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Recording the 12-Lead Electrocardiogram (ECG): At a glance

This article will:

- Provide an overview of a 12-lead ECG recording
- Add clinical context to the recording of a 12-lead ECG
- Expose the reader to evidence-based practice to support the process of recording a 12-Lead ECG
- Provide a ‘how to’ procedural guide to the recording of a 12-Lead ECG

The recording of a 12-lead Electrocardiogram (ECG) has become common place within the healthcare environment. It is regarded to be the most frequently performed cardiovascular test worldwide, with over 200 million ECG’s recorded in 2017 (Macfarlane *et al*, 2017). The 12-lead ECG is an important test, and in the context of presenting symptoms and a detailed history, can prove to be essential in the delivery of effective patient care (National Institute of Health and Care Excellence, 2018). The timely recording of the 12-lead ECG may minimise additional risk and reduce negative patient outcomes (Farley *et al*, 2012), for example, if a patient is experiencing chest pain. The information obtained from the 12-lead ECG can aid with diagnosis and may also signify a need for urgent intervention (Alinier *et al*, 2006), for example, the patient may be experiencing a myocardial infarction. However, if a poor technique is

applied and the 12-lead ECG is not accurately recorded from the start, the information gained during the process may lead to the mismanagement of the patient (Jevon, 2010).

The ECG provides a sophisticated measurement of cardiac function and the interpretation of the electrical waveforms can be incredibly complex (Sampson and McGrath, 2015). A patient's 12-lead ECG recording must be interpreted without delay by a suitably qualified healthcare professional and any abnormal findings acted upon in a timely and effective manner. Registered nurses and midwives must work in partnership with the multidisciplinary team to deliver appropriate care and act in the best interests of the patient at all times. (Nursing and Midwifery Council, 2015).

The recording of a 12-lead ECG may be required in a variety of situations and settings (see [table 1](#)); continuing to deliver dignified care and demonstrating compassion is crucial and must always be of the highest standard (Cook, 2014). Empowering, informing and reassuring the patient, with the use of effective communication, can also enhance the overall patient experience (Hooks, 2016).

The ECG Machine

The ECG machine is a complex device which records the characteristic spread of electricity through the heart during each cardiac cycle (Davey, 2008). The 12-lead ECG machine has 10 cables which attach to 10 electrodes, the gel stickers applied to the patient's skin. One electrode is placed on each limb and six electrodes are placed at specific points on the chest. When the cables are attached to the electrodes, electrical activity can be recorded. The ECG machine processes the information from the ten cables connected to the electrodes to generate 12 different views or 'leads' of the resulting electrical waveforms of the heart. The limb electrodes generate 6 views of the heart from the coronal or frontal plane (leads I, II, III, aVR, aVL and aVF) and the chest electrodes generate 6 views of the heart from the transverse or horizontal

plane (leads V1 to V6) (Garcia, 2015). A change in size, shape, pattern or timing of the waveforms, may indicate an abnormality (Sampson and McGrath, 2015).

The clinical context

Before undertaking the recording of a 12-lead ECG, familiarise yourself with the operation of the ECG machine and locate the instruction manual and any trouble shooting guides. Make sure you have received enough training to use the ECG machine and have met your employer's mandatory training requirements regarding the use of medical devices. Familiarise yourself with relevant locally agreed policies relating to this procedure, for example, data protection; moving and handling; privacy and dignity; consent; and infection prevention and control.

A 12-lead ECG recording may be required in an emergency, so be aware of where your ECG machine is stored and ensure it is always ready for use (see table 2). The ten cables that extend from the ECG machine should be untangled and ready for use. Each cable must be clearly marked with its corresponding electrode position, e.g. red (RA) cable which will attach to the right arm electrode. Each cable must have a working connector which is compatible with the type of electrodes being used. The ECG machine must be maintained in compliance with the manufacturer's recommendations and meet health and safety requirements. The integrity of the equipment should be ensured at each time of use, for example, the condition of the electrodes, and any 'use by dates' acknowledged, for example the packaging containing the electrodes.

Careful consideration should be given to infection prevention and control when recording the 12-lead ECG, with standard precautions taken throughout (Bloomfield, 2015). The use of personal protective equipment must be considered, and effective and appropriate hand-washing/decontamination must be performed before and after patient contact. Jevon (2009)

refers to a potential risk of infection from the re-useable cables of the ECG machine. It is therefore important to clean equipment in-between patient use, adhering to locally agreed policy.

Recording a 12-Lead ECG: A step-by-step process	
Step 1	
	Establish the urgency for performing this procedure and consider the needs of the patient, for example, meal times. Before performing the procedure, introduce yourself and correctly identify the patient using locally agreed policy. Explain the procedure, why it is required and gain consent.
Step 2	
	Prepare the environment to ensure a safe and effective recording of the 12-lead ECG, for example, the re-positioning of bedside furniture and the adjustment of the trolley or bed to a suitable height. Due to the positioning of the electrodes, this procedure is ideally performed with the ECG machine to the patient's left side.
Step 3	
	Ensure privacy and dignity. Close doors and curtains and/or secure screens and prevent any unnecessary interruption during the procedure. Remember, this procedure requires the patient to remove items of clothing, exposing their chest. Consider the use of a chaperone.
Step 4	

Assist the patient into a comfortable position ready for ECG electrode application. A semi-recumbent position of 45 degrees is recommended (Campbell *et al*, 2017).

Step 5

Before applying the electrodes to the patient, ensure the electrodes have not expired and are fit for purpose. Check for patient allergies, if an allergy is identified, source alternative electrodes. Check skin integrity. It may not be possible to place electrodes in the standard positions (see figure 1), if so, remember to document this on the 12-lead ECG recording and the reason for the deviation from the standard position. Consider preparing the patient's skin to allow for enhanced electrode adhesion. This can include cleaning, degreasing, exfoliation and hair removal at the electrode site. Effective electrode adhesion can reduce interference or artefact, produce a higher quality ECG recording and eliminate the need to apply filters. Filters should only be applied if deemed necessary and the effect of the filter understood (Gregg *et al*, 2008). For example, applying a filter may be useful in eliminating somatic muscle interference but may also distort the ECG (Campbell, *et al* 2017). Clinical judgement may be called upon at times, as the urgency and opportunity for recording the 12-lead ECG may have greater priority over skin preparation, and/or the consideration of a filter.

Step 6

Attach the 10 cables to the electrodes ensuring the correct cable is connected to the corresponding electrode (see figure 1). Ensure the cables have sufficient 'slack' to minimise the chance of disconnection. This may also reduce electrical interference. The right arm cable (RA, red) attaches to the right forearm electrode. The left arm cable (LA, yellow) attaches to the left forearm electrode. The left leg cable (LL, green) attaches to the left lower leg electrode.

The right leg cable (RL, black) attaches to the right lower leg electrode. The cables should be attached proximal to the wrists and ankles whenever possible, allowing for skin integrity, and only moved up the limb in response to significant tremor or amputation. The appearance of the ECG may be altered by moving the electrodes up the limbs and wave amplitude recording can be significantly altered by placing limb electrodes on the torso, potentially invalidating the recording (Campbell *et al*, 2017).

The chest (precordial) cables attach to electrodes in the following positions. The V1, (red, C1) cable attaches to the electrode applied to the skin at the fourth intercostal space at the right sternal edge. The V2, (yellow, C2) cable attaches to the electrode applied to the skin at the fourth intercostal space at the left sternal edge. The V3, (green, C3) cable attaches to the electrode applied to the skin midway between V2 and V4. The V4, (brown, C4) cable attaches to the electrode applied to the skin at the fifth intercostal space in the mid-clavicular line. The V5, (black, C5) cable attaches to the electrode applied to the skin at the left anterior axillary line at the same horizontal level as V4. The V6, (purple, C6) cable attaches to the electrode applied to the skin at the left mid-axillary line at the same horizontal level as V4 and V5 (Campbell *et al*, (2017). Crawford and Doherty (2008) note how, for females, the fifth intercostal space can only be found by lifting the breast. They recommend the V4 electrode be placed under the left breast. It may be necessary to place V5 and V6 electrodes under the breast also, if the breast covers these positions. Ensure electrodes applied under the breast are removed following the recording to prevent tissue damage.

Step 7

Input the patient details into the ECG machine to ensure the 12-lead ECG recording is correctly labelled using an agreed local policy. Confirm the correct time and date. Confirm the correct paper speed (25mm/second) and amplitude (10mm/mv) (see figure 2). Ask the patient to

remain as relaxed as possible, breathing normally, during the recording. If interference distorts the ECG trace, consider switching on the filter (see step 5). Campbell *et al* (2017) advise all filters should be ‘off’ when recording the initial ECG. Ideally, all waveforms should be clearly visible and free of interference on the screen. Nearby electronic devices running from mains power supply, such as infusion pumps and the patient’s bed, may cause interference to the ECG during recording. If this equipment is suspected to be the cause of interference and is significantly distorting the recording, consider switching this equipment to battery mode during the 12-lead ECG recording, **ONLY IF SAFE TO DO SO, AND CONTINUOUS FUNCTION OF THE EQUIPMENT CAN BE MAINTAINED**, remembering to return this equipment back to its original power supply when the procedure is complete. Do not stop or interrupt any medical treatment or therapy to record a 12-lead ECG if the procedure is likely to compromise patient safety or be detrimental to patient health and wellbeing.

Obtain a printout of the 12-lead ECG following the manufacturer’s instructions. Ensure the 12-lead ECG recording is labelled with the correct patient details, accurate time and date and the reason for recording (see figure 2). Consider leaving the electrodes and cables attached to the patient if a repeat 12-lead ECG is to be performed soon after. Ensure privacy and dignity is maintained and the patient remains comfortable and warm during this period.

IMPORTANT. Inadvertently pressing any button which creates a printout of a 12-lead ECG, other than the intended print button, for example a ‘copy’ button, may produce a printout of a previously stored 12-lead ECG recording. Inadvertently pairing the wrong 12-lead ECG recording with a patient could potentially cause serious patient harm. Always confirm the 12-lead ECG recording belongs to the correct patient and is labelled correctly with the corresponding patient details.

Step 8

Ensure the 12-lead ECG recording is reviewed immediately by a person qualified to interpret the findings. As a nurse or midwife, you must recognise and work within the limits of your competence. This includes making a timely and appropriate referral to another practitioner when it is in the best interests of the individual needing any action, care or treatment. This also includes, asking for help from a suitably qualified and experienced healthcare professional to carry out any action or procedure that is beyond the limits of your competence (NMC, 2015). Ensure the patient is informed of the outcome of the 12-lead ECG recording and any treatment/action being taken as a result of the findings. Be prepared to respond to the patient's questions in response to the findings. The 12-lead ECG recording should be filed in the patients notes and any additional documentation completed in a timely manner.

Step 9

When the procedure is complete, disconnect the cables from the electrodes and remove the electrodes from the patient, taking care not to damage the skin. Dispose of the electrodes in adherence with locally agreed policy. Assist the patient with dressing and ensure comfort, respecting privacy and dignity. Return the cables to the storage device on the ECG machine. Switch off the machine and clean the ECG machine and cables as necessary, following the manufacturer's recommendations and locally agreed policy.

Step 10

Return the ECG machine to the usual storage location. Plug the ECG machine in to the mains power supply and ensure any battery charging light is illuminated. Check the machine is in correct working order with the cables tidy, equipment re-stocked and ready for next use.

Conclusion

The circumstances in which a patient will require the recording of a 12-lead ECG will vary and consideration must be given to the clinical context; however, a 12-lead ECG which is not recorded to an appropriate standard may result in inappropriate treatment (Campbell *et al*, 2017). In the pursuit of excellence, quality care requires patient safety, clinical effectiveness and a positive patient experience (Flott *et al*, 2018). The successful recording of a 12-lead ECG will reflect this.

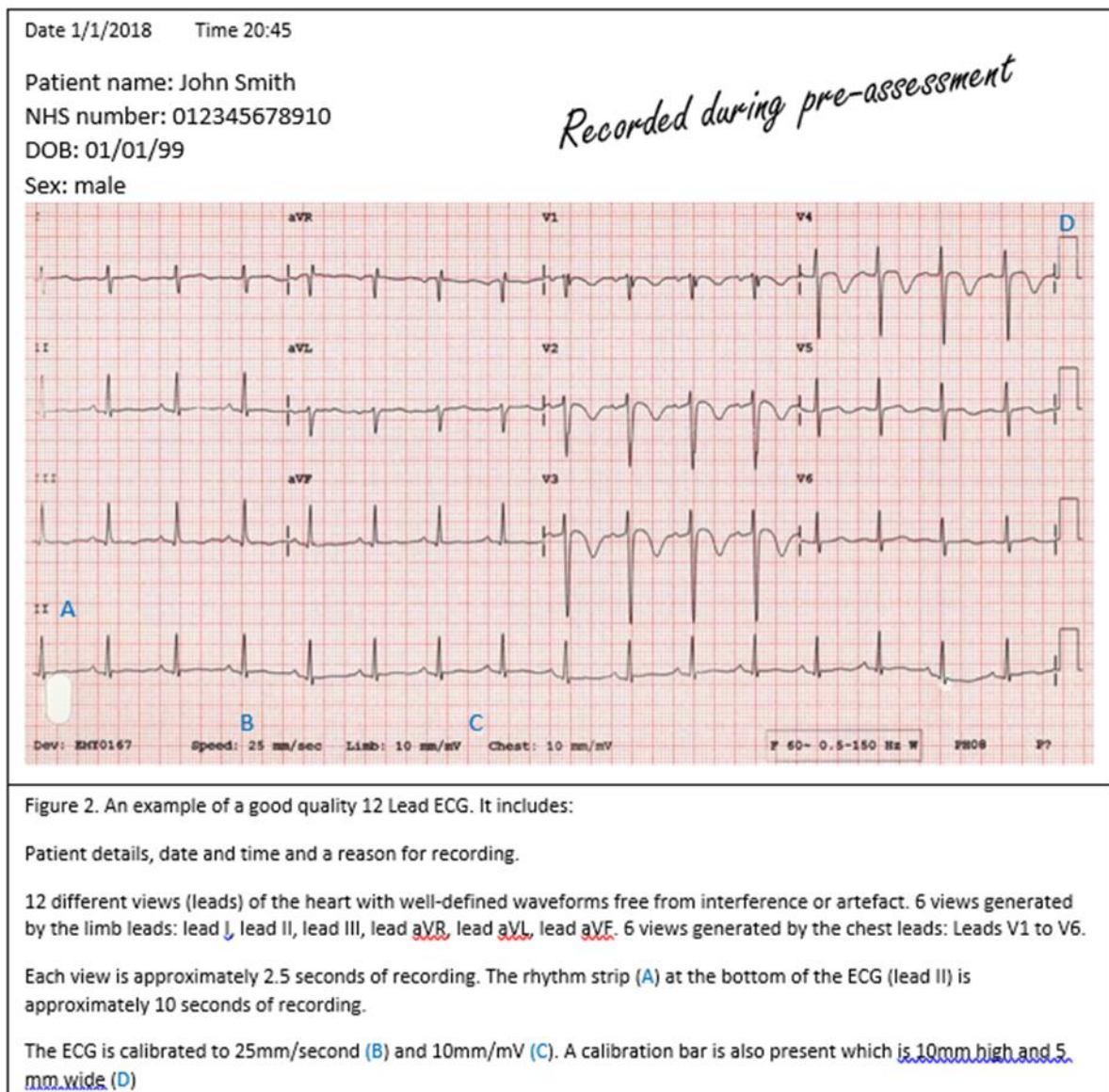
Table 1. Potential reasons for recording a 12-lead ECG

- As part of a treatment pathway
- As part of a routine health check
- Changes with heart rate or rhythm
- Preoperative and postoperative assessment
- Chest pain (recorded during and after)
- Upper abdominal pain
- Symptoms associated with breathing
- Blood pressure abnormalities
- Suspected acute coronary syndrome
- Suspected heart failure
- During a peri-arrest period or post successful CPR
- History of dizziness
- Collapse or history of falls
- Palpitations

Table 2. Resources required for this procedure

- 12-lead ECG Machine
- ECG paper
- Pack of electrodes compatible with the ECG machine cable connectors
- Skin preparation equipment
- Adjustable bed or trolley
- Hand washing/decontamination provision
- Personal protective equipment
- Appropriate waste reciprocal

Figure 2: An example of a 12-lead ECG recording



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