



Society of  
Cardiopulmonary  
Technology (NZ) Inc

**Clinical Guidelines for Recording a  
Standard 12 Lead  
Electrocardiogram (ECG)**

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## Introduction

The 12 lead electrocardiogram has been in use in clinical practice for many decades. It is a commonly performed procedure used to assist in the diagnosis of acute cardiac and blood electrolyte disorders. Genetic abnormalities that can dispose patients to cardiac arrhythmias can also be detected using ECGs. The ECG is also used to monitor patients being given drugs that may alter cardiac parameters as treatment for other conditions such as cancer. Given its prevalence in clinical practice in hospitals, clinics and general practice, it is vital that the procedure is correctly performed by trained staff.

The quality of 12 Lead ECG recordings varies significantly across the health sector. This can be attributed to a number of factors: lack of recognised guidelines, lack of formal training, and limited resources. These guidelines aim to provide a recommended standard to be followed by all health professionals involved in recording 12 Lead ECG's.

These guidelines have been developed by the Society of Cardiopulmonary Technology (NZ) Inc. They are based on the current standards of practice and the knowledge and experience of technical staff working in the field. These guidelines will be reviewed on a regular basis to ensure that they continue to reflect recommended best practice.

## Training

All operators should be accredited to perform a 12 Lead ECG.

This should be in the form of either completing:

1. the Cardiac component of the Certificate in Physiological Measurement (CPM) (Cardiac Physiology Technicians only) or,
2. the Certification of Clinical Physiologists (CCP) (Cardiac Physiologists only) or,
3. attending an ECG Certification course which will cover the practical and theory content required to achieve quality diagnostic recordings.

For information regarding the Certificate in Physiological Measurement and Certification of Clinical Physiologists visit the SCT website [www.sct.org.nz](http://www.sct.org.nz) .

Note that the ECG Certification Course is under development as at April 2016. Once completed, information will be available on the SCT website [www.sct.org.nz](http://www.sct.org.nz)

## Equipment

### ECG Machine <sup>2</sup>,

- **Gain:** should be adjustable and have the following options available – 5 mm/mV, 10mm/mV, 20mm/mV.
- **Frequency response:**

Earlier generation ECG machines with analogue filtering <b>diagnostic</b> frequency bandwidth	0.05 Hz to 100 Hz 0.05 Hz to 150 Hz
Modern generation ECG machines with digital processing methods allowing zero phase distortion (and have proven fidelity testing by manufactures) <b>diagnostic</b> frequency bandwidth	0.67 Hz to 150 Hz for adults and adolescents  0.67 Hz to 250 Hz in children and infants

- **Calibration:** The standardised voltage should be a signal of 1mV.
- **Speed:** There should be a minimum of two speed selections available 25mm/sec and 50 mm/sec.

### Electrodes

Non-disposable or disposable electrodes may be used. You must use the same type of electrodes in all body positions. If you use different electrodes, the half-cell potential formed at each electrode-skin interface may be very different between electrode sites. This may saturate the differential amplifier, giving a flat or clipped ECG.<sup>5</sup>

## Procedure

### Patient Management

1. Confirm the identity of the patient
2. Ensure that the patient understands the procedure.
3. Patient privacy is maintained throughout the procedure. A gown or other clothing is used to cover women. Women will need to remove their bra in order to obtain correct electrode placement.

### Patient Preparation

1. The patient should be in a supine position whenever possible – the appearance of the ECG can vary depending on the position of the patient. If a supine position is not possible this should be noted on the final ECG recording.
2. The patient should be relaxed and comfortable on the bed; they should be able to rest their arms alongside their body.
3. Access to the chest area, arms and legs should be unrestricted; once electrode application is complete the patient may be covered with a blanket.

### Skin Preparation

1. Clean skin is required for an ECG. In most cases skin preparation is usually not necessary. If the patient has iodine, talc, moisturiser on their skin or they are perspiring, it will be necessary to clean the electrode sites with an alcohol wipe prior to electrode application. This will reduce the impedance of the skin and therefore assist you to obtain an artefact free recording.
2. The hair should be parted so that the electrode makes contact with the skin, or if the patient is particularly hairy, they may need to be shaved.

### Electrode Application

1. You should always work from the patient's left side to ensure correct positioning of electrodes and to avoid leaning over the patient unnecessarily.
2. Electrodes should be flat against the skin.

### Limb Leads

Standard limb electrode placement places electrodes on the arms and legs, not the torso.

Arm electrodes may be placed anywhere on the arm. It is recommended that the electrodes are placed on a fleshy area between the elbow and the shoulder to assist with reduction of somatic tremor on the recording.

Leg electrodes may be placed anywhere on the leg. It is recommended that the electrodes are placed on a fleshy area between the ankle and knee.

In patients who have had one leg amputated, it is possible to place both leg electrodes on the same leg – this is because the right leg electrode is a reference electrode. If the patient is a double amputee you can either place your electrodes on the stumps or on the lower torso.

In patients who have one or both arms amputated you will need to either place your electrodes on the stumps or on the shoulders.

Limb electrode colours:  
Right Arm (RA) – White  
Left Arm (LA) – Black  
Right Leg (RL) – Green  
Left Leg (LL) – Red

### Chest Leads

Incorrect chest electrode positioning can significantly affect the shape and size of the ECG waveforms. To enable comparison between recordings the positioning must be correct and consistent.

Standard positions:

V1 – fourth intercostal space at the right sternal border

V2 – fourth intercostal space at the left sternal border

V3 – midway between V2 and V4

V4 – fifth intercostal space in the mid-clavicular line

V5 – left anterior axillary line, horizontal with V4

V6 – left mid-axillary line, horizontal with V4 & V5

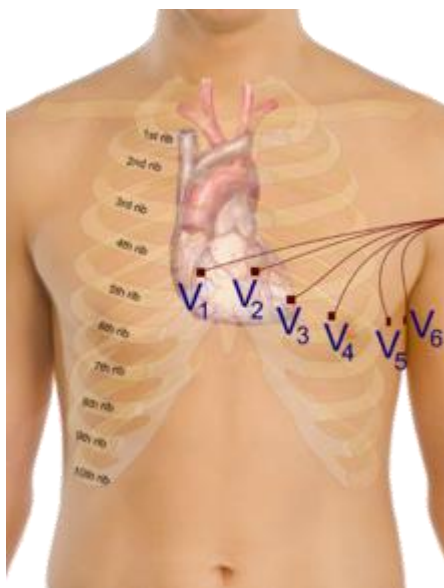


Image courtesy of Wikipedia. <https://en.wikipedia.org/wiki/Electrocardiography>

## How to locate chest electrode positions

Count the intercostal spaces down from the clavicle – the small space between the clavicle and the first rib is not an intercostal space.

To locate V1 and V2, count down to the fourth intercostal space. This may also be done by locating the Sternal Angle (Angle of Louis) which is a small sternal notch, the space immediately below the notch is the second intercostal space. NOTE: the Sternal Angle is not easily located in some patients.

Next you should find V4 – the electrode should be placed in the fifth intercostal space in line with the midpoint of the clavicle.

Once you have placed the V4 electrode correctly, you can place V3 directly midway between V2 and V4.

V5 and V6 are placed in a horizontal line with V4 – you should be careful not to follow the line of the ribs. V5 is placed in line with the anterior axilla and V6 in line with the mid-axilla.

Female patients – electrodes can be placed either under or on top of the breasts depending upon which approach will allow electrodes to be placed in the correct position.

## Recording the ECG

In order to record a good quality ECG, the patient must be fully relaxed and comfortable. Some patients may have difficulty relaxing due to pain from other conditions – you need to make them as comfortable as possible.

Patient details should be entered into the ECG machine – name and a secondary ID such as NHI number are essential.

Before recording the ECG check that the patient is still and relaxed. If the patient is tense or fidgeting, it may not be possible to obtain a high quality ECG.

- Record your ECG by pressing the appropriate button on the machine.
- Assess your recording to confirm the accuracy and diagnostic quality:
- Check that the calibration pulse is correct
- Check that the paper speed is set at 25mm/sec
- Check for the expected transition through the chest leads: negative polarity QRS in V1 to positive polarity QRS in V6.
- Check that aVR is negative.
- Check that the correct patient details are on the recording.
- Check that the operator ID is on the recording.
- Add any important comments such as any deviation from routine practice, significant patient symptoms etc.



## Filters

Filters should not be used on your initial ECG recording – settings should be as specified in the Equipment section of this document.

If you have severe artefact and have exhausted all options for removing the artefact, you can then proceed with recording a filtered ECG. It must be noted on the ECG that the frequency response has been altered. Both the filtered and un-filtered ECG's should be placed in the patients file for interpretation. You must ensure that the filtered ECG is clearly labelled as such.

### Note

Using the filter will reduce the amount of interference on the ECG but will also distort the ECG waveforms. It should only be used when absolutely necessary.<sup>2</sup>

## Paediatric ECG'S

The procedure is the same as for an adult with a few exceptions.

**Patient positioning:** Whenever possible the patient is placed in supine position. In the interests of obtaining a good quality diagnostic ECG, it may be necessary to have the patient in a sitting position to prevent restlessness. **This should be noted on the ECG recording.**

**Electrode placement:** The standard electrode positions should be used. In addition to this you may be required to record extra leads such as V3R or V4R. Please refer to your local policies and procedures for preferences.

**Voltage:** In a situation where the patient has large voltage complexes that overlap, it may be necessary to record two ECG's. The first ECG should be recorded at the standard gain setting of 10mm/mV, for the second ECG the chest leads should be recorded with a gain of 5mm/mV.

*Frequency response:*

Earlier generation ECG machines with analogue filtering <b>diagnostic</b> frequency bandwidth	0.05 Hz to 100 Hz 0.05 Hz to 150 Hz
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## Dextrocardia

The term dextrocardia refers to any situation where the heart is located within the right side of the chest rather than the left side. It may be associated with the condition situs inversus where all of the patient's organs are in a mirror image position.

If a 12 Lead ECG is carried out with the electrodes in the standard positions on a patient with dextrocardia, and there is no technical error such as LA and RA transposition, the ECG will show the following:

- Positive QRS complexes (with upright P and T waves) in aVR
- Inverted PQRST waves in Lead I
- Poor or absent R wave progression across the chest leads

A second ECG should be recorded using the following electrode positions:

1. Apply the limb electrodes as per standard guidelines
2. Place V1 and V2 in their usual positions
3. Place V3 to V6 on the right side of the chest, using the same intercostal spaces and anatomical landmarks. You must label these leads as V3R, V4R, V5R and V6R to clearly indicate that you have moved them to the right.

This approach will provide a true ECG representation. The limb lead complexes will continue to appear inverted, demonstrating the abnormal location of the heart. The repositioned chest leads however, will now show the appropriate R wave progression.

Clear annotation describing the repositioned electrode should be documented onto the hard copy (for example V3R, V4R etc.).

## References

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