ECG Training in Primary Care

Dave Richley
Cardiac Physiology Lecturer Practitioner
North of England Cardiovascular Network
System Evaluation:
Atrial fibrillation with rapid ventricular response with premature ventricular or aberrantly conducted complexes
Nonspecific intraventricular block
Anterolateral infarct, age undetermined
Abnormal ECG
Fact: most ECGs are recorded with the chest electrodes positioned wrongly.


If you want a really thorough MoT you’ll have to go private. Bupa’s health and fitness assessment (www.bupa.com) includes a cardio-respiratory exercise to test heart and lung function. It lasts up to two hours and costs £480 for men.

KING IT FURTHER
www.bpassoc.org.uk
The website of the Blood Pressure Association gives excellent advice on how to detect and treat high blood pressure.
www.malehealth.co.uk
A resource provided by the Men’s Health Forum, where men can find out about potentially embarrassing medical conditions.
www.netdoctor.co.uk
A respected source of health information that gives explanations of the diagnostic tests you’re likely to receive from a doctor.

Home health-screening
Measuring blood pressure yourself can be done with a simple self-inflating monitor (see kit bag) but do ensure the cuff fits and is used correctly. Most people should aim to get a reading of below 140/85mmHg and preferably below 130/80mmHg. If it’s consistently higher than this over a two-week period, consult your GP.

The best place to check your own pulse is on the wrist. Always use your index and second finger rather than a thumb as it has its own pulse, which can confuse matters. The rhythm should be regular and adults should have a resting heart rate of between 60 and 90 beats per minute.
THUMB
YOU WIN:
Ronaldinho
is all smiles
after joining
Barcelona
yesterday
RONALDO IS THE NEW TELLY TUBBY

Brazil legend Ronaldo, once hailed as the best player in the world, is now not even the best Ronaldo in the world...
How do you find out what the correct positions are?
Where **not** to put V1 and V2
TAKING AN ECG: GETTING THE BEST POSSIBLE RECORDING

An electrocardiogram (ECG) is a quick and non-invasive way of recording the heart’s electrical activity. One of its many uses is in the diagnosis of myocardial infarction, angina, and rhythm disturbances. Although the ECG is a simple and easy test to perform, it is vital to obtain the best possible recording because of its importance.

The ECG has become the most commonly conducted cardiovascular diagnostic procedure and is a fundamental tool in clinical practice. It is necessary for the diagnosis and prompt initiation of therapy in patients with acute coronary syndromes (ACS) and is the most accurate means of diagnosing conduction disturbances and arrhythmias. It can also be used to detect electrolyte abnormalities, particularly potassium and calcium, and some forms of genetic
Follow the 5th intercostal space to the left until your fingers are immediately below the beginning of the axilla, or under-arm area. This is the position for V5.

Follow this line of the 5th intercostal space a little further until you are immediately below the centre point of the axilla, (mid-axilla). This is the position for V6.
### Accuracy in ECG Lead Placement Among Technicians, Nurses, General Physicians and Cardiologists

R. Rajaganesha, C. L. Ludlam, D. P. Francis, S. V. Parasramka, R. Sutton

<table>
<thead>
<tr>
<th>Staff Group</th>
<th>Number</th>
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<tbody>
<tr>
<td>Cardiac technician</td>
<td>10</td>
</tr>
<tr>
<td>Nurse</td>
<td>37</td>
</tr>
<tr>
<td>Non-cardiologist physician</td>
<td>52</td>
</tr>
<tr>
<td>House officer</td>
<td>15</td>
</tr>
<tr>
<td>Senior house officer</td>
<td>15</td>
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<tr>
<td>Registrar</td>
<td>19</td>
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<tr>
<td>Consultant</td>
<td>3</td>
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<tr>
<td>Cardiologist</td>
<td>20</td>
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<tr>
<td>Senior house officer</td>
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<tr>
<td>Registrar</td>
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<tr>
<td>Consultant</td>
<td>3</td>
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<td><strong>Total</strong></td>
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Accuracy in ECG lead placement among technicians, nurses, general physicians and cardiologists

R. Rajaganeshan,¹,² C. L. Ludlam,¹,³ D. P. Francis,³,⁴ S. V. Parasramka,⁵ R. Sutton⁴
Vertical positioning of V1 electrode

Accuracy in ECG lead placement among technicians, nurses, general physicians and cardiologists

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In this study, we have found that other than cardiac technicians, hospital staff involved in performing ECGs in the acute medical situation cannot be trusted to place the chest electrodes in the correct positions.

Why are cardiac technicians better than nurses and doctors at this task? It is an essential part of their early training and examinations that they are able to accurately position electrodes.
Does it really matter if the electrodes aren’t positioned correctly? Yes!


Effect of incorrectly positioned chest electrodes

UNCONFIRMED INTERPRETATION
- MD SHOULD REVIEW
sinus rhythm (slow)
RSR in V1
slight inferior repolarization disturbance, consider ischemia, LV overload or aspecific change
small negative T in aVF with negative T in III
Borderline ECG
V1 – V3 electrodes too high
A  Correct chest positions

B  Chest electrodes too high
Correct chest electrode positions

V4 – V6 too low
The Society for Cardiological Science and Technology

Certificate in Practical Electrocardiography

The Society gives this award to candidates who can demonstrate an ability to safely and accurately record a 12-lead resting electrocardiogram (ECG) under examination conditions. This is designed as an entry-level qualification for any practitioner wanting to demonstrate the skills needed to perform ECGs in a clinical environment.

Candidates will be expected to demonstrate the following outcomes in a practical examination. Supplemental questions will be used to check underpinning knowledge:

- Check that the equipment is safe to use and know how to report faults
- Confirm the patient identity, explain the test using appropriate language and obtain verbal consent
- Correctly position chest and limb electrodes in accordance with SCST consensus guidelines
- Correctly attach recording wires to electrodes and obtain an accurate, artefact-free recording
- Recognise common recording errors
- Differentiate between common sources of artefact and take appropriate action to improve the recording quality
- Explain how to check calibration and standard recording settings
- Outline situations when recording settings may be altered
- Recognise the limits of operational responsibility and when to seek assistance

Candidates should ensure that their preparation for the examination considers all points in the following syllabus.

Syllabus

(1) ANATOMY, PHYSIOLOGY AND PATHOPHYSIOLOGY

- Anatomy of the thorax including the rib cage, sternum, manubrium, clavicle, axilla
- The main indications for recording an electrocardiogram.

(2) PRACTICAL ELECTROCARDIOGRAPHY:

Standard recording settings and how to alter basic controls
- Paper speed
- Gain
- Filters
- Lead selector
- Manual/automatic operation

Care of the equipment
- Care of recording paper
- Battery maintenance
- Care of leads and cables

Electrodes
- Application of and connection to electrodes
- Care of electrodes
- Electrode positions
- Significance of right leg (neutral) electrode

Preparation of the patient
- Explanation of the procedure at a level appropriate to oral consent
- Positioning of the patient
- Encouraging the patient to relax
- Maintaining the privacy and dignity of the patient at all times.

Practical electrocardiography
- Choice of appropriate leads for a particular patient category
- Setting of controls as appropriate for the specific recording
- Preparation of electrode sites to give optimum electrode contact and to minimise artefact
- Correct application and positioning of limb and chest electrodes, in accordance with the Society for Cardiological Science and Technology guidelines
- Recording of a resting electrocardiogram from patients of all ages using both manual and automatic mode
- Recording of the resting electrocardiogram from a patient who:
  - Is unconscious
  - Has language or communication difficulty
  - Is infectious or is in isolation
  - Has a physical disability (including amputation)
- Evaluation of the recording, re-recording as appropriate
- Recognition and elimination or reduction of artefacts due to:
  - Muscle tension
  - Muscle tremor
  - Alternating current interference
  - Limb movement
  - Broken lead
  - Sweat
  - Respiratory chest movement
  - Right and left arm connection transposal
- Labelling of completed recordings as appropriate
- Cleaning, preparation and storage of equipment ready for subsequent recordings, including correct sterilisation and disposal procedures.
Training package

- slide presentation
- manual
- practical instruction
## Trainees

<table>
<thead>
<tr>
<th>Area</th>
<th>Practices</th>
<th>Trainees</th>
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<tbody>
<tr>
<td>Co Durham</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>Newcastle</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Leeds</td>
<td>2</td>
<td>9</td>
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</tbody>
</table>

Professions:
- GPs
- Practice nurses/sisters
- HCAs
- Receptionist
Pre-training self-assessment

- can record ECG properly
- know chest positions
- recognise good/bad quality
- improve a poor ECG
- recognise LA/RA reversal

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>can record ECG properly</td>
<td></td>
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<tr>
<td>improve a poor ECG</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>recognise LA/RA reversal</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
**Pre-training**

*40 of 53 trainees said they knew the correct chest electrode positions*

- **The correct position for Lead V1 is:**
  - 5 cm below right clavicle
  - 4th intercostal space, right sternal edge
  - Mid-sternum
  - 3rd intercostal space, right sternal edge
  - None of the above
  - I don’t know

- **The correct position for the V5 electrode is:**
  - 5th intercostal space, anterior axillary line
  - 5 cm to the left of V4
  - Anterior axillary line, same horiz level as V4
  - Immediately below the left nipple
  - Midway between V4 and V6
  - None of the above
  - I don’t know
Pre-training

7 of 51 trainees said they could recognise transposal of RA and LA connections

Transposing the right and left arm connections results in:

- A straight line
- The ECG being written backwards
- A negative P wave and QRS complex in lead I
- A negative T wave in aVR
- I don’t know

![Graph showing that 7 of 51 trainees can recognise LA/RA reversal]
Post-training: 35/53 trainees who had thought they knew how to record ECGs correctly

Previous recordings

- Mostly right: 5
- Some right/some wrong: 15
- Mostly wrong: 5

Prev knowledge adequate?

- Yes: 10
- No: 30

Amount learnt

- Lot: 30
- Moderate: 5
- Little: 0

Do things differently from now on?

- Yes: 30
- No: 5
Clinical skills in junior medical officers: a comparison of self-reported confidence and observed competence

Les Barnsley, Patricia M Lyon, Susan J Ralston, Emily J Hibbert, Ilona Cunningham, Fiona C Gordon & Michael J Field

Medical Education 2004; 38: 358–367
doi:10.1046/j.1365-2923.2004.01773.x

Figure 5 ECG: PGYI self-reported levels of confidence and OSCE assessment of PGYI levels of competence.
Diploma in Electrocardiography

The Society for Cardiological Science and Technology
Diploma in Electrocardiography

Diploma in Electrocardiography
The Society gives this award to candidates who can demonstrate an ability to accurately record and interpret a 12-lead resting electrocardiogram (ECG) under examination conditions. This is designed as an intermediate level award for senior cardiographers, associate physiologists, and any other practitioners wishing to advance their skills beyond certificate level.

Candidates will be expected to demonstrate the following outcomes in practical and written examinations:

- Evaluate the indication for the test and explain the ECG abnormalities that may be associated with this
- Identify potential health and safety risks related to ECG and select appropriate strategies to minimise risks
- Recognise and address patient anxiety and recording difficulties
- Perform an accurate resting 12-lead ECG in patients of all ages according to SCST consensus guidelines
- Accurately measure standard ECG intervals and compare these with normal values
- Describe how electrical events on the ECG are related to the cardiac cycle
- Correctly identify normal and abnormal wave morphology and rhythms using standard terminology to describe these
- Explain which common cardiovascular pathologies may be associated with specific ECG abnormalities (provide a differential diagnosis)
- Identify situations when the patient requires urgent treatment and respond appropriately
- Recognise the limits of operational responsibility and when to seek assistance

Candidates should ensure that their preparation for the examination considers all points in the following syllabus:

**Syllabus**

(1) **ANATOMY and PHYSIOLOGY OF THE CARDIOVASCULAR SYSTEM**
- General structure and function of the heart, including:
  - The role of the heart in the circulation

(2) **ELECTROCARDIOGRAPHY**
- **Instrumentation**
  - Instrumentation and basic principles of lead theory needed for the effective and safe practice of electrocardiography
  - **Standard recording settings and how to alter controls**
    - Paper speed
    - Gain
    - Filters
    - Lead selector
    - Manual/automatic operation
  - **Care of the equipment**
    - Care of recording paper
    - Battery maintenance

Pathology of the cardiovascular system
- **Overview of the following pathological processes**
  - Coronary atherosclerosis
  - Acute coronary occlusion
  - Myocardial infarction
  - Hypertension
  - Stable angina
  - Unstable angina
  - Prinzmetal’s angina
  - Non-ST elevation myocardial infarction
  - ST-elevation myocardial infarction
  - Ventricular arrhythmias
  - Hypertrophic cardiomyopathy
  - Atrial and ventricular septal defects
  - Coarctation of the aorta
  - Valvular stenosis and regurgitation
  - Pericarditis

- **Care of leads and cables**
- **Electrodes**
  - Application of and connection to electrodes
  - Care of electrodes
  - Electrode positions
- **Lead systems**
  - Hexaxial reference system
  - Wilson’s central terminal
  - Einthoven’s triangle
  - Significance of right leg (neutral) electrode
- **Preparation of the patient**
  - Explanation of the procedure at a level appropriate to the patient and obtaining oral consent
  - Positioning of the patient
  - Encouraging the patient to relax
  - Maintaining the privacy and dignity of the patient at all times
- **Practical electrocardiography**
  - Choice of appropriate leads for a particular patient category
  - Setting of controls as appropriate for the specific recording
  - Correct application and positioning of limb and chest electrodes in accordance with the Society for Cardiological Science and Technology guidelines
  - Preparation of electrode sites to give optimum electrode contact and to minimise artefact
  - Recording of a resting electrocardiogram from patients of all ages using both manual and automatic mode
  - Recording of the resting electrocardiogram from a patient who:
    - Is unconscious
    - Has language or communication difficulty
    - Is infectious or is in isolation
    - Has a physical disability (including amputation)
  - Evaluation of the recording, re-recording as appropriate
  - Recognition and elimination or reduction of artefacts due to:
    - Muscle tension
    - Muscle tremor
    - Alternating current interference
    - Limb movement
    - Broken lead
    - Sweat
    - Respiratory chest movement
  - Recognition of ECG findings associated with transposals of the right arm and left arm connections
  - Labelling of completed recordings as appropriate
  - Cleaning, preparation and storage of equipment ready for subsequent recording, including correct decontamination and disposal procedures
Electrocardiographic interpretation: Normal features and basic measurements
- Relationship of the electrocardiogram to the electrical events of the heart.
- Relationship of the electrical events to the mechanical events of the cardiac cycle.
- Definitions, measurement and normal ranges of heart rate, PR interval, QRS duration, QT interval and mean frontal plane axis.
- Calculation of corrected QT interval (QTc) by Bazett’s formula.
- Appearance of the normal resting electrocardiogram including R wave progression in precordial leads.

Normal variations of the electrocardiogram in relation to:
- Age
- State of activity
- Body build
- Ethnic origin

The normal electrocardiogram and common abnormalities
Rhythms arising from the sinus node:
- Normal sinus rhythm
- Sinus arrhythmia
- Sinus tachycardia
- Sinus bradycardia
- Sinus arrest

Supraventricular tachyarrhythmias
- Atrial premature contractions (ectopics)
- Atrial tachycardia
- Atrial flutter
- Atrial fibrillation
- AV nodal re-entrant tachycardia
- AV re-entrant tachycardia
- Accelerated AV nodal (junctio nal) rhythm

Conduction abnormalities
- Ventricular pre-excitation
- Left and right bundle branch block
- Left anterior and posterior fascicular block
- 1st degree AV block
- 2nd degree AV block: Mobitz I (Wenckebach), Mobitz II and 2:1 block
- 3rd degree (complete) AV block

Rhythms arising from the ventricles:
- Ventricular escape beats
- Ventricular premature beats (ectopics)
- Ventricular tachycardia
- Ventricular flutter

- Ventricular fibrillation
- Ventricular standstill

The electrocardiogram associated with an artificial cardiac pacemaker:
- Identification of pacemaker stimulus on the electrocardiogram
- Unipolar and bipolar pacing
- Differentiation between atrial and ventricular pacing
- Failure to sense
- Failure to capture

Interpretation of changes in the electrocardiogram arising from abnormal cardiac conditions, including
- Myocardial ischaemia
- Myocardial infarction
- Left ventricular hypertrophy
- Right ventricular hypertrophy
- Pericarditis
- Dextrocardia
- Massive pulmonary embolism

Interpretation of changes in the electrocardiogram arising from abnormal metabolic, endocrine and electrolyte states
- Hypothermia
- Hypothyroidism
- Hyperthyroidism
- Hyperkalaemia
- Hypokalaemia

Recognition of electrocardiographic features of ion channelopathies
- Long QT syndrome
- Brugada syndrome
- Early repolarisation syndrome
The plan

- BHF has commissioned 12 x 5-day DipECG courses from SCST over next year
- BHF will offer the course to all its HCPs
- BHF health care professionals who gain the Diploma can train primary care staff in ECG recording
Award in Practical Electrocardiography
Diploma in Electrocardiography

www.scst.org.uk