

How to record a 12 lead ECG

Explain the procedure to the patient. Patient will have to remove the shirt to expose the chest. Reassure that it will be painless and will only take a few minutes. Patient should then be helped on the couch and asked to lie with legs and arms uncrossed.

- Clean areas of electrode placement with alcohol wipes.
- Place pads for limb and chest electrodes.
- Limb leads are colour coded. Pneumonic **Ride Your Green Bike** will help you remember how to place the leads. Start with the red lead and attach it to the right wrist. Yellow is attached to the left wrist, green to the left leg and black to the right leg.
- Position of chest leads
 - V1: Fourth intercostal space at the right sternal border. (First palpable intercostals space, below the clavicle is the 2nd intercostal space.
 - V2: Fourth intercostal space at the left sternal border
 - V3: Midway between V2 and V4
 - V4: Fifth intercostal space in the midclavicular line
 - V5: Anterior axillary line at the same horizontal level as V4
 - V6: Mid-axillary line at the same horizontal plane as V4 and V5

Switch on the machine, if it has a filter button press it to erase previously recorded ECG. Record ECG.

How to read ECG

I will try to explain the important points in ECG as briefly and simply as I can. For the OSCE you will obviously need to check the patient's name, date of birth and date when ECG was done.

ECG machines pick up electrical activity through 4 limb electrodes and 6 chest electrodes and convert it into 6 limb leads (I, II, III, aVR, aVL and aVF) and 6 chest leads (V1-V6)

- Leads I and aVL look at the left side of the heart
- Leads II, III and aVF look at the inferior surface of the heart
- aVR is always negative as it looks at the heart from the position of the right shoulder and electrical current moves away from it. The negative waves confirm that the electrodes have been connected correctly

The 6 chest leads look at the heart in the horizontal plane, from the front and around

- V1 and V2 give information about the right heart
- V3 and V4 about the interventricular septum
- V5 and V6 give information about the left side of the heart

Waves

- P wave: represent atrial systole
- QRS complex: ventricular systole
- T wave: ventricular relaxation or diastole

- Atrial systole gets buried in the ventricular systole and therefore does not produce a wave form
- Q waves: When heart muscles are damaged the electrical current does not pass through them and instead of upright R waves, downwards Q waves are produced

Intervals

When ECG is recorded the paper speed is 25 millimetres/second so in 1 second ECG tracing covers 5 large squares or 1 large square is equal to 0.2 seconds and one small square is equal to 0.04 seconds.

- PR interval is measured from the start of the P wave to the beginning of the QRS complex. The normal PR interval is 0.12 to 0.2 seconds or 3-5 small squares
- Duration of QRS complex is normally 0.12 seconds or 3 small squares
- QT interval is the time between the onset of depolarization to repolarization. It is affected by diet, gender, alcohol, time of the day, menstrual cycle and heart rate. QTc is the QT interval which has been corrected for the heart rate
 - $QTc = QT \text{ msec} / \text{square root of RR}$

I don't know about you but I have limited mathematical skills and cannot calculate QTc with the above formula. An easier way is to calculate the RR interval (number of large squares) and if QT interval is longer than 50% of the RR interval (again check the number of large squares between beginning of Q and end of T) it is an indication that it is prolonged. You can then take out your calculator and do it properly

Potential consequences of QT prolongation include torsade de pointes (syncope), ventricular fibrillation and sudden death. **If QTc prolongation is associated with T wave changes refer to the cardiologist.**

Heart rate

Heart rate can be easily determined by counting the number of large squares between 2 consecutive QRS complexes (R-R interval). Normally the heart rate is between 60 and 100/min.

- 1 large square: rate is 300/m
- 2 large squares: rate is 150
- 3 large squares: rate is 100
- 4 large squares: rate is 75
- 5 large squares: rate is 60 (1 QRS per second)
- 6 large squares: rate is 50

Patient is said to be bradycardiac if under 60 and tachycardic if heart rate is more than 100.

How to determine axis?

Axis can be checked by looking at the direction of wave forms in leads I, II and III. A normal (11'o clock to 5 o' clock axis means that current is flowing towards leads I, II and III and results in upward deflections in all 3.

- In right axis deviation the deflections in I will become negative with positive waves in II and III.
- In left axis deviation waves are negative in II and III
- If deflections are negative in all 3 it is extreme left axis deviation

How to read a rhythm strip?

Have gone through the basics lets move on to reading a rhythm strip. 6 questions need to be answered.

1. Is electrical activity present? (Does the tracing have any wave forms)
2. What is the heart rate?
3. Is atrial activity present? (Are p waves present)
4. Is the ventricular rhythm regular or irregular? (QRS complexes equally spaced or not)
5. Is QRS complex width normal or prolonged? (3 small squares or more)
6. How is atrial activity related to ventricular activity? (Every p wave should be followed by a QRS complex)

Important rhythm abnormalities

- Atrial flutter (I.H.D/Digitalis toxicity): Saw tooth appearance of p waves. It is due to re-entry within the atria. As compared to A Fib rhythm is relatively regular. Often presents with 2:1 or 4:1 AV blocks
- Atrial fibrillation: A chaotic rhythm, which originates from multiple sites in atria. Only some impulses get through to the ventricles. Atria contract rapidly and ventricular response is generally variable so every p wave will not be followed by QRS complex
- Ventricular tachycardia: H.R > 100, QRS complexes wide (> 3 small squares). P waves may or may not be present.
- Ventricular fibrillation: Irregularly irregular heart rate. No p waves. Wide QRS complexes. Medical emergency treated with cardioversion.

Myocardial infarction and Acute coronary syndrome

- Acute MI is characterised by ST elevation of 2 mm (2 small squares) in the chest leads or 1 small square in the limb leads.
- T wave inversion denotes ischaemic changes (acute and chronic)
- ST depression signifies acute coronary syndrome or unstable angina
- Elevation/depression in a single lead is insignificant

Hyperkalemia

- Tall T waves or tenting of T waves.
- If associated with QRS prolongation it can lead to life threatening ventricular arrhythmias.

