Health Services Safety Investigations Body

Investigation report

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

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Cardiac, Emergency care

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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

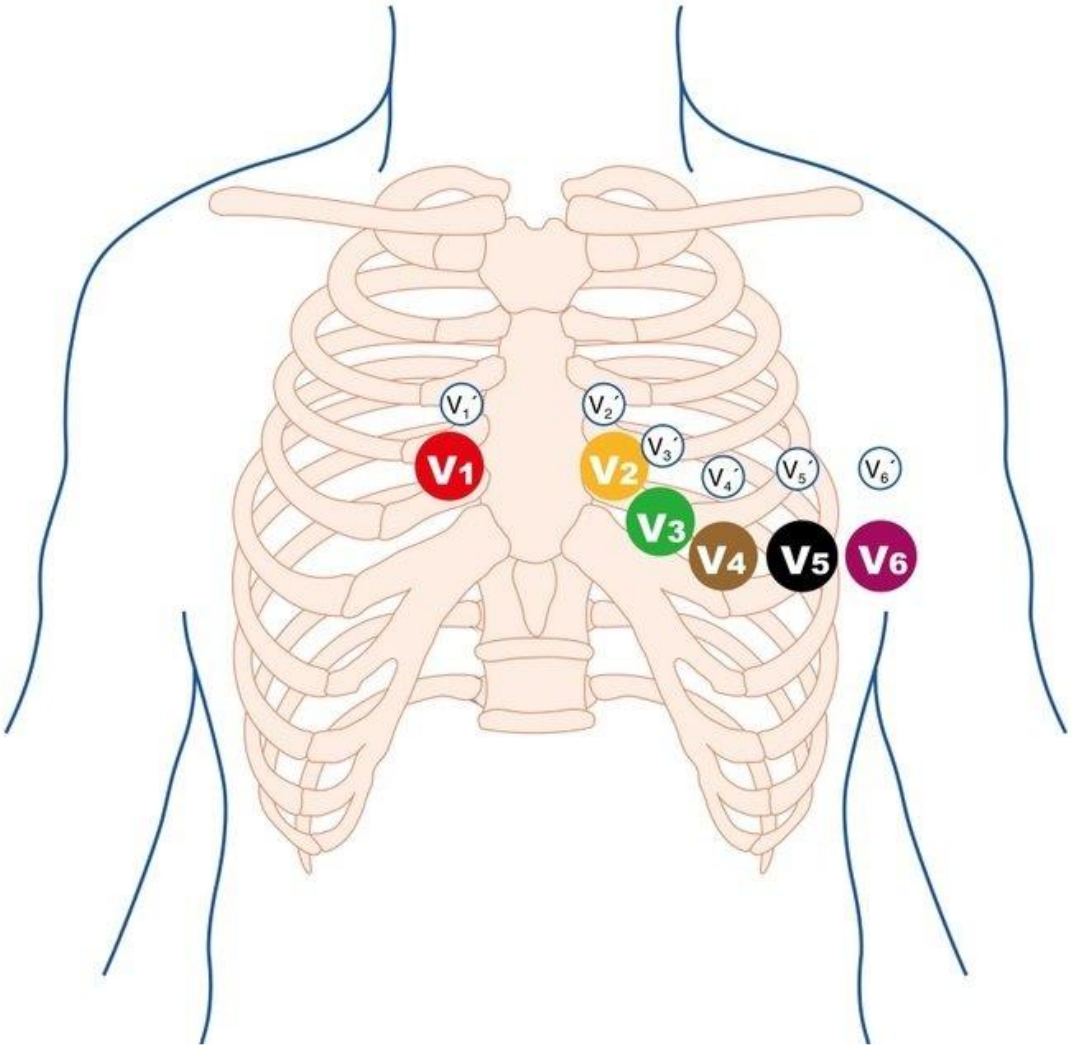
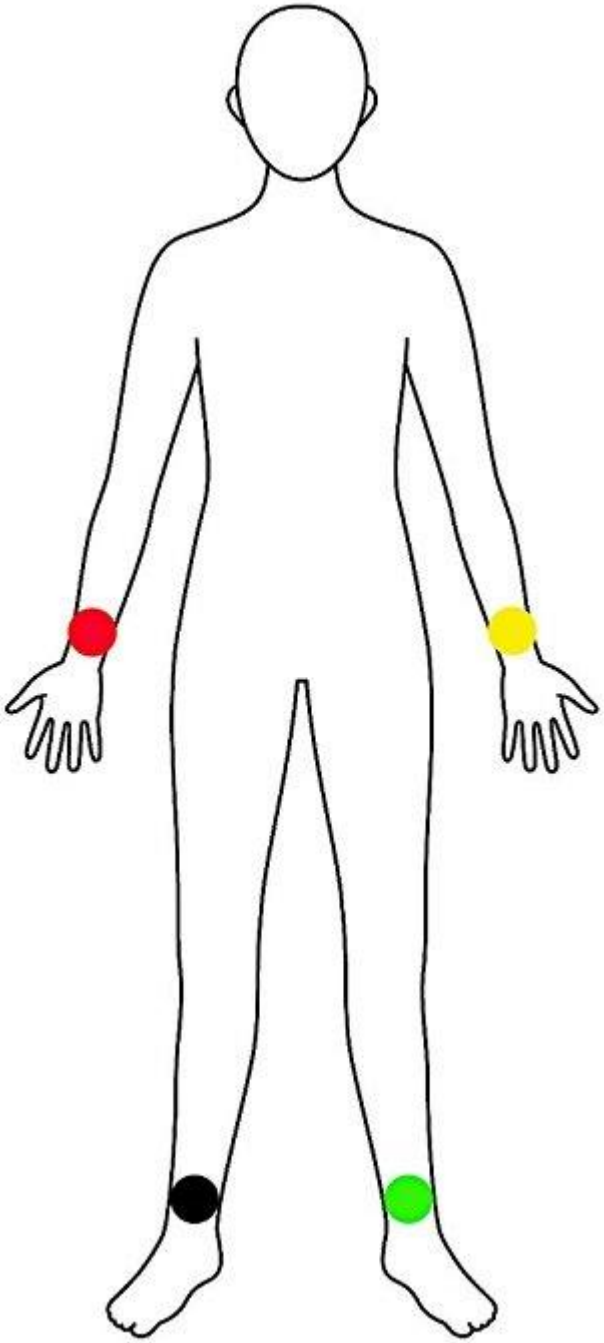
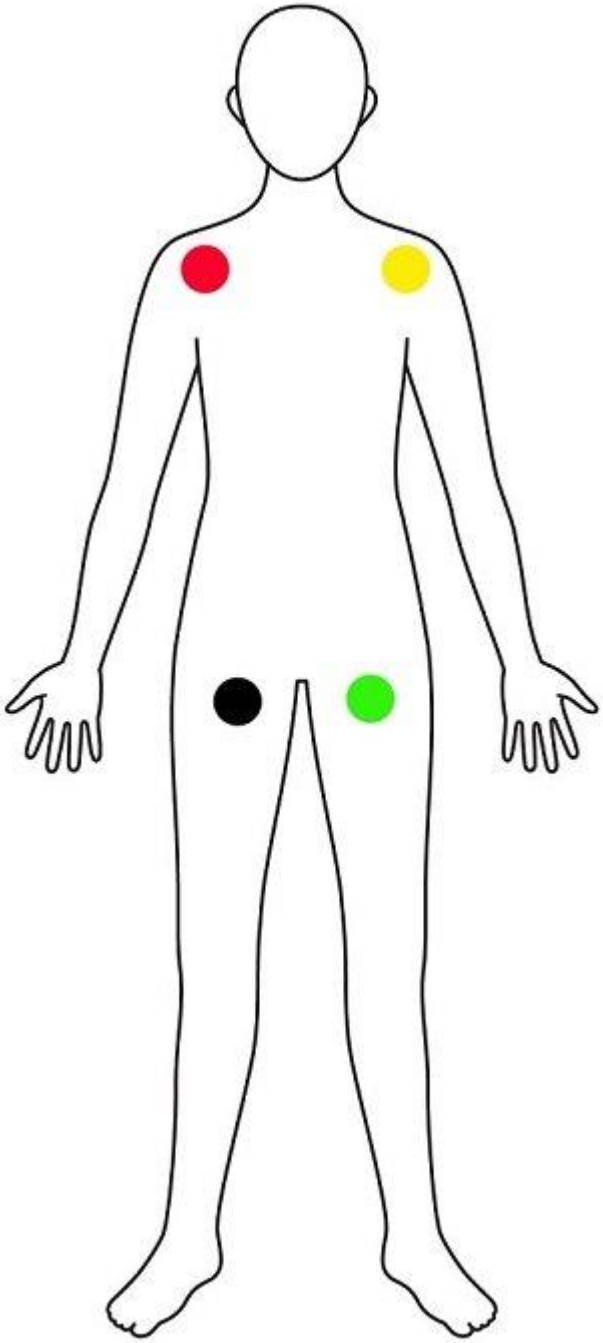


Figure 2a Placement of electrodes on a patient's arms and legs for a 12-lead ECG



Standard limb lead placement

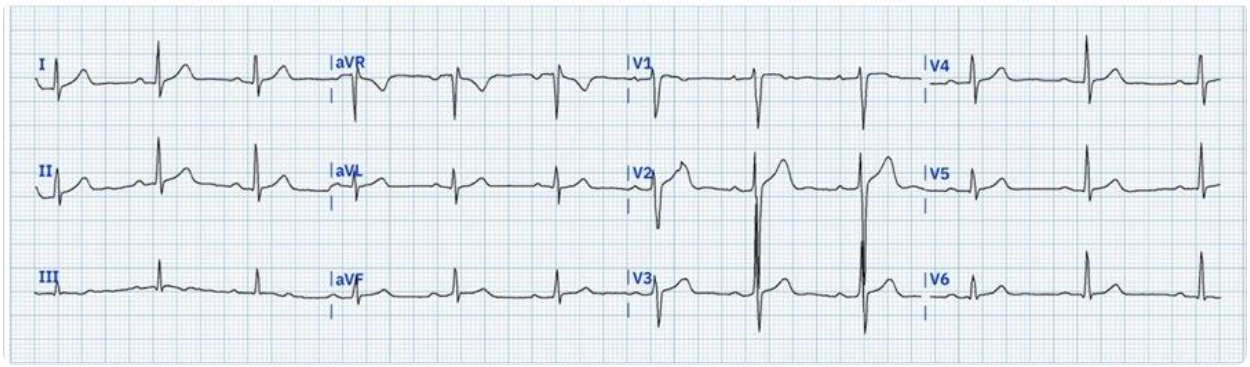
Figure 2b Alternative electrode placement positions for a 12-lead ECG



Alternative limb lead placement

1.3.3 Once the leads are in place, an ECG provides results to clinicians, in the form of a graph known as a ‘trace’ which is presented on a screen or printed out. This requires accurate interpretation to determine what activity is being recorded in different parts of the heart (see figure 3).

Figure 3 Example of a 12-lead ECG



1.3.4 The investigation did not find any UK data available to suggest how often paramedics perform an ECG. One ambulance trust told the investigation it carried out around 19,000 ECGs per month, representing an ECG being completed in one out of every four patients seen, and over 300 million ECGs are thought to take place worldwide every year in multiple care settings (Zhu et al, 2020).

1.3.5 Some ECG machines provide an auto-interpretation function (also known as auto-diagnostics) to help clinicians to interpret the ECG results. The use of auto-interpretation to diagnose STEMI will be explored further as part of the second investigation.

1.3.6 There are many occasions when a paramedic may be required to carry out and/or interpret an ECG. Guidance by the Joint Royal Colleges Ambulance Liaison Committee (JRCALC) (2024) identifies over 40 distinct guideline entries where an ECG may be indicated in clinical care. In many guidelines, the importance of early and accurate ECG interpretation is also stressed. Individual trusts may also have their own local guidance on when an ECG should be completed.

1.3.7 The JRCALC clinical guidelines are overseen and developed by the Association of Ambulance Chief Executives (AACE), as an essential resource for paramedics. The guidelines cover a wide range of topics, including resuscitation, medical emergencies, trauma, obstetrics, medicines, major incidents and staff wellbeing. The guidelines are an important part of clinical risk management and are intended to ensure uniformity in the delivery of high-quality patient care.

1.4 Curriculum guidance issued by the College of Paramedics

1.4.1 The College of Paramedics (CoP) is the professional body for paramedics in the UK. It has published a curriculum for the profession since 2006, although it is not mandatory for higher education institutions (HEIs) to follow this guidance. The previous curriculum has not included mention of any specific requirements about ECG. However, the most recent, 6th edition, curriculum states that paramedics should be able to:

- ‘Describe and demonstrate a systematic and accurate approach to the interpretation and reporting of the 12-lead ECG.
- Describe, analyse, and interpret the relationship between ECG lead placement (including altered lead placement for posterior and right ventricular views) and the different regions of the heart shown on the 12-lead ECG.
- Recognise, analyse, and interpret ECG changes that are indicative of conditions of cardiac origin e.g. acute coronary syndrome.
- Recognise, analyse, and interpret ECG changes associated with non-cardiac medical conditions.
- Identify, analyse, and evaluate the significance of ECG findings (including occasions of limited change in the ECG) within the broader context of patient assessment and diagnostic reasoning.’ (College of Paramedics, 2024)

1.5 Standards set by the Health and Care Professions Council

1.5.1 The Health and Care Professions Council (HCPC) is the regulator of 15 health and care professions in the UK, including the paramedic profession. The HCPC sets standards for education/training, professional knowledge/skills, conduct, performance and ethics. It has a role in approving undergraduate degree programmes that paramedics must complete before they can join its register and sets standards of education and training guidance (Health and Care Professions Council, 2021). The 'paramedic' title is protected in law and all paramedics must be registered with the HCPC to be able to practice.

1.5.2 The HCPC (2020) states that its education standards are outcome focused, ‘enabling education providers to deliver programmes in different ways, as long as individuals who complete the programme meet the relevant proficiency standards’. There is a two-stage process for HCPC to approve a programme:

- Stage 1: The HCPC takes assurance that HEI level standards are met by the institution delivering the proposed programme(s).
- Stage 2: The HCPC assess to be assured that programme level standards are met by each proposed programme.

1.5.3 The HCPC identifies 51 HEIs across the country offering a total of 81 programmes for paramedic students (Health and Care Professions Council, n.d.). The investigation focused on the more common 3-year Bachelor of Science (BSc) course. However, learning identified by the investigation will be relevant to other programmes.

1.6 Becoming a paramedic

1.6.1 To practise as and use the title paramedic, a person must be registered with the HCPC. One way to do this is by successfully completing an approved qualification in paramedic science (College of Paramedics, n.d.).

1.6.2 In 2021, the HCPC changed the threshold level of qualification for paramedics from ‘Equivalent to Certificate of Higher Education’ to a ‘Bachelor degree with honours’. This did not affect the eligibility of existing paramedics to remain registered with the HCPC.

1.6.3 Following qualification, all paramedics are deemed newly qualified paramedics (NQPs) by NHS ambulance services, typically for a period of 2 years. During this period they undergo a preceptorship programme within the ambulance service.

1.6.4 The NQP preceptorship period is based on the NQP Consolidation of Learning Programme (NHS Employers, 2017). This aims to ‘provide a structured programme to properly integrate and support NQPs into the ambulance service workplace, enabling time to consistently apply academic knowledge, skills and placement experience into confident practice’.

1.6.5 The HCPC provides principles for preceptorship to the professions it regulates (Health and Care Professions Council, 2023a), including paramedics. NHS England also provides an Allied Health Professions Preceptorship Standards and Framework (NHS England, 2023). This incorporates the HCPC principles and expands on them to provide best practice guidance on preceptorship programmes to ambulance services.

2. Patient safety events and harm

2.1 The following patient stories are shared to identify where organisations have reported concerns about how paramedic undergraduate and professional education may not have prepared paramedics to undertake 12-lead electrocardiograms (ECGs) in practice, particularly in relation to more complex patient presentations.

2.2 The investigation did not re-investigate these events and extracts from the patient safety event reports are included below to demonstrate the impact of this risk on patient safety. Patient stories such as these will as also be presented as part of the second investigation, specifically in relation to cases of ST elevation myocardial infarction (STEMI).

Patient 1 (as described in HM Coroner prevention of future deaths (PFD) report)

2.3 An ambulance crew was called out to a woman, aged 29 years, who was vomiting and experiencing chest and arm pain. On arrival the crew noted the patient's observations, which included her blood pressure, pulse and respiratory rate, as 'normal'. An ECG was carried out and the machine's auto-diagnostic function indicated that the patient was likely having an anterior infarct (a heart attack caused by blockage of one of the arteries that supplies blood to the heart).

2.4 The paramedic and emergency medical technician (EMT), both of whom had over 8 years' experience, interpreted the ECG as 'normal' and reported this to the patient. Based on that information, the patient declined to attend hospital. Later the same day, a second ambulance crew was asked to attend the patient; they found her in cardiac arrest. The patient was found to have had a myocardial infarction (heart attack) and the crew were not able to save her life.

2.5 The trust's incident report noted the ambulance crew had felt reassured about the patient's condition. This was due to the 'patient's age' and because she 'appeared well'. The ambulance crew were also described to have considered that some of the patient's symptoms were related to another 'ongoing medical issue'.

2.6 The PFD report highlighted education and training within higher educational institutions (HEIs) as matters of concern, stating 'the training provider and/or regulator must ensure that training is effective'. HM Coroner noted that interpretation of an ECG was a 'fundamental part of the job of a paramedic'.

2.7 Concerns were raised that there was 'no evidence at inquest of any qualitative assessment of the ECG aspect of [the paramedic's] training'. The absence of such assessment was said to 'present a risk to patient safety'. HM Coroner also noted that the paramedic and technician 'had not received any further training [from their employer] following the [patient's] death'.

Patient 2

2.8 An ambulance crew, comprising of a paramedic and EMT, was called out to a woman aged 85 years. On arrival the crew documented that she 'had been experiencing nausea for a duration of 2 hours, accompanied by a single episode of vomiting'. The patient did not have chest pain when assessed, and was also noted to be moving around the house.

2.9 The paramedic carried out an ECG. They documented that there were no abnormalities and discharged the patient, who was advised to re-contact emergency services if her symptoms worsened.

2.10 Later the same day another emergency call was received. The same ambulance crew went to the patient, supported by another two crews. On arrival, the paramedic began advanced life support and the patient was taken to her local emergency department, but died later the same afternoon. The patient's cause of death was recorded by HM Coroner as a myocardial infarction (heart attack).

2.11 The trust's incident report found that the ambulance crew acknowledged the ECG findings during the initial examination, but did not consider them a true representation of the patient's symptoms. The trust found the patient was unable to make an informed decision about going to hospital or receiving onward care, because she had not been informed of the ECG changes and the associated subsequent risks.

2.12 The trust found that the paramedic and EMT had 'not considered the signs and symptoms that the patient presented with, and the information outlined in the Joint Royal College Ambulance Committee (JRCALC) guidelines'. This was particularly in relation to guidance that while women do generally suffer from chest pain when experiencing a myocardial infarction, there are occasions where chest pain will not be evident.

2.13 The ambulance crew stated they felt the ECG training they had previously received from the trust was limited and focused on obvious heart rhythms and rates. One of the paramedics stated that their knowledge surrounding ECGs had been expanded throughout their career by word of mouth and gaining experience from other experienced clinicians, rather than being gained through formal training.

Patient 3

2.14 An ambulance crew was called out to a man, aged 33, who was experiencing chest pain and vomiting. On arrival the crew, comprising of a newly qualified paramedic and EMT, noted that the patient appeared anxious, clammy, had quick speech and no difficulty in breathing.

2.15 The patient explained to the crew that he took regular medication for anxiety and had previously had panic attacks. However, he said he had run out of his medication and had not taken it for 2 days. He stated that he had previously had episodes similar to the one he was experiencing that day, as a result of not taking his anxiety medication.

2.16 An ECG was carried out which showed that the patient was having a STEMI; this was misinterpreted as sinus tachycardia (a normal heart rhythm where the heart beats faster than usual). The patient was taken to the local emergency department and his care was handed over

to hospital staff. Observations were done and the ECG was reviewed, at which point the hospital consultant recognised that the patient was having a STEMI. The patient went into cardiac arrest before transfer to a specialist primary percutaneous coronary intervention (PPCI) centre could be arranged. Resuscitation was attempted but was unsuccessful and the patient died at the hospital.

2.17 The trust's incident report noted that if the STEMI had been recognised the crew could have discussed the patient's case with the PPCI centre team. If the PPCI centre was not able to accept him, the patient would have been taken to the nearest emergency department, under emergency road conditions, with a pre-alert to ensure rapid assessment on arrival. The trust found the need for paramedic crews to have 'additional ECG refresher training and materials to assist them when interpreting ECGs'.

Patient 4

2.18 An ambulance crew, comprising of a paramedic and EMT, was called to visit a man, aged 69, who was complaining of chest pain and vomiting. It was noted the patient 'had pain in his central chest' and 'upper epigastric pain [pain below the ribs in the upper abdomen]', that felt 'like a fist under his ribs', which had 'worsened over the past 4 days, radiating into [the] right arm'.

2.19 An ECG was carried out which showed that the patient was having a STEMI; the ECG was repeated three times because the paramedic felt it was unclear and a STEMI was not diagnosed. The patient was instead thought to be suffering from acid reflux and was taken to the local emergency department. A further ECG was obtained 2 hours after the patient's arrival at the emergency department, which suggested that he had suffered a STEMI. The patient suffered damage to the heart muscle.

2.20 The trust's incident report highlighted the need for further ECG training. It stated that the process in place for newly qualified paramedics was not as supportive as it could have been: the 'process did not prepare [the paramedic] for the rigours of being a paramedic'.

Summary

2.21 The investigation found that some of the main findings and recommendations made by individual services and HM Coroner in response to patient safety events related to the education, training and competence of paramedics in ECG interpretation. Assessment of a patient's clinical condition and the resulting potential diagnosis is based on a range of factors. However, an ECG is an important element of a paramedic's clinical decision making.

2.22 Many of the reports did not appear to consider the complexities faced in paramedic practice or provide additional insight into how paramedics are educated, trained, and supported to maintain competence in ECG practice. The next section of this report explores the systemic factors linked to education, training, and competence that may impact on the ability of paramedics to conduct and interpret pre-hospital ECGs.

3. Analysis and findings

This section sets out the investigation's analysis and findings in relation to paramedic education, training and competence in 12-lead electrocardiogram (ECG) practice. It explores factors that influence the ability of paramedics to perform and interpret ECGs. Details of the investigation approach are set out in the appendix.

The analysis and findings are presented under the following headings:

- The changing role of the paramedic.
- The task of carrying out and interpreting a 12-lead ECG.
- Undergraduate education for paramedics.
- Professional training for paramedics.

3.1 The changing role of the paramedic

3.1.1 The College of Paramedics (CoP) recognises that paramedics can work in 'complex and high-pressure situations', as well as 'unfamiliar and often unpredictable environments'. It describes a paramedic's role as somebody who 'works autonomously as a generalist clinician across a range of healthcare settings, usually in emergency, primary or urgent care' (College of Paramedics, n.d.).

3.1.2 Since the 1970s, the role of paramedics has shifted from being a patient transport service to an increasingly professionalised and medicalised practice (Brooks et al, 2016). Central to this change in the ambulance service was the 'Bradley report', a strategic review of NHS Ambulance Service by the Department of Health (2005). The report emphasised the need to better use practitioners' skills in order to meet cost and efficiency targets, often referred to as a shift from 'scoop and run' to 'see and treat'.

3.1.3 The Health and Care Professions Council (HCPC) also recognised that paramedics were being 'required to deliver urgent and unscheduled care in addition to emergency care' and models of care had 'moved from stabilisation and transfer to increasingly providing more

definitive care on scene and referring to appropriate care pathways' (Health and Care Professions Council 2017). In 2021, the threshold level of education for paramedics increased to requiring a BSc honours degree.

3.1.4 A report published by the Association of Ambulance Chief Executives (AACE), in collaboration with NHS Providers and NHS Confederation (2024), recognised the potential for ambulance services to play a leading and co-ordinating role in urgent and emergency care. The report said that this was because they 'already have highly skilled, increasingly multi-professional workforces, with a range of skill sets able to triage and operate autonomously in all environments'.

3.1.5 Paramedics have been required to undertake ECGs as part of their role for many years. Stakeholders told the investigation that ECG interpretation is a "top five critical skill" for paramedic staff. Newly qualified and experienced paramedics who were interviewed as part of the investigation stated they were typically required to carry out an ECG on every working shift.

3.1.6 Despite being a generalist post, stakeholders told the investigation that the specialist knowledge paramedics were expected to have appeared to be increasing. In the context of ECGs, this included a shift away from paramedics being able to identify 'obvious' heart rhythm problems to interpreting more complex or nuanced heart rhythms and clinical presentations. Stakeholders told the investigation that the 'simple' process of undertaking an ECG could also be more complex than some realised, particularly in the context of increasing complexity and multimorbidity's patient's may present with.

3.2 The task of carrying out and interpreting a 12-lead ECG

3.2.1 The investigation was told that the task of carrying out and interpreting an ECG was complex and that it was a tool to be used as part of the holistic care of a patient. Other factors such as the patient's clinical signs and symptoms and medical history were equally important and needed to be taken into account when deciding the most appropriate action to take.

3.2.2 To understand the challenges that this task could pose, the investigation spoke with stakeholders, reviewed academic literature, and participated in simulated ECGs.

Correct patient positioning and lead placement

3.2.3 Correctly preparing a patient, considering both the position of the patient and placement of the leads, is important when conducting an ECG. Ideally, an ECG is performed with a patient lying still in a semi-recumbent position (that is, with their head and torso raised higher than their legs). However, the investigation was told that it was not always possible for paramedics to carry out ECGs in this way.

3.2.4 The investigation heard examples of a range of patient presentations that could impact on the ability to carry out an ECG, where patients were unable to lie in an optimised position. These included older patients who may not be able to lie down and patients who were distressed and in pain who could not keep still.

3.2.5 The investigation was also told that the environment in which an ECG was being carried out could be important. Paramedics could be required to care for patients in a variety of environments, from patients' own homes to public spaces. The investigation was told by paramedics that the presence of electronic devices could affect the way ECG machines and other electronic equipment operated and also needed to be considered.

3.2.6 To ensure an accurate reading, the ECG electrodes need to be placed onto specific locations on a patient's chest and limbs (see figures 1 and 2). The accuracy of ECG electrode placement can influence the accuracy of ECG readings and interpretation (Gregory, et al. 2019). Good skin contact with the electrodes is also required for an accurate ECG reading. However, this is not always possible if a patient's skin is clammy.

3.2.7 The HCPC told the investigation that its standards (HCPC, 2021; HCPC, 2023b) include guidance for paramedics to ensure that their practice is inclusive for all service users and that they take an active approach to supporting equality, diversity, and inclusion. The investigation found that there were a range of considerations about patients with protected characteristics and privacy and dignity issues that paramedics must consider when placing ECG electrodes. This included, but was not limited to:

- Religious and cultural considerations: Paramedics told the investigation that some cultures and religious groups may be unwilling to allow an ECG to take place, if this required paramedics to expose patients or required male paramedics to perform an ECG on a female patient.
- Male and female patients: Paramedics told the investigation that 'hairy men' may need to be shaved in order for ECG electrodes to adhere and remain in place. Paramedics also told the investigation that it could be difficult to accurately place ECG electrodes on women with large breasts. Male paramedics told the investigation they were particularly cautious about exposing women's chests and reported that they would sometimes choose not to remove a woman's bra making accurate ECG electrode placement more difficult. Privacy and dignity were particularly important to consider in cases where it was necessary to do an ECG in public.
- Patients with physical disabilities: Paramedics told the investigation that it was not always possible to place electrodes in the positions shown in figures 1 and 2. This was where patients may have physical disabilities that meant it was not possible due to their anatomy,

or where electrodes could be placed on the extremities of the arms and legs but could receive inaccurate readings.

- Age: Paramedics told the investigation that some ECG stickers seemed ‘stickier’ than others and could remove skin from older patients when they were taken off. This could affect their decisions about where to place ECG electrodes.
- Patients who may be overweight: Paramedics told the investigation that it was not always possible to accurately place electrodes on overweight patients due to challenges in locating the physical markers (typically done by counting ribs) to guide the placement of electrodes.

ECG interpretation

3.2.8 ECG interpretation is a skill that takes considerable time and effort to develop (Kashou et al, 2019). The investigation heard from paramedics, student paramedics, higher education institutions (HEIs), and subject matter advisors (SMAs) that ECG interpretation requires knowledge of what a ‘normal’ ECG reading looks like. It also requires knowledge of many types of heart rhythms, as well as the anatomy and physiology of the heart. Paramedics need to understand what the different ECG leads show and what the changes in the various waves of the ECG trace mean.

3.2.9 Factors relating to a patient’s protected characteristics could impact on how an ECG result should be interpreted in the context of the patient’s clinical signs and symptoms. A range of academic literature has highlighted how patients in different groups may present differently in ECGs, both with and without acute coronary syndromes (ACS). Factors that may affect an ECG result included:

- The patient’s age: ECG appearances change from birth through childhood and into adulthood in healthy individuals (Simonson, 1972; Macfarlane, 2018).
- The patient’s sex: There are significant differences in the measured ECG parameters between females and males, from adolescence onwards (Moss, 2010).
- The patient’s race: Differences in ECG readings are also considered to be ‘well described’ within various literature. For example, differences have been seen in ECGs particularly between patients from white, Asian and black populations (Macfarlane et al, 2014; Santhanakrishnan et al, 2016).
- The patient’s other health concerns: For example, patients with Type 1 diabetes who are having a heart attack may not typically have chest pain (Tabibiazar and Edelman, 2003).

3.3 Undergraduate training for paramedics

3.3.1 As highlighted in sections 3.1 and 3.2, paramedics need in-depth knowledge, understanding and clinical skills across a wide range of topics, including the ability to exercise professional judgement in the accurate set-up and interpretation of an ECG.

Student and paramedic views

3.3.2 The investigation was told that ECG education was ‘hugely variable’ with a lack of consistency between different HEIs. ECG interpretation was seen by paramedics and university staff alike as a “marmite” subject – that is, one that paramedics either liked or disliked. It was explained that paramedics typically either really enjoyed ECG interpretation, taking a keen interest in the subject at university and through their professional career, or they struggled with it.

3.3.3 Most of the paramedics and paramedic students interviewed told the investigation that ECG interpretation was an area where they particularly lacked confidence. This was especially the case when it came to interpreting more nuanced, complex ECGs and patient presentations.

3.3.4 Student and newly qualified paramedics (NQPs) told the investigation that there may be limited time spent by HEIs teaching ECG during their degree. This varied between the different groups interviewed and was said to range anywhere between a few hours to 1 or 2 days, throughout the period of the 3-year course.

3.3.5 The investigation was told the situation was also compounded by other factors that impacted on paramedic students and NQPs in their training periods, and paramedics in practice. This included paramedics getting limited regular exposure to more complex ECG presentations. SMAs told the investigation that this was linked to a lack of job planning (NHS England, 2019) by ambulance services to consider the case mix paramedics may be exposed to (and on student placements set out at 3.3.15), often because of operational demands on the service.

3.3.6 SMAs highlighted opportunities for NQPs and paramedics to be rostered across a range of different services, areas, and with different colleagues, which could support wider learning. While some paramedics felt they had received adequate ECG training, the general consensus among students and NQPs was that they needed to be equipped with better knowledge and skills in ECG interpretation. This was in the context of perceived increased expectations on the knowledge and skills a paramedic was expected to have in ECG interpretation.

Undergraduate course content

3.3.7 HEIs are required to teach paramedic students a broad range of clinical skills and knowledge, including ECGs. Many of the HEIs the investigation spoke with took a ‘spiral curriculum’ approach. Students were introduced to the basic concepts of ECG in the first year, learning how to correctly place ECG electrodes and how to undertake an ECG. The topic was then revisited in years 2 and 3, increasing the complexity of understanding such as the physiology of the heart, how it influences the ECG trace and recognising the different types of abnormal heart rhythms. It was reported that ECGs were taught in the wider context of making a holistic assessment of the patient, with the ECG being a tool to support this.

3.3.8 HEIs the investigation engaged with stated that there was a limit on the depth and breadth of what they could teach within a 3-year course. They had to be selective about what to teach to create the best quality programme they could in the limited time they had available.

3.3.9 There were mixed views on the ECG content of HEI courses. Some NQPs felt they had received good ECG training from HEIs. Some also said they were able to spend time at specialist cardiac centres to gain additional insight and experience. Others felt the ECG content in HEI programmes was too in depth and scientific and that there was a need to go “back to basics”. Conversely, there were also comments that not enough detail was provided in ECG education, which sometimes focussed on teaching pattern recognition, as opposed to having a deeper level of understanding of the requirements for ECG interpretation. This reflected concerns about a potential lack of certainty around what the expectations for paramedic skills in ECG should be.

3.3.10 Students and NQPs told the investigation that the method for delivering ECG training at HEIs tended to be via presentation, and that the practical application of ECG training, such as correctly placing ECG electrodes, could be limited. The use of simulation to teach ECG is considered at 3.3.24.

3.3.11 The HCPC told the investigation that its standards (HCPC, 2021) require that there are appropriately qualified and experienced staff, with relevant specialist knowledge and expertise, in place to deliver an effective programme. However, SMAs told the investigation that there was no consistency in the level of competency in ECG among HEI staff who may be asked to teach the topic. This was supported by academic literature that highlighted how the taught components of HEI courses may not always match the experience of paramedic educators if they have not kept up to date with clinical practice and do not have contemporary clinical experience to draw on in their teaching (O’Meara et al, 2017).

3.3.12 Variation in the way ECG was taught created differing expectations of what knowledge was required of lecturers. Some HEIs used cardiac specialists (including cardiologists and paramedics with additional cardiology qualifications and training) to support ECG training, whereas others did not.

3.3.13 The investigation was also told that there was a reliance on students to conduct further self-directed study to embed their learning. While this is a common requirement in any higher education programme, paramedic students felt they did not have enough time to consolidate their ECG learning, especially as ECG was considered to be a highly important and technical skill. This impacted student paramedics' confidence in making a safe diagnosis using ECG while completing other study and working in practice as part of their course.

Placement during the undergraduate programme

3.3.14 The HCPC stated that its standards (HCPC, 2021) required there to be an effective process in place to ensure the availability and capacity of practice-based learning. Reliance was placed on students' ambulance service placements to provide the opportunity to practise their newly developing ECG skills. The investigation was told that up to 50% of the undergraduate degree was spent on placement at a local ambulance service. Placement hours was an area of concern raised by students and HEIs. It was highlighted that there were often too many students for the number of placement hours available which meant some students were not meeting the required minimum number of weekly shifts.

3.3.15 Paramedic students also told the investigation that they may only have limited exposure to certain health conditions while on placement. In relation to ACS, SMAs told the investigation that it was likely that students would see some patients with chest pain during a placement. However, an important part of ECG skills development was the ability to recognise what was 'normal' and this often required some time, and a number of patient interactions, to fully develop. The CoP highlighted that paramedic students may benefit from placements across a broad range of areas, including specialist heart attack services, in order to gain more experience.

3.3.16 Students were assigned a practice educator who supported them through their clinical placement and assessed their work. The HCPC told the investigation that there must be an adequate number of appropriately qualified and experienced staff involved in practice-based learning, who had the relevant knowledge, skills and experience to support safe and effective learning for paramedic students.

3.3.17 The investigation heard from stakeholders that practice educators had varying levels of education or training on ECG interpretation. The evidence suggested this could be an issue in relation to the quality of education and support that students received on placement, dependent on the level of expectation placed on ECG skills by HEIs and the ambulance service.

3.3.18 Some stakeholders told the investigation that the level of support for paramedic students was being affected by the departure of experienced paramedics from the ambulance service, who may have helped less experienced paramedics to increase their knowledge. Paramedics

were leaving the ambulance service to work in other healthcare settings because of the diversification of paramedic roles away from ambulance services to other parts of the NHS, such as general practice.

3.3.19 There was also evidence of a mismatch in expectations between some HEIs and ambulance services. The investigation heard that on placement, students had sometimes been told it was the HEI's responsibility to provide the educational aspect of training, and on placement the educators were there to provide guidance only. In contrast, some paramedics and HEIs described minimal ECG teaching at university with a reliance on practice educators to do this operationally.

3.3.20 The HCPC stated that its standards set out how HEIs should work with practice education providers to ensure paramedic students are competent when they complete the undergraduate programme (HCPC, 2020). Despite the diversification in the paramedic role away from the ambulance sector, ambulance services are still the primary, and sometimes only, practice-based learning experience students receive on an HEI programme. The CoP told the investigation that it supported student paramedics learning from other professionals and gaining experience in ECG and coronary care while on placement. However, gaining experience outside of ambulance service placements is not a requirement for HCPC validation.

Feedback mechanisms between HEIs and ambulance services

3.3.21 The HCPC and CoP told the investigation that HEIs needed a route for giving and receiving feedback to and from local ambulance services, so they could both influence training and placements. Feedback opportunities between the universities and ambulance services on any element of education or the placement varied across the different HEIs. Some described no formal feedback routes, while others referred to quarterly meetings with their local ambulance service.

3.3.22 The CoP told the investigation that there were geographically based education networks where HEIs, ambulance service representatives and student representatives could meet and discuss issues, such as ECG education provision. The CoP had 10 educational networks, operating across the UK. However, they were not decision making forums and 'solid partnerships' between HEIs and ambulance service were needed to help make any changes to a curriculum.

3.3.23 HEIs told the investigation that they faced a challenge in how much they could respond to feedback as they were limited in how much of an undergraduate course they could change following HCPC validation. The HCPC told the investigation that its intention is to empower education providers, to develop their programmes. It recognised the challenges HEI's shared with the investigation and said it did regular work with education providers and others to explain how its regulatory quality assurance functions when changes were made to courses.

3.3.24 A lack of effective feedback mechanisms, and ability to act on feedback by HEIs, limited the ability for improvements to be made in HEIs and ambulance services to address any ECG learning needs that may be identified.

Equipment and simulation

3.3.25 There was a range of ECG equipment in use across different ambulance services in England and at HEIs. The type of ECG machine used in training would often depend on what the local ambulance service in that area used. If possible, HEIs would aim to teach students using that specific piece of equipment, but this was not always possible. While the machine functionality would largely be the same, its practical use would likely differ and would require an element of local training.

3.3.26 The investigation heard that simulated scenarios were used on the undergraduate programme and that this was often done using technology and required students to interpret ECG traces on a screen. On an ambulance, an ECG trace would normally be printed out as it is not reliable to use the screen on the ECG monitor. The investigation learned that an ECG trace can therefore look different on paper than on a screen, which lowers the fidelity of the ECG simulation provided by some HEIs.

3.3.27 Most ECG machines have a built-in ‘auto-diagnostic’ function which uses pattern recognition software to automatically interpret an ECG trace and produce a diagnosis. Most of the HEIs the investigation engaged with did not teach their students how to use or manage the auto-diagnostic function. The investigation was told that HEIs focused their teaching on “holistic” care, using the ECG trace as one piece of information in a wider clinical picture that would help the paramedic to make an accurate diagnosis and ensure the care pathway was safe for the patient. The use of the auto-diagnostic function to help diagnose patients with STEMI will be explored in the second part of this investigation.

Assessment of ECG competency

3.3.28 There was no requirement setting out whether, how, or to what level of competency HEIs should assess students’ ECG set-up and interpretation skills. The investigation heard that a high level of competency was expected of student paramedics by the time they reached an ambulance service, which may not be realistically achievable given current training and opportunities to practise.

3.3.29 The absence of clear guidance on how ECG competency should be assessed meant there were inconsistencies across HEIs in the competency assessment methods used. Assessment methods included formal assessment, objective structured clinical examination, a portfolio of evidence or a combination of the above. Some HEIs did not incorporate formal

examination at all. The portfolio used by HEIs was also described as being inconsistent, with variance in the amount of evidence required and a lack of assurance to HEIs on the ‘sign-off’ process for students on placement within providers.

3.3.30 One of the challenges faced by HEIs that used examinations in their programme was establishing a suitable pass mark. The HCPC told the investigation it would not normally define pass mark thresholds, but that students who successfully complete a course are required to meet the standards of proficiency (HCPC, 2023b) and that any assessment method used must be appropriate to, and effective at, measuring the learning outcomes.

3.3.31 The investigation heard from HEIs that they had a 40% pass mark at undergraduate level for most degree level qualifications, including paramedic science. This also applied to individual modules, including ECG assessment. While “dangerous” practice, if identified, could result in a student failing the module, most students were supported to enable them to pass the assessment and they were given several attempts to do so.

3.3.32 The CoP told the investigation that in its view the pass mark for any module assessing ECGs should sit at 70%. Similarly the HCPC stated it also felt the pass mark for ECG assessments should be higher than 40%, given the potential safety impact of incorrect ECG interpretation by paramedics. However, while the HCPC stated it would work more closely with professional bodies such as the CoP, it could not stipulate the actual pass mark as part of its generic standards of proficiency or standards of education and training. Any move towards increasing the pass mark for ECG could lead to a ‘hierarchy’ of modules within an undergraduate programme, which would mean identifying which paramedic skills could be considered more important than others.

3.3.33 On consultation, the CoP told the investigation that with immediate effect it would recommend to raising the pass mark of ECG assessment to a pass mark of no less than 70%. The CoP also said that it was exploring the option of setting a professional exam to ensure consistent standardised assessment for paramedics at the point of registration.

Education about patient characteristics, including protected characteristics

3.3.34 As highlighted in section 3.2, there are various patient characteristics to take into account when setting up and interpreting an ECG. The investigation found that there was variability and limitations in the education HEIs provided around patient characteristics.

3.3.35 In terms of setting up and carrying out an ECG, HEIs largely focused on maintaining dignity, for example, when exposing a woman’s breasts or taking into account religious preferences. The investigation found some evidence that HEIs provided education about how factors such as age, race, and sex can influence ECG practice and interpretation in patients with ACS, but this was not consistent among HEIs. The lack of consistency in what was being

taught about patient characteristics meant not all student paramedics or NQPs had the same awareness of how these characteristics can impact on an ECG, affecting decisions about patient care.

3.3.36 The investigation also found that when manikin's were used for education in ECG lead placement, these were typically of a 'standard' proportion. This did not offer students the opportunity to practically address some of the complexities of ECG lead placement set out in 3.2.6. The investigation heard that ECG machines may allow for ethnicity to be considered as part of the auto-interpretation. This will be explored in the context of STEMI diagnosis in the second part of this investigation.

The role of the Health and Care Professions Council (HCPC) and College of Paramedics (CoP) in undergraduate education

3.3.37 The HCPC told the investigation that although it is the recognised regulator for the paramedic profession, it could not stipulate the course content taught by HEIs in any clinical detail. This was in part because it regulates numerous professions as an overarching body and its standards are outcome focused to ensure paramedics are 'fit to practise' at the point of registration (Health and Care Professions Council, 2021). Instead, the HCPC states that its standards of proficiency (Health and Care Professions Council, 2023b) complement information and guidance issued by other organisations, such as the paramedics 'professional body' (the CoP) or employer, with whom it states it works closely.

3.3.38 The HCPC stated that it would expect HEIs to decide what they needed to deliver and then design their curriculum, which would then be approved by the HCPC. The HCPC does not refer to ECGs in any way within its guidance. The investigation was told by HEI course leaders that they therefore have some autonomy in deciding what to teach as part of the paramedic science degree. SMAs engaged by the investigation stated they believed part of the problem faced in paramedic ECG interpretation was the lack of nationally agreed standards that stipulate exactly what clinical detail HEIs need to teach for ECG competency. It is recognised that paramedic accuracy in ECG interpretation can significantly increase, depending on the higher education and specialist training received (Wyld et al, 2023).

3.3.39 HCPC approval for an HEI's undergraduate programme usually lasts for 5 years, although the HCPC approves programmes on an ongoing basis depending on the level of risk and performance of the HEI. The HCPC told the investigation that HEIs are required to complete a reflective portfolio, submitting evidence against key themes, one of which asks what the education provider has done in relation to the introduction of curriculum guidance issued by a professional body. In addition, a yearly proactive review of data and intelligence is undertaken through regular informal engagement with education providers.

3.3.40 The HCPC stated that its current approach allows flexibility so HEIs ‘can design a programme that responds to changes in current practice and takes account of relevant curriculum frameworks and other guidance that is specific to your profession’ (HCPC, Standards of Education and Training Guidance, January 2017). It also explained they do not set 'inputs' (such a specific range or length of practice-based learning, or staff/learner ratios) because the standards are instead outcome-focused to deliver individuals who meet HCPC requirements for registration. This is the fundamental question HCPC answer through their education quality assurance processes.

3.3.41 HEIs that deliver pre-registration undergraduate paramedic programmes, leading to eligibility to apply for registration with the HCPC, may also apply to the CoP for endorsement of their programme. However, this is not compulsory. The investigation was told by education providers that it was ‘optional’ to have CoP endorsement, which was viewed more as a ‘badge of honour’. HEIs told the investigation that CoP accreditation also came at a financial cost, which some HEIs may not wish to incur.

3.3.42 The CoP told the investigation that approximately 44% of HEIs currently hold additional endorsement with itself as a professional body. The HCPC expressed a positive appetite to work alongside the CoP to reduce the regulatory burden and overlap between both bodies endorsing HEI programmes.

3.3.43 The CoP told the investigation that currently there was no mandate for course providers to follow its curriculum guidance and it was aware of variance in the quality of ECG teaching being delivered by HEIs nationally. The CoP expressed concerns about the HCPC validation process, informing the investigation the HCPC should assure itself as a regulatory body that education was being properly delivered by HEIs.

3.3.44 The CoP stated that it had seen continuing themes around the accuracy of ECG interpretation over a period of time, with concerns being expressed by ambulance services. To try and bridge this gap, the CoP stated that additional detail about ECG competency had been added to the 6th edition of its curriculum (College of Paramedics, 2024), as previous versions of the curriculum did not refer to specific ECG competencies.

3.3.45 The CoP stated that it would like its curriculum to be adopted by all UK education providers offering pre-registration paramedic programmes, albeit it has ‘no power’ as a professional body to enforce this. The CoP told the investigation that it is engaging with the HCPC in relation to adoption of its curriculum, i.e. for the HCPC’s consideration when validating UK paramedic programmes.

3.3.46 The CoP told the investigation that its curriculum does not expressly refer to the consideration of individual protected characteristics. Instead it stated that this was to be dealt with by the curriculum's requirement for paramedics to ensure they identify, analyse, and evaluate the significance of ECG findings 'within the broader context of patient assessment and diagnostic reasoning' (College of Paramedics, 2024).

3.3.47 The investigation explored with the HCPC whether it was possible to adopt or endorse the CoP curriculum to increase consistency. The HCPC advised that this was not possible, as by adopting an external curriculum, the HCPC would be unable to assure itself about the content if it was adapted or changed at a later date by the CoP.

3.3.48 The investigation was informed by the HCPC that it has added a question to its assessment guidance for HEIs to confirm if the CoP curriculum has been adopted when HEIs review their course content. The HCPC told the investigation this would help make HEIs aware of changes to the CoP curriculum and allow it to understand any reasons for non-adoption. This question has been asked for the first time this year, but only seven providers were scheduled for review. The HCPC told the investigation it would expect higher numbers next year and could then report on CoP curriculum adoption with more information.

3.3.49 The HCPC told the investigation that it is currently reviewing its standards of education and training. The review is exploring how the HCPC would use a standard to help frame more requirements for curriculum guidance and how this may more closely align with requirements set out in professional curricula, such as that issued by the CoP.

Summary

3.3.50 The investigation identified multiple factors that influenced the knowledge and skills of student and newly qualified paramedics and their confidence in ECG interpretation. These included inconsistency in the paramedic education being delivered across HEIs and placement providers, and the lack of a consistent approach to the minimum standards required for training in ECG for paramedic students.

3.3.51 Both the HCPC and CoP expressed to the investigation a desire to improve joint working and explore further opportunities to consider how issues identified by the investigation in relation to undergraduate ECG teaching may be improved, and how any overlap in oversight may be reduced.

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 how paramedic students are educated about electrocardiograms.

3.4 Professional training for paramedics

3.4.1 This section explores the post-qualification training of paramedics, contrasting the training provided by employers and the HCPC's requirement for paramedics to keep their own skills and knowledge up to date as a part of continuing professional development (CPD). The HCPC explains:

'CPD is how … registrants learn and develop throughout their career, keeping their skills and knowledge up to date. We know that employers will want to encourage their employees to learn and develop, so they keep their practice up to date. This is the best way of ensuring that they stay on the Register and are able to practice safely.' (Health and Care Professions Council, 2024)

Newly qualified paramedics

3.4.2 It is recognised that NQPs can initially suffer a 'reality shock' when they find themselves required to fulfil this role as a lead clinician in a minimally supervised setting (Gregory, 2013).

3.4.3 During the NQP period, ambulance services are expected to provide a preceptorship period to NQPs, with a local induction and a dedicated period of time allowing them to work alongside an experienced paramedic for peer support. In addition, employers should provide a dedicated clinical mentor or practice educator to provide further support and guidance as necessary. However, paramedics have been noted to have lacked clinical supervision and meaningful feedback in these foundation years, resulting in graduates leaving ambulance services (Hayes, 2022).

3.4.4 The NQPs interviewed by the investigation had a mix of views on how the preceptorship period helped them. Some staff stated they received a good induction, incorporating guidance on local policies and ECG training. However, other NQPs raised concerns about their induction process, including the support offered via the ambulance service and more senior paramedics, and the ability to work with other paramedics to embed learning if they were instead placed to work alongside other ambulance staff. Currently, the lack of standardisation of preceptorship programmes can result in challenges for NQPs (Eaton, 2023).

3.4.5 Although the preceptorship period provided an opportunity for NQPs to become familiar with the specific ECG equipment being used by their employing ambulance trust, this training was often not in depth. Although some trusts provided training on ECG equipment as part of a paramedics induction, the investigation found that training on ECG equipment was often provided by ECG equipment manufacturers/suppliers when new equipment was being purchased. This meant that NQPs who had not received this training relied on colleagues to help them understand how equipment worked.

3.4.6 The HCPC principles (Health and Care Professions Council, 2023) and Allied Health Professions Preceptorship Standards and Framework (NHS England, 2023) provides some guidance on what a preceptorship programme should aim to include. However, this guidance is not specific and allows ambulance services to develop programmes to meet local needs. Although this flexibility could be beneficial, SMAs told the investigation that it could lead to unwarranted variability across ambulance services. It was unclear to the investigation to what extent support for ECG training or competence could be a common factor within different ambulance services' programmes.

3.4.7 The CoP told the investigation that it was in the process of developing a Paramedic Foundation Preceptorship programme to support all paramedics in their transition from learner to autonomous practitioner. This will sit over the NQP preceptorship programme as it currently exists, creating a 'day 1 development needs assessment' that will help direct new registrants to seek out development opportunities, recognising their individual areas of challenge.

3.4.8 One of the ambulance services visited by the investigation stated that staff retention was a particular issue and experienced clinicians were needed to support the service. The investigation was told that previously an ‘experienced paramedic’ was considered to be someone with many years of experience, but now paramedics with as little as 5 years’ service (including 2 years as a newly qualified paramedic) were often among the most experienced in many services. NHS England also told the investigation that there was less experience on the ground because of the turnover of the paramedic workforce within the ambulance sector.

3.4.9 This change in the workforce impacted on the preceptorship period for NQPs. Although guidance from more senior paramedic practitioners was available within all ambulance services, not all NQPs had the opportunity to work alongside more experienced paramedics for extended periods of time during their preceptorship. This limited the opportunity to learn about ECG from more experienced colleagues.

3.4.10 The investigation went on to consider how experienced paramedics were able to refresh their ECG skills and keep up to date with any new knowledge, or increased expectation, about the skills required in ECG in the ambulance sector.

Mandatory training and continuous professional development for all paramedics

Organisational expectations

3.4.11 Most of the paramedics the investigation spoke with said they did not feel they were provided with enough training throughout their career to meet the demand of the increased depth of knowledge and expertise that they felt was now required of them in relation to ECG interpretation. SMAs told the investigation that this could impact on the generalist nature of the paramedic role, stating “we cannot make paramedics cardiologists at the expense of other aspects of their role”.

3.4.12 Training was also a concern raised by many of the ambulance services visited. They explained training was restricted due to the overall demand and pressure to keep ambulances and paramedic teams on the road, as well as the reduced number of paramedics generally available within the service.

3.4.13 The CoP told the investigation that “training was the first thing to go” when operational demand was high. This was supported by comments from paramedics and ambulance services. The CoP emphasised the importance of mandatory training and CPD, stating ambulance services and paramedics alike must take responsibility for maintaining training. Stakeholders told the investigation that unlike some clinical specialties, ambulance services could not discontinue their services while training was delivered.

3.4.14 The investigation found that ambulance service clinical training mainly consisted of two annual training days, delivered through a mixture of online and face-to-face courses. These covered a range of topics including manual handling, ECGs, sepsis, maternity, paediatrics, mental health, and guidance around alternative care pathways. Due to the variety of topics that may need to be refreshed, it was not always possible to teach ECG competency. However, the investigation saw that this subject had been revisited by some services more recently following the prevention of future deaths report referred to in section 2.

3.4.15 In order to decide what refresher training to include, ambulance services stated they listened to staff requirements locally, also looking to see what trends/themes were emerging from patient safety events. The investigation was not told of any national mechanism to help bring together wider learning and help prioritise topics that should be included in annual training.

3.4.16 Of the ambulance services where ECG had recently featured in annual training, evidence of teaching relating to how different protected characteristics featured in ECG competency was only seen at one of the ambulance services visited. Some paramedics told the investigation that they were not taught about the effect of differences in sex, age or ethnicity as part of their training. However, working in a more multicultural city was said to help develop their knowledge of such differences.

HSSIB makes the following safety observation

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.

Professional expectations

3.4.17 As part of its standards of proficiency the HCPC also expects paramedics to keep their own ‘skills and knowledge up to date and understand the importance of continuing professional development (CPD) throughout their career’ (that is, in addition to any mandatory training provided by employing ambulance services) (Health and Care Professions Council, 2023). However, challenges in completing CPD, because of limited protected time being available for learning while on the job, was an issue raised by almost all the ambulance services and

paramedics interviewed. Protected time is referred to as ‘job planning’ within national guidance issued by NHS England for allied health professionals, including paramedics (NHS England, 2019).

3.4.18 Paramedics told the investigation that training sometimes took place on days they had been rostered off, which meant they could not attend unless they attended on a scheduled day off work. Paramedics also told the investigation they were sometimes unable to access funds or time off for training courses, given the overwhelming priority was to provide operational cover.

3.4.19 Paramedics expressed concern to the investigation, questioning how effectively they could maintain CPD in their own spare time after finishing busy and tiring working shifts. Paramedics and management staff alike felt CPD should be “embedded” into “business as usual”, being “paid for” by ambulance services. This approach is supported by NHS England in its guidance on job planning for allied health professionals. This sets out that paramedic job plans should include time for specified supporting professional activities, including training and CPD (NHS England, 2019).

3.4.20 The CoP told the investigation that an intercollegiate document by the College of Paramedics, Royal College of Nursing and Unison (Royal College of Nursing, 2007) had recommended a minimum of 6 days CPD per year; however, this was removed in 2019 due to pressure from stakeholders. The CoP stated it had a suite of CPD training which could be tailored around the main patient safety themes in individual ambulance trusts. Although the CoP stated there would be some costs involved for ambulance services, it believed many trusts were already paying for external ECG training.

3.4.21 HEIs also questioned how effectively staff could maintain competence in topics they learned as an undergraduate where access to training and CPD may be limited. Senior managerial staff within some of the ambulance services visited stated there were “lots of marginal gains to be made”. These included the need for paid time off work for CPD and a recognition that training is important and that there may be continuing negative impacts on patient safety if it is consistently deprioritised ahead of operational demands.

HSSIB makes the following safety observation

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.

3.4.22 Some paramedics told the investigation that they were aware of ongoing discussions about whether ECG competency should be formally checked by ambulance services after graduation and throughout paramedics' careers.

3.4.23 Staff and ambulance services stated that ECG competency was not formally checked and there were concerns about the possible effect of this on operational capacity. Practical concerns were shared with the investigation about what an ambulance service could do if paramedics were unable to show they could accurately interpret 'more complex' ECGs after leaving an HEI. This would likely require the paramedic to be restricted in how they can practise and they would need further support and training. However, operational demands would make this challenging and result in a further paramedic resource being unavailable to the service, who could have been used to help care for patients and may be competent in other areas of care.

3.4.24 All ambulance services were seen to have mechanisms to provide staff with clinical guidance in cases where paramedics expressed concerns around ECG interpretation and complex presentations. The range and effectiveness of these mechanisms in relation to STEMI diagnosis will be explored in more detail in the second part of this investigation.

Paramedic skill fade

3.4.25 Paramedics keep their skills up to date through regular practice. The investigation was told by many of the ambulance services visited that paramedics may have experienced 'skill fade' in relation to more complex ECG interpretation. Skill fade is the decay of ability or adeptness of a skill over a period of non-use, where for example paramedics have not been able to practise their skills regularly for the reasons outlined below.

3.4.26 Although conducting ECGs remains a key part of paramedics' skillset, it was stated that exposure to less common scenarios, that would help to maintain ECG competency was limited. Similar to student paramedics, the investigation was told this could be due to the case mix to which paramedics were exposed.

3.4.27 SMAs and paramedics also stressed that potential skill fade was in part due to paramedics now being required to spend extended periods of time queuing outside hospital emergency departments, which has been the subject of previous HSSIB reports (Health Services Safety Investigations Body, 2023). This meant paramedics were not seeing as many patients as they would previously, potentially leading to decaying skills.

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.

3.4.28 Mechanisms to help mitigate skill fade, such as the provision of clinical advice and support, and the auto-interpretation function available on ECG machines, will be explored in the second part of this investigation.

Feedback for paramedics as a means of learning and continuous improvement

3.4.29 The investigation was told by all the ambulance services visited that the use of feedback as a means of continuous learning for paramedics was very limited. Paramedics also expressed frustration stating they were rarely informed of patient outcomes and were therefore unable to learn about their decision making. The main sources of feedback cited by paramedics were complaints, commendations and incident debriefs. Paramedics were limited in being able to reflect on their practice and learning, which can lead to ‘perceived isolation’ (Eaton-Williams et al, 2020). NHS England told the investigation that it would also be helpful for instances where an ECG does not go to plan, to be recorded to the NHS learn from patient safety events (LFPSE) service as they may meet the definition of patient safety events and enable further learning.

3.4.30 Research shows that the provision of feedback, or information about health-related patient outcomes following incidents that paramedics have attended, provides paramedics with a way of assessing and developing their diagnostic and decision making skills (Eaton-Williams et al, 2020). However, additional research has acknowledged that mechanisms for effectively sharing feedback to ambulance staff are yet to be fully developed and would benefit from further research (Wilson et al., 2023).

3.4.31 The investigation was told that data protection issues and cost were seen as a barrier to sharing this information, although the investigation was told that one ambulance trust had managed to secure an appropriate data sharing agreement across a geographic region. This is learning that can be shared to help enable other ambulance services to apply similar measures for effective feedback.

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.

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5. Appendix: Investigation approach

Investigation approach

To ensure adequate breadth and depth, the investigation reviewed multiple sources of evidence to help identify risks that may be posed to patient safety in relation to paramedic education, training and competence in electrocardiograms (ECGs). This included:

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

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

Multiple stakeholders highlighted specific challenges in interpreting ECGs for patients with chest pain. In particular, concerns were raised about diagnosis of ST elevation myocardial infarction (STEMI), as the most serious form of heart attack, which poses the greatest risk to patients.

HSSIB searched the Strategic Executive Information System (StEIS), which is a national database for reporting serious safety incidents in healthcare. The incident data reviewed also suggested a significant impact particularly when it came to STEMI, with 30 of 52 incidents (58%) between January 2022 and January 2024 involving STEMI or suspected STEMI. Of these 52 incidents, 40 involved the death of the patient, thus demonstrating a significant outcome impact on patient safety.

Evidence gathering

The investigation visited 5 out of 10 ambulance services in England, based on the different type of ECG equipment being used, and engaged with a selection of specialist treatment centres (providing primary percutaneous coronary intervention – PPCI).

Patient safety incident reports relating to incorrect ECG interpretation were requested from ambulance services and reviewed alongside incidents reported on StEIS to understand some of the common emerging safety themes. The investigation team also spoke to a variety of higher education institutions that deliver paramedic education, consulting a wide range of people from the paramedic world. This included undergraduates, newly qualified/experienced paramedics, specialist paramedics, lecturers, course leaders and management staff (see below).

Semi-structured interviews were conducted, guided by the Systems Engineering Initiative for Patient Safety (SEIPS) framework. The SEIPS framework was also used as a guide during site visits for evidence collection and in the thematic analysis of all the data gathered. SEIPS provides a human factors framework for understanding the work system (that is, the external environment, organisation, internal environment, tools and technology, tasks, and people), work processes (including physical, cognitive and social/behavioural aspects) and the relationship between these and the resulting outcomes in healthcare (Carayon et al, 2006).

Stakeholder engagement and consultation

The investigation engaged with many stakeholders and subject matter advisors to gather evidence during the course of the investigation. This also enabled checking for factual accuracy and overall sense-checking. The stakeholders contributed to the development of the safety recommendation based on the evidence gathered and are listed below.

Reference and comparison site organisations	**Staff**	**National organisations**	**Subject matter advisors**
5 ambulance services in England	Newly qualified paramedics Paramedics Ambulance service managers Paramedic safety specialists	NHS England	Consultant paramedic

Reference and comparison site organisations	Staff	National organisations	Subject matter advisors
5 higher education institutions across England	Student paramedics Paramedic lecturers Paramedic course leaders Academic management staff	Health and Care Professions Council	Specialist paramedic in ECG education
		College of Paramedics	Academic with interest in ECG software
		Association of Ambulance Chief Executives	

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