Electrocardiography (ECG) or (EKG)

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Outline

1. Review of the conduction system
2. ECG waveforms and intervals
3. ECG leads
4. Determining heart rate
5. Determining heart axis
6. Determining heart rhythm

What is an ECG?

- The electrocardiogram (ECG) is a simple non-invasive test that records the heart's electrical activity.
- ECG provides information about the structure of the heart and the function of its electrical conduction system

What types of information can we obtain from an ECG?

- Heart rate
- Heart Rhythem
- Myopathies
- Electrolyte disturbances (i.e. hyperkalemia, hypokalemia)
- Drug toxicity

Electrocardiography

- The procedure of recording the electrical activity of the heart through cardiac cycle by placing electrodes on the surface of patient's skin.

- These electrodes (conductive pads) detect the tiny electrical changes that are a consequence of cardiac muscle depolarization followed by repolarization during each cardiac cycle (heartbeat).

- **Electrocardiograph** is the machine.

- **Electrocardiogram** is the record.

The normal conduction system

Sinoatrial node

↓

AV node

↓

Bundle of His

↓

Bundle Branches

↓

Purkinje fibers

The depolarization wave spread through the heart

↓

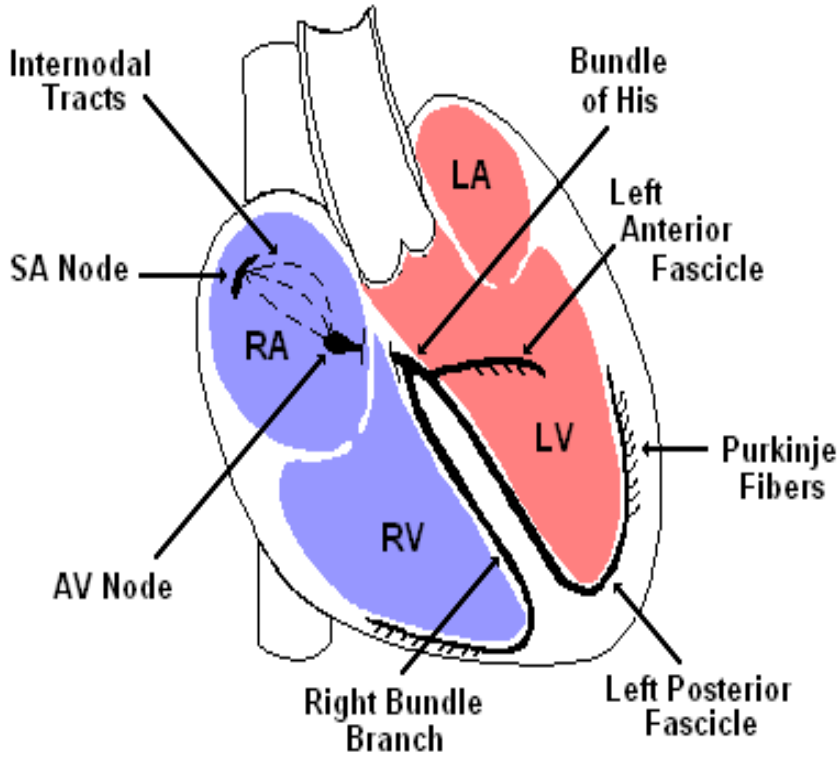
electrical currents pass into the surrounding tissue

↓

part of the current reaches the surface of the body

↓

- **The electrical potentials generated by these currents can be recorded from electrodes**

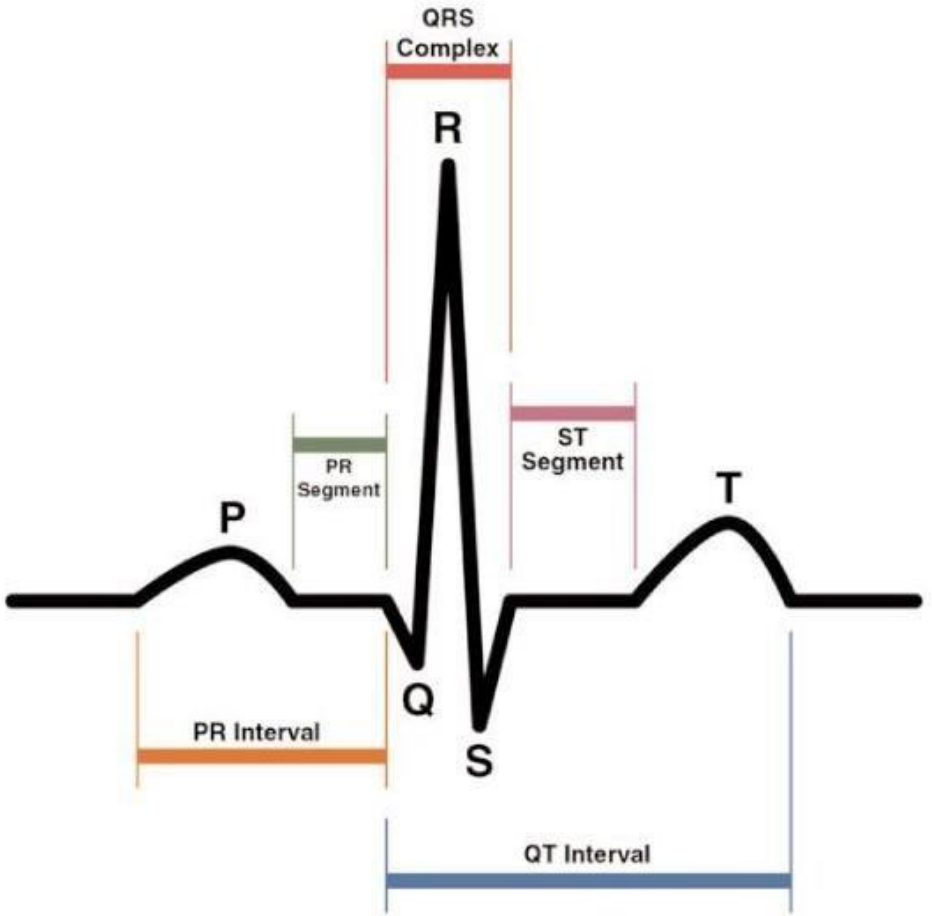


The Normal Electrocardiogram (ECG)

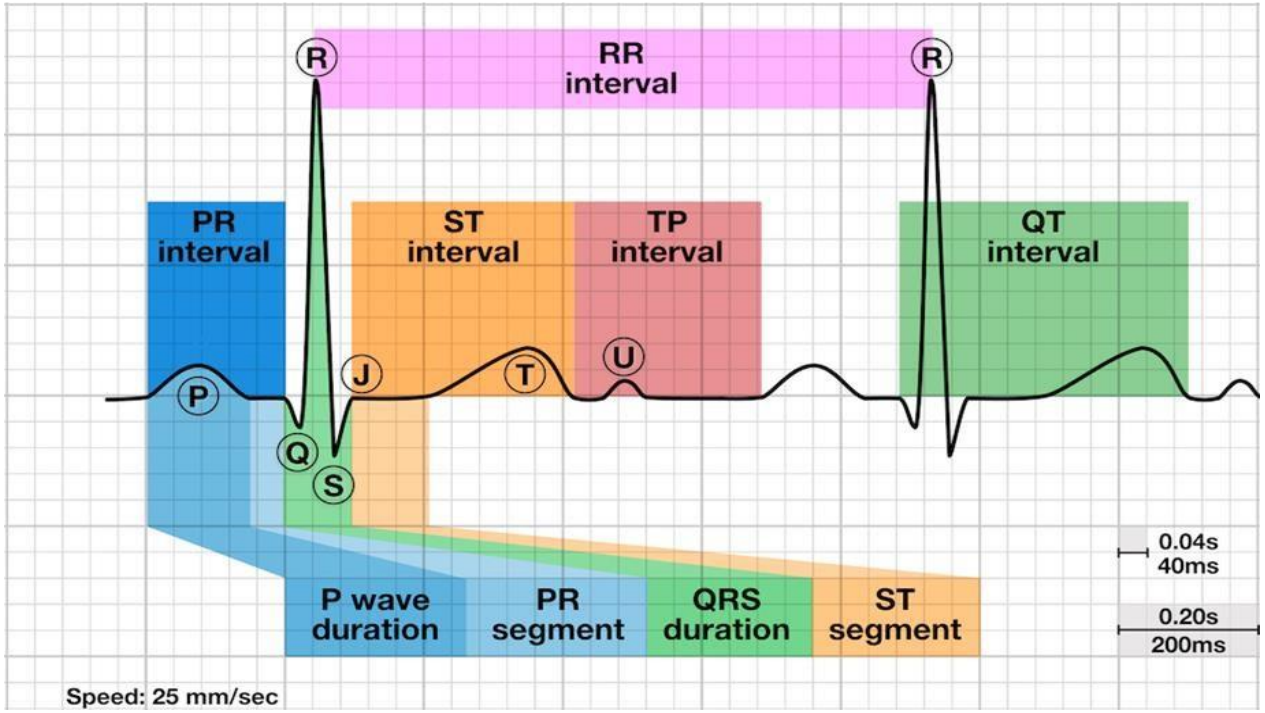
P wave (completed in 0.1 s): is caused by **atrial depolarization** before atrial contraction begins(when atria contract they'll make the P wave)

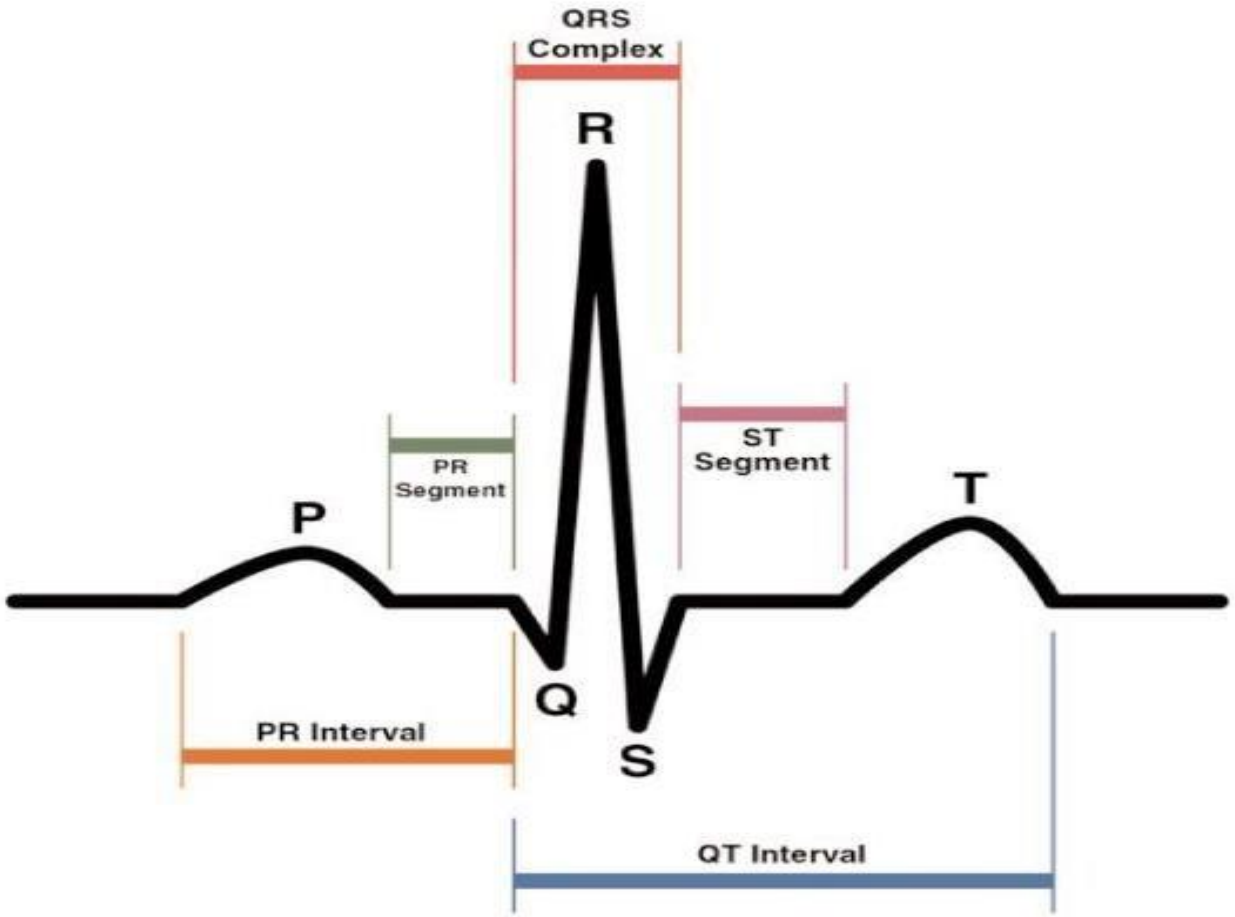
QRS complex (0.08-0.12s): is caused by **depolarization of the ventricles** before contraction (when ventricles contract they'll make the QRS wave)

T wave: **repolarization of the ventricles** 0.25 to 0.35 seconds after depolarizing (when ventricles eject the blood then relax)



Waveforms, intervals and segments





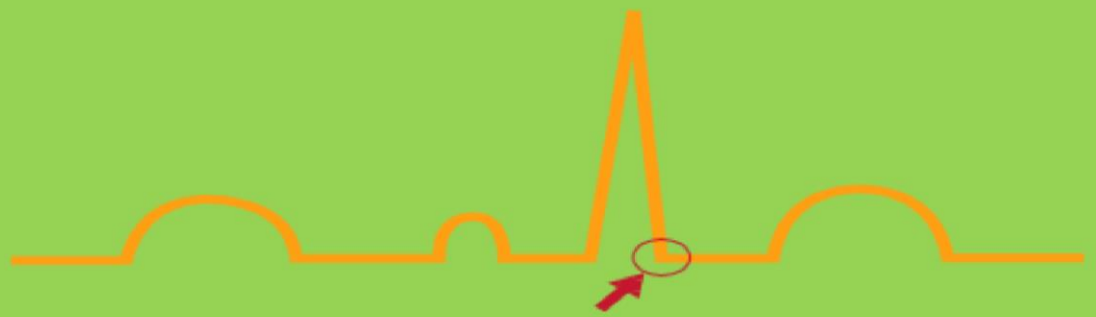
Waveforms, intervals and segments

Interval is a part of the ECG and a segment is a part of an interval.

PR Interval:	From the start of the P wave to the start of the QRS complex 0.12 - 0.20 sec
PR Segment:	From the end of the P wave to the start of the QRS complex
J Point:	The junction between the QRS complex and the ST segment
QT Interval:	From the start of the QRS complex to the end of the T wave $\leq$ 0.40 sec (0.4 – 0.44)
ST Segment:	From the end of the QRS complex (J point) to the start of the T wave

Waveform Components: J-Point

Junction between end of QRS and beginning of ST segment; Where QRS stops & makes a sudden sharp change of direction



Electrocardiograms are recorded by machines that consist of a set of electrodes connected to a central unit

Methods for Recording Electrocardiograms

1. **Computer-based** and electronic display
(common nowadays especially in the ICU)

2. **Pen recorder** and a moving sheet

1

2

ECG Paper

- The ECG paper is a strip of graph paper consists of large squares. Each large square then divided into 25 small squares.
- At a typical paper speed of 25 mm per second:

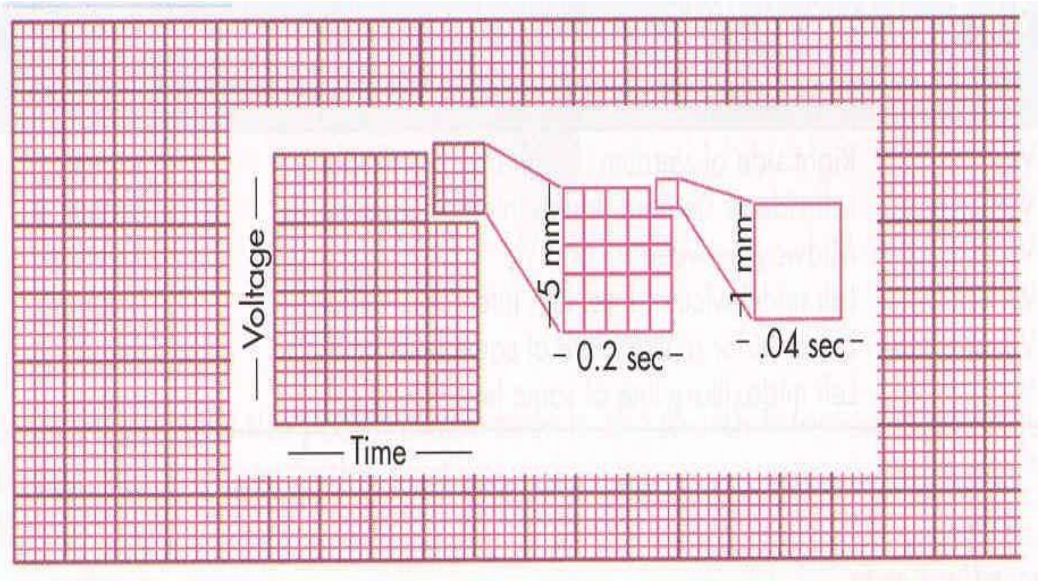
❑The horizontal axis of the ECG paper records time

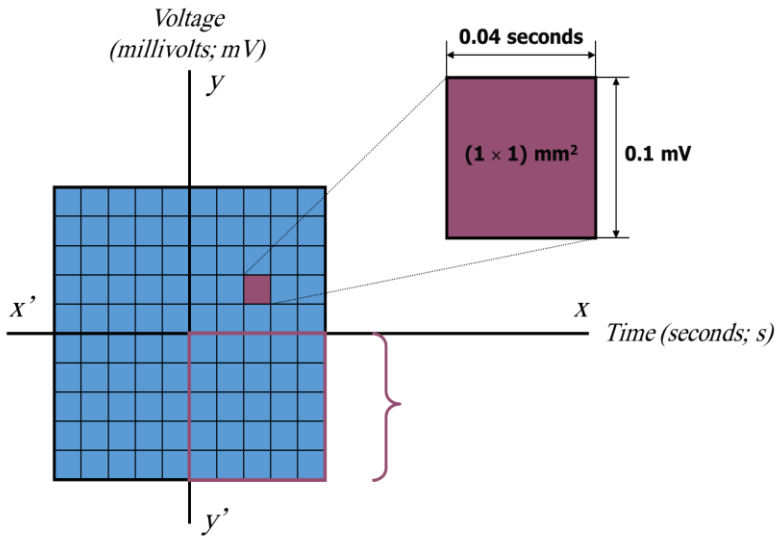
On the horizontal axis, each large square represents 0.2 seconds. Also, each small square represents 0.04 seconds.

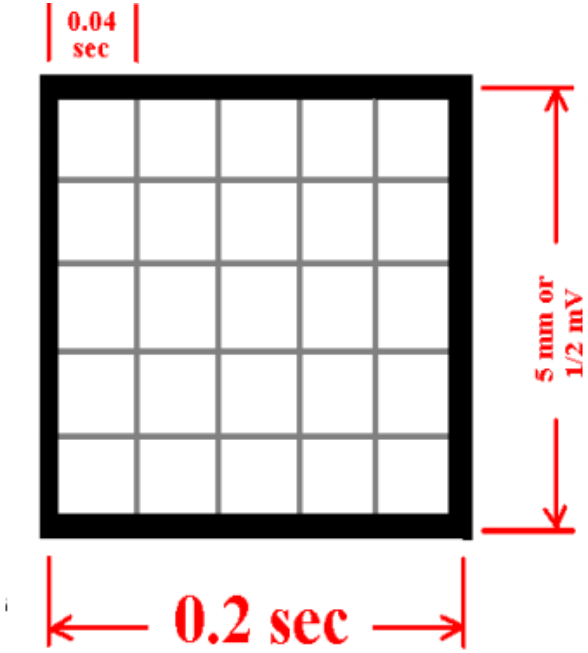
❑ The vertical axis records ECG amplitude (voltage)

In standard calibration, each 10 mm equals 1 mV:

On the vertical axis, each large square represents 0.5 mv. Also, each small square represent 0.1 mv.







ECG LEADS

- Electrodes are the actual conductive pads attached to the body surface.
- Any pair of electrodes can measure the electrical potential difference between the two corresponding locations of attachment. **Such a pair forms a lead.**

Leads measure the difference in electrical potential between either:

1. Two different points on the body (bipolar leads)
2. One point on the body and a virtual reference point with zero electrical potential, located in the center of the heart (unipolar leads)

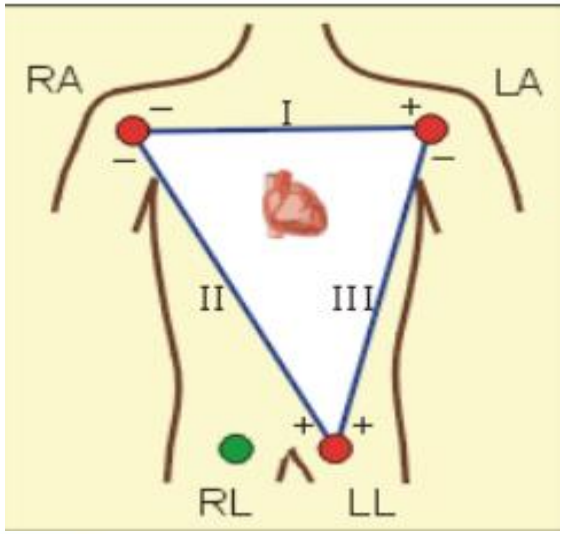
Electrocardiographic leads

The standard ECG has 12 leads:

- ✓3 Standard Limb Leads
- ✓3 Augmented Unipolar Leads
- ✓6 Chest Leads (Precordial Leads)

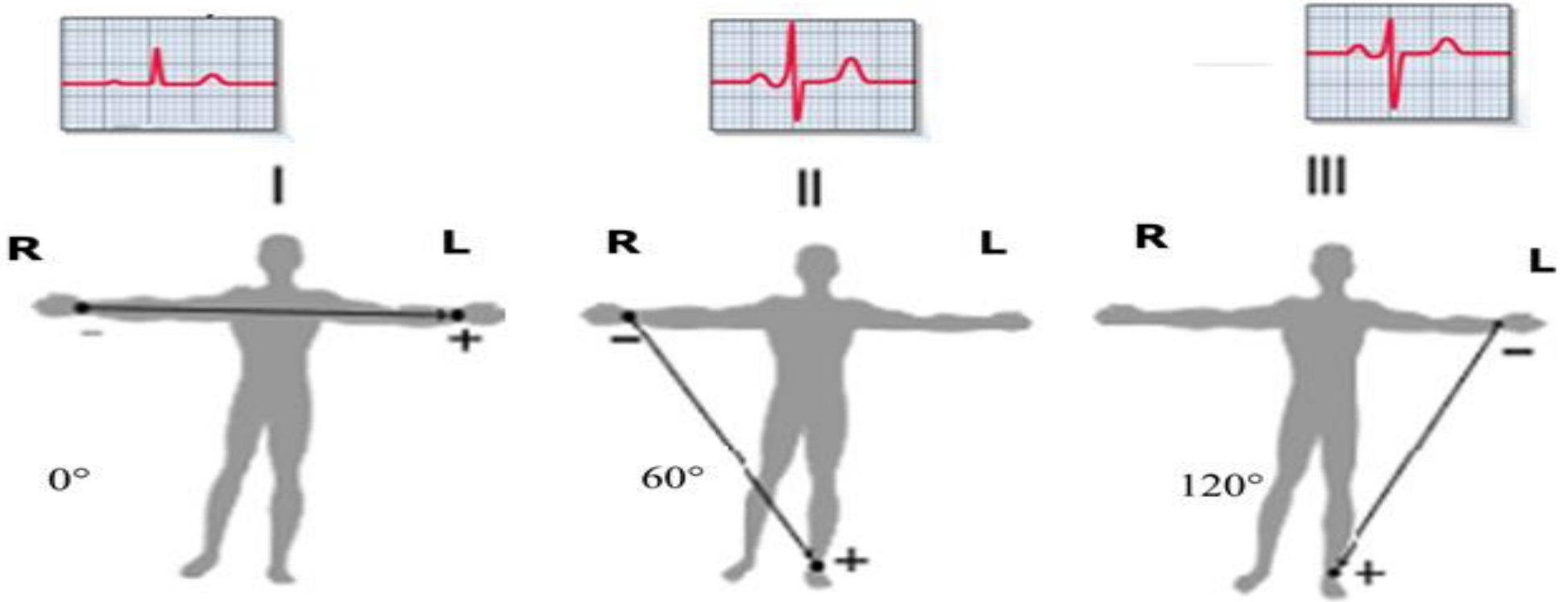
The axis of a particular lead represents the viewpoint from which it looks at the heart.

Standard limb leads



Record the differences in potential between two limbs;
There are Three Bipolar Limb Leads:

leads I, II, and III.

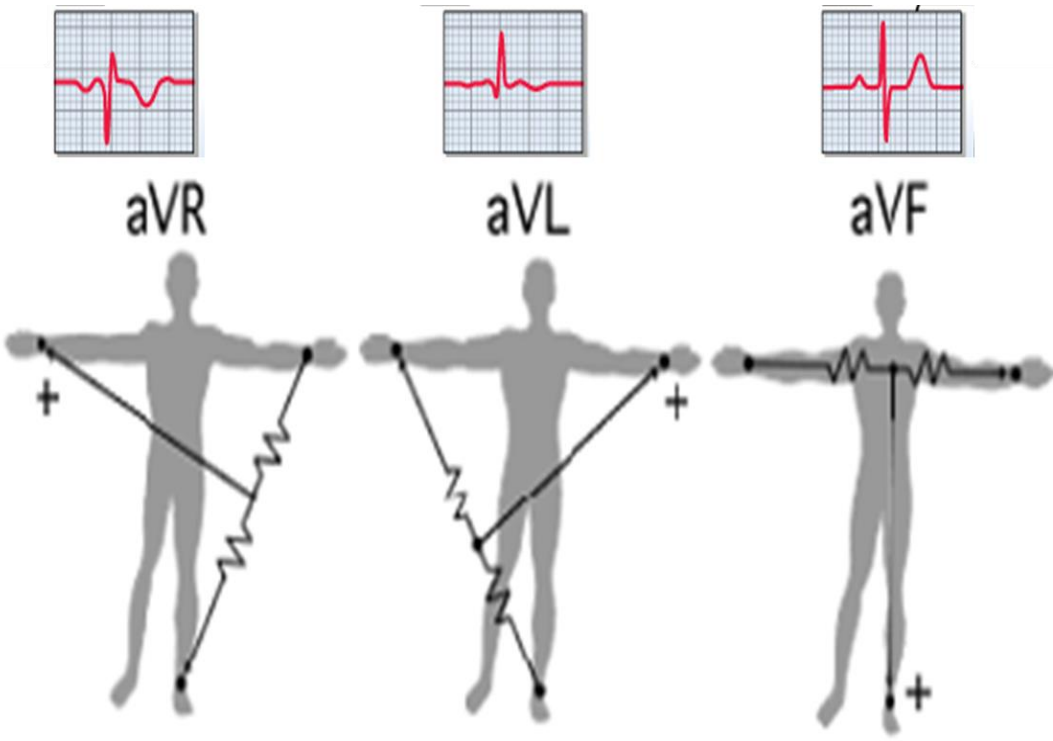


Augmented Unipolar Leads

Two of the limbs are connected to the negative terminal of the electrocardiograph, and the third limb is connected to the positive terminal.

There are Three Augmented Unipolar Leads: aVR, aVL, and aVF

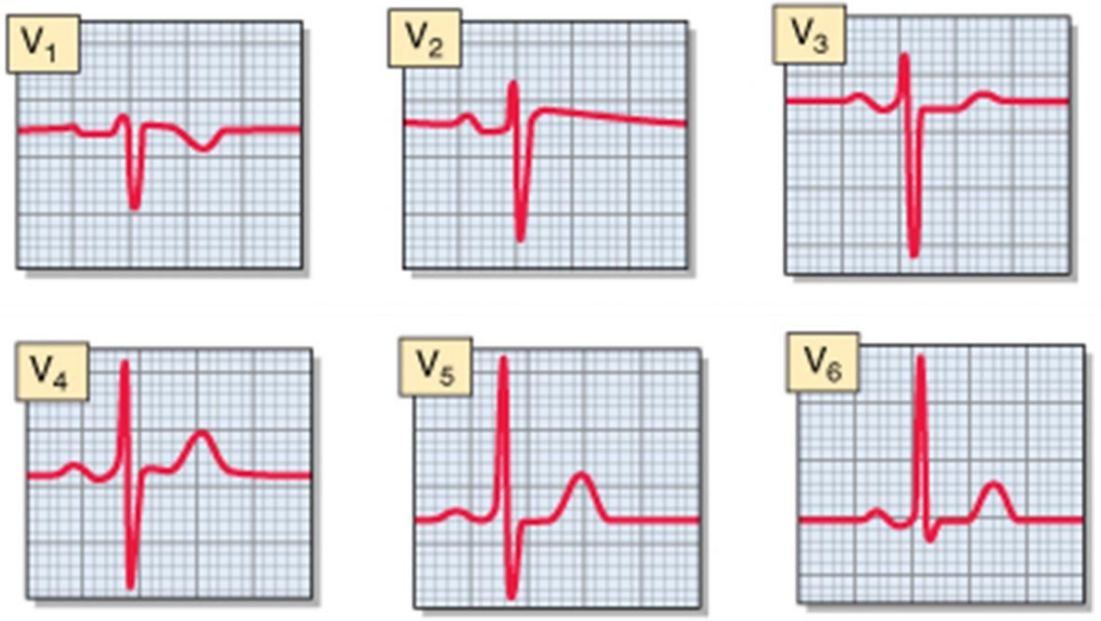
- ❑In aVR lead, the positive terminal is on the right arm
- ❑ In aVL lead, positive terminal is on the left arm
- ❑ In aVF lead, the positive terminal is on the left leg

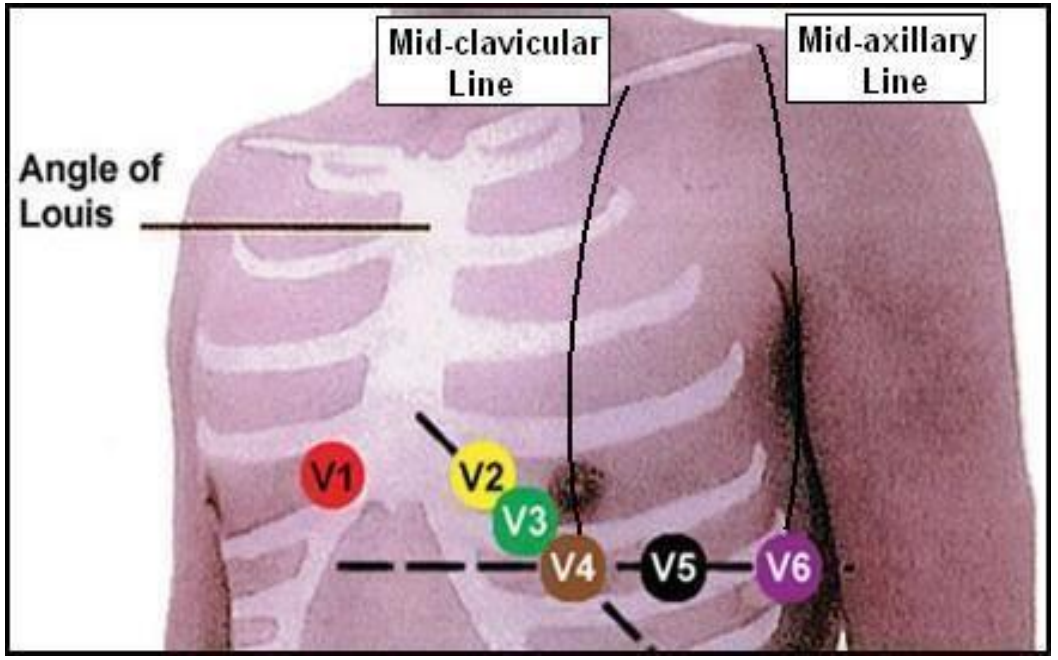


Electrocardiographic leads

✓ Chest Leads (Precordial Leads)

Chest leads, known as leads V1, V2, V3, V4, V5, and V6, are connected to the positive terminal of the electrocardiograph, and the *indifferent electrode,* or the negative electrode, is simultaneously connected to the left arm, left leg, and right arm.





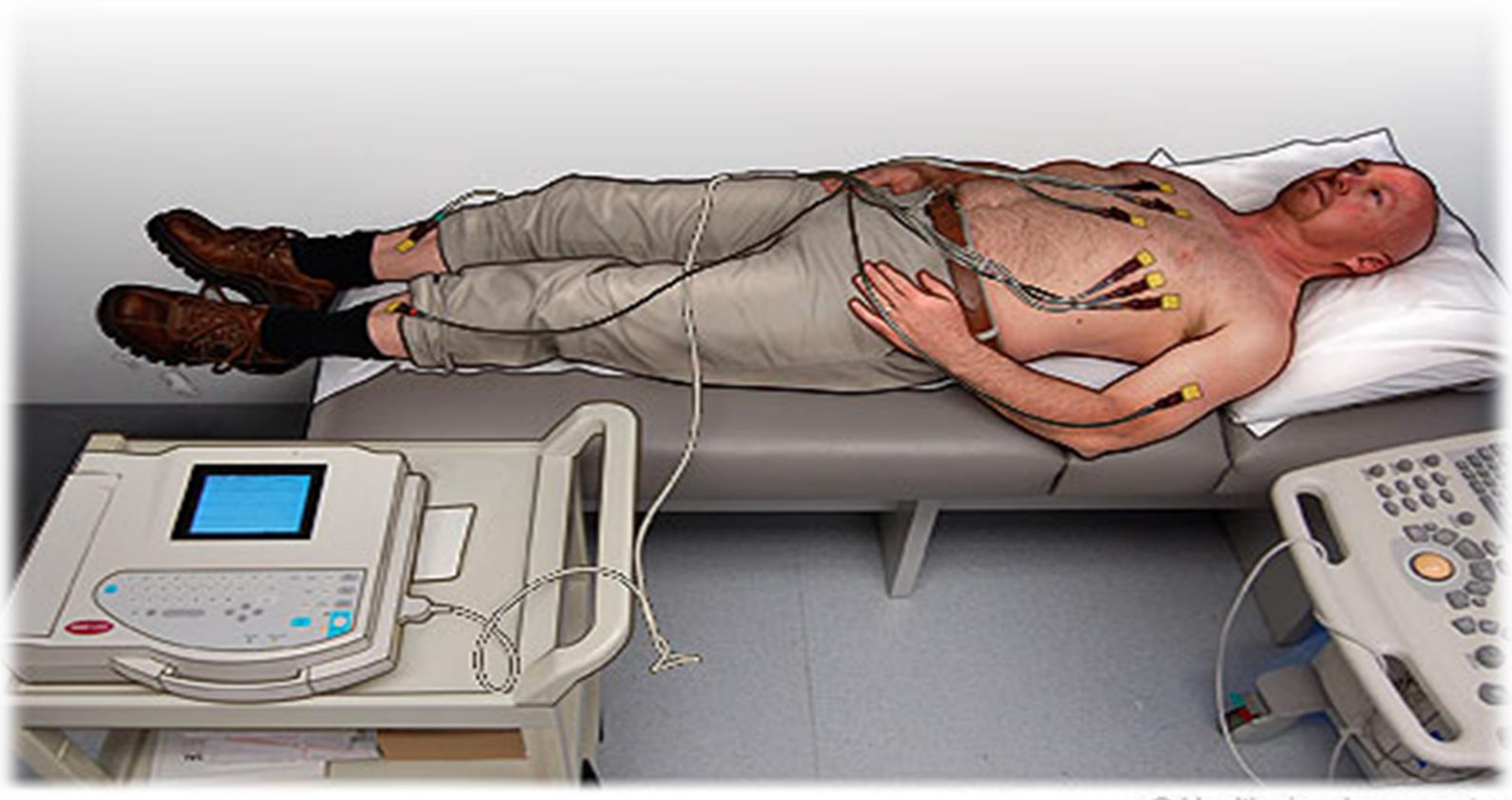
ECG Recording

Preparation

- Ensure that the client did not receive any medication.
- Ask your patient to remove any metal jewelry or other objects that may interfere with the test.
- Usually ECG is taken while the patient is resting so ask your patient to lie down.

Preparation

- The patient must be relaxed (ideally not even talking).
- Electrically conductive gel should be used on the surface of electrodes.
- The electrodes are labeled and placed on the patient's body.

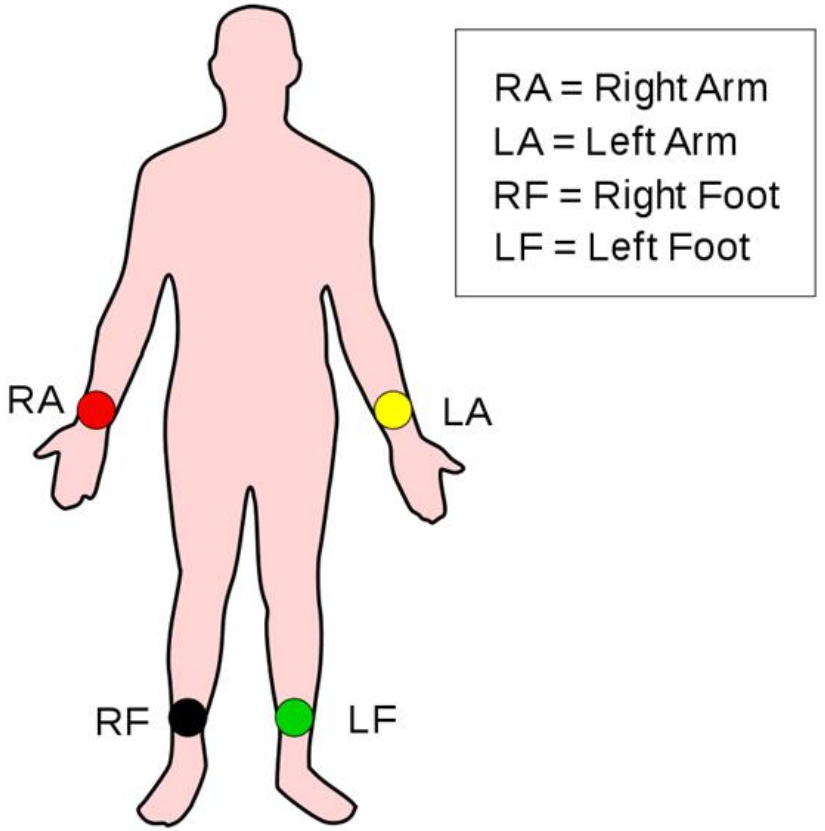


Placement of electrodes

Limb leads placement

- **Limb** electrodes are marked with a special color

Electrode name	Electrode placement	Colour
RA	placed on the right arm	Red
LA	placed on the left arm	Yellow
RL	placed on the right leg	Black
LL	placed on the left leg	Green



V1: right 4th intercostal space.

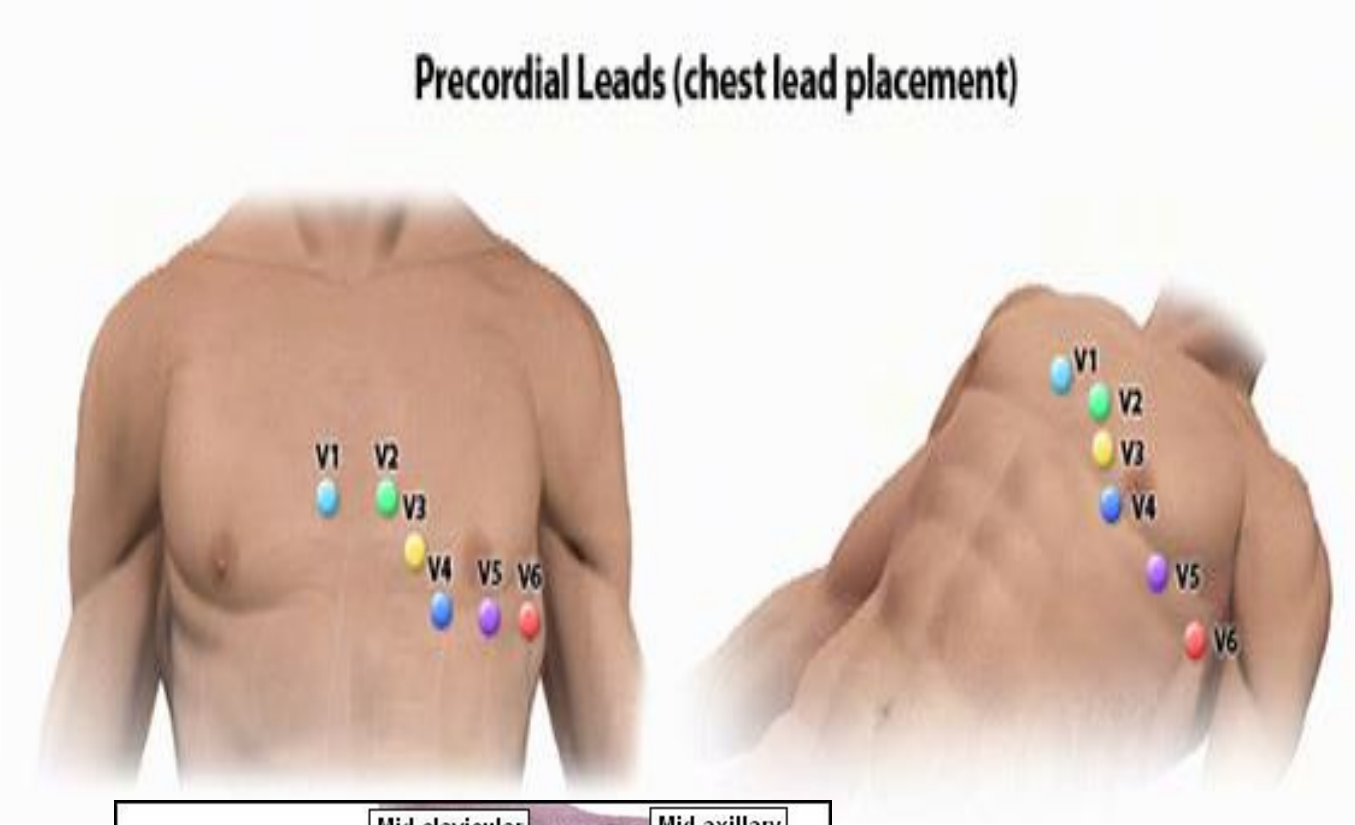
V2: Left 4th intercostal space.

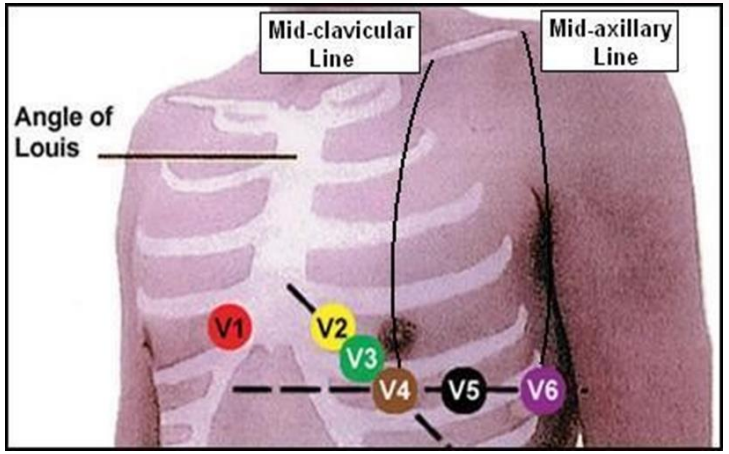
V3: midway between V2 and V4.

V4:Left 5th intercostal space, at left mid clavicular line.

V5: Left 5th intercostal space, at left anterior axillary line.

V6: Left 5th intercostal space, at left mid-axillary line.





Analysis of ECG

1. Heart Rate (normal 70 – 80)

- The heart rate is the **repetition of the time interval** between two successive heartbeats

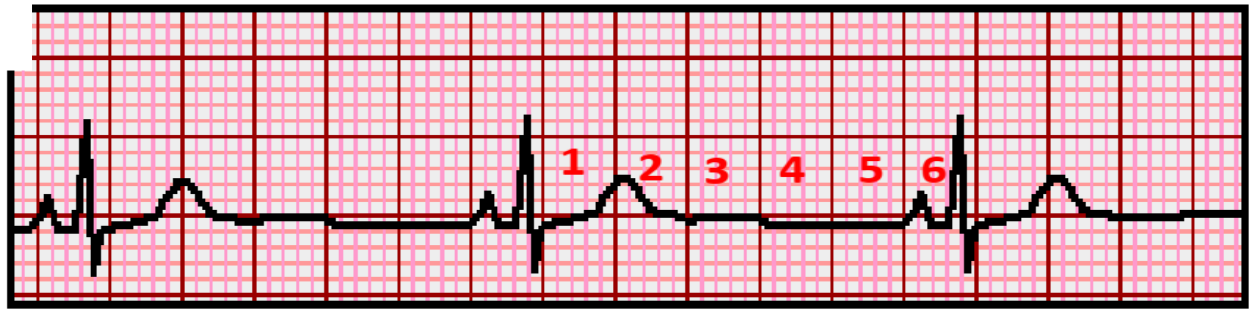
Determining the heart rate:

1- Rule of 300: With a regular rhythm

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

Although fast, this method only works for regular rhythms.

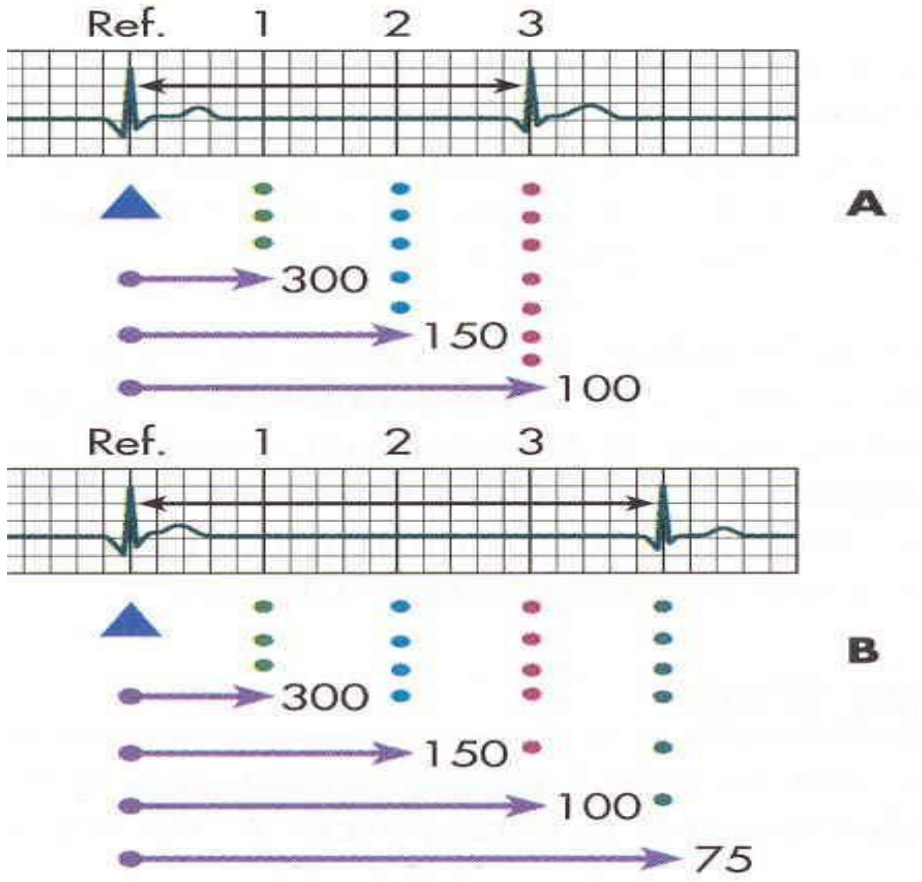
(300 / 6) = 50 bpm



H.R. = 300/ number of large squares between 2 "R - R" waves

H.R. = 1500 / number of small squares between 2 "R - R" waves

One quick and easy way to measure the heart rate is to examine the RR interval and use a standard scale to find the rate. Find an R-wave located on or near **a heavy vertical line**. for each subsequent heavy vertical line, we use the following numbers:



For irregular rhythm

- ✓the R-waves appearing at varying intervals
- ✓count the number of R waves in a 6 second strip and multiply by 10.

30 large squares equals 6 seconds

•Number of QRS complexes in 6 sec i.e. (30 large squares) = 7

7 x 10 = 70 b/min

Analysis of ECG

- **2-Rhythm :** The rhythm is either **sinus rhythm or not sinus rhythm**. Sinus rhythm refers to the origination of the electrical activity coming from the sinus node

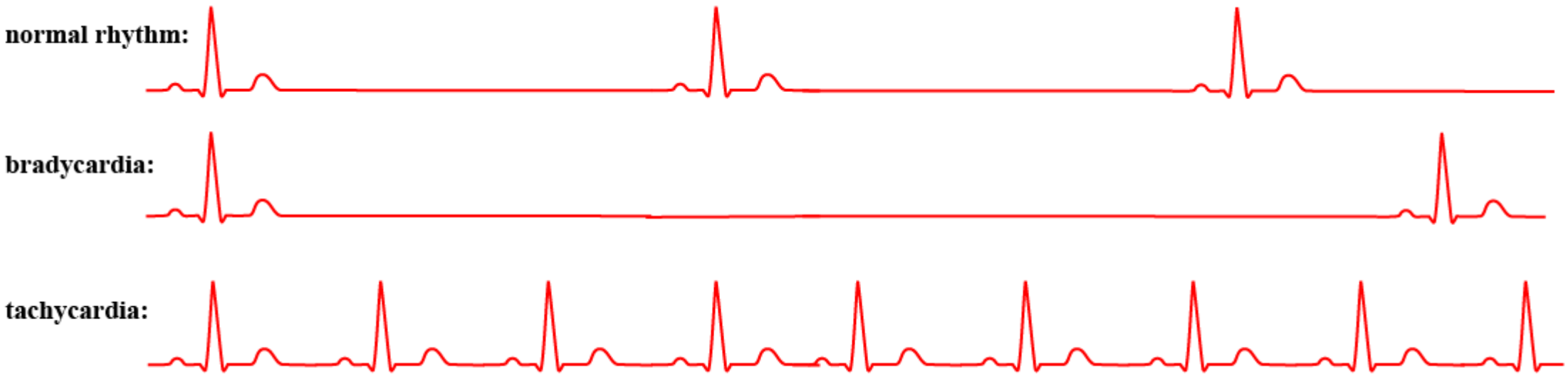
- Heart rhythm can be either regular or irregular.

In a regular rhythm:

- **Consistent R-R intervals.**
- **P waves round, same shape and Single p-wave precedes every QRS complex**
- **Normal and constant PR interval (0.12-0.20 sec or 3-5 small boxes)**
- **Normal and constant QRS interval (< 0.12 sec or < 3 small boxes)**
- **QRS positive in leads I, II, aVF, V3-V6**

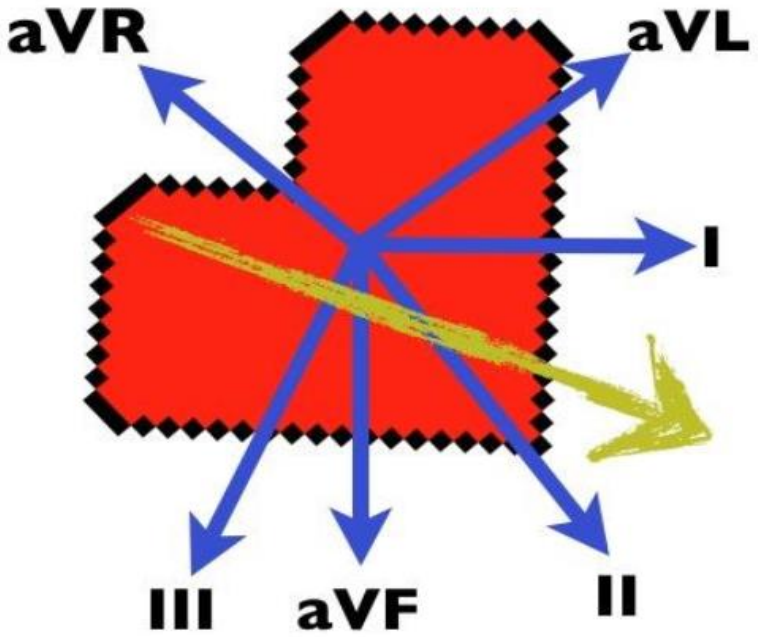
- **Normal hear rate: 60-100**

- If there is sinus rhythm, and the heart rate is less than 60 beats per minute, then sinus bradycardia is present. If there is sinus rhythm, and the heart rate is greater than 100 bpm, then sinus tachycardia is present.



Analysis of ECG

- **<u>3-Electrical axis</u>**: Cardiac axis describes the net overall direction of the heart's electrical activity or depolarization wavefront
- The depolarization wave normally spreads through the ventricles in a direction from base of the heart to its apex
- It is important to decide whether this axis is in normal direction or not.



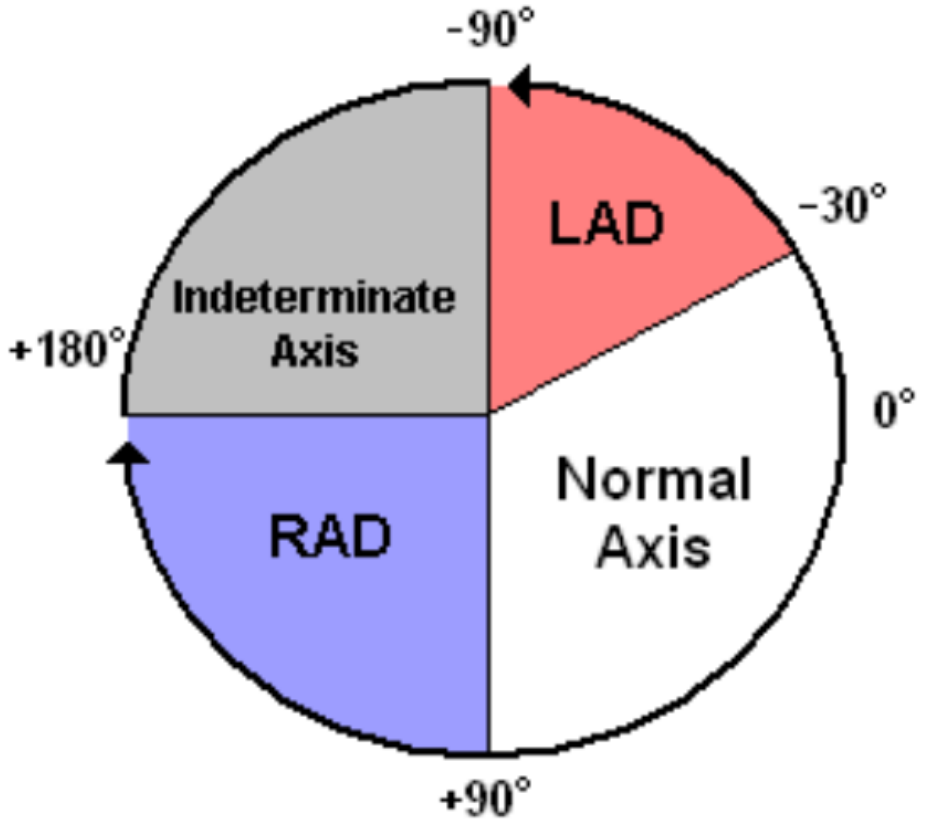
Cardiac axis

- The normal QRS axis is defined as ranging from -**30° to +90°.**

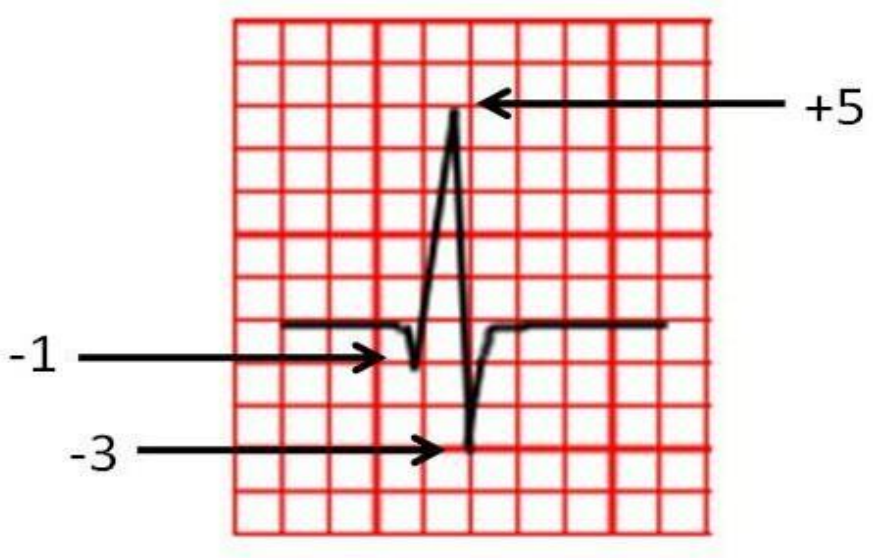
❖-30° to -90° is referred to as a left axis deviation (LAD)

❖+90° to +180° is referred to as a right axis deviation (RAD)

❖Extreme Axis Deviation = QRS axis between -90° and 180°



- Use two leads, namely leads I and aVF.
- Looking at the QRS complexes in these leads, calculate the overall size and polarity of the QRS complex in each by subtracting the depth of S wave from the height of the R wave. Construct a vector diagram and draw arrows that represent the sum of size and polarity for each lead on the diagram.
- The point at which the two perpendicular lines meet, constitute the tip of the cardiac axis. Draw a line from that point to zero point and this will be the cardiac axis.



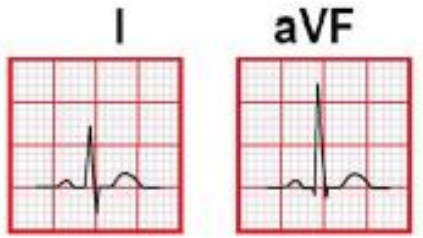
Net deflection = 5 – 1 – 3

= +1

Step 1

Look at leads I & III

I and aVF

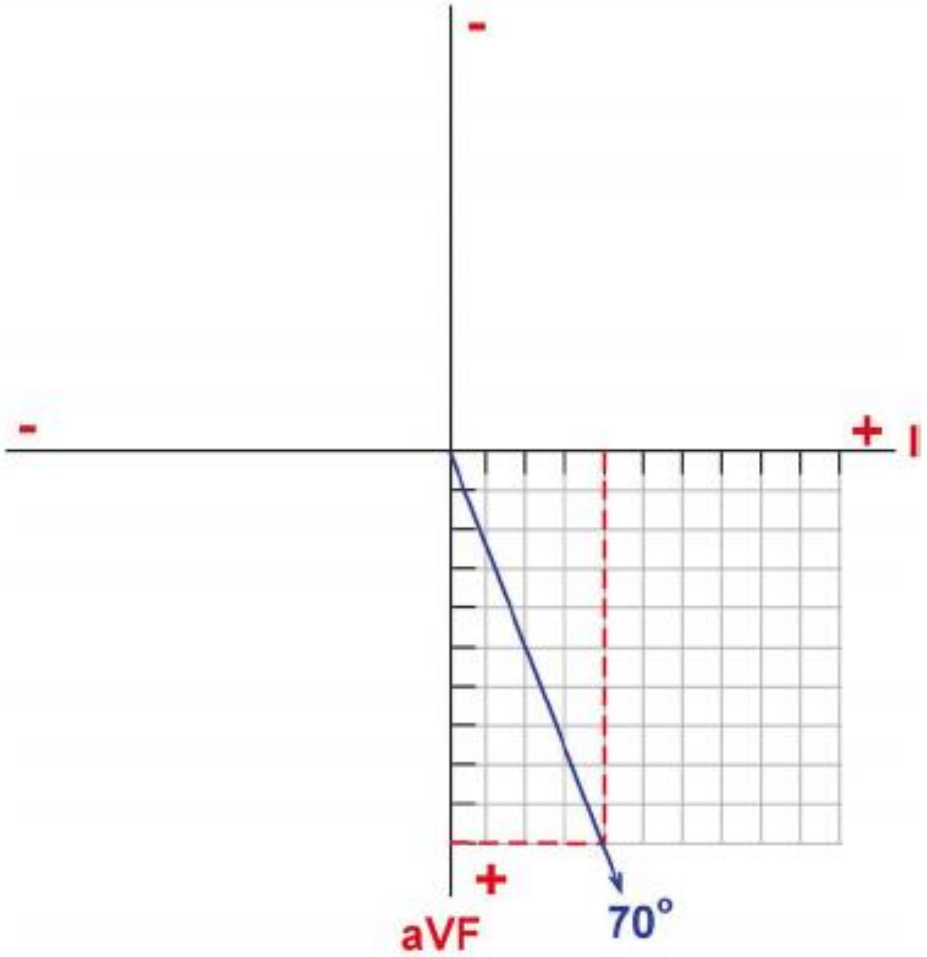


Step 2

Calculate the average size and polarity of QRS complex in each

Step 3

Plot on the hexaxial reference system



- **Causes of LAD :**
  - **Physiologic:** Mechanical shift, such as with expiration or raised diaphragm (e.g., pregnancy, obesity)
  - **Pathologic:** Left ventricular hypertrophy, inferior wall MI, Conduction defects (left bundle branch block)
- **Causes of RAD:**
  - Normal variation (e.g., children, young adults, inspiration)
  - Limb-lead reversal (left- and right-arm electrodes)
  - Right ventricular hypertrophy, Conduction defects (right bundle branch block)
  - Lateral wall myocardial infarction
  - Dextrocardia

Thank you