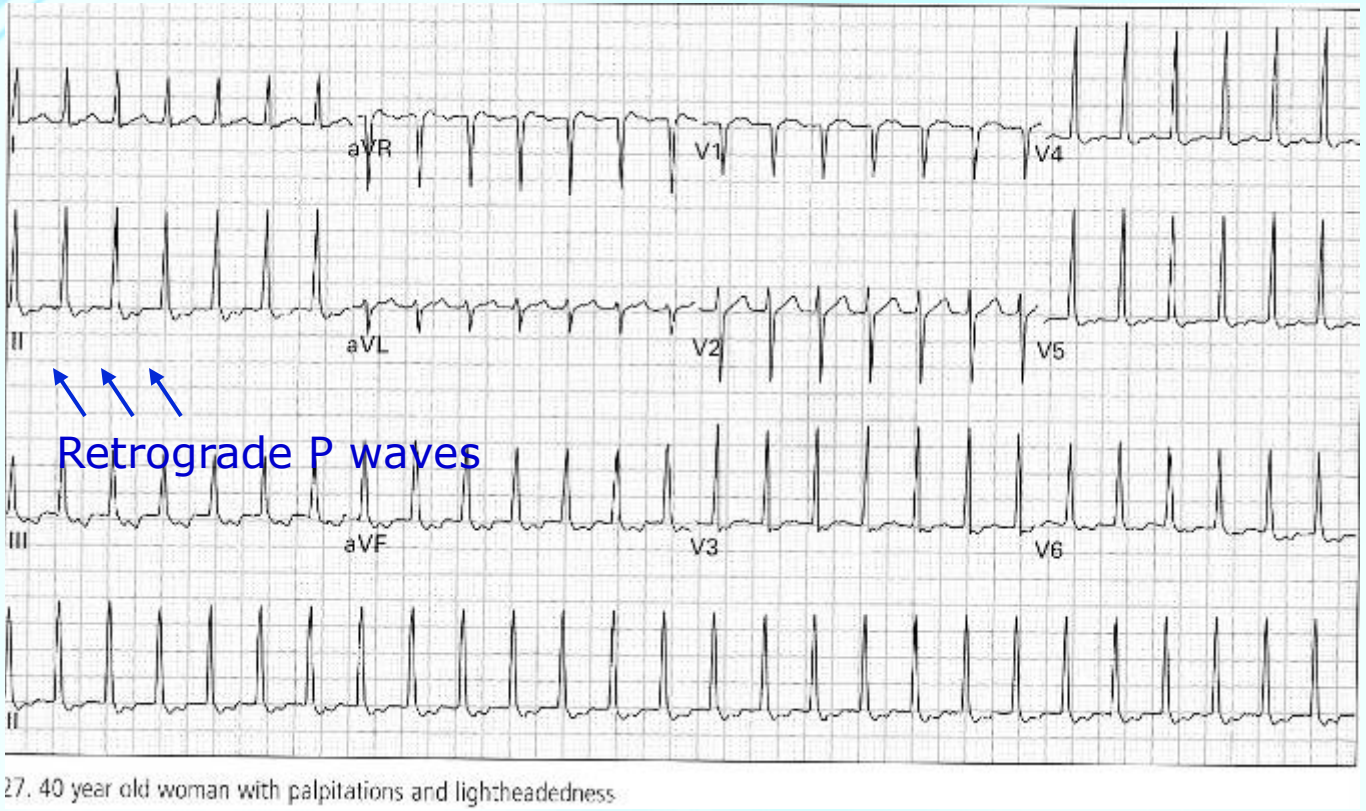
# Right Bundle Branch Block




7. 43 year old man, asymptomatic

V1: RSR prime pattern with inverted T wave
V6: Wide deep slurred S wave

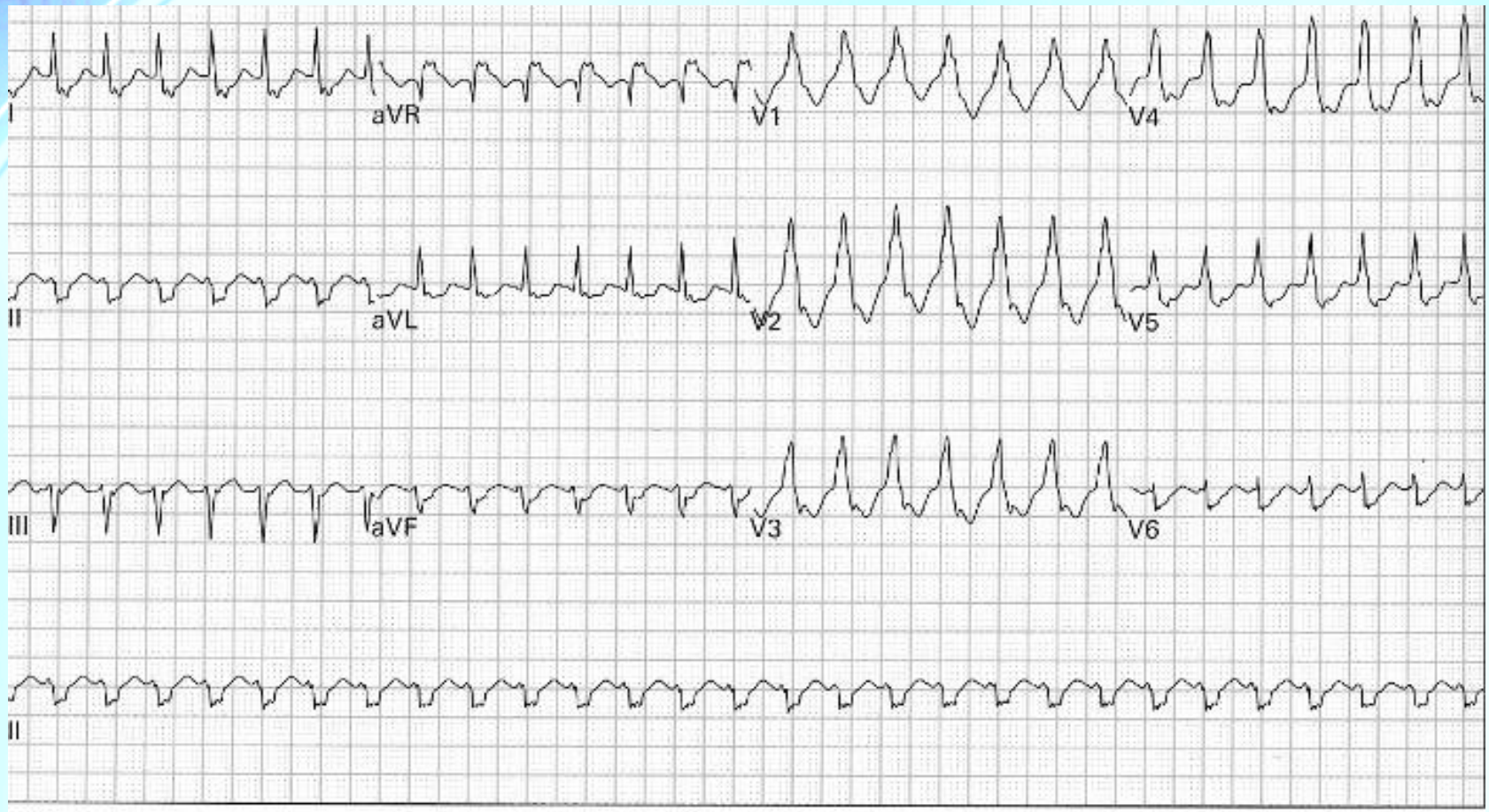
# Supraventricular Tachycardia




27. 40 year old woman with palpitations and lightheadedness

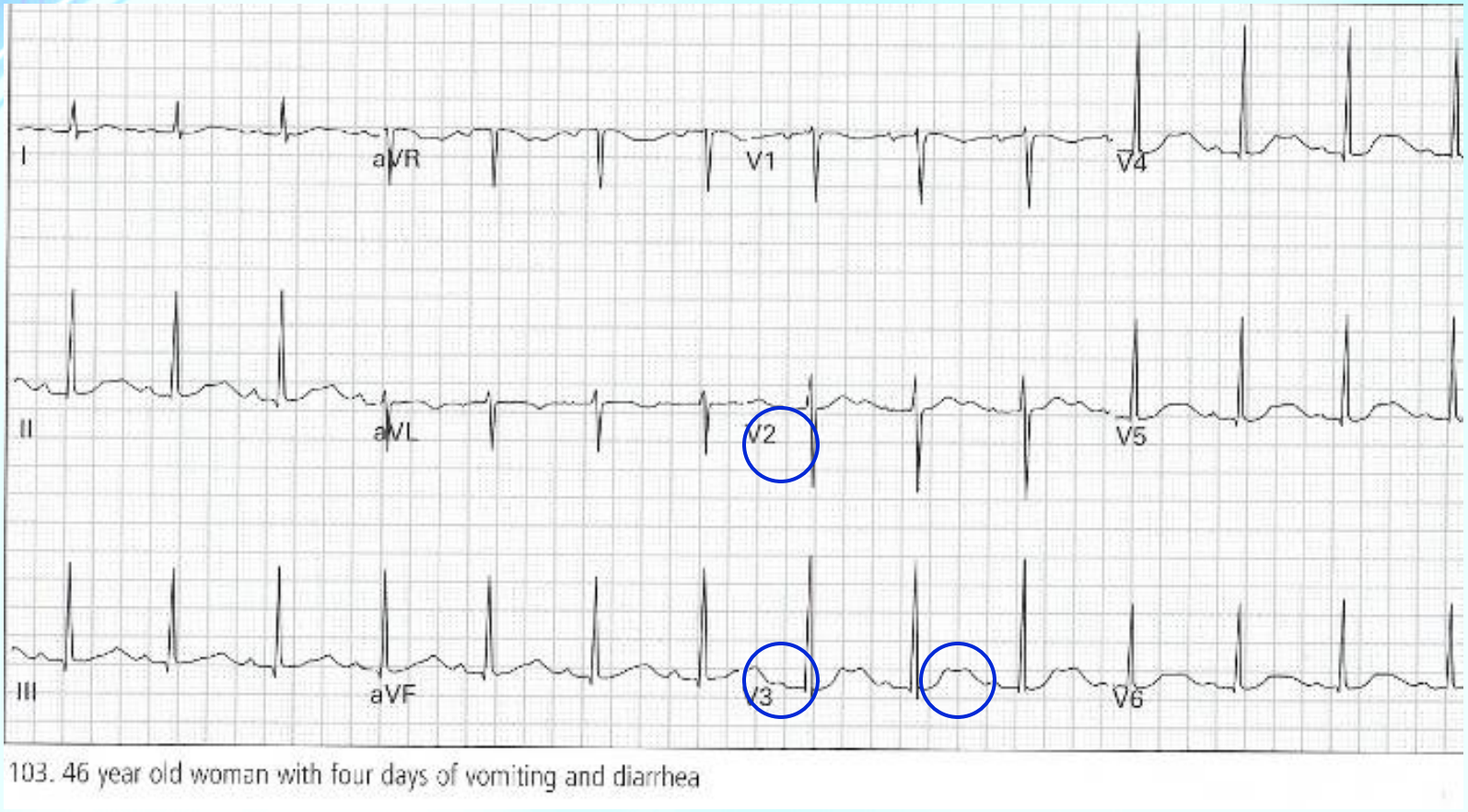
Narrow complex, regular; retrograde P waves, rate <220

# Ventricular Tachycardia




9. 74 year old man with chest pain and palpitations

# Hypokalemia




103. 46 year old woman with four days of vomiting and diarrhea

U waves

Can also see PVCs, ST depression, small T waves

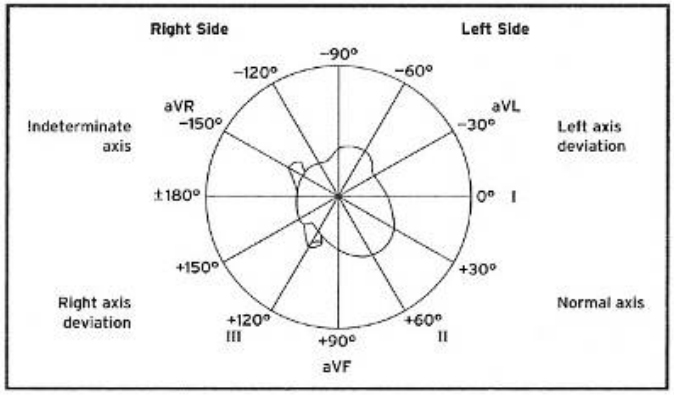
# Ekg CHEKLIST

## 12-Lead EKG Interpretation Checklist

Use this checklist to document your findings on 12-lead EKGs.

### The Basics

- Rhythm _____
- Rate _____
- Intervals PR _____ QRS _____ QT _____




### Axis

- Degree marking _____

### Intraventricular Conduction Defects (IVCDs)

Check if present:

❑ RBBB ❑ LBBB ❑ LAHB ❑ LPHB

## 12-Lead EKG Interpretation Checklist (con't)

### Hypertrophy

Check if present:

❑ RAE ❑ LAE ❑ RVH ❑ LVH

### Infarction

Check if present:

❑ Anterior MI
❑ Inferior MI
❑ Lateral MI
❑ Posterior MI
❑ Anteroseptal MI
❑ Extensive anterior (anterior-lateral) MI
❑ Subendocardial MI
❑ Ischemia

### Miscellaneous Effects

Check if present:

❑ Hyperkalemia
❑ Severe hyperkalemia
❑ Hypokalemia
❑ Hypercalcemia
❑ Hypocalcemia
❑ Digitalis effect
❑ Quinidine effect

# *Thanks for your attention*