



Health Services Safety
Investigations Body

Investigation report

12-lead electrocardiograms (ECGs) in ambulance services: paramedic education, training and competence

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Theme:

Emergency care, Cardiac

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A note of acknowledgement

We would like to thank the patients and families whose experiences are documented in this report. We would also like to thank the healthcare staff and external organisations who engaged with the investigation for their openness and willingness to support improvements in this area of care.

About this report

This report is intended for healthcare organisations, healthcare staff, policymakers, higher education institutions and the public to help improve patient safety in how 12-lead electrocardiograms (ECGs) are taught, obtained and interpreted by paramedics.

The investigation primarily considered paramedic education, training and competence in the ambulance sector through the lens of acute coronary syndromes (ACS). ACS is a range of disorders that affect blood flow within the heart's own arteries called the coronary arteries. Some forms of ACS involve a sudden reduction or complete interruption of blood flow within the coronary arteries that results in permanent damage to the heart muscle, this is called a myocardial infarction often referred to as a 'heart attack'.

Terms used in the report

In this report, the term 'paramedic education' refers to the undergraduate training provided by higher education institutions for student paramedics. 'Training' is used when discussing annual professional training and continuous professional development for qualified paramedics. 'Competence' refers to the combination of training, skills, experience and knowledge that a person has and their ability to apply them to perform a task safely.

Executive summary

Background

This is the first of two investigation reports exploring the use of 12-lead electrocardiograms (ECGs) in ambulance services. An ECG is a test that records the electrical activity of a patient's heart. It needs to be correctly carried out and accurately interpreted by clinicians to determine the patient's condition and potential diagnosis.

This investigation looked at paramedic education, training and competence in ECG practice, and the task of carrying out and interpreting an ECG in the context of the patient's clinical signs and symptoms.

The second investigation report, which is due to be published in October 2025, will consider how patients with suspected ST elevation myocardial infarction (STEMI) (a type of heart attack) are diagnosed. It will explore the clinical advice and support available to paramedics, including the design, functionality and use of ECG equipment to aid in clinical decision making. [More information about this two-part investigation is available on HSSIB's website.](#)

The investigation

HSSIB received a prevention of future deaths (PFD) report, issued by HM Coroner in November 2023, which raised concerns about an incident involving a female patient aged 29 with chest pain. An ECG was reported as being misinterpreted and the patient later died of an acute myocardial infarction (heart attack). The PFD highlighted paramedic education, training, and competence in ECG interpretation as factors in the patient's death.

The investigation spoke to key stakeholders to understand the safety risks that may be present in this area. The way 12-lead ECGs are undertaken and interpreted was identified as a growing area of concern, with systemic safety risks that can have a significant impact on the outcome for patients.

Findings

- The task of carrying out and interpreting a 12-lead ECG is an important skill for paramedics. It is a complex task involving multiple factors that can impact on its accuracy.
- There is confusion about the level of specialist knowledge paramedics may be expected to have about 12-lead ECGs. This has created challenges in

understanding and implementing the required level of education, training, competence, and professional expectations of paramedics in this area.

- Paramedics are generalist clinicians who are required to have a broad knowledge base to respond to many different emergency and non-emergency situations. Any expectations for paramedics to have more specialist knowledge of 12-lead ECGs would need to be balanced with the need to support specialist knowledge in other areas.
- Paramedics and student paramedics often lacked confidence in their ability to accurately interpret more complex 12-lead ECG and patient presentations.
- There is no formal national requirement setting out if, how and to what standard 12-lead ECG competency should be assessed by higher education institutions (HEIs) and ambulance services.
- There was variation in the way 12-lead ECG skills were taught across different HEIs, including variation in the time and level of detail, assessment methods, and the subject matter knowledge of lecturers involved in teaching about ECGs.
- ECG refresher training does not always form part of paramedic annual training.
- Practice-based learning about undertaking 12-lead ECGs for student paramedics could be limited by the range of clinical scenarios they encountered and the 12-lead ECG skills of their placement supervisors.
- There was variability in the level of support and training provided to newly qualified paramedics in 12-lead ECGs via preceptorship programmes.
- There was a lack of consistency in feedback mechanisms between higher education institution's and ambulance services which limited the ability to address any 12-lead ECG learning needs.
- There was a lack of feedback provided by hospitals to ambulance services and paramedic crews about their 12-lead ECG interpretation once patients had been taken to hospital. This limited the opportunity for paramedics to learn about ECG interpretation.
- Some ambulance services and hospitals had been able to develop data sharing agreements feeding back information on patient diagnostics and outcomes to support learning.
- There was variability in the approach to supporting protected time for training for staff within ambulance services. Pressure on ambulance services and paramedics meant that time for annual training and continuous professional development was often sacrificed to ensure operational demands could be met.

- There was variability in the education and training provided by HEIs and ambulance services around patient protected characteristics, health inequalities and other specific patient factors, and how this may impact on 12-lead ECGs and decisions about patient care.

HSSIB makes the following safety recommendation

Safety recommendation R/2025/058:

HSSIB recommends that the Health and Care Professions Council and the College of Paramedics work in collaboration with relevant stakeholders to improve the undergraduate teaching of 12-lead electrocardiograms by reviewing and updating any relevant standards, guidance, and curricula to provide clarification on:

- the level of education and expected level of competency and assessment required of student paramedics in relation to electrocardiograms
- any minimum expected standards for electrocardiogram education in higher education institutions, including the time spent on electrocardiogram learning, methods used, and subject matter expertise required of teaching staff
- how patient protected characteristics, health inequalities and other specific patient factors are taught in relation to electrocardiograms
- how effective feedback mechanisms can be developed between higher education institutions and ambulance services.

This is to help improve consistency in the way paramedic students are educated about electrocardiograms.

HSSIB makes the following safety observations

Safety observation O/2025/063:

Ambulance services can improve patient safety by including patient protected characteristics, health inequalities and other specific patient factors that can impact on the task of carrying out and interpreting a 12-lead ECG, when developing refresher training.

Safety observation O/2025/064:

Ambulance services and national organisations can improve patient safety by providing and supporting protected time and resources for paramedic training and continuous professional development, while understanding the potential impact on operational performance.

Safety observation O/2025/065:

Ambulance services can improve patient safety by providing additional support to paramedic students and paramedics through exposure to a range of clinical scenarios that help develop and maintain 12-lead ECG competency on a regular basis.

Safety observation O/2025/066:

Acute hospitals and ambulance services can improve patient safety by developing local mechanisms to share information about patient outcomes where paramedics have undertaken a 12-lead ECG. This can help to support learning for paramedics and provide feedback on where their practice may be improved.

1. Background and context

1.1 Introduction

1.1.1 This report focuses on the pre-hospital interpretation of 12-lead electrocardiograms (ECGs) in ambulance services, specifically exploring how paramedics are educated, trained and required to maintain competency in this field

throughout their employment. The report discusses the interpretation of ECGs generally in relation to acute coronary syndromes (ACS), a term which encompasses a range of disorders that are caused by a sudden reduction of blood flow to part of the heart muscle.

1.1.2 As part of its terms of reference the investigation explored:

- the undergraduate education of paramedics in conducting an ECG and interpreting its results
- the professional training and support available to paramedics in maintaining competence in ECG practice
- the approach adopted in education and training in considering different protected characteristics under the Equality Act 2010.

1.1.3 The investigation did not explore the role of other ambulance service personnel, as this was outside its terms of reference. However, findings from this investigation may also be relevant to their education and training.

1.1.4 The second part of this investigation, which is due to be published in October 2025, will focus on paramedic response to ST elevation myocardial infarction (STEMI). A STEMI is a type of heart attack where a complete blockage of a coronary artery results in the blood supply to a person's heart being interrupted. This requires emergency treatment at a primary percutaneous coronary intervention (PPCI) centre, where the coronary artery is unblocked to restore blood flow and minimise damage to the heart muscle. The second part of the investigation will consider how patients with suspected STEMI are diagnosed, exploring the clinical advice and support available to paramedics, including the design, functionality and use of ECG equipment to aid in clinical decision making.

1.2 Background to the investigation

1.2.1 HSSIB received a prevention of future deaths (PFD) report, issued by HM Coroner in November 2023, about an incident in which an ECG was reported as being misinterpreted for a woman aged 29 years with chest pain who later died of a heart attack. PFD reports can be issued to interested parties (including a person, organisation, local authority, government department or agency) where HM Coroner believes that action should be taken to prevent future deaths (Courts and Tribunals Judiciary, n.d.).

1.2.2 The PFD report highlighted paramedic education, training and competence as factors in the patient's death. Evidence presented during the inquest also raised concerns that although ECG interpretation formed part of paramedic's initial/annual training, no evidence was seen of any assessment to confirm their competence.

1.2.3 HSSIB did not investigate the incident reported in the PFD. Instead, the investigation considered the PFD along with multiple other sources of evidence to help identify potential patient safety risks. These sources included:

- national incident recording systems
- academic literature
- national and international publications.

1.2.4 The investigation also engaged with a wide range of stakeholders (see appendix) to learn more about the potential safety issues surrounding ECGs and identify areas on which an investigation could focus to help improve patient safety.

1.2.5 The way in which paramedics undertake and interpret ECGs was identified by stakeholders as a growing area of concern, with systemic safety risks that can have a significant impact on the outcome for patients. Reliance is placed on paramedics to be able to accurately perform and interpret ECGs (see 1.3.2) to support their clinical decision making, taking into account the patient's overall clinical condition and past medical history.

1.3 Undertaking an ECG

1.3.1 An ECG is a test that measures and records the electrical activity of a person's heart, including the rate and rhythm and should be used alongside the clinical skills and considerations taught to paramedics when assessing a patient, An ECG is one of the most common heart tests and the electrical activity the ECG captures can help in the diagnosis of some conditions.

1.3.2 A 12-lead ECG usually involves the placement of 10 electrodes on a patient's body to record 12 different views of their heart's electrical activity. This involves accurately placing leads on a patient's torso and on their arms and legs (see figures 1 and 2). ECGs can also be carried out with fewer electrodes for monitoring purposes, but these are not considered in this report.

Figure 1 Placement of electrodes on a patient's torso for a 12-lead ECG

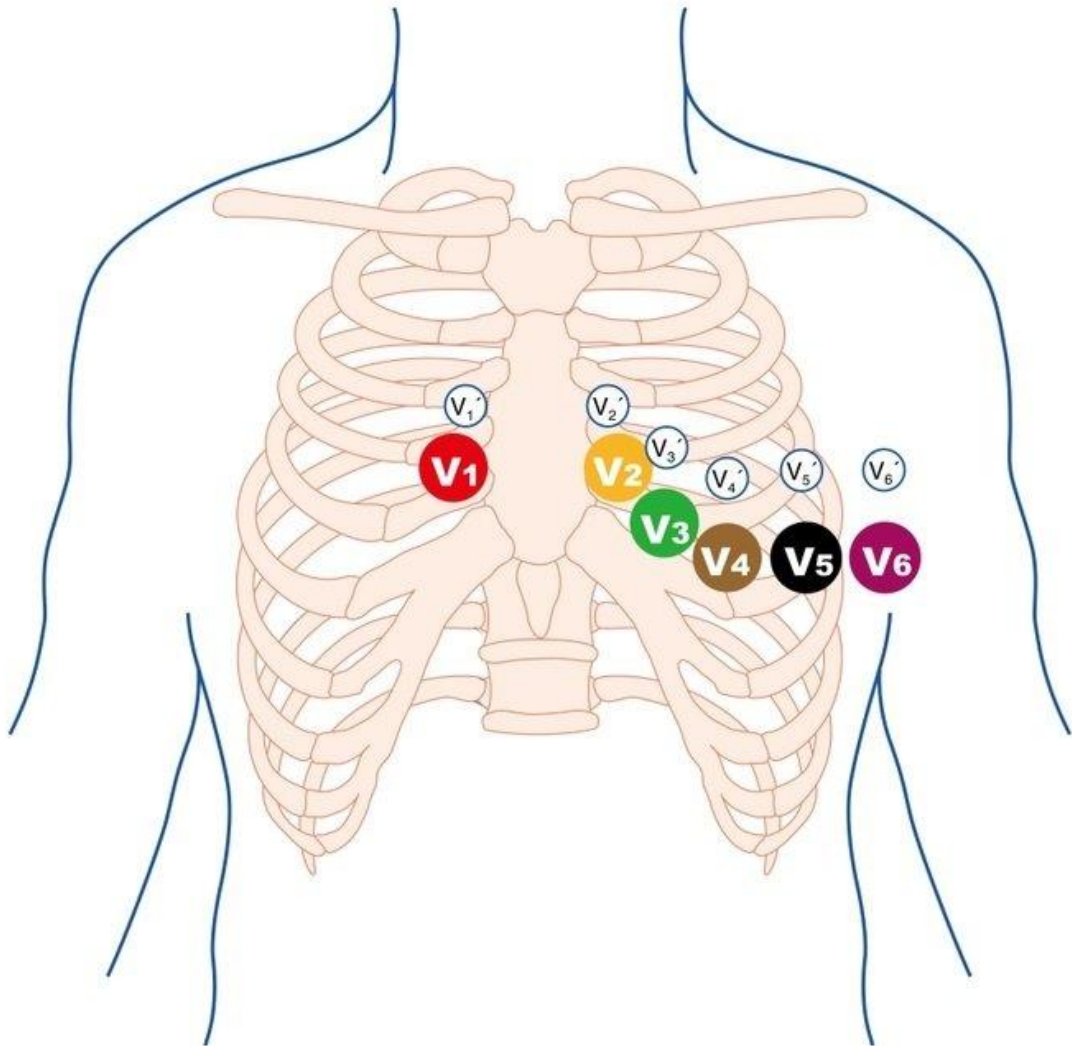


Figure 2a Placement of electrodes on a patient's arms and legs for a 12-lead ECG