



Investigation report

Emergency response to heart attack

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Emergency care, Access to care

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A note of acknowledgement

We are grateful to Phil, whose experience is documented in this report. The report's safety recommendations, which have been developed by examining the care Phil received and the issues which arose, support Phil and his family's wish to prevent other patients having the same experience.

We are also grateful to the organisations and staff who contributed to the investigation at various stages. Their expertise and insight allowed greater depth of understanding of the issues explored, and supported the development of the safety recommendations and safety observations that will ultimately help to improve safe and effective care in future.

Executive Summary

Introduction

This investigation explores the impact of ambulance delays on the emergency treatment of heart attack. It uses a real patient safety incident, referred to as 'the reference event', to examine the issues involved.

Timely treatment of heart attack is needed to avoid further damage to the heart and is recognised to improve patient outcomes. The current preferred model of care in the NHS in England is for patients to receive primary percutaneous coronary intervention (PPCI), a procedure which involves widening a blocked artery and inserting a stent to keep the artery open. The effectiveness of PPCI is dependent on the timescale in which it can be carried out.

National figures have identified increasing delays in ambulances taking people with a type of heart attack known as ST-elevation myocardial infarction (STEMI) to hospital so that PPCI can be provided within target timescales. This may lead to worse outcomes for these patients. Alternative treatment using thrombolytic medicine (medicines used to dissolve blood clots) is advised where specific timescales for providing PPCI may not be met.

The reference event

Phil, who was aged 61 at the time of the event, went with friends on a road cycle through hilly terrain to a friend's house in a rural location. During the ride, Phil suffered several episodes of what he believed to be indigestion, for which he self-medicated with an antacid. The friend's house was undergoing restoration, and the day after arriving there Phil spent the day painting and helping to work on the house. The house did not have a landline telephone.

In the evening, Phil and his friends went out for a meal. At about 00:30 hours the following morning, Phil awoke with chest pains and was breathless and sweating. He thought he was having another episode of indigestion. He woke one of his friends (a retired GP) who recognised that Phil was displaying symptoms of a heart attack.

The retired GP left the house to get a mobile phone signal to call 999, and after some initial connection problems, was able to explain the issue to the emergency call handler. The ambulance trust (referred to here as 'the Trust') triaged the call and identified that Phil was suffering from symptoms that may have meant he was having a heart attack. A Category 2 ambulance response was requested. A Category 2 response means that on average a suitable ambulance should arrive with the patient within 18 minutes, with a 90th percentile target of calls receiving an ambulance response within 40 minutes.

Due to the volume of calls to the Trust, there was a delay in the response to the 999 call. A rapid response vehicle (RRV), crewed by a solo paramedic, was dispatched to Phil and arrived 67 minutes after the 999 call. The paramedic carried out an electrocardiogram (ECG) to check the rhythm and electrical activity of Phil's heart, which confirmed that Phil was experiencing a STEMI. The paramedic requested assistance from a double-crewed ambulance (DCA), as they felt unable to take Phil to hospital in the RRV. A DCA resource was identified and dispatched which arrived 130 minutes after the initial 999 call was made.

Phil was transferred to the ambulance and the DCA crew assisted the RRV paramedic and carried out a further ECG. On the way to the hospital, the ECG data was transmitted to the hospital's on-call cardiologist who alerted their team and prepared to carry out PPCI. The DCA arrived at the hospital at 04:39 hours and Phil underwent PPCI at 05:20 hours to place two stents in his artery. In total, the time from informing 999 about Phil's condition until Phil received PPCI was 229 minutes. Phil survived the STEMI and stayed in hospital for 9 days receiving further care and treatment. He now reports that he has reduced physical activity levels and ongoing medical needs.

National investigation

HSIB was notified of the incident via a safety awareness notification submitted on its website by Phil and his family. The HSIB investigation gathered additional information and assessed the incident against its investigation criteria.

The national investigation considered:

- treatment options available for patients who have suffered a heart attack (specifically STEMI)
- safety issues across the healthcare system relating to the emergency response to heart attack.

In addition, the investigation sought to identify any other system-wide safety issues that may require further investigation by HSIB.

Findings

- There are increasing delays in ambulance responses to chest pain calls.
- PPCI is the preferred treatment option for STEMI where patients can present to hospital within 12 hours of the onset of their symptoms, and where PPCI can be given within 120 minutes of the time when a STEMI is diagnosed.
- Where patients may have suffered a STEMI, ambulance delays can impact on the ability to provide PPCI within target timescales.
- Delays in receiving PPCI can increase the risk of in-hospital and 30-day patient mortality.
- There is a lack of evidence to show the impact on death rates in the longer term beyond 30 days, the effect on patients' health in the longer term, and the impact on NHS resources stemming from delays in patients receiving PPCI.
- National and professional guidance recommends thrombolysis as an alternative treatment for STEMI where PPCI cannot be provided within target timescales.
- There is a lack of evidence to support which treatment option is best in treating STEMI where patients encounter delays: PPCI delayed beyond the target timescale of 120 minutes from a STEMI diagnosis, or thrombolysis provided after 120 minutes of a STEMI diagnosis.
- Thrombolysis is now rarely used within the NHS for pre-hospital STEMI treatment.
- Thrombolysis medication is no longer carried by 6 of the 10 English ambulance services.
- In four ambulance services, thrombolysis medication is only retained in more rural areas where patients may routinely be unable to access PPCI within target timescales or where it is administered by specialist paramedics.
- Paramedic staff may not be competent to administer thrombolysis medication due to the limited circumstances in which this is now required.
- The withdrawal of thrombolysis as an alternative treatment, and lack of competence of paramedics to administer thrombolysis, places greater emphasis on the need to ensure STEMI patients present to hospital as soon as possible for PPCI.

HSIB makes the following safety recommendations

Safety recommendation R/2021/117:

HSIB recommends that NHS England and NHS Improvement revise the Ambulance Clinical Quality Indicator: Clinical Outcomes for ST-elevation myocardial infarction to reflect each element of the call to balloon response and review this indicator alongside the critical time standards workstream.

Safety recommendation R/2021/118:

HSIB recommends that the Association of Ambulance Chief Executives, working with the College of Paramedics and cardiology specialists, produces a position statement on the use of pre-hospital thrombolysis by paramedics.

Safety recommendation R/2021/119:

HSIB recommends that NHS England and NHS Improvement support the Joint Ambulance Improvement Programme to respond to emerging risks and research highlighting factors impacting on effective ambulance response.

HSIB makes the following safety observations

Safety observation O/2021/101:

It may be beneficial if NHS emergency call handling triage systems consider how intelligent analytics or increased clinical oversight may be enhanced to assist in the early identification of STElevation myocardial infarction calls.

Safety observation O/2021/102:

It may be beneficial if current guidance on the use of thrombolysis as an alternative to primary percutaneous coronary intervention in England is reviewed to consider the challenges posed in safely administering thrombolysis in the pre-hospital setting.

Safety observation O/2021/103:

It may be beneficial if further work was conducted to identify the impact of delays in primary percutaneous coronary intervention on the morbidity of patients, and longer-term mortality of patients, suffering from ST-elevation myocardial infarction.

1 Background and context

1.1 Chest pain

1.1.1 Chest pain can have many different causes including angina, indigestion, muscle strain, anxiety and chest infections. In most cases, chest pain is not caused by a heart problem (NHS, 2020). However, chest pain can indicate that a patient is suffering from a heart attack. A heart attack is life threatening and requires emergency treatment (NHS, 2020).

1.2 ST-elevation myocardial infarction (STEMI)

1.2.1 Myocardial infarction with STsegment elevation (STEMI) is a form of heart attack. It occurs when a coronary artery (one of the arteries that supplies blood to the heart) becomes blocked by a blood clot, causing the heart muscle supplied by the artery to die (see figure 1). The highest priority in the management of STEMI is to restore adequate blood flow to the heart as quickly as possible.

1.2.2 National and international guidance recommends two possible treatment options where STEMI is diagnosed; primary percutaneous coronary intervention (PPCI) and thrombolysis (also known as fibrinolytic therapy) (National Institute for Health and Care Excellence, 2020; European Society of Cardiology, 2017). The aim of each treatment is to restore blood flow to the heart as soon as possible.

Figure 1: Normal versus STEMI heartbeat rhythm on electrocardiograph reading

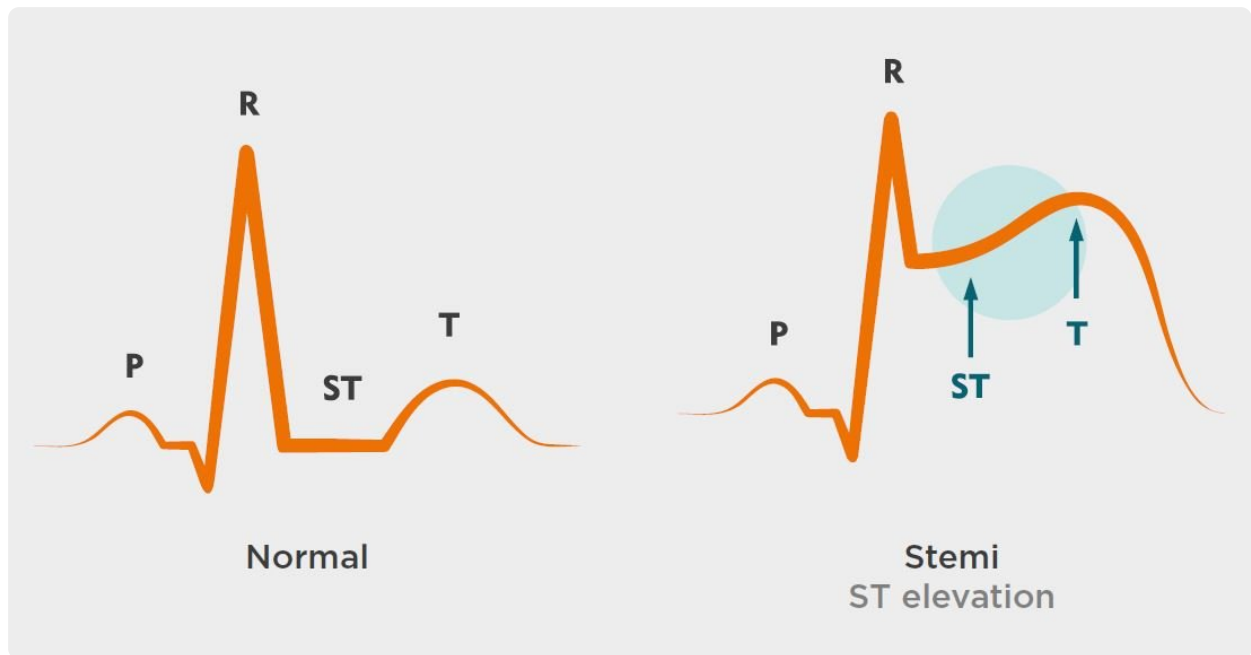
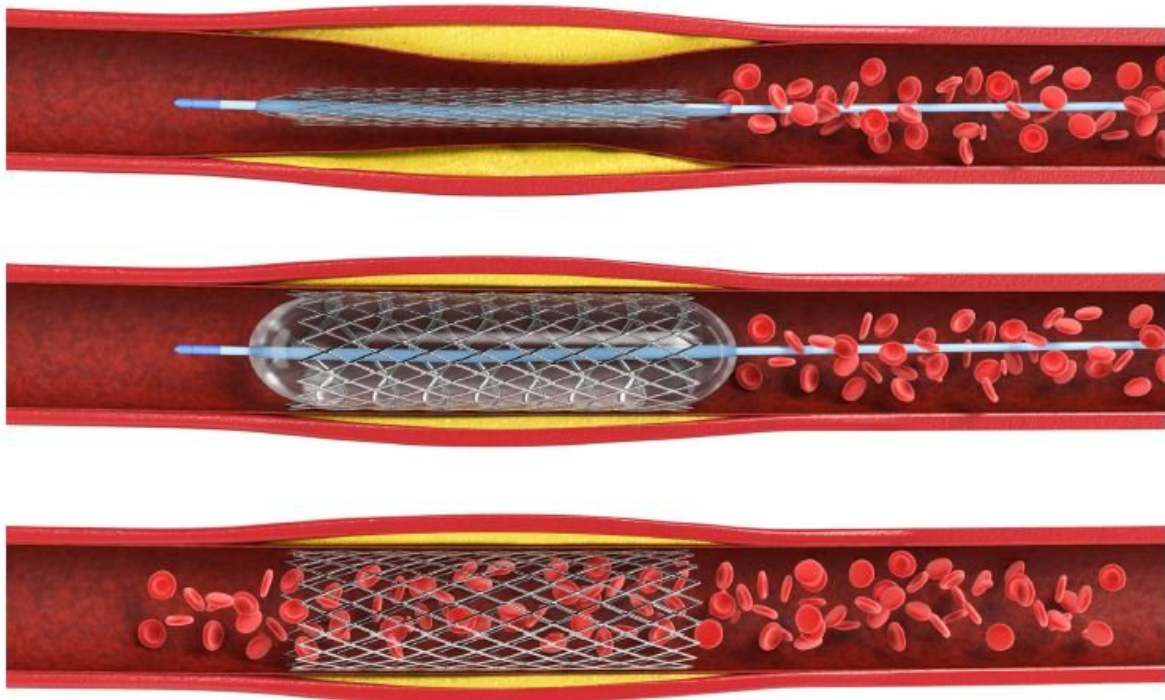


Figure 2: Coronary artery stent



1.3 Primary percutaneous coronary intervention (PPCI)

1.3.1 PPCI is the primary treatment option in England for a STEMI. It involves an initial procedure, known as a coronary angioplasty, to widen the blocked coronary artery. This is done by inserting a tube (catheter) with a balloon at the end through a larger artery in the groin or arm. Once in position at the site of the blocked artery, the balloon is inflated to widen the artery

and allow the insertion of a stent (a wire mesh tube) (see figure 2). The stent ensures that the artery remains open after the procedure is completed. This procedure is carried out at specialised heart attack treatment centres (NHS, 2019).

1.4 Thrombolysis

1.4.1 Thrombolysis involves giving a patient specific medicines that are designed to dissolve clots in blood vessels, improve blood flow and prevent damage to tissues and organs.

1.4.2 The NHS first introduced a comprehensive framework to provide thrombolysis to STEMI patients in 2000 (NHS, 2000). This included the use of thrombolytic medicines by paramedics to provide prehospital treatment. By 2007, 22% of patients treated with thrombolysis for STEMI received it before arriving at hospital (Myocardial Ischaemia National Audit Project, 2008).

1.4.3 Thrombolysis treatment can cause complications, including an increased risk of bleeding into the brain and, in around 20% to 30% of cases, a risk that additional treatment (such as PPCI) may be required to resolve STEMI (Resuscitation Council, 2015).

1.5 The National Infarct Angioplasty Project (NIAP)

1.5.1 NIAP was established to test the feasibility of developing PPCI services as an initial treatment for heart attack in England (Department of Health, 2008). The key findings from the project included:

- PPCI can be delivered within acceptable treatment times in a variety of settings. The shortest times to treatment are achieved through direct admission to a cardiac catheter laboratory. Longer times to treatment are associated with a higher mortality rate (death rate).
- PPCI is more expensive to deliver than thrombolysis but is both clinically and cost effective when delivered within 120 minutes of a patient's call for professional help.
- While NIAP was not set up to compare PPCI and thrombolysis, it was noted that PPCI was associated with few complications, low recurrence of heart attack, low incidence of stroke and a low mortality rate, comparing favourably to published thrombolysis data.
- PPCI services need to be 24/7. Hybrid services offering daytime PPCI and out-of-hours thrombolysis are not satisfactory.
- If a PPCI service cannot be established, pre-hospital thrombolysis by ambulance services is preferable to in-hospital thrombolysis.

1.5.2 NIAP identified that there was an increase in the rates of in-hospital mortality, 30-day mortality and one-year mortality for patients whose PPCI was undertaken later than 120 minutes after their call to emergency services. 1.5.3 NIAP also identified that mortality rates for

patients receiving thrombolysis rather than PPCI were greater at 30 days (7.9% compared with 5.6%), one year (12.4% compared with 8.7%) and 18 months (14.8% compared with 9.9%) following admission to hospital. However, NIAP stressed that this data may not be directly comparable, and the purpose of the NIAP project was not to compare the relative impact on mortality of each treatment.

1.6 The Myocardial Ischaemia National Audit Project (MINAP)

1.6.1 The MINAP audit is operated by the National Institute for Cardiovascular Outcomes Research (NICOR). NICOR is commissioned by the Healthcare Quality Improvement Partnership with funding from NHS England and NHS Improvement.

1.6.2 MINAP research measures the performance of hospitals that treat heart attack in the UK against best practice. MINAP (2014) identified that national and international guidelines recommend that PPCI should be performed as soon as possible: within 90 minutes of arrival at hospital (door-to-balloon time) and within 150 minutes of a patient's call for help (call-to-balloon time).

1.6.3 The response to STEMI is recorded against two targets:

- Call-to-balloon: the total time during which the ambulance service must respond to the call, make a pre-hospital assessment, provide appropriate treatments, take the patient to hospital, and for hospital based PPCI care to be delivered. This requires that 69% of patients receive PPCI within 150 minutes and 42% within 120 minutes of the call for help.
- At hospital (DTB). Door-to-balloon time: during which hospital staff must confirm the diagnosis, assess the patient's suitability for PPCI, and prepare for and begin to perform the PPCI. This requires that 87% of patients receive PPCI within 90 minutes of arrival at hospital and 73% within 60 minutes of arrival.

1.6.4 Currently, no target timescale is set against the call to door element of the STEMI pathway. This is the part of the pathway in which the ambulance service must respond to the call and transport a patient to hospital.

1.6.5 The 150-minute call-to-balloon target time set out by MINAP is also designed to account for a 30-minute response time by emergency services to reflect the time it may take to diagnose a STEMI and start thrombolytic therapy. It then allows for 120 minutes for transport to hospital and for PPCI to take place, in line with national guidance (National Institute for Health and Care Excellence, 2020).

1.7 National Institute for Health and Care Excellence (NICE)

1.7.1 NICE provides national guidance and advice to improve outcomes for people using the NHS and other public health and social care services in the UK. 1.7.2 NICE guidance (2020) advises that the preferred treatment option for a confirmed STEMI is PPCI where:

- presentation by the patient to medical professionals is within 12 hours of the onset of the patient's symptoms, and
- PPCI can be delivered within 120 minutes of the time when thrombolysis could have been given to the patient.

The NICE guidance (2020) also advises:

- offering fibrinolysis (thrombolysis) to people with acute STEMI presenting within 12 hours of onset of symptoms if PPCI cannot be delivered within 120 minutes of the time when fibrinolysis could have been given.

1.7.3 The timescale for when thrombolysis could have been provided would be expected to run from the point at which an electrocardiogram (ECG) (a test to check the rhythm and electrical activity of the heart) could be conducted to confirm whether a patient was suffering from a STEMI.

1.8 The European Society of Cardiology (ESC)

1.8.1 The ESC is a professional association that facilitates the improvement and harmonisation of standards of diagnosis and treatment of cardiovascular diseases.

1.8.2 In 2017, the ESC updated its guidelines on treatment of STEMI (European Society of Cardiology, 2017). The ESC identified that PPCI was the preferred treatment option where PPCI could be provided within 120 minutes of a STEMI diagnosis being confirmed. The guidance states that a STEMI diagnosis requires a suitable clinician to carry out and interpret an ECG before such a diagnosis can be made.

1.8.3 The ESC considered that if timely PPCI could not be achieved following a STEMI diagnosis, then thrombolysis was recommended in patients who presented within 12 hours of the onset of symptoms and who did not have any contraindications for thrombolysis (that is, there were no clinical reasons why thrombolysis would be unsuitable for the patient).

1.9 NHS England and NHS Improvement Ambulance Response Programme (ARP)

1.9.1 The ARP was established in 2015. Its stated aim was to increase the operational efficiency of ambulance services while maintaining a focus on the clinical needs of patients. Three objectives were stated to be central to the programme (NHS England and NHS Improvement, 2018):

- prioritising the sickest patients, to ensure they receive the fastest response
- driving clinically and operationally efficient behaviours, so the patient gets the response they need first time and in a clinically appropriate timeframe
- putting an end to unacceptably long waits by ensuring that resources are distributed more equitably among all patients.

1.9.2 The ARP conducted large-scale clinical trials within English ambulance services and issued final ARP guidance to ambulance services in July 2017. It established new ambulance response categories and the average response times expected for each. These are:

Category 1: For calls to people with immediately life-threatening and time-critical injuries and illnesses. These will be responded to in a mean average time of 7 minutes, with the 90th centile of calls receiving a response within 15 minutes.

Category 2: For emergency calls, such as cases of stroke or chest pain, which may require rapid assessment and/or urgent transport. These will be responded to in a mean average time of 18 minutes, with the 90th centile of calls receiving a response within 40 minutes.

Category 3: For urgent calls which require treatment and transport to an acute setting (such as a hospital emergency department). The aim is for the 90th centile of calls to receive a response within 120 minutes.

Category 4: For less urgent calls where some patients may also be given advice over the telephone or referred to another service. The aim is for the 90th centile of calls to receive a response within 180 minutes.

Category 5: For calls which require clinical assessment but not an ambulance response. The aim is for the 90th centile of calls to receive a call back from a clinician within 180 minutes.

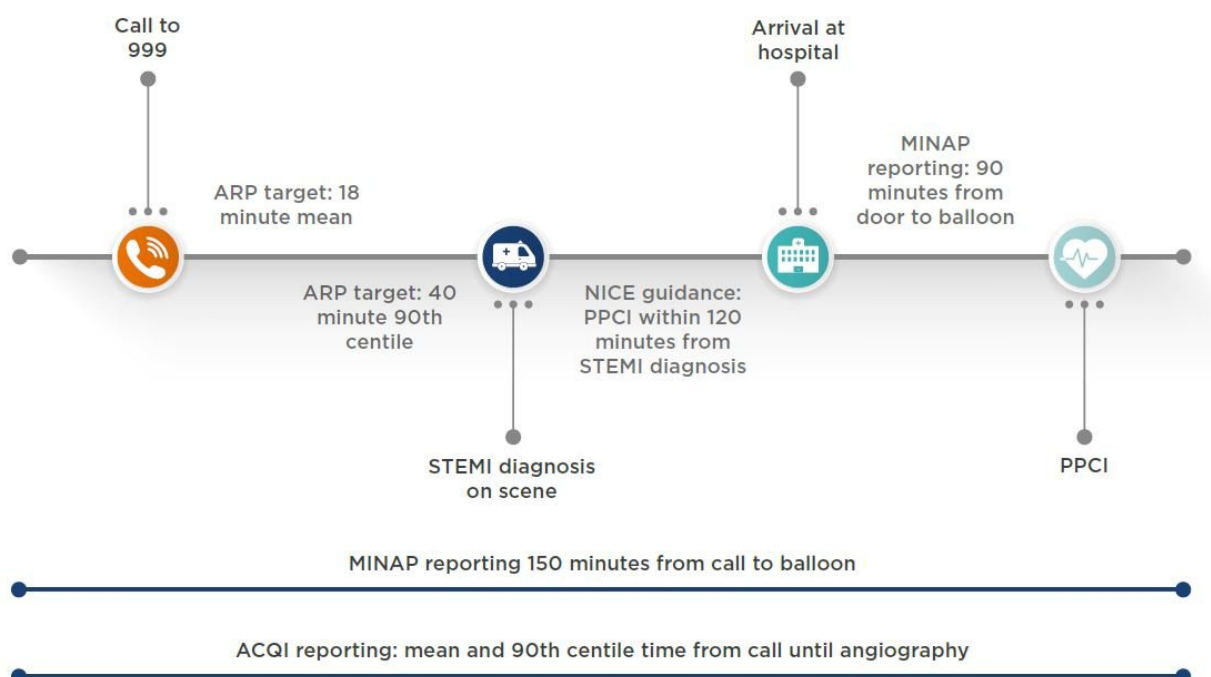
1.9.3 Under the ARP system, triage of chest pain would normally be classified as a Category 2 response, unless the patient or caller reported other more urgent symptoms that may require a Category 1 response.

1.10 NHS England and NHS Improvement Ambulance Clinical Quality Indicators (AQIs)

1.10.1 AQIs were introduced in April 2011 for all ambulance services in England and look at the quality of care provided as well as the speed of response to patients.

1.10.2 Patient outcomes from acute STEMI are included as one of 11 quality indicators by which the ambulance service is measured. Data is collected on the mean average time in which patients receive angiography (medical imaging to look at the inside of the heart) following their call and the time in which 90% of patients receive angiography to determine whether PPCI is required.

Figure 3: Overview of various response times for STEMI



2 The reference event

This investigation used the following patient safety incident, referred to as 'the reference event', to examine the issue of the impact of ambulance delays on the emergency treatment of heart attack.

2.1 On 11 June 2018, Phil, a man aged 61, went with friends for a road cycle ride through hilly terrain from his home to a remote village by the coast. The friends were planning to stay at a house which was undergoing renovation. One of the friends in the group was a retired GP. During the cycle ride, Phil had several incidences of shortness of breath. He assumed that he had indigestion and took anti-acid medication, which seemed to improve how he felt.

2.2 On 12 June 2018, Phil and his friends spent the day painting the house. The house did not have a landline telephone installed. Mobile telephone signal in the village was intermittent. That evening, the group went to the local pub for an evening meal. After returning from the pub, Phil went to bed at approximately 23:00 hours. He shared a room on the ground floor with a friend.

2.3 On 13 June 2018, at approximately 00:30 hours, Phil woke with chest pain and breathlessness. He assumed it was a further episode of indigestion and took an anti-acid medication to relieve the discomfort. After approximately 30 minutes, Phil was still experiencing chest pain and difficulty breathing and so he woke his roommate and asked them to wake the retired GP. The retired GP quickly recognised that the symptoms Phil was displaying suggested that he may have been having a heart attack.

2.4 While with Phil, the retired GP tried to call 999 on his mobile phone but had no mobile phone signal. He decided to take a five-minute walk up a hilly road to a high point to try and make the 999 call.

2.5 The retired GP made the first 999 call at 01:28 hours, but the call was cut off due to a poor mobile phone signal before he was able to explain the problem. Over the next two minutes, he tried to call 999 again and the Trust's emergency call handler tried to return the call three times to re-establish contact with the retired GP.

2.6 At 01:31 hours, the retired GP was able to communicate his message to the emergency call handler. A Category 2 (Cat2) response for chest pain was identified and an ambulance was requested. Once this category was assigned to the call, it was automatically passed to the dispatch team, which started to look for a vehicle to respond. The role of the dispatch team is to manage the allocation of resources to calls, and to manage calls waiting for a resource to be allocated (locally known as the 'waiting call stack').

2.7 There were several calls categorised as Cat2 in the waiting call stack at the time the retired GP rang for assistance and the dispatcher was unable to assign a vehicle to respond Phil immediately.

2.8 At 01:54 hours, the dispatcher referred the call to the clinical support desk (CSD) for assessment. The CSD is normally comprised of nurses and paramedics. They carry out a range of functions related to review of Category 1 and Category 2 calls, hear and treat (deal with calls by providing telephone advice), clinical safety management, and so on. A key function of the CSD is to assess calls that have been waiting for some time to provide advice and determine if a more or less urgent ambulance response should be provided. 2.9 Between 01:54 and 02:03 hours, the paramedic on duty in the CSD tried to contact the retired GP but was not able to reach him on the telephone. They left messages on his answer phone providing advice on what to do if Phil's condition deteriorated and to confirm that they would call again at 02:45 hours, and then every hour after that, until an ambulance arrived.

2.10 At 01:59 hours, the dispatcher was actively looking for a vehicle to respond to the call and was aware that one was due to become available after the crew completed a planned rest break. The vehicle was a rapid response vehicle (RRV). RRVs are generally cars or motorbikes (in this case a car) carrying a single paramedic and are not classed as vehicles that can take a patient to hospital. Therefore, the RRV would be unable to convey Phil to hospital. However, as the only ambulance resource available to assist at that time, the dispatcher allocated the RRV (identified by the call sign RRV 0420) to the call at 02:03 hours.

2.11 RRV 0420 was crewed by a single paramedic. They estimated that their time of arrival (ETA) at Phil's location would be 02:28 hours (25 minutes after they were allocated to the call), having travelled 20 miles over mostly minor and single-track roads.

2.12 While the paramedic was on the way to Phil's location, they made an Airwave [1] radio call to dispatch at 02:31 hours to ask whether they would be receiving back-up from a double-crewed ambulance (DCA). A DCA is an ambulance designed and equipped for the transport, basic treatment and monitoring of patients (NHS England and NHS Improvement, 2019). The paramedic identified that the symptoms that Phil was experiencing most likely indicated a heart attack and believed that Phil would need to be conveyed to hospital. The paramedic made the enquiry at this point because they knew the area where Phil was staying had poor mobile phone signal and reduced radio coverage/signal.

2.13 The dispatcher told the paramedic that once they had attended and assessed Phil, they could then request a priority one (P1) back-up (a request for the next available ambulance crew to respond to an urgent situation) from a DCA if one was needed, as current resource meant that a DCA was not immediately available and this would require a 'general broadcast' to request further assistance. A general broadcast is a radio broadcast sent to all ambulances on duty to request assistance, including ambulances that may show as unavailable or on scheduled breaks.

2.14 At 02:35 hours the paramedic arrived at Phil's location: 67 minutes after the initial 999 call was made. Approximately three minutes after arrival (02:38 hours), the paramedic had first contact with Phil. The paramedic carried out observations, took a history and undertook an electrocardiogram (ECG).

2.15 The paramedic interpreted the ECG and suspected an ST-elevation myocardial infarction (STEMI) (**see 1.2.1**). Phil reported that he was in pain and breathless, so the paramedic administered aspirin to reduce the formation of blood clots and glyceryl trinitrate (GTN) spray to relax and widen the blood vessels in Phil's heart and in the rest of his body. The paramedic also discussed Phil's symptoms with the retired GP and confirmed to the retired GP that Phil had suffered a heart attack. The paramedic did not have thrombolytic medication available on the RRV to consider providing thrombolysis at this point.

2.16 The paramedic was unable to contact dispatch via their Airwaves radio or mobile phone but was able to send a text message from their RRV Airwaves radio at 03:04 hours. The text read 'P1 BACK UP PLEASE CONFIRM MI [myocardial infarction]. no radio or phone signal'. As soon as this message was received the dispatcher made a general broadcast for assistance which was transmitted to all ambulance crews.

2.17 At 03:06 hours, a DCA (identified by the call sign DCA 0103) became available and was allocated to the call with an ETA of 38 minutes. At 03:07 hours, the dispatcher sent a text message to RRV 0420 to confirm receipt of RRV 0420's text message. The dispatcher's text message was received by the vehicle but was not passed from the vehicle's radio to the paramedic's handheld radio.

2.18 At 03:11 hours, another DCA (identified by the call sign DCA 0900) became available at a closer location and was allocated to the patient, and DCA 0103 was stood down. DCA 0900 had approximately 20 miles to travel to the patient over mostly minor and single-track roads.

2.19 Between 03:11 and 03:19 hours, four calls were made via 999 between the retired GP and emergency call handlers. These calls were conducted at the request of the paramedic, to confirm a DCA was on the way. During these calls, the emergency call handler was unable to let the retired GP know that an ambulance was on its way as the mobile phone signal was lost on all four occasions.

2.20 At 03:20 hours, the retired GP was able to establish that a DCA had been allocated and was on its way to Phil. Dispatch sent a further text to RRV 0420 at 03:21 hours to confirm that a DCA was on its way.

2.21 DCA 0900 arrived on the scene at 03:38 hours, 130 minutes after the initial 999 call was made. It was crewed by a paramedic and an emergency medical technician. Phil agreed that he would walk out to the ambulance as it was not possible to get the ambulance trolley into the house. He was escorted to the vehicle with instructions to stop if he started to feel unwell.

2.22 After a brief discussion between the RRV and DCA paramedic, the RRV paramedic used the ECG machine from the DCA to conduct a further ECG. As the RRV paramedic had been the primary carer for Phil during the response, it was decided that the paramedic should travel with Phil in the DCA until the ECG data could be transmitted and advice received from the on-call consultant cardiologist (heart specialist). The DCA technician would drive the RRV and follow the DCA. Like the RRV, the DCA did not carry thrombolytic medication.

2.23 At 03:54 hours, the DCA left the house. At 03:57 hours, once it had acquired a mobile phone signal, it was able to transmit the ECG data to the hospital. At 04:05 hours, the on-call consultant cardiologist reviewed the ECG data and confirmed that Phil was suitable for primary percutaneous coronary intervention (PPCI) (**see 1.2.1**). The cardiologist alerted the members of the on-call PPCI team and they started making their way to the hospital.

2.24 Once the RRV paramedic was content that ECG data had been transmitted and advice received from the PPCI team, they arranged for the DCA to stop at a local ambulance station on the way to the hospital so that they could transfer back to their RRV. This allowed the paramedic to become available for other tasks as required by the dispatch team.

2.25 At 04:39 hours, the DCA arrived at the local hospital and the DCA crew handed Phil's care over to the PPCI team. The PPCI procedure was undertaken at 05:20 hours, with two stents being inserted. The total call-to-balloon time, from when the retired GP was first able to relay information about Phil's condition to the emergency call handler at 01:31 hours to Phil's PPCI procedure at 05:20 hours, was 229 minutes.

2.26 An echocardiogram (a type of ultrasound scan used to look at the heart and nearby blood vessels) was later performed to check Phil's heart function and showed only a mild reduction in heart pump function. A pacemaker was inserted three days later to help correct further heart rhythm problems arising from the STEMI. Phil had two further stents inserted the following week and stayed in hospital for a total of nine days.

2.27 Over the following months, Phil was able to make some recovery from the STEMI, although he still has restrictions on his activities and ongoing medical needs.

Involvement of the Healthcare Safety Investigation Branch

This section outlines how HSIB was alerted to the issue of how ambulance delays can impact on emergency treatment of heart attack. It also shows how the issue met HSIB's investigation criteria, the scope of the investigation and the methods and evidence used.

3.1 Notification of reference event

3.1.1 HSIB received notification of a safety concern from Phil and his family via a safety awareness notification submitted through the HSIB website.

3.1.2 Phil had concerns about a delay in an ambulance attending him following a 999 call. He also had concerns that the attending paramedic crews did not have access to pre-hospital thrombolysis (medication that can help to break down blood clots) which is a potential treatment for patients who have suffered a heart attack.

3.2 Decision to investigate

3.2.1 HSIB conducted an initial scoping investigation which determined that the patient safety concern met the criteria for investigation (see below). HSIB's Chief Investigator authorised a national investigation.

Outcome impact – what was, or is, the impact of the safety issue on people and services across the healthcare system?

A person suffering from a heart attack (ST-elevation myocardial infarction (STEMI), **see 1.2.1**) requires a time-critical response to ensure they receive the most appropriate medical intervention. Any delay in responding to a patient, or in transporting them to hospital, increases the risk of the patient suffering additional harm. Timely recognition and treatment of STEMI increases the chances of recovery and can improve patient outcomes.

In 2018/19, 31,364 patients in the UK were diagnosed with STEMI (Myocardial Ischaemia National Audit Project, 2020), down from 35,740 patients in 2017/18 (Myocardial Ischaemia National Audit Project, 2019). However, there has been a decreasing ability for ambulance services to ensure that patients are transferred to a primary percutaneous coronary intervention (PPCI) centre and undergo PPCI (see 1.3.1) within timescales set out in national guidance (Myocardial Ischaemia National Audit Project, 2020).

The National Infarct Angioplasty Project (Department of Health, 2008) identified that there was an increase in the in-hospital mortality, 30-day mortality and one-year mortality for patients that encountered delays in receiving PPCI beyond 120 minutes from their call to emergency services. The British Cardiovascular Intervention Society audit (2018) shared data which suggested that for every 15-minute delay beyond target timescales in PPCI being provided there were 6.3 more deaths per 1,000 STEMI patients.

Systemic risk – how widespread and how common a safety issue is this across the healthcare system?

STEMI outcomes are a recognised quality indicator for ambulance trusts in England (NHS England and NHS Improvement, n.d.a).

In November 2019, the mean average time from a 999 call being made to a PPCI procedure being undertaken was 137 minutes (against the Myocardial Ischaemia National Audit Project standard of 150 minutes), with 10% of cases averaging at least 191 minutes. These are the longest times recorded since these measures were first collected in November 2017.

By February 2020, the mean average time from a 999 call being made to a PPCI procedure being undertaken had improved to 132 minutes, with 10% of cases averaging at least 179 minutes (NHS England and NHS Improvement, n.d.a). The investigation has used February 2020 as the latest data set to mitigate against any impact of the COVID-19 pandemic on the ability of the healthcare system to respond to these calls.

The period between a 999 call being made and a patient arriving at hospital has been identified as the primary factor impacting on the timeliness of PPCI being provided to patients (Myocardial Ischaemia National Audit Project, 2019; Myocardial Ischaemia National Audit Project, 2020).

Learning potential – what is the potential for an HSIB investigation to lead to positive changes and improvements to patient safety across the healthcare system?

An HSIB national investigation has the ability to consider the systemwide safety issues relating to the emergency response to heart attack and examine treatment options available for patients who have suffered a STEMI.

The investigation focused on ambulance transfer directly to PPCI centres. The National Infarct Angioplasty Project (Department of Health, 2008) acknowledges that additional delays may occur if patients are initially conveyed to a non-PPCI centre, before requiring transfer to a PPCI centre. However, these considerations were not within the remit of this investigation.

3.2.2 The national investigation considered:

- treatment options available for patients who have suffered a heart attack (specifically STEMI)
- the system-wide safety issues relating to the emergency response to heart attack.

3.2.3 In addition, the investigation sought to identify any other system-wide safety issues that may require further investigation by HSIB.

3.3 Investigation methodology

3.3.1 HSIB does not seek to apportion blame or liability in its investigations. It considers the healthcare system in its entirety to identify the factors that have contributed to the reference event.

3.3.2 The investigation was completed between June 2019 and December 2020. The COVID-19 pandemic, and the need for HSIB to refocus some operational work in this period, had an impact on the investigation.

3.3.3 The HSIB investigation team members were from a range of backgrounds including healthcare systems, engineering and human factors. The investigation also received specialist input from clinical and non-clinical subject matter advisors.

3.3.4 Phil and his wife were interviewed to establish their perspective on the reference event. The retired GP was also interviewed to establish their view on the reference event. The staff directly involved in the reference event and senior operational staff at the Trust were also interviewed.

3.3.5 Stakeholders across the healthcare system were identified to seek their perspective on the issue of emergency response to heart attack. These included:

- NHS England and NHS Improvement
- National Institute for Health and Care Excellence
- National Institute for Cardiovascular Outcomes Research
- Myocardial Ischaemia National Audit Project
- British Cardiovascular Intervention Society
- Association of Ambulance Chief Executives
- College of Paramedics
- a consultant paramedic
- a consultant cardiologist.

3.3.6 The investigation gathered and reviewed a range of evidence, including:

- Phil's clinical records
- the Trust's emergency call recordings and resource logs
- the Trust's policies, procedures and practice
- relevant incidents reported to two national databases of patient safety incidents: the NHS Strategic Executive Information System and the National Reporting and Learning System
- national guidelines and standards
- observation visits
- interviews
- literature relevant to the identified safety risks.

3.3.7 The evidence gathering process adopted an iterative approach; as further information was gained, additional sources were identified. The investigation gathered both interview and observational evidence from the healthcare settings visited.

3.3.8 The findings were shared with the stakeholders identified by the investigation. This enabled checking for factual accuracy and overall sense-checking. The stakeholders contributed to the development of the safety recommendations based on the evidence gathered.

4 Analysis and findings from the reference event

This section describes the investigation's findings in relation to the reference event. The findings are grouped according to key processes identified by the methods described in section 3:

- ambulance service response to the 999 call
- clinical review
- back-up request
- arrival at the scene and treatment
- transport to hospital.

4.1 Ambulance service response to the 999 call

Dispatching an ambulance resource

4.1.1 Once the retired GP was able to make contact, the emergency call handler used triage software to ascertain that Phil had “chest pain and shortness of breath” and was feeling sick. Based on the retired GP's responses to the call handler's questions, Phil was correctly categorised as requiring a Category 2 (Cat2) ambulance response in line with the Ambulance Response Programme (ARP) guidance (NHS England and NHS Improvement, 2018) (**see section 1.9**). A Cat2 response is an emergency response ‘where there are potentially serious conditions that may require rapid assessment and urgent on-scene intervention and/or urgent transport’ (NHS England and NHS Improvement, 2018).

4.1.2 The stated aim of the NHS England and NHS Improvement ARP is that the right vehicle is sent to the patient at the right time (NHS England and NHS Improvement, 2018). The response times required under the ARP are only met once a suitable vehicle is in attendance; the clock cannot be stopped by sending an inappropriate vehicle to an emergency call.

4.1.3 In this case, Phil had central chest pain and would most likely need to be transported to hospital. Therefore, the appropriate response to this call would have been to allocate a double crewed ambulance (DCA) which had the capability to assess Phil's condition and then convey him to hospital.

4.1.4 Following confirmation that a Cat2 ambulance response was needed, the call was routed to the dispatch team to begin to look for a suitable vehicle to respond. The investigation observed that the dispatch team is presented with call information on an electronic dispatch system in chronological order from when the call was categorised and in the order of category of response required. The dispatch team allocates resources based on this presentation of information; that is, they allocate resource to the next highest priority first, then to the call that has been waiting the longest.

4.1.5 On the night of the reference event, nine DCAs and three rapid response vehicles (RRVs) were on duty across the Trust's geographic area. This was an increase in one RRV from the planned ambulance resource that night. The Trust told the investigation that the level of planned ambulance resource was determined based on an assessment of anticipated activity that took into account a number of variables, including historical activity levels.

4.1.6 At the time the 999 call was made there were nine Cat2 calls in the 'waiting call stack' (see 2.6) either being responded to or awaiting a resource to be allocated. In addition, responses were being provided to a Category 3 call and a Category 4 call. Out of the nine calls in the Cat2 waiting call stack, four calls already had DCAs allocated to them and five were awaiting resource allocation (see table 1). This meant that there were more Cat2 calls than resources available to respond to them.

Table 1: Number of calls and status at the time of the 999 call

Category of call	Actively being responded to	Awaiting a response vehicle
Category 1	0	0
Category 2	9	5
Category 3	1	4
Category 4	1	1
Total	11	10

Figure 4: A rapid response vehicle (RRV) and a double-crewed ambulance (DCA)



4.1.7 On the evening of the reference event, due to high demand for Cat2 responses, it took 38 minutes for a dispatcher to be able to allocate an ambulance response to Phil's call. There was not a DCA available to respond to the chest pain call, so the dispatcher selected an RRV crewed by a single paramedic (see figure 4).

4.1.8 The ARP target timescales suggest that the mean response time for a Cat2 call is 18 minutes, with a 90th centile target of calls receiving a response within 40 minutes. At the time of the reference event, in June 2018, the Trust's reported actual mean timings for Cat2 response were 27 minutes and a 90th centile response of 56 minutes.

4.1.9 Trust staff told the investigation that the RRV did not routinely have the capability to convey patients to hospital and should only be considered as a means of transport where there were significant delays in providing care. However, the dispatch team made the decision to send a paramedic in an RRV to ensure that Phil was able to be seen by a clinician as soon as possible and so that, if required, any urgent life-saving treatment could begin.

4.1.10 The dispatcher allocated the RRV to Phil's call 35 minutes after the initial 999 call was received and 32 minutes from when the retired GP was able to pass on Phil's information. The time taken for the RRV to arrive at the scene was 67 minutes from the initial 999 call. As this was not a suitable vehicle to convey the patient to hospital, the clock continued to run on the ARP target time:

'For Category 2-4 calls there has also been a change in that reported times for transported patients reflect provision of a transporting vehicle not just first response. The objective of these changes was to make times for all calls more transparent including any waits for transporting vehicles.'

(NHS England and NHS Improvement, 2018)

4.1.11 The time taken for the DCA to arrive at the scene after the initial 999 call was 130 minutes, which is 90 minutes past the ARP 90th centile Cat2 target time. The DCA was a suitable vehicle to convey Phil to hospital and its arrival at the scene stopped the clock for the ARP response time.

4.1.12 As the ambulance response to Phil's call did not meet the mean or 90th centile ARP target times, it fell into the proportion of Cat2 ambulance responses that are not expected to meet target timescales.

4.2 Clinical review

4.2.1 Any call waiting longer than the 90th centile target (40 minutes) triggers an internal process at the Trust where the dispatch team passes the details of the call to a clinical support desk (CSD).

4.2.2 The CSD consists mainly of nurses and paramedics who are able to call patients/referrers back and carry out a more detailed triage to assess the patient's needs. Depending on the outcome of this triage, the CSD has the ability to upgrade the call to a higher category or downgrade to a lower category response as required.

4.2.3 Between 01:54 hours and 02:03 hours on the night of the reference event, the CSD attempted to contact the retired GP on a number of occasions but were not able to contact him. Because of this they could not make a decision about whether to change or maintain the current priority of the call. However, at 02:03 hours the RRV was allocated to respond to the Cat2 call and was en-route as an emergency response.

4.2.4 HSIB has previously made a safety recommendation to NHS England and NHS Improvement on the role of clinical staff assisting in emergency call handling in its investigation report, 'Potential under-recognised risk of harm from the use of propranolol' (Healthcare Safety Investigation Branch, 2020). A response to this safety recommendation by NHS England and NHS Improvement outlined that work is ongoing to develop a Clinical Oversight Framework for Emergency Operations Centres (HSIB, 2020).

4.3 Back-up request

4.3.1 While the RRV was driving to Phil's location, the paramedic on board made a call to the dispatch team to ask whether they would be receiving any back-up. The RRV paramedic told the investigation that when they were responding to the call, they had a strong suspicion that they were attending a patient who was having a heart attack. The paramedic knew the geographical area well and had experienced communication difficulties there in the past, so decided to make an early enquiry about suitable DCA back-up.

4.3.2 The dispatcher responded to the RRV paramedic's request by stating that they could not allocate back-up at that time and stated that the paramedic should instead request back-up again once they had attended the patient. This would then enable the dispatcher to make a general broadcast if required. The Trust's standard operating procedure relating to back-up states:

'Ambulance clinicians must confirm whether back-up is required on arrival at the incident.'

4.3.3 The Trust policy defines a 'Priority 1 (P1) back-up' as when a healthcare professional needs priority assistance from another resource. If an appropriate resource is not available, the dispatcher will make a general broadcast on the Airwaves system. This broadcast is sent to all Trust ambulance crews and asks for any crew to respond to the request for P1 back-up.

4.3.4 The Trust policy did not consider situations that may make this challenging, such as where there are known communication issues affecting specific areas. A proactive assessment of the potential impact and risks of this policy, prior to its implementation, could have helped to identify where complying with the policy could lead to unintended consequences, and could have assisted in mitigating against any potential communication issues. The investigation shared this finding with the Trust to ensure it could consider this issue. The investigation cannot determine whether an earlier request for priority back-up would have resulted in a DCA being allocated immediately or earlier than it ultimately was in this instance.

4.3.5 On arrival at the scene, the RRV paramedic was not able to make an audio call from his vehicle to the dispatcher but was able to send a text message to let them know that they had arrived with Phil. The paramedic had a handheld radio set and the vehicle had a radio set built in. The handheld set has a smaller power and reception capacity so in areas of reduced service it may not be possible to send and receive voice or text communications. The vehicle set had a greater range for receiving and transmitting voice and text messages.

4.3.6 Due to communication issues the RRV paramedic was not able to speak to the dispatcher and request a DCA P1 back-up from Phil's location once Phil had been assessed. Instead, the paramedic initially requested that the retired GP contact 999 and relay the same message so that the paramedic could stay with Phil.

However, the retired GP also had communication issues and was unable to relay this message. The paramedic then had to leave Phil and return to his vehicle where they were able to send a text message to request a P1 backup. The message said 'P1 BACK UP PLEASE. CONFIRMED MI [myocardial infarction]. no radio or phone signal'.

4.3.7 The message was seen and responded to by the dispatcher by making a general broadcast as no vehicles were available for dispatch. The dispatcher replied to the paramedic via text, but the paramedic's handheld set did not receive the message. The lack of information and knowledge that a P1 back-up was on its way created increased anxiety for the patient and retired GP.

4.3.8 The area in which the paramedic was operating was known to local crews to have a reduced radio and mobile phone signal. However, the Trust did not have a plan to manage this as it was understood by the operational management team that even if a voice message could not be sent, a text message would get through.

4.3.9 There is a facility within the radio system that allows the handheld set to be linked to the more powerful vehicle set. This means that if the handheld set is in range of the vehicle, any messages (either voice or text) will be sent through the vehicle's equipment, therefore increasing the probability that a message will be transmitted. The RRV paramedic and the crew of the DCA attending Phil told the investigation that they were aware of this facility. The investigation could not determine whether the RRV paramedic had linked his handheld set to the vehicle in this instance. The investigation shared its finding about linking radio systems with the Trust to enable it to take any necessary mitigating action.

4.3.10 The investigation did not consider any communication challenges in more detail as the Trust reported that these were very rare. In addition, there is currently an ongoing national programme to upgrade the emergency radio network available to ambulance services that seeks to address any remaining communication blackspots (Home Office, 2019).

4.3.11 Following the incident, Phil was keen to understand whether it was always the intention that a DCA would also attend the call, or whether it was the P1 back-up request that initiated a further request for a DCA resource to ensure that he could be transported to hospital. The investigation found no evidence that the Trust stopped actively looking for a DCA to attend Phil's call, despite an RRV being in attendance. However, there was no available DCA resource that could have been sent to Phil's location.

4.3.12 Once the paramedic confirmed that Phil had suffered a heart attack and that a P1 back-up was needed, the dispatcher was able to make a general broadcast to request assistance. This allowed a DCA to be identified and the dispatcher allocated it as a priority ahead of other calls waiting in the chronological waiting call stack. The distance that the DCA had to travel was not particularly far but the transit time was significant due to the rural location and need to use single-track country roads.

4.3.13 Staff told the investigation that they normally aimed P1 back-up calls at those crews who were just about to complete a response or those crews that were on a rest break. Crews that are on rest breaks are protected from being allocated to emergency calls but can choose to respond to P1 back-up requests.

4.3.14 Ambulance crews told the investigation that, in such circumstances, they are more likely to respond to a P1 backup call from a trusted colleague, rather than requests to become available for new calls, as they trust that a patient has received an initial medical review from a colleague and that further assistance is definitely required.

4.4 Arrival at the scene and treatment

4.4.1 When the RRV arrived at the scene the paramedic quickly carried out an electrocardiogram (ECG) and diagnosed that Phil had suffered an ST-elevation myocardial infarction (STEMI). The ECG machine that was carried on the RRV did not have a capability to transmit the ECG data to hospital. Machines carried by the RRV are not intended to transmit data as RRVs would not routinely be expected to transport patients to hospital. The Trust told the investigation that there was the ability for photos to be taken of the completed ECG and shared via the paramedic's portable electronic patient care reporting records. However, in this case due to the lack of mobile signal this was not possible.

4.4.2 When the DCA arrived, the RRV paramedic carried out a further ECG using the DCA's equipment. The DCA ECG equipment allows for ECG data to be transmitted to the on-call cardiologist to inform a decision on the appropriate treatment options for a patient while an ambulance is on its way to hospital.

4.4.3 The paramedic had arrived in an RRV, which was an estate car carrying a range of equipment. The Trust policy is that patients should not routinely be conveyed in a single-crewed RRV as the paramedic would be unable to care for the patient during the journey. The paramedic told the investigation that they considered whether it would be necessary to deviate from the policy; however, at that time Phil's condition appeared to be stable. The paramedic felt they would be better able to manage any deterioration in Phil's condition in the house rather than at the roadside on the way to hospital.

4.4.4 After carrying out the initial ECG, the RRV paramedic administered aspirin and glyceryl trinitrate (GTN) spray. The RRV paramedic told the investigation that they did not have any other medication or treatments available to them to provide to Phil in response to his STEMI. In the past, they had given thrombolytic medicine (see section 1.3) to patients having a heart attack when this was available to paramedics in the Trust.

4.4.5 The Trust decided in 2017 that it would no longer carry thrombolytic medicines routinely in DCAs and RRVs. This decision was based on several factors including a cost-benefit analysis, a lack of use of the medicine over several years, the benefit and risks of administration and the competence of crews to administer the medicine. The investigation's cardiology subject matter advisor also commented that thrombolysis carries risks of serious bleeding arising, due to the way it breaks down blood clots when it is administered. This in turn increases the bleeding risks associated with a primary percutaneous coronary intervention (PPCI) procedure.

4.4.6 The Trust identified that thrombolytic medicines cost £739.15 per vial and that to equip all its frontline ambulance resources with this medicine would cost approximately £454,000 per annum, based on having to stock 613 medicine bags with the medicine and associated stock.

The Trust identified that, even in the limited number of ambulances on which thrombolysis was carried, it had been required to destroy £8,869.80 of unused medication in 2018/19 due to the infrequency with which patients had required pre-hospital thrombolysis.

4.4.7 In line with guidance on the use of PPCI, the Trust conducted a review in 2016 to identify where thrombolytic medicine could be safely removed from ambulance resources. This identified that over 95% of potential patients were able to routinely access PPCI within 150 minutes of a call to emergency services. In addition, the Trust was only able to identify two instances between 2014 and 2016 where thrombolysis was required in line with National Institute for Health and Care Excellence (NICE) guidance (2013).

4.4.8 It was not possible for some patients to access PPCI within guidance timescales in specific, remote geographical regions of the Trust. Where this was the case, the Trust explained that all patients were within a two-hour travel time from the nearest emergency department where thrombolytic medication could be provided. As a further precaution, the Trust had retained thrombolytic medicine for use in two remote areas of the Trust where there may routinely be delays in accessing appropriate treatment, and for use by the air ambulance.

4.4.9 In the reference event, two specialist RRVs that carried thrombolytic medicine in the remote areas of the Trust were not close enough to respond to Phil's call. The air ambulance (which is not funded by the NHS and is operated by a charitable organisation) did not fly after 02:00 hours. Therefore it could not be dispatched to Phil at the point it became clear that he would encounter significant delay in an appropriate ambulance resource being available.

4.4.10 In response to the incident, the Trust reviewed the frequency with which it may have been required to provide thrombolysis where delays in an ambulance response meant that a patient who should have been able to access PPCI within the timescale set out in NICE guidance failed to do so.

4.4.11 During the six-month period from July to December 2018, the Trust identified that it had dealt with 984 cases of suspected heart attack. Of those cases, eight patients (0.8%) had met the Trust's criteria for pre-hospital thrombolysis to be provided based on delays in accessing PPCI treatment and patient suitability for thrombolysis.

4.4.12 The investigation spoke to ambulance crews about thrombolysis and took their view on whether this medication should be carried. The RRV paramedic in the reference event had a special interest and experience in cardiac conditions and recounted that in 17 years of service they had administered thrombolysis treatment on eight occasions. Given their further training in cardiac care, including postgraduate qualifications, they felt confident in administering thrombolysis if required.

4.4.13 Other crews explained that, even when thrombolysis had been carried by ambulances, it was rare for it to have been administered. This was because crews considered it safer to transport patients to hospital before any medication was given, owing to the known complications that could arise in providing thrombolysis.

4.4.14 Due to the relative rarity with which thrombolysis had been given previously, or may be required under current guidance, there were concerns among ambulance crews about their ability to maintain a sufficient level of competency to safely administer thrombolysis.

4.4.15 The investigation's cardiac subject matter adviser also noted that, at the time Phil underwent PPCI, the blood vessel seen to be the cause of the heart attack was not completely blocked. Although the blood vessel was severely narrowed, it was likely to have opened spontaneously at some point after the heart attack and before arrival at hospital. This may have meant that thrombolysis treatment was not indicated.

4.5 Transport to hospital

4.5.1 The investigation was told that it was decided that the RRV paramedic should ride in the ambulance with Phil alongside the ambulance paramedic. This was to ensure that the most experienced staff with knowledge of cardiac conditions were able to travel with Phil until the point that the ECG data could be transmitted to the local hospital and further advice taken from the PPCI team. To ensure that no ambulance resource was left at the scene unnecessarily, the DCA ambulance technician drove the RRV.

4.5.2 The investigation found that ensuring the paramedic with the most relevant clinical experience was able to care for the patient in transit represented an adaptive and responsive approach to managing the clinical risk. This approach also allowed the ambulance crews to mitigate their lack of access to further advice and support from the on-call cardiology team while they were at the scene, caused by the reception issues they encountered. It also helped to ensure that the RRV was available to respond to further calls as soon as possible.

5 Analysis and findings from the wider investigation

This section sets out the findings of the investigation's analysis of emergency response and treatment for heart attack in the context of the wider healthcare system. This element of the investigation considered national policy and guidance and the regulations that govern this aspect of medical care. The findings are presented within the following themes:

- performance against current guidance impact of delays in receiving primary percutaneous coronary intervention (PPCI)

- the MINAP metric
- thrombolysis for ST-elevated myocardial infarction (STEMI)
- PPCI versus thrombolysis for delayed STEMI treatment
- paramedic competence to administer thrombolysis
- ambulance response times.

5.1 Performance against current guidance

5.1.1 PPCI is the preferred treatment option in the NHS for patients that have suffered an STEMI and who present to hospital within the appropriate target timescales (National Institute for Health and Care Excellence, 2020).

5.1.2 The National Infarct Angioplasty Project (NIAP) (Department of Health, 2008) estimated that it should be possible to provide PPCI within acceptable treatment times to approximately 95% of the population in England and Wales.

5.1.3 By 2018/19, there were 85 NHS hospitals in England (and a total of 118 NHS and private hospitals throughout the UK) where PPCI could be provided (see figure 5).

Figure 5: Location of PPCI centres in the UK (British Cardiovascular Intervention Society, 2019)



5.1.4 The Myocardial Infarction National Audit Project (MINAP) report (2020) identified that the median call-to-balloon time (see 1.6.2) in England has increased each year from 117 minutes in 2015/16 to 125 minutes in 2018/19.

5.1.5 In 2018/19, 31% of patients with STEMI did not receive PPCI within 150 minutes of their call for help (The Myocardial Infarction National Audit Project, 2020). The percentage of cases that have not met the 150-minute treatment time has increased year on year since 2015/16 when 25% of patients failed to receive PPCI within the 150-minute target.

5.1.6 MINAP identified that there had been only minimal changes in the door-to-balloon time (see 1.6.2) once a patient arrived at hospital (The Myocardial Infarction National Audit Project, 2020). It considered that the increase in call-to-balloon time was caused by an increase in call-to-door times for an ambulance response. Although not reported as a formal target, MINAP identified that the average call-to-door time in 2018/19 was 77 minutes and has increased year on year since 2013/14 when it was 64 minutes.

5.1.7 The time taken to respond to emergency calls that are confirmed to be STEMI are also a quality indicator for ambulance services. In England in November 2019, the mean average time from an emergency call being made to angiography being carried out to determine if PPCI is required (the 'call to PPCI' time) was 137 minutes, with 10% of cases averaging at least 191 minutes. These are the longest times recorded since these measures were first collected in November 2017 (NHS England and NHS Improvement, n.d.a).

5.1.8 By February 2020, the mean average time from a call to PPCI had improved to 132 minutes, with 10% of cases averaging at least 179 minutes (NHS England and NHS Improvement, n.d.a). The investigation has used February 2020 as the latest data set to mitigate against any impact of the COVID-19 pandemic on the healthcare system's ability to respond to these calls.

5.1.9 This means that the average time from call to PPCI has been within the 150-minute MINAP target. However, this data shows that a significant proportion of patients are waiting longer than 150 minutes to receive PPCI from the time of their call.

5.2 Impact of delays in receiving PPCI

5.2.1 NIAP (Department of Health, 2008) identified that there was an increase in the in-hospital mortality, 30-day mortality and one-year mortality for patients who encountered delays in receiving PPCI beyond 120 minutes from their call to emergency services.

5.2.2 Patients who encountered up to 60-minute delays in PPCI had an increased risk of in-hospital mortality (4.5% compared with 2.7%), 30-day mortality (4.9% compared with 2.9%), and one-year mortality (8.7% compared with 5.1%). Patients who encountered a delay in receiving PPCI of more than 60 minutes had a much greater risk of in-hospital mortality (11.4% compared with 2.7%), 30-day mortality (12.2% compared with 2.9%), and one-year mortality (15.9% compared with 5.1%).

5.2.3 The British Cardiovascular Intervention Society audit (2018) shared data which suggested that for every 15-minute delay beyond target timescales in PPCI being provided there were 6.3 more deaths per 1,000 STEMI patients.

5.2.4 Considering the ambulance response statistics for STEMI (see 5.1.7 and 5.1.8), there may be a risk of increased patient mortality owing to the increasing delays encountered by patients waiting for an ambulance response and transport.

5.2.5 In addition to any excess deaths that may be caused by a delay in accessing PPCI, a delay in accessing appropriate treatment for STEMI may have further short-term and long-term impacts on patient health. This is because of the increased damage to the heart caused by delays in PPCI being provided. The health impacts may include lengthened rehabilitation periods following a STEMI, longer-term medical interventions, or earlier death.

5.2.6 Since the NIAP report (Department of Health, 2008), the investigation could not identify any available national data to confirm the longer-term impact on patient mortality and morbidity (ill health), and the wider impact on the healthcare system, of increasing delays in accessing PPCI treatment following STEMI.

5.2.7 Without additional insight into the impact on patient outcomes and NHS resources, the NHS cannot currently be assured that delays in accessing PPCI have been fully considered in light of the challenges faced in providing a timely ambulance response (see section 5.7).

HSIB makes the following safety observation

Safety observation O/2021/103:

It may be beneficial if further work was conducted to identify the impact of delays in primary percutaneous coronary intervention on the morbidity of patients, and longer-term mortality of patients, suffering from ST-elevation myocardial infarction.

5.2.8 The investigation acknowledges the significant challenges faced by the Ambulance Response Programme (ARP) in ensuring that ambulance resource can be correctly allocated and provided to emergency calls that are received by ambulance services.

5.2.9 Chest pain calls, such as the call made in the reference event, are routinely triaged in line with the ARP as Category 2 (Cat2) calls (**see 1.9.2**). The nature of chest pain symptoms means it is challenging within NHS triage systems to differentiate between calls triaged as chest pain that may relate to non-life-threatening conditions (such as indigestion) and calls that may relate to STEMI. It is only possible to diagnose STEMI once a clinician has attended a patient and performed an electrocardiogram (ECG).

5.2.10 Intelligent analytics (machine learning to help better analyse and act information given by callers) has begun to be adopted to assist in understanding more about calls made to emergency services and to help analyse and consider where ambulance responses may be more targeted. The future development and integration of enhanced intelligent analytics into triage software may further assist in helping to identify the most potentially serious calls, where STEMI may be indicated, and assist in a more targeted response to ambulance allocation. In addition, further oversight and integration of clinical support in emergency call centres (see 4.2.4) may assist in this goal.

HSIB makes the following safety observation

Safety observation O/2021/101:

It may be beneficial if NHS emergency call handling triage systems consider how intelligent analytics or increased clinical oversight may be enhanced to assist in the early identification of ST-elevation myocardial infarction calls.

5.3 Current target timescales

5.3.1 Prior to the implementation of the ARP, ambulance performance was measured using two response time targets (NHS Providers, 2019):

- 75% of Category A (immediately life-threatening) calls should receive a response within eight minutes
- if a Category A patient requires transport, this should arrive within 19 minutes of the request for transport being made, 95% of the time.

5.3.2 From June 2013, the former Category A was further separated into Red 1 and Red 2 calls:

- Red 1 calls were the most time critical and covered heart attack patients who were not breathing and did not have a pulse, and other severe conditions.
- Red 2 calls were serious but less immediately time critical and covered conditions such as stroke and fits.

5.3.3 The 150-minute target time on which MINAP collects data is designed to account for a 30-minute response time by emergency services following an emergency call, in which they could respond to a patient and diagnose any suspected STEMI, to allow thrombolysis to begin. It then allows for 120 minutes for transport to hospital and for PPCI to take place, in line with national guidance (National Institute for Health and Care Excellence, 2020).

5.3.4 NIAP (Department of Health, 2008) did not include this 30-minute response element when determining that PPCI was most effective when provided within 120 minutes of a call for help. MINAP told the investigation that the 30-minute timescale had been developed in response to NIAP report data on the average times seen for patients to access thrombolysis (Department of Health, 2008). This was intended to be a pragmatic target to reflect the average times in which patients may expect to receive thrombolysis based on an understanding of the ambulance response and availability of thrombolysis at that time.

5.3.5 Under the old call system, suspected heart attack or chest pain would be categorised as a 'red' call that required an ambulance response within eight minutes in 75% of cases. Following the introduction of the ARP, the same suspected heart attack or chest pain calls would now routinely be responded to as a Cat2 call. This means that the mean time for an ambulance to respond is now 18 minutes, with 90th centile of calls being responded to within 40 minutes.

5.3.6 Ambulance response data from February 2020 (NHS England and NHS Improvement, n.d.a) showed that the mean average response time for an ambulance to a Cat2 call was 21 minutes. Response times may also vary depending on seasonal demands; for example, the mean average response time in December 2019 was 28 minutes. In addition, there may now be limits in the number of ambulance services that carry thrombolytic medication (**see section 5.4**) and that would be able to begin thrombolysis as an alternative to PPCI.

5.3.7 Considering the re-categorisation of chest pain calls when the ARP was implemented, and the change in the provision of thrombolysis, current data MINAP is asked to collect may not reflect current practice and challenges in ensuring PPCI can be provided in a timely way.

5.3.8 There is no current 'maximum acceptable' call-to-door time and MINAP have identified (MINAP, 2020) that there is likely to be a 'trade-off' between the benefit of meticulous prehospital assessment and care and the potential detriment of consequent delays to hospital admission. However, delays in call-to-door response have a significant impact on the ability for door-to-balloon times, and the overall call-to-balloon time target, to be met.

5.3.9 In England, NHS England and NHS Improvement primarily funds the National Institute for Cardiovascular Outcomes Research to provide the MINAP audit in England. A review of the metrics MINAP is asked to report on is now required to clarify the various parts of the 150-minute target and consider the impact of increasing delays in PPCI treatment being provided.

5.3.10 Proposals for the transformation of urgent and emergency care put forward by NHS England and NHS Improvement include the development of critical time standards to improve the quality of care for life-threatening conditions, with the aim of saving more lives and reducing avoidable deaths (NHS England and NHS Improvement, 2020).

5.3.11 Currently, the wider transformation project references optimising performance in the ambulance service. The critical time standards are currently more narrowly focused on evidence-based clinical interventions that should be commenced within one hour of a patient's arrival in an acute hospital, including treatment for STEMI. Adopting a broader consideration of ambulance response to STEMI as part of the critical time standards work would assist in developing a more holistic view of STEMI treatment and aid in the response to issues identified within this report. This would help ensuring both pre-hospital (call-to-door) and in hospital (door-to-balloon) were considered together to identify improvements across the care pathway.

HSIB makes the following safety recommendation

Safety recommendation R/2021/117:

HSIB recommends that NHS England and NHS Improvement revise the Ambulance Clinical Quality Indicator: Clinical Outcomes for ST-elevation myocardial infarction to reflect each element of the call to balloon response and review this indicator alongside the critical time standards workstream.

5.4 Thrombolysis for STEMI

5.4.1 Where a delayed ambulance response occurs, guidance suggests that there is an alternative treatment option to PPCI. Both NICE (2020) and European Society of Cardiology (2017) guidelines suggest that thrombolysis should be considered as a treatment option where PPCI cannot be provided within 120 minutes of a STEMI diagnosis being confirmed by a clinician. This is the practical point from which thrombolysis could be provided following diagnosis of STEMI.

5.4.2 Guidance by the Joint Royal Colleges Ambulance Liaison Committee (JRCALC) (2019), the organisation that provides clinical oversight and advice to UK ambulance services, also advises ambulance paramedics that thrombolysis is a treatment option that should be considered where a patient is unable to access PPCI within target timescales.

5.4.3 Given the increasing delays in PPCI being accessed an increase in the use of thrombolysis may be expected, in line with national guidance. However, MINAP (2020) identifies that in 2018/19 only 118 patients received thrombolysis (0.38%), compared with 142 in 2017/18 (0.4%) and 301 (0.9%) in 2016/17.

5.4.4 Other European countries have developed different models of care where fewer PPCI centres may be available and more routine use of thrombolysis may be required. However, in the UK, the move toward PPCI as the preferred treatment option for STEMI has led to a significant reduction in the number of patients with STEMI being treated with thrombolysis.

5.4.5 The investigation found that a majority of ambulance services have now completely removed thrombolysis medication from their ambulances. With the assistance of the Association of Ambulance Chief Executives, the investigation established that 6 of the 10 English ambulance services no longer reported carrying thrombolytic medicine. The remaining four ambulance services retained thrombolytic medicine only in rural areas where patients may not be able to routinely access a PPCI centre within target timescales and where specialist paramedics were tasked with administering thrombolysis.

5.4.6 HSIB's investigation of the reference event reflected some considerations about the decision to withdraw thrombolysis treatment from ambulances, highlighting the potential cost of the treatment and the relatively low frequency with which it may be required. In addition, the investigation spoke with a number of clinical staff who expressed concerns about the use of thrombolysis in pre-hospital practice, owing to the number of contraindications and complications that may arise from its use.

5.4.7 In practice, this means that currently the alternative treatment method suggested by NICE and JRCALC is not routinely available to treat patients who are not able to be transported to hospital within the 120-minute target timeframe from diagnosis of STEMI.

5.4.8 This absence of an alternative treatment option for patients who may face a delay in accessing PPCI places an increased emphasis on the need to ensure patients are transported to hospital as soon as possible to receive timely PPCI.

5.5 PPCI versus thrombolysis for delayed STEMI treatment

5.5.1 The investigation considered whether an increase in the use thrombolytic medicine by ambulance services would assist in mitigating any potential impact of delays in call-to-door times (see 1.6.3) and STEMI patients accessing PPCI.

5.5.2 NICE told the investigation that it was unable to identify any academic studies that were specifically designed to determine the impact of any PPCI-related time delay, where the relative benefits of delayed PPCI were considered against the potential benefits of thrombolysis.

5.5.3 Instead, NICE guidance has accounted for studies related to the association between time delays in providing PPCI and patient outcomes. These studies supported favouring PPCI over thrombolysis for PPCI-related time delays of up to two hours. Importantly, none of the studies identified by NICE provided any evidence to consider the impact of PPCI-related time delays beyond two hours on the relative benefit of PPCI versus thrombolysis.

5.5.4 This means that there is no specific evidential basis on which to understand at what point beyond the 120-minute limit referred to in guidance that thrombolysis becomes a better option than PPCI.

5.5.5 The European Society of Cardiology guidance (2017) also cautions that 'the extent to which any PPCI-related time delay diminishes the advantages of PPCI over [thrombolysis] has been widely debated. Because no specifically designed study has addressed this issue, caution is needed when interpreting available data from post hoc analyses'. The Society recognises the lack of contemporaneous data and evidence to support a specific time limit to choose thrombolysis over PPCI.

5.5.6 NIAP (Department of Health, 2008) identified that mortality rates for patients receiving thrombolysis rather than PPCI were greater at 30 days (7.9% compared with 5.6%), one year (12.4% compared with 8.7%) and 18 months (14.8% compared with 9.9%) following admission. However, NIAP stressed that this data may not be directly comparable, and its purpose was not to compare the relative impact of each treatment on mortality.

5.5.7 There is a need to ensure that patients reporting symptoms of chest pain are responded to as an emergency, due to the time-critical nature of treatment and the potential need for life support efforts. However, the lack of academic studies or recent evidence makes it challenging to consider whether the current timescale in which PPCI is seen as more beneficial than thrombolysis in treating STEMI can be accurately assessed.

5.5.8 NICE (2020; 2013) identified as a research priority the need to consider whether the outcomes of patients who had suffered a delay of between 120 and 180 minutes in receiving PPCI were similar, better, or worse than had they been provided with pre-hospital thrombolysis. To date, the investigation cannot identify whether any such further research has been conducted in this area.

5.5.9 Further evidence would give the NHS a greater insight into the relative benefits of PPCI over thrombolysis. It would also help the NHS to consider in more detail the relevant timescales in which PPCI may still be more effective and inform decisions on the use of thrombolysis in practice.

5.5.10 The investigation acknowledges that ethical considerations may make it difficult to conduct such research. However, without further evidence it may not be possible to update current guidance based on evidence and the question regarding the relative value of PPCI versus thrombolysis at different time intervals will remain.

5.6 Paramedic competence to administer thrombolysis

5.6.1 The investigation found that there are currently limited circumstances in which ambulance crews may provide thrombolysis for STEMI. This is in part due to the limited use of thrombolysis in responding to STEMI and the decision by ambulance services to remove thrombolytic medicine from many frontline ambulances.

5.6.2 The College of Paramedics stated that the level of detail in which thrombolysis is addressed may vary between paramedic training courses provided by different higher education institutions. As part of the investigation, the College of Paramedics asked for details of how thrombolysis was taught in 44 relevant courses provided across 12 higher education providers. This identified that only six courses included relevant teaching about thrombolysis.

5.6.3 The College identified that thrombolysis training may instead be provided only in professional practice by ambulance trusts, although, given the limited number of trusts carrying thrombolysis, this may be challenging to achieve. The investigation understands that the College of Paramedics is currently engaging with Health Education England to undertake a review of paramedic training and that the teaching of thrombolysis will be considered as part of this work.

5.6.4 The College of Paramedics also told the investigation that thrombolysis is rarely given by paramedics and it would be very challenging for paramedics to maintain their scope of practice in this area. Considered in the context of the 2019 MINAP report data, there were 27,210 paramedics registered with the Health and Care Professions Council (HCPC) in 2018 with only 142 patients receiving thrombolysis during 2017/18.

5.6.5 The HCPC, which regulates paramedics, sets out standards of performance, conduct and ethics which state:

‘You must keep within your scope of practice by only practising in the areas you have appropriate knowledge, skills and experience for.’

(Health and Care Professional Council, 2016)

5.6.6 Given increases in the time taken for STEMI patients to receive PPCI, it could be expected that an increase in the use of thrombolysis may follow if it is not possible for ambulance services to guarantee that timescales for STEMI treatment can be met.

5.6.7 Should action be taken to increase the use of thrombolysis in light of increased delays to STEMI, there is a risk that paramedics who may be required to administer thrombolysis will have become de-skilled and may not have relevant and current experience in administering thrombolysis. This would pose a risk to patients and NHS staff.

5.6.8 The investigation engaged with the Association of Ambulance Chief Executives and the College of Paramedics to consider whether a consensus statement on the use of thrombolysis would assist in ensuring there was clarity about what may be required for paramedics to be deemed competent to administer thrombolysis. This may help mitigate the potential impact of any increased use of thrombolysis, and ensure safe practice is clearly articulated for paramedics in more rural areas who may already be required to provide thrombolysis.

5.6.9 By way of an analogy, the College provided the investigation with its consensus statement on intubation (the insertion of a tube into a patient's airway to support their breathing) (College of Paramedics, 2018). This is an area in which the value of the intervention has been questioned when performed by practitioners without extensive training and with relatively limited experience of the procedure. In this case, it was deemed necessary for paramedics to undertake 60 supervised intubations before being deemed competent. They are also required to undertake two intubations per month in practice and undergo annual refresher training.

5.6.10 The Association of Ambulance Chief Executives told the investigation that a clinical decision about the benefits and risks of the appropriateness and timeliness of thrombolysis treatment is difficult for a paramedic to make and may require additional cardiology advice. There are significant risks in using thrombolysis and the Association also reflected that the consent process is also crucial, to ensure the patient understands the risks versus benefits of thrombolysis.

5.6.11 The additional concerns identified by the investigation about paramedic competence means that a position statement would help to further highlight potential safety issues to paramedic staff and provide additional guidance on professional competence.

HSIB makes the following safety recommendation

Safety recommendation R/2021/118:

HSIB recommends that the Association of Ambulance Chief Executives, working with the College of Paramedics and cardiology specialists, produces a position statement on the use of pre-hospital thrombolysis by paramedics.

HSIB makes the following safety observation

Safety observation O/2021/102:

It may be beneficial if current guidance on the use of thrombolysis as an alternative to primary percutaneous coronary intervention in England is reviewed to consider the challenges posed in safely administering thrombolysis in the pre-hospital setting.

5.7 Ambulance response times

5.7.1 Given the limitations in providing thrombolysis identified by the investigation, there is presently an increased focus on the need for patients to be transported to PPCI centres as soon as possible following their call for help and within target timescales.

5.7.2 Although the investigation focused primarily on the emergency treatment options for heart attack, it is necessary to provide additional comment on the ambulance system in order to put this investigation into context.

5.7.3 The investigation has engaged with a number of stakeholders within the emergency and urgent care sector and reviewed other HSIB national investigation reports. HSIB has learnt that there are a variety of factors that may be impacting on ambulance services' ability to respond to patient calls within target timescales. Examples of factors that have been reported to influence response times include:

- calls that ultimately do not require a patient to be transported to hospital (O'Cathain et al, 2018)
- handover delays at hospitals (Nuffield Trust, 2020a)
- **transfers between hospitals** (Healthcare Safety Investigation Branch, 2019)
- **ambulance service capacity to deal with Cat2 call volumes** (Healthcare Safety Investigation Branch, 2020)
- **variation in ambulance service response to calls** (Healthcare Safety Investigation Branch, 2020)

- perception of emergency response categorisation by triage tools (Phillips, 2020; McKew, 2017)
- decisions on whether to access primary care services (Booker et al, 2019)
- the ability to re-categorise calls passed from NHS 111 (Phillips, 2020).

5.7.4 The examples provided demonstrate the complexity involved in considering why it may be challenging for ambulance services to routinely respond to patient calls within ARP target timescales. These challenges go beyond ambulance services' ability to respond to emergency calls for chest pain and impact on ambulance services' ability to respond to any calls made to the service.

5.7.5 The increase in the mean average response time for Cat2 calls reflects growing demands on the ambulance service. The Nuffield Trust (2020b) identified that 'since the Category 2 targets were introduced in April 2018, both the average and 90th centile response time targets have never been met. Response times have fluctuated but worsened overall'.

5.7.6 The investigation was told by healthcare system leaders that any changes to the current ARP categorisation system would require complex considerations. The ARP target timescales were developed after significant research and testing (NHS England and NHS Improvement, 2018) and are designed to make the best use of the available ambulance resource in the NHS.

5.7.7 In the context of the investigation, if a response to chest pain calls was upgraded to a Category 1 response to account for STEMI, this would impact on responses to other conditions. A Category 1 response would be disproportionate for non-life-threatening chest pain calls (for example, indigestion) and would mean fewer ambulance resources would be available to attend Cat2 calls that could involve a response to a life-threatening situation (for example, stroke).

5.7.8 Any consideration about the categorisation within ARP would require additional evidence to consider the impact of the categorisation on STEMI outcomes and potential to identify STEMI calls at the point of triage. Any considerations that did not only impact on the response to STEMI calls would require a much broader consideration of the ARP system and how it may be operating in response to the increased challenges faced by ambulance services.

5.7.9 The importance of timely transport for STEMI patients has been emphasised within this investigation in light of the potential impact on patient outcomes and the lack of alternative treatment options in many ambulance services. If Cat2 response targets are met, an increased majority of patients should be able to access PPCI within target timescales and benefit from better outcomes.

5.7.10 To consider the various factors that impact on the ability of ambulance services to respond to calls within ARP target timescales would require a greater system-level consideration of the significant factors that interact to impact on the efficiency of the ambulance service within the current available resource.

5.7.11 The NHS England and NHS Improvement Joint Ambulance Improvement Program works with key stakeholders to take responsibility for management of national work to develop the ambulance service. The Program would be an appropriate forum for further work to take place to identify where challenges to efficiency exist and how a systems approach could be taken to help support ambulance services in achieving the ARP response-time targets.

HSIB makes the following safety recommendation

Safety recommendation R/2021/119:

HSIB recommends that NHS England and NHS Improvement support the Joint Ambulance Improvement Programme to respond to emerging risks and research highlighting factors impacting on effective ambulance response.

6 Summary of HSIB findings, safety recommendations and safety observations

6.1 Findings

- There are increasing delays in ambulance responses to chest pain calls.
- PPCI is the preferred treatment option for STEMI where patients can present to hospital within 12 hours of the onset of their symptoms, and where PPCI can be given within 120 minutes of the time when a STEMI is diagnosed.
- Where patients may have suffered a STEMI, ambulance delays can impact on the ability to provide PPCI within target timescales.
- Delays in receiving PPCI can increase the risk of in-hospital and 30-day patient mortality.
- There is a lack of evidence to show the impact on death rates in the longer term beyond 30 days, the effect on patients' health in the longer term, and the impact on NHS resources stemming from delays in patients receiving PPCI.
- National and professional guidance recommends thrombolysis as an alternative treatment for STEMI where PPCI cannot be provided within target timescales.

- There is a lack of evidence to support which treatment option is best in treating STEMI where patients encounter delays: PPCI delayed beyond the target timescale of 120 minutes from a STEMI diagnosis, or thrombolysis provided after 120 minutes of a STEMI diagnosis.
- Thrombolysis is now rarely used within the NHS for pre-hospital STEMI treatment.
- Thrombolysis medication is no longer carried by 6 of the 10 English ambulance services.
- In four ambulance services, thrombolysis medication is only retained in more rural areas where patients may routinely be unable to access PPCI within target timescales or where it is administered by specialist paramedics.
- Paramedic staff may not be competent to administer thrombolysis medication due to the limited circumstances in which this is now required.
- The withdrawal of thrombolysis as an alternative treatment, and lack of competence of paramedics to administer thrombolysis, places greater emphasis on the need to ensure STEMI patients present to hospital as soon as possible for PPCI.

HSIB makes the following safety recommendations

Safety recommendation R/2021/117:

HSIB recommends that NHS England and NHS Improvement revise the Ambulance Clinical Quality Indicator: Clinical Outcomes for ST-elevation myocardial infarction to reflect each element of the call to balloon response and review this indicator alongside the critical time standards workstream.

Safety recommendation R/2021/118:

HSIB recommends that the Association of Ambulance Chief Executives, working with the College of Paramedics and cardiology specialists, produces a position statement on the use of pre-hospital thrombolysis by paramedics.

Safety recommendation R/2021/119:

HSIB recommends that NHS England and NHS Improvement support the Joint Ambulance Improvement Programme to respond to emerging risks and research highlighting factors impacting on effective ambulance response.

HSIB makes the following safety observations

Safety observation O/2021/101:

It may be beneficial if NHS emergency call handling triage systems consider how intelligent analytics or increased clinical oversight may be enhanced to assist in the early identification of ST-elevation myocardial infarction calls.

Safety observation O/2021/102:

It may be beneficial if current guidance on the use of thrombolysis as an alternative to primary percutaneous coronary intervention in England is reviewed to consider the challenges posed in safely administering thrombolysis in the pre-hospital setting.

Safety observation O/2021/103:

It may be beneficial if further work was conducted to identify the impact of delays in primary percutaneous coronary intervention on the morbidity of patients, and longer-term mortality of patients, suffering from ST-elevation myocardial infarction.

7 Endnotes

[1] The Airwave radio system is the current communications system in use by all emergency services in Great Britain, covering 99% of the landmass in England, Scotland and Wales.

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