Health Services Safety Investigations Body

Investigation report

Maternity pre-arrival instructions by 999 call handlers

Date Published:
17/02/2022

Theme:
Maternity,Emergency care

Contents

Considerations in light of coronavirus (COVID-19)

A number of national investigations were in progress when the COVID-19 pandemic significantly affected the UK in 2020. Much of the work associated with developing the investigation reports necessarily ceased as HSIB's response was redirected.

For this national report, while the learning described has not changed due to COVID-19, the processes HSIB used to engage with staff had to be adapted. This included fewer face-to-face interviews and interactions and an increased use of virtual interviewing. Owing to the nature of this investigation there was no need to visit clinical areas to observe work in practice.

A note of acknowledgement

We are grateful to the family whose experience is central to this investigation. In accordance with their wishes, the mother is referred to by her name, Amy, the father is referred to by his name, Jeremy, and their son is referred to by his name, Benjamin. The information Amy and Jeremy shared helped to inform the investigation and provided invaluable insight into the impact of such incidents. Amy and Jeremy hope that their story might help to promote change.

We also thank the NHS staff and subject matter advisors who gave their time to provide information and expertise which contributed towards this report, and the stakeholder organisations and professional bodies that have supported the investigation.

About this report

This report is intended for healthcare organisations, policymakers and the public to help improve patient safety in relation to the instructions 999 call handlers give to women and pregnant people who are waiting for an ambulance because of an issue with their pregnancy. For readers less familiar with this area of healthcare, terms are explained in section 1.

Our investigations

Our investigators and analysts have diverse experience of healthcare and other safety-critical industries and are trained in human factors and safety science. We consult widely in England and internationally to ensure that our work is informed by appropriate clinical and other relevant expertise.

We undertake patient safety investigations through two programmes:

National investigations

Concerns about patient safety in any area of NHS-funded healthcare in England can be referred to us by any person, group or organisation. We review these concerns against our investigation criteria to decide whether to conduct a national investigation. National investigation reports are published on our website and

include safety recommendations for specific organisations. These organisations are requested to respond to our safety recommendations within 90 days, and we publish their responses on our **website.**

Maternity investigations

We investigate incidents in NHS maternity services that meet criteria set out within one of the following national maternity healthcare programmes:

- Royal College of Obstetricians and Gynaecologists' 'Each Baby Counts' report
- MBRRACE-UK 'Saving Lives, Improving Mothers' Care' report.

Incidents are referred to us by the NHS trust where the incident took place, and, where an incident meets the criteria, our investigation replaces the trust's own local investigation. Our investigation report is shared with the family and trust, and the trust is responsible for carrying out any safety recommendations made in the report.

In addition, we identify and examine recurring themes that arise from trust-level investigations in order to make safety recommendations to local and national organisations for system-level improvements in maternity services.

For full information on our national and maternity investigations please **visit our website**.

Executive Summary

Background

This investigation explores factors influencing the instructions 999 call handlers give to women and pregnant people who have called an ambulance because of problems with their pregnancy and are waiting for it to arrive. These instructions are known as 'pre-arrival instructions'. As an example, which is referred to as the 'reference event', the investigation considered the experience of Amy, a woman aged 30 who called 999 when she experienced abdominal pain and vaginal bleeding during her pregnancy.

The reference event

Amy, who was 39 weeks and 4 days pregnant with her first child, telephoned her local maternity unit for advice as she had “fresh red vaginal bleeding”. She was advised to ring 999 for an ambulance to take her urgently to hospital. Amy called 999. The information the call handler received was that she was bleeding vaginally, with constant abdominal pain and that she was at home on her own.

The call handler asked Amy to collect towels and blankets, string or a shoelace, a safety pin and sheets (items she would need if she gave birth at home). When Amy had collected the items, she was advised to lie on her back in the centre of the bed or on the floor and raise her head with pillows until the ambulance arrived.

The ambulance arrived and took Amy to hospital where baby Benjamin was delivered by emergency caesarean section. It was confirmed after the delivery that the placenta had come away from Amy’s uterus prematurely; this was the cause of her pain and bleeding. Amy had lost 1.4 litres of blood and was admitted to the high dependency unit (HDU) for 12 hours following the birth.

At birth Benjamin required resuscitation to help him breathe on his own, he was intubated (a tube was inserted into his airway to help him breathe), and he received 72 hours of therapeutic cooling (his body was cooled down to prevent further brain injury following lack of oxygen to the brain). Benjamin required hospital care for 13 days.

The reference event formed one part of an initial investigation carried out by the HSIB maternity investigation programme, as it met the ‘Each Baby Counts’ criteria (a set of criteria defined by the Royal College of Obstetricians and Gynaecologists and used by HSIB to decide what to investigate). HSIB maternity programme investigations are not published or made publicly available. The initial investigation identified a potential patient safety risk regarding the pre-arrival instructions given to women/pregnant people by 999 call handlers while they wait for an ambulance. Aspects of the pre-arrival instructions did not align with UK evidence-based maternity guidance (for clinicians in a clinical setting). This was considered to present a risk of harm to women or pregnant people and/or babies.

Similar concerns relating to maternity pre-arrival instructions given by 999 call handlers were identified in 15 HSIB maternity investigations. These were referred to HSIB’s national investigation programme for consideration for a national investigation.

The national investigation

HSIB looked into the reference event further in terms of the triage process and the and pre-arrival instructions given by the 999 call handler. The investigation contacted the Ambulance Trust where the reference event 999 call was triaged, to gain further understanding.

Following additional information gathering and evaluation against the HSIB patient safety risk criteria, HSIB's Chief Investigator authorised a national safety investigation.

The objective of the investigation was to understand the context and contributory factors influencing maternity pre-arrival instructions given by 999 call handlers. The investigation reviewed the triage clinical decision support systems in use across ambulance trusts in England to understand consistency, alignment to evidence-based guidance, and governance and regulatory mechanisms.

The investigation visited organisations that had chosen different triage systems to share learning from their use of these systems and engaged with key national and international stakeholders that provided valuable insight to this aspect of healthcare.

Findings

- There are two triage clinical decision support systems in use in England which provide different pre-arrival instructions for the same maternity clinical scenario for women/pregnant people who are waiting for an ambulance to arrive.
- Specific to a woman/pregnant person describing their symptoms as per the reference event, the two triage clinical decision support systems would provide noticeably different pre-arrival instructions for:
    - the collection of items in preparation for birth
    - how a woman/pregnant person should position themself (with regard to aortocaval compression, where the weight of the baby in the uterus presses on the main blood vessels in the woman's/pregnant person's abdomen, which can cause a restriction in oxygen supply to the baby)
    - umbilical cord clamping (if a woman/pregnant person gave birth before an ambulance arrived).
- Pre-arrival instructions used for triage of maternity emergencies are derived from guidance that has been developed by clinicians for clinicians working in a

clinical environment, or from expert consensus of maternity specialists familiar with the pre-arrival environment.

- The different pre-arrival instructions across triage clinical decision support systems, for the same reported symptoms, have different clinical implications/ risks, creating a ‘postcode lottery’ of care.
- Where there is no definitive guidance to inform maternity pre-arrival instructions in the non-visual, non-clinician-attended environment (that is, where guidance is given over the phone, and there is no healthcare professional with the patient), expert opinion has been used.
- Stakeholders acknowledged a gap in maternity emergency guidance relating to the non-visual, non-clinician-attended environment.
- The investigation found no evidence of a regulatory mechanism for 999 call handler pre-arrival instructions.
- The investigation did not identify any ‘poor outcome’ evidence linking pre-arrival instructions given in the Advanced Medical Priority Dispatch System (AMPDS) clinical decision support system (for a woman/pregnant person to lie on their back) to a recognised patient safety risk (aortocaval compression).
- Local (hospital/trust level) investigations into poor outcomes for either a woman/ pregnant person or baby, do not routinely consider the clinical impact of pre-arrival instructions given by ambulance trust call handlers.

HSIB makes the following safety recommendations

Safety recommendation R/2022/180:

HSIB recommends that the Department of Health and Social Care commissions the National Institute for Health and Care Excellence to work with relevant stakeholders to develop guidance for maternity emergencies in the non-visual, non-clinician-attended environment.

Safety recommendation R/2022/181:

HSIB recommends that the Department of Health and Social Care identifies a suitable regulatory mechanism to provide formal oversight of 999 maternity pre-arrival instructions across NHS-funded care in England.

Safety recommendation R/2022/182:

HSIB recommends that NHS England and NHS Improvement develops the content of the patient safety incident investigation (PSII) standards to further support cross-boundary investigations.

1 Background and context

This section provides a description of terms that feature throughout the report.

1.1 999 service

1.1.1 Each ambulance trust in England is an NHS service responsible for providing ambulance services. Each trust provides 24-hour, 365-days-a-year accident and emergency services to those in need of emergency medical treatment and transport.

1.1.2 Ambulance trusts that provide 999 services are commissioned regionally. For the purpose of ambulance service provision, England is divided into 10 geographical areas, with a different ambulance trust running the service in each area.

1.1.3 Each ambulance trust is required to ‘assess and triage all calls, using an accredited triage tool to assess the required response, as received from the public via the 999 telephone system’ (NHS England, 2018a). This process is explained further in 1.2.1.

1.2 Clinical decision support systems

1.2.1 When someone calls 999 and is put through to an ambulance trust, the call is taken by a non-clinical call handler – that is, a staff member who is not a qualified healthcare professional but who is trained to deal with emergency calls. The call handler takes information about the patient’s condition and enters it into a digital triage clinical decision support system (CDSS) to establish the most appropriate response depending on the details given (a process known as triage). The triage process produces a disposition or determinant code (depending on which CDSS is used) that determines the urgency of the ambulance response. These codes are mapped to NHS England’s Ambulance Response Programme Category of call. The categories range from Category 1 (where the patient has immediately life-threatening and time-critical injuries) to Category 4 (for less urgent calls).

1.2.2 There are currently two triage CDSS approved in England for 999 assessments: NHS Pathways and the Advanced Medical Priority Dispatch System (AMPDS) (NHS England, 2018b). These are described in more detail in sections 1.3 and 1.4. Individual ambulance trusts must choose one of these two approved triage CDSS for 999 calls.

1.2.3 In England, six ambulance trusts use the AMPDS, and four ambulance trusts use NHS Pathways. The AMPDS is an internationally recognised system, hosted in the US. NHS Pathways is owned by the Department of Health and Social Care (DHSC), commissioned by NHSX and delivered by NHS Digital (NHS Digital, n.d.).

1.2.4 Each triage CDSS has protocols (sets of questions and procedures) for different urgent and emergency situations, including maternity-related emergencies. Each protocol is supported by algorithms (computerised problem-solving rules/operations to guide decision making). There is a pre-defined set of questions, which the call handler asks to help prioritise the level of response the patient needs, and pre-arrival instructions (PAIs) for the call handler to give to callers while they wait for the ambulance to arrive.

1.2.5 PAIs are used in the context of a non-visual (over the telephone), non-clinician-attended environment (that is, the instructions are given to the caller at home or wherever the emergency has taken place, where there is no medically trained person present).

1.2.6 The AMPDS has system-generated questions, instructions, and advice; there is a requirement that call handlers follow these in a systematic way without deviation from the script. The scripted nature of the questions maintains the clinical reasoning that supports the algorithms. Deviation from the script can affect an ambulance service’s audit results and accreditation standards.

1.2.7 Within NHS Pathways, each question needs to be answered but the call handler does not necessarily need to ask them in a scripted manner. They can reword/rephrase the questions as long as this does not change their clinical meaning.

1.2.8 Requests can be made for changes to the protocols, their supporting algorithms, and associated PAIs. Requests can be made individually by an ambulance trust or collectively involving national ambulance groups. The change request process can be challenging, for example, the AMPDS system is used in many different countries where clinical advice and treatment may differ. Therefore a robust evidence base is required to effect change.

1.2.9 The functionality of approved triage CDSS varies, but systems are approved on the basis of being able to determine as far as possible differing levels of acuity (how serious/urgent the emergency is) and the priority of response required for immediately life-threatening medical emergencies (NHS England, 2018b).

1.3 Advanced Medical Priority Dispatch System

1.3.1 AMPDS telephone calls are initially assessed by non-clinical trained call handlers. This system uses standardised, universal question sets to triage the call and identify the appropriate response.

1.3.2 The AMPDS is designed to enable an objective clinical prioritisation of all clinical scenarios received by call handlers. The system is able to amend and update the clinical details when a change in a patient's condition is reported, including increasing the priority of the response if a patient's symptoms get worse.

1.3.3 Where telephone PAIs are required, such as while a patient waits for an ambulance to arrive, AMPDS has step-by-step guidance for telephone support appropriate for the clinical scenario.

1.3.4 The AMPDS is delivered by the Priority Dispatch Corporation in the US, which is licensed to publish and maintain the system in the UK. The AMPDS has protocols for different emergencies (maternity emergency calls are detailed within protocol 24). The content of these protocols is governed by the International Academies of Emergency Dispatch to establish a universal standard for emergency dispatchers taking calls (International Academies of Emergency Dispatch, n.d.a; n.d.b).

1.3.5 The AMPDS has been in use in the US since 1978 and is currently used by emergency services in 59 countries. The content is kept as consistent as possible across different countries. There is variation in some protocols to reflect situations that are relevant to particular patient demographics, regions or countries.

1.4 NHS Pathways

1.4.1 NHS Pathways is a clinical triage system that contains approximately 800 symptom-based pathways. It uses standardised, universal question sets to identify the appropriate response depending on a patient's symptoms.

1.4.2 NHS Pathways is overseen by the National Clinical Governance Group (NCGG), which is hosted by the Royal College of General Practitioners. This group is made up of representatives from UK medical royal colleges. Senior clinicians from the NCGG

provide independent oversight and scrutiny of the NHS Pathways content. Changes to the NHS Pathways content cannot be made unless there is a majority agreement at the NCGG.

1.4.3 When an emergency call is assessed using NHS Pathways, the outcome could result in a request for an ambulance to be dispatched, referral to a treatment centre or primary care (for example, the patient might be referred to their doctor), or self-care, based on the symptoms reported by the caller at the time.

1.4.4 Services commissioned by NHS England and suppliers of the host computer systems on which trusts use NHS Pathways sign a licence with the Secretary of State for Health and Social Care; either a licence to ‘use’ (services) or a licence to ‘embed’ (host system suppliers) (NHS Digital, n.d.).

1.5 UK ambulance services governance

1.5.1 The Association of Ambulance Chief Executives (AACE) is a key stakeholder of the ambulance services’ main partner agencies at national level – including the DHSC and NHS England. The Association enables ambulance trust chief executives to have a greater say in national policy development.

1.5.2 A workstream within the AACE is the National Ambulance Services Medical Directors’ Group (NASMeD). The purpose of NASMeD is to improve clinical safety and quality of care by reducing unwarranted variation and sharing best practice across the English ambulance services (Association of Ambulance Chief Executives, n.d.a).

1.5.3 NASMeD acts as the point of reference for the standards of clinical care across UK ambulance services. It is responsible for the UK Clinical Practice Guidelines for Ambulance Services produced by the Joint Royal Colleges Ambulance Liaison Committee (JRCALC).

1.6 Antepartum haemorrhage

1.6.1 An antepartum haemorrhage is bleeding from the vagina that occurs after 24 weeks of pregnancy and before the birth of a baby. This occurs in 3% to 5% of pregnancies and is associated with an increased risk of fetal hypoxia (a lack of oxygen to a baby), slow growth of a baby in the womb, premature birth and stillbirth (Royal College of Obstetricians and Gynaecologists, 2011).

1.7 Category 1 caesarean section

1.7.1 There are four categories describing the urgency for a caesarean section. A Category 1 caesarean section is the most urgent, where there is immediate threat to the life of the woman/pregnant person or baby. Once health professionals have decided that it is necessary, a Category 1 caesarean section is performed as quickly as possible, ideally within 30 minutes (National Institute for Health and Care Excellence, 2011).

1.8 Placental abruption

1.8.1 The placenta develops along with a baby in the uterus (womb) during pregnancy. It connects a baby with a woman’s or pregnant person’s blood system and provides the baby with its source of oxygen and nourishment. The placenta is delivered after a baby and is also called the afterbirth.

1.8.2 A placental abruption is a condition in which the placenta starts to come away from the wall of the uterus before a baby is born. The symptoms are usually abdominal pain and bleeding, although sometimes it is concealed, and no blood loss is seen. Its effect on a woman or pregnant person and their baby depends on the severity of the bleeding and the gestation of the pregnancy (how long the baby has been in the womb).

1.8.3 If the abruption is severe, it can cause collapse (a reduced conscious level) in a woman or pregnant person and/or distress (a sign of not being well) in a baby, and urgent delivery is needed. Although there are certain factors that may mean some women or pregnant people are at higher risk of placental abruption, it can happen in any pregnancy.

1.9 Therapeutic (active) cooling

1.9.1 Therapeutic (active) cooling is a procedure where a baby is cooled to between 33C and 34C, with the aim of preventing further brain injury following a hypoxic (lack of oxygen) injury.

2 The reference event

This investigation used the following patient safety incident, referred to as ‘the reference event’, to examine the factors that influence the pre-arrival instructions given by 999 call handlers to women or pregnant people who are waiting for an ambulance because of an issue relating to their pregnancy.

The reference event was one aspect of an initial investigation carried out by the HSIB maternity investigation programme because it met the ‘Each Baby Counts’ criteria – a set of criteria defined by the Royal College of Obstetricians and Gynaecologists and used by HSIB to decide what to investigate. The HSIB national investigation looked into the reference event further in terms of the triage process and the pre-arrival instructions given by the call handler.

2.1 In August 2019 Amy, who was 30 years old and pregnant for the first time, telephoned her local maternity unit for advice. She was at 39 weeks and 4 days gestation and she had “fresh red vaginal bleeding”. It was established during the telephone call that Amy’s baby had been moving well, that Amy had experienced abdominal pain and that she was on her own at home.

2.2 Amy was advised to wear a pad and to ring 999 for an ambulance to take her urgently to hospital. Amy immediately called 999, at 19:26 hours. The call was taken by a non-clinical call handler who remained on the line while an ambulance was dispatched.

2.3 During the initial part of the 999 call the call handler took Amy’s address and phone number and asked some initial key questions. Amy was alert and co-operative and she voluntarily placed her dog into another room in preparation for the arrival of the paramedics.

2.4 Amy told the 999 call handler that she was 39 and a half weeks pregnant, bleeding vaginally which was not stopping, had constant abdominal pain, and that she was on her own at home.

2.5 The triage clinical decision support system (CDSS) directed the call handler to follow a pathway for an ‘imminent delivery’. This prompted the call handler to focus on preparing Amy for the birth of her baby while waiting for the ambulance to arrive.

2.6 To prepare for an imminent birth, approximately 3 minutes and 25 seconds into the call, Amy was instructed to collect towels and blankets, some string or a shoelace, and a safety pin. Approximately 8 minutes and 5 seconds into the call Amy had carried out these instructions, while experiencing constant abdominal pain and continued vaginal bleeding.

2.7 Approximately 8 minutes and 20 seconds into the call, Amy was instructed to collect a sheet or blanket and pillows and remove all clothing below her waist, including the pad that maternity unit staff had instructed her to put on, in preparation for birth. Amy stated twice “you’re frightening me now” to the call handler, who offered reassurance that these were precautionary measures.

2.8 The triage CDSS then prompted the call handler to instruct Amy to lie on her back on the centre of the bed or on the floor and raise her head with pillows. Amy decided to use the bed and the call handler instructed her to spread the sheet over it. As Amy was putting the sheet over the bed, she made the call handler aware that she was “still bleeding quite a bit”. Approximately 11 minutes and 10 seconds into the call Amy confirmed that she had removed her clothing below the waist and then lay on her back on the bed with her head raised by pillows.

2.9 A single paramedic arrived at Amy’s home at 19:43 hours and was by Amy’s side at approximately 19:46 hours (20 minutes into the call). On the call handler’s confirmation that the paramedic had arrived, the 999 call was ended. A double-crewed ambulance (staffed by two paramedics) arrived at 19:51 hours, leaving the scene at 20:18 hours to take Amy to hospital, where they arrived at 20:47 hours.

2.10 The baby, Benjamin, was delivered by Category 1 caesarean section at 22:05 hours. Placental abruption was confirmed at the delivery. Amy had experienced excessive blood loss totalling 1.4 litres and after the birth was admitted to the high dependency unit for 12 hours.

2.11 At birth Benjamin required resuscitation to help him breathe on his own, he was intubated (a tube was inserted into his airway to help him breathe), and he received 72 hours of therapeutic (active) cooling. Benjamin required hospital care for 13 days, after which time he was able to go home with Amy and his father Jeremy.

3 Involvement of the Healthcare Safety Investigation Branch

This section outlines how HSIB was alerted to the potential safety risk associated with maternity pre-arrival instructions (PAIs) given by 999 call handlers not aligning with UK evidenced-based maternity guidance (for clinicians in a clinical setting), which has the potential to cause harm to woman or pregnant people and their babies. It also describes the criteria HSIB used to decide whether to proceed with the investigation, and the methods and evidence used in the investigation process.

3.1 Notification of the reference event and decision to investigate

3.1.1 A review of previous HSIB maternity investigations identified 15 incidents (as of October 2020), including the reference event, where people called 999 and were given pre-determined PAIs that did not match aspects of UK evidence-based maternity guidance (for clinicians in a clinical setting). The HSIB maternity programme considered this a safety risk and referred it to the national investigation programme. HSIB maternity programme investigations are not published or made publicly available.

3.2 Decision to conduct a national investigation

3.2.1 HSIB conducted an initial scoping investigation which determined that the patient safety risk 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?

3.2.2 Safety recommendations made by HSIB maternity investigations have arisen because of poor outcomes for babies; PAIs, as directed by triage clinical decision support systems (CDSS), potentially contributed to poor outcomes in varying amounts.

3.2.3 In 9 of the 15 instances identified by the HSIB maternity investigation programme, the PAIs were reported to have been a potential contributory factor in the poor outcomes.

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

3.2.4 The 15 instances described within HSIB maternity investigation reports reflect only those cases that fulfilled the criteria of the HSIB maternity programme (Healthcare Safety Investigation Branch, n.d.). Other families who contact the ambulance services are potentially being given the same instructions based on the algorithms used.

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

3.2.5 HSIB maternity investigation reports have made safety recommendations to ambulance trusts regarding changing aspects of the Advanced Medical Priority Dispatch System advice. This has not been resolved as local ambulance trusts have advised HSIB of their limited ability to effect change within an international triage system.

3.2.6 There is the potential for learning for providers of triage CDSS to mitigate safety risks and improve outcomes for women/pregnant people and babies when 999 is called during an emergency.

3.2.7 A national investigation can provide an understanding of the regulation and governance surrounding 999 call handler triage CDSS, to gain an understanding of current mechanisms in place in support of this activity.

3.2.8 It is important to understand the challenges in providing consistent 999 maternity PAIs across England. A national investigation can aid understanding of how the ‘postcode lottery’ of differing PAIs can be mitigated.

3.3 Evidence gathering

3.3.1 Evidence gathered in this investigation included:

- a review of Amy’s clinical records
- a review of Amy’s 999 call audio recording
- a review of policies, procedures, and practice in place at the Ambulance Trust where the reference event telephone triage occurred
- telephone conversations with Amy
- meetings with Ambulance Trust staff
- a review of the Ambulance Trust’s internal review process
- a review of literature relevant to the safety risk

- interviews and meetings in person and by telephone with representatives of relevant national and international organisations, subject matter advisors, and members of medical royal colleges.

3.4 Methods used to analyse the evidence

3.4.1 HSIB uses a standard process in all its investigations which may be supplemented by additional steps specific to the event under investigation. The process is as follows:

- gather all relevant evidence
- establish the factual circumstances leading up to the reference event
- analyse the evidence
- identify the most significant safety issues contributing to the safety risk being investigated
- identify which safety issues contributed to the reference event
- identify which safety issues are likely to contribute to future, similar events nationally – these inform the wider investigation (see section 5)
- assess the adequacy of risk controls in place
- develop safety recommendations and safety observations to reduce the likelihood of the identified safety risk occurring.

3.4.2 During the analysis of the investigation's findings, systems diagrams were used to illustrate the dynamics occurring in the reference event and wider healthcare system. An Australian Transport Safety Bureau (2008) technique (see appendix) was used to consider the vertical interaction among levels of a sociotechnical system (a system that involves people and technology). This encompasses decision making through the levels of management and governance, as well as economic considerations and workload pressures.

3.5 Verification of findings

3.5.1 The findings were shared with the healthcare organisations involved in the investigation. This enabled factual accuracy and sense checking of the interpretation of information presented. The investigation's findings and proposed safety recommendations were presented to the stakeholder groups so that they could contribute to the verification and design of the final safety recommendations.

3.5.2 Further verification and sense checking was achieved through consultation with influential national organisations and stakeholders. These included:

- The Department of Health and Social Care
- NHS England and NHS Improvement
- NHS Digital
- The National Institute for Health and Care Excellence
- The Royal College of Midwives
- The Royal College of Obstetricians and Gynaecologists
- The Association of Ambulance Chief Executives
- The College of Paramedics
- The Medicines and Healthcare products Regulatory Agency
- The Care Quality Commission
- The International Academies of Emergency Dispatch
- Several NHS ambulance service trusts in England.

4 Analysis and findings – the reference event

In order to identify the safety issues and the controls put in place locally to minimise risk, the investigation reviewed Amy's clinical records and engaged with frontline staff at the Ambulance Trust where the reference event took place. In addition, national guidance was reviewed to determine whether actions taken in the reference event aligned with relevant guidance.

4.1 The initial HSIB maternity programme investigation

4.1.1 Positioning a woman or pregnant person on their back can cause aortocaval compression. This means that the weight of the baby in the uterus presses on the main blood vessels in the woman's/pregnant person's abdomen (see figure 1). This can cause a restriction in oxygen supply and can cause a baby to become unwell or, in the most severe cases, die. (Lee et al, 2012; Carbonne et al, 1996).

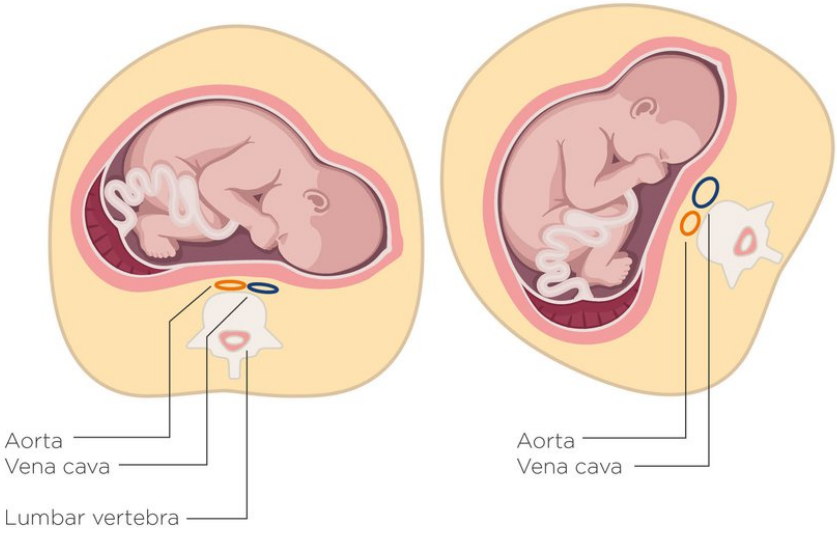


Figure 1 Compression of the blood vessels supplying blood to the baby

The image on the left represents compressed blood vessels (aorta and vena cava) with a woman/pregnant person lying on their back. The image on the right represents a woman/pregnant person lying on their left side with the baby receiving full blood flow.

4.1.2 The initial HSIB maternity programme investigation determined that the appropriate advice for both an antepartum haemorrhage (see 1.6) and imminent birth would be for a woman or pregnant person to lie on their left-hand side to avoid aortocaval compression to improve blood flow to a baby, and assist the baby being born onto a safe surface. If birth occurs, the umbilical cord should be left alone until a clinician arrives. This is in line with NHS Pathways pre-arrival instructions (PAIs) for a woman/pregnant person with the clinical symptoms described by Amy (see section 5).

4.1.3 The initial HSIB maternity programme investigation made the following safety recommendation to the Ambulance Trust:

- ‘The Ambulance Trust should remove the element of the maternity algorithm that advises mothers or family members to collect items such as string or shoelaces for the cord and to lay flat.’

4.1.4 The Ambulance Trust advised HSIB that its selected triage clinical decision support system (CDSS) was the Advanced Medical Priority Dispatch System (AMPDS), and that because it was an international tool, changes to it were outside of the Ambulance Trust's control.

4.1.5 The HSIB maternity investigation learned from the Ambulance Trust that the 999 telephone call made by Amy was internally reviewed and considered to have been in line with local standards.

4.1.6 The Ambulance Trust's internal review was not clinical in nature; it was part of routine practice to audit an individual call handlers' compliance with the use of the triage tool.

4.2 Algorithm sensitivity to the possibility of placental abruption

4.2.1 The AMPDS algorithm did not identify the risk of a placental abruption when Amy called reporting a main complaint of a vaginal bleed with constant abdominal pain.

4.2.2 The investigation learned that the call handler is presented with an option for 'HIGH RISK complications'; this includes risk of placental abruption, on which there is additional information. The additional information on placental abruption states: 'Occurring in 1% of pregnancies, it is a significant contributor to mortality [death] of the mother and/or baby.'

4.2.3 The call handler asked Amy if she had any high-risk complications. Amy replied that she did not. The investigation learned that information about high-risk complications needs to be volunteered by a caller; complications are not established by the AMPDS algorithm.

4.2.4 Amy did not know that she was experiencing, or had a risk of, a placental abruption. Amy knew that she was bleeding with constant abdominal pain but was not aware she was experiencing a high-risk complication. A risk of placental abruption was not identified by the triage CDSS.

4.2.5 Placental abruption is most likely to occur during late pregnancy (Royal College of Obstetricians and Gynaecologists, 2011). A study found that 'approximately 70% of cases of placental abruption occur in low-risk pregnancies' (Toivonen et al, 2002). Therefore, placental abruption is an important consideration for women and pregnant people with no identified high-risk complications.

4.2.6 The investigation learned that the AMPDS has a rule that ‘Abdominal pain/ cramping anytime during pregnancy should be considered contractions [labour] until proven otherwise’. The constant pain experienced by Amy was classified as contractions that were less than 2 minutes apart, therefore the ‘worst case scenario’ of imminent delivery was indicated by the algorithm.

4.2.7 Guidance by the Royal College of Obstetricians and Gynaecologists (RCOG) (2011) states that the triage process for a woman or pregnant person with a haemorrhage should:

‘… determine whether there is pain associated with the haemorrhage. Placental abruption should be considered when the pain is continuous. Labour should be considered when the pain is intermittent.’

4.2.8 The AMPDS and RCOG have different interpretations of the symptom of continuous abdominal pain alongside a haemorrhage. RCOG guidance considers constant abdominal pain (as described by Amy) alongside vaginal bleeding to be associated with placental abruption.

4.2.9 Further identifiers of whether a woman or pregnant person is in labour could increase triage CDSS sensitivity to enable the correct identification of a mother’s condition. The NHS (NHS, 2020) and Joint Royal Colleges Ambulance Liaison Committee (JRCALC) consider that these identifiers could include:

- Does a woman/pregnant person believe their waters have broken?
- Prior to the constant abdominal pain was a woman/pregnant person experiencing pain intermittently (contractions), did the intervals become ‘longer, stronger and more frequent’ over time?
- The urge to push or bear down.

4.2.10 In the case of Amy, who was experiencing a vaginal bleed with constant abdominal pain, the AMPDS algorithm was not sensitive to a placental abruption with the information given. The algorithm followed the ‘imminent delivery’ protocol, which prompted the collection of items in preparation for this, while Amy was not in the advanced stages of labour.

4.2.11 If the triage system’s interpretation that Amy’s constant abdominal pain was caused by a placental abruption, and not by imminent delivery, this would have removed the requirement for Amy to collect items and lie on her back in preparation for birth. The investigation learned from the Ambulance Trust that there are no specific CDSS instructions to manage an internal (vaginal) bleed.

4.2.12 The investigation was informed that although the PAIs may be different if a placental abruption, rather than an imminent delivery, was determined by the CDSS, the high prioritisation and therefore ambulance response time requirement would likely be the same.

4.3 Collecting items in preparation for birth while experiencing a haemorrhage

4.3.1 The first 3 minutes and 30 seconds of the 999 call was spent gathering logistical information and asking key questions. From the time Amy was asked by the 999 call handler to collect towels, blanket, string or shoelace and a safety pin, it took her approximately 4 minutes and 40 seconds to search for and retrieve them. When asked further to collect a sheet or blanket and to remove her clothing below the waist, it took Amy 2 minutes and 50 seconds to do so. Amy spent a total of 7 minutes and 30 seconds searching for items and removing clothing while experiencing a haemorrhage (placental abruption).

4.3.2 Amy was alert, orientated and did not report any symptoms of imminent collapse. Amy was however experiencing a haemorrhage (placental abruption). The RCOG (2019) describes haemorrhage as ‘the most common cause of maternal collapse’. The advice to look around the house for equipment while experiencing a placental abruption (unknown by the call handler) increased Amy’s risk of experiencing a maternal collapse in an awkward position and/or dangerous location (for example, on the stairs) in her home.

4.3.3 The International Academies of Emergency Dispatch (IAED), which governs the AMPDS, informed the investigation that its database ‘reveals about 35 thousand 1st party childbirth cases [where a woman/pregnant person gives birth on their own] over the last 5 years with no such collapses reported’. The IAED information indicates that the risk of a woman or pregnant person experiencing a collapse during a 999 call is low.

4.3.4 Although IAED information indicates that the risk of maternal collapse is low, a comprehensive risk (collapse of a woman or pregnant person in an awkward position and/or dangerous location) versus benefit (collecting items in preparation for birth) assessment for first-party 999 patients calling with maternity complications such as a haemorrhage may be worthy of consideration.

4.4 Alignment of AMPDS call handler pre-arrival instructions to guidance

The woman/pregnant person lying on their back

4.4.1 The AMPDS gave PAIs for Amy to lie on her back on the floor, or in the middle of the bed, with her head raised by pillows.

4.4.2 UK national guidance states:

‘From around 20 weeks of gestation onwards the gravid uterus reduces venous return in the supine [lying on the back] position. As a consequence, cardiac output is reduced by up to 30–40%. Supine hypotension itself can precipitate maternal collapse, which is usually reversed by turning the woman into the left lateral position.’
(Royal College of Obstetricians and Gynaecologists, 2019)

This means that from around 20 weeks of pregnancy, lying on their back can cause a woman’s/pregnant person’s blood pressure to drop. This effect is usually reversed if they lie on their left side.

4.4.3 Additionally, the RCOG (2019) commented that lying on the left side is:

‘… the universally accepted ‘recovery’ position. It helps to minimise the risk of aspiration of gastric contents [stomach contents entering the airway or lungs] … Vomiting can easily occur in the face of significant pain and distressing altered mental consciousness at an advanced pregnancy gestation.’

4.4.4 UK national guidance (Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK, 2019) states:

‘From 20 weeks of gestation onwards, the pressure of the gravid uterus must be relieved from the inferior vena cava and aorta. A left lateral tilt of 15° on a firm surface will relieve aortocaval compression in the majority of pregnant women.’

4.4.5 The UK Pre-Hospital Practical Obstetric Multi-Professional Training (PROMPT) (2020) guidance is to ‘Encourage mother to lie on left side or sit upright in ambulance (keep comfortable and discourage from lying flat)’.

4.4.6 The UK Joint Royal Colleges Ambulance Liaison Committee ambulance service clinical guidelines (JRCALC) provide ‘guidance for NHS paramedics, although the principles are applicable to the work of all pre-hospital clinicians’ (Association of Ambulance Chief Executives, n.d.b). The JRCALC guidelines state that if birth is imminent, ‘Reassure the woman and support her in a comfortable position, avoiding the supine position’.

4.4.7 In summary, the AMPDS PAI for Amy to lie on her back was not in line with in-hospital or pre-hospital (JRCALC) UK clinical guidance (for clinicians).

4.4.8 In a scenario such as the reference event, the length of time that a woman or pregnant person will lie on their back will vary depending on both the categorisation of the 999 call, and the availability of appropriate ambulance trust resource, which will determine how long it takes for an ambulance to arrive. The effect and impact of aortocaval compression on a woman/pregnant person and their baby will vary accordingly.

Umbilical cord clamping

4.4.9 Amy received a PAI to gather ‘string or a shoelace’. The AMPDS PAIs for a woman or pregnant person in the same clinical scenario as Amy, who gives birth before an ambulance arrives, is to tie the umbilical cord with string or a shoelace after 3 minutes.

4.4.10 World Health Organization (WHO) guidance recommends that:

‘Delayed (Timely) umbilical cord clamping (not earlier than 1 min after birth) is recommended for improved maternal and infant health and nutrition outcomes.’ (World Health Organization, n.d.)

WHO guidance also provides background information which states that:

‘Waiting to clamp the umbilical cord for 2–3 min, or until cord pulsations cease, allows a physiological transfer of placental blood to the infant (the process referred to as “placental transfusion”), the majority of which occurs within 3 min.’
(World Health Organization, 2014)

4.4.11 Royal College of Midwives (RCM) guidance states that:

‘There is good evidence that delayed cord clamping (between one and three minutes after birth) can have positive effects on neonatal outcomes such as higher birthweight, early haemoglobin [a protein in red blood cells that carries oxygen] concentration, and increased iron reserves up to six months after birth.’
(Royal College of Midwives, 2018)

The investigation did not identify RCM umbilical cord clamping guidance specific to a physiological birth (that is, with no active clinical intervention/medication).

4.4.12 The RCOG’s opinion is that:

‘In healthy term babies, the evidence supports deferring clamping [not clamping until at least 2 minutes after delivery] of the umbilical cord, as this appears to improve iron stores in infancy.’
(Royal College of Obstetricians and Gynaecologists, 2015)

The investigation did not identify RCOG umbilical cord clamping guidance specific to a physiological birth.

4.4.13 UK national guidance (National Institute for Health and Care Excellence, 2017) for physiological birth, as in the reference event, includes a package of care that includes ‘no clamping of the cord until pulsation has stopped’.

4.4.14 The actions at birth set out by the Pre-hospital Practical Obstetric Multi-Professional Training (2020) state:

- ‘There is no need to clamp and cut the umbilical cord immediately after birth unless there are complications with either mother or baby.
- If the baby is healthy, wait until cord has stopped pulsating before clamping and cutting.

- Benefits of leaving the cord attached include increased stem cell transfer and haemoglobin levels.’

4.4.15 JRCALC states: ‘Allow the umbilical cord to stop pulsating prior to clamping and cutting.’

4.4.16 To summarise, regarding the AMPDS PAIs for a woman or pregnant person to tie the umbilical cord 3 minutes after a physiological birth, should there be no further complications:

- These instructions are in line with WHO, RCM and RCOG guidance on specified timeframes for umbilical cord clamping.
- National Institute for Health and Care Excellence, PROMPT and JRCALC guidance does not specify a timeframe to clamp, but states that the healthcare professional should wait for the umbilical cord to stop pulsating before clamping.
- If the umbilical cord should be tied, there was no guidance identified to suggest what should be used to do this in a pre-hospital environment by a non-clinician. The decision on the most appropriate procedure or item to use to clamp the cord, by a woman or pregnant person on their own, is outside the scope of this investigation.

4.4.17 Although it is typically beneficial to defer umbilical cord clamping, the investigation learned that for some complications it is not appropriate. These are catered for within the AMPDS. For example, immediate cord clamping can be indicated during certain complications, such as umbilical cord rupture or when a woman/pregnant person and/or baby require immediate resuscitation.

Conflicting clinical approaches within the ambulance trust (AMPDS and JRCALC)

4.4.18 The AACE states that the JRCALC principles apply to the work of all pre-hospital clinicians (Association of Ambulance Chief Executives, n.d.b). Although not clinicians, ambulance trust call handlers give PAIs which have clinical implications, before clinicians (paramedics) arrive at the scene. For example, Amy was instructed to lie on her back while waiting for an ambulance to arrive.

4.4.19 JRCALC states that for haemorrhage when a woman is 20 weeks pregnant or more:

‘… the gravid uterus may compress the inferior vena cava in a patient who is supine. Therefore, it is important to ensure adequate venous return before

determining the need for fluid resuscitation; this can be achieved by using manual uterine displacement or alternatively by placing the woman in a full lateral (‘recovery’) position or by lying her supine with lateral tilt (towards her left side where possible).’
(Association of Ambulance Chief Executives, 2019)

4.4.20 For a paramedic from the reference event Ambulance Trust arriving at the scene, to ensure adequate venous return [flow of blood back to the heart] and determine the need for fluid resuscitation [replenishing bodily fluid] during a haemorrhage would require changing the woman’s/pregnant person’s position from lying on their back (which was the instruction given by a call handler from the same Ambulance Trust) to a more favourable left lateral position.

4.4.21 There are conflicting approaches to the same clinical scenario within the same ambulance trust (AMPDS PAIs versus paramedic JRCALC guidance). A paramedic arriving at an imminent birth or serious haemorrhage event may be required to intervene to stop a woman/pregnant person carrying out actions that are in line with AMPDS PAIs (lying on their back), or to change those already carried out, to then be able to determine any need for fluid resuscitation.

4.4.22 AMPDS PAIs are not consistent with the JRCALC clinical practice guidance in relation to the positioning of a woman or pregnant person who is experiencing a haemorrhage when determining the need for fluid resuscitation.

4.5 Effect on outcome

4.5.1 It is not possible to determine whether the PAIs generated by the AMPDS affected the outcome for Amy and Benjamin, and if they did, the extent of that affect. The PAIs formed one aspect of a considerably longer birth event, which was investigated in full by the initial HSIB maternity programme investigation.

4.5.2 The placental abruption Amy experienced before calling 999, which was confirmed at birth, had associated risks of less blood flow and reduced oxygen to Benjamin. This is irrespective of the AMPDS PAIs for Amy to lie on her back, with the associated risk of aortocaval compression.

5 Analysis and findings – the wider investigation

This section sets out the findings from the investigation's analysis of evidence in the context of the wider healthcare system. The wider investigation gathered evidence and developed safety recommendations with the reference event scenario in mind.

The findings are presented within the following themes:

- NHS Pathways advice for the reference event scenario
- consistency of triage clinical decision support systems (CDSS) across 999 services in England
- guidance in the non-visual, non-clinician-attended environment
- assurance, governance and regulation of CDSS pre-arrival instructions (PAIs)
- healthcare system investigations and awareness of outcomes.

The investigation held several roundtable meetings with key stakeholders across the healthcare system. This enabled a shared understanding of considerations identified by the investigation and a collaborative approach to the identification of methods to influence positive change.

5.1 NHS Pathways advice for the reference event scenario

5.1.1 The symptoms Amy reported during the reference event were used to explore the other triage clinical decision support system (CDSS) available in England, NHS Pathways. This identified how NHS Pathways PAIs differed from those of the Advanced Medical Priority Dispatch System (AMPDS).

Collecting items in preparation for birth while experiencing a 'serious haemorrhage'

5.1.2 The investigation learned that NHS Pathways PAIs would not have directed the call handler to advise a woman/pregnant person with the same reported symptoms as Amy to collect items from around the house. There would have been advice to keep any towels, if used, to be checked when help arrives. This would enable a visual estimate of the amount of blood a woman/pregnant person had lost at home for future consideration by clinicians.

The woman/pregnant person lying on their back

5.1.3 The NHS Pathways algorithms would have advised a woman/pregnant person with the same reported symptoms as Amy to lie on their left side, reducing the risk of aortocaval compression. This is different to the AMPDS PAIs for a woman/ pregnant person to lie on their back with their head raised by pillows.

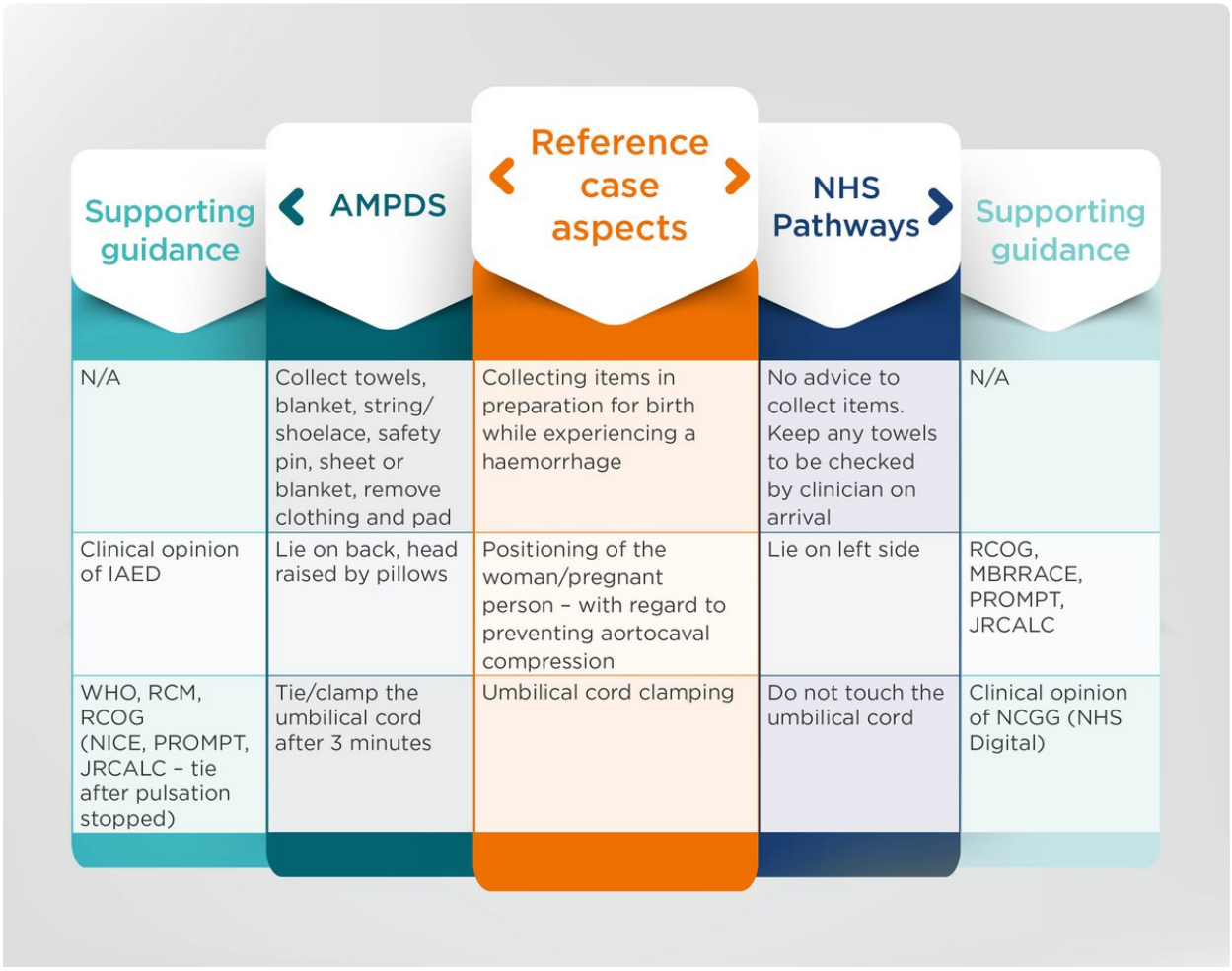
Umbilical cord clamping

5.1.4 After the birth of a baby, NHS Pathways call handler PAIs to a woman/pregnant person is to ‘keep yourself and baby warm and comfortable’. The NHS Pathways PAIs would also state ‘do not touch the umbilical cord’. This is different to the AMPDS PAIs to tie the umbilical cord 3 minutes after birth.

5.1.5 The NHS Pathways PAI to ‘not touch the umbilical cord’ does not align with maternity guidance, written for clinicians in a clinical environment, that the cord should be clamped either at a specified time or when cord pulsation has stopped. This is discussed further in section 5.3 – guidance for the non-visual, non-clinician-attended environment.

5.2 Consistency of CDSS across 999 services in England

5.2.1 Table 1 highlights the main inconsistencies between the PAIs from the AMPDS used by the Ambulance Trust in the reference event, and the PAIs from NHS Pathways. This is in consideration of physiological birth guidance (for birth with no active clinical intervention/medication).



Supporting guidance	AMPDS	Reference case aspects	NHS Pathways	Supporting guidance
N/A	Collect towels, blanket, string/ shoelace, safety pin, sheet or blanket, remove clothing and pad	Collecting items in preparation for birth while experiencing a haemorrhage	No advice to collect items. Keep any towels to be checked by clinician on arrival	N/A
Clinical opinion of IAED	Lie on back, head raised by pillows	Positioning of the woman/pregnant person – with regard to preventing aortocaval compression	Lie on left side	RCOG, MBRRACE, PROMPT, JRCALC
WHO, RCM, RCOG (NICE, PROMPT, JRCALC – tie after pulsation stopped)	Tie/clamp the umbilical cord after 3 minutes	Umbilical cord clamping	Do not touch the umbilical cord	Clinical opinion of NCGG (NHS Digital)

Table 1 Inconsistencies between AMPDS and NHS Pathways pre-arrival instructions for physiological birth

The woman/pregnant person lying on their back

5.2.2 The investigation asked the International Academies of Emergency Dispatch (IAED) to comment on whether a ‘proposal for change’ had ever been submitted regarding the advice for a woman/pregnant person to lie on their back. The IAED’s response was that ‘there has been no related Proposal for Change submission. This instruction has been in the [A]MPDS for decades with no reported complications’.

5.2.3 The IAED further commented that:

‘In response to your query about positioning moms on their backs during labor and delivery, there should be no problem as mothers often choose this position for rest during labor and when it comes time to push she can raise up into a more comfortable position. In addition, once the baby has dropped and is engaged in the pelvis there is less pressure on the aorta.’

5.2.4 It would be challenging to determine when a baby has dropped and is engaged (when a baby's head moves down into a pelvis ready for labour), when giving advice on the telephone, and when the woman/pregnant person is at home and there is no clinician present (referred to in this report as a non-visual, non-clinician-attended environment).

5.2.5 In a hospital setting a baby's heart rate will be regularly monitored by a clinician. If there is concern about a baby's heart rate (fetal distress) then conservative measures (non-surgical management) can be implemented such as 'encourage the woman to mobilise or adopt an alternative position (and to avoid being supine)' (National Institute for Health and Care Excellence, 2017). This would reduce the risks associated with aortocaval compression for a woman/pregnant person and/or their baby and would be one measure to attempt to reduce fetal distress.

5.2.6 When a woman/pregnant person is at home during a 999 call without a clinician in attendance there is no facility to listen to a baby's heart rate. When a woman/pregnant person is lying on their back there is no way of knowing if a baby is experiencing fetal distress. Avoiding the supine position, as discussed by guidance and research (see section 4), would appear to be the safest option for a woman/pregnant person and their baby in a non-clinician-attended, pre-hospital setting.

Umbilical cord clamping

5.2.7 UK and international guidance (for clinicians in a clinical setting) recommend that the umbilical cord be clamped, either at a specific time or when cord pulsation has stopped. The AMPDS maternity protocol provides PAIs to tie/clamp the umbilical cord; the NHS Pathways maternity protocol provides PAIs to 'not touch the umbilical cord'.

5.2.8 The NHS Pathways maternity protocol is not in line with maternity guidance (for clinicians in a clinical setting) to clamp the umbilical cord. However, the investigation found that many of the clinicians it engaged with during the investigation, from across the healthcare system, were of the opinion that leaving the umbilical cord alone was the safest option if a clinician (paramedic) was on the way with cord clamps available.

5.2.9 The investigation was informed that NHS Pathways recently undertook a thorough review of maternity pre-arrival advice with the Royal College of Midwives, which was completed in October 2021. The review concluded that the current NHS Pathways advice to not touch the umbilical cord was correct and appropriate in this situation, with no changes suggested.

5.2.10 To understand the appropriateness of instructions to tie/clamp the umbilical cord in the non-visual (over the telephone) and non-clinician-attended (woman/pregnant person at home with no health professional present) environment of emergency dispatch is challenging. The AMPDS PAIs for this align with guidance written for clinicians in clinical settings.

5.2.11 In a clinical environment, the umbilical cord is clamped to enable it to be cut, as the clamp prevents bleeding from the blood vessels in the umbilical cord which is still attached to the baby. The AMPDS PAIs do not include cutting of the umbilical cord after clamping, therefore the requirement to clamp is unclear. The IAED informed the investigation that the option to not clamp the umbilical cord is currently under internal review.

5.2.12 There is inconsistency in guidance for the timing of umbilical cord clamping both internationally and within the UK. The guidance is written for clinicians and, excluding Joint Royal Colleges Ambulance Liaison Committee (JRCALC) guidance, for in-hospital settings. The investigation found no authoritative guidance that relates to umbilical cord clamping for unexpected imminent birth (physiological) outside of the hospital environment when a clinician is not present.

5.2.13 The investigation found a consensus of opinion that, during an unexpected home birth scenario (physiological) with no identified complications with the woman/pregnant person or baby, leaving the umbilical cord alone until the arrival of a clinician with appropriate clamps would present no significant risks.

5.2.14 The investigation did not identify any risk/benefit analysis or research to determine whether it would be safer to leave the umbilical cord alone and untied until a clinician arrived, with the subsequent use of preferred (sterile) clamps, as per the NHS Pathways PAIs, rather than tying (clamping) the umbilical cord as per clinical guidance and the AMPDS PAIs.

5.2.15 The inconsistency of umbilical cord clamping guidance presents a recognised challenge for organisations that govern the PAIs within the triage CDSS endorsed for use in England. ‘Conflicting guidelines from different professional bodies can also confuse and frustrate practitioners’ (Woolf et al, 1999). This risks divergence of opinion and approach.

Summary

5.2.16 There are inconsistencies across the two triage CDSS endorsed for use in England. The PAIs given by each CDSS regarding the same reported clinical symptoms differ and have different clinical implications/risks associated with them. This creates a ‘postcode lottery’ of care.

5.3 Guidance in the non-visual, non-clinician-attended environment

5.3.1 Maternity guidance is primarily written for ‘in-hospital’ care by a clinician, not for a birth at home by a woman or pregnant person who is potentially on their own or being supported by someone with no medical training, such as a partner or family member. The investigation heard differing views and opinion across the healthcare system regarding the suitability of using ‘in-hospital’ maternity guidance to derive the content for 999 PAIs, or to provide the most appropriate maternity care for the non-visual and non-clinician-attended environment.

5.3.2 As remote triage with subsequent advice and instructions is increasingly used in healthcare services in England, the recognition of this type of care as a specialism becomes increasingly important, with the need for robust and applicable guidance. Specialist PAI guidance is not only relevant for maternity care, but also applicable across all CDSS protocols, to ensure that the non-visual, non-clinician-attended environment is considered appropriately.

5.3.3 In discussions with triage CDSS stakeholders, it was identified that when an organisation is developing clinical guidance it may be advantageous to engage with providers and developers of triage CDSS. This would enable the non-visual and non-clinician-attended environment of emergency dispatch to be considered during guidance development, and a shared understanding of the associated specific challenges.

5.3.4 Where there is no definitive evidenced-based guidance to support PAIs for maternity-related emergencies, subjective expert opinion has been used within triage CDSS. This opinion is formed by extrapolating and interpreting clinical guidelines, alongside personal knowledge and experience. Where expert opinion is used in the clinical governance of different triage CDSS providers, there is an inherent likelihood of differing opinion, as is the case between the providers of the two triage CDSS in use by ambulance trusts in England.

5.3.5 The ‘Commissioning framework: a framework for the commissioning of ambulance services’ (NHS England, 2018a) states that:

‘Consideration should be given to moving towards a standardised triage tool across all ambulance services in England to enable efficiencies and ensure patients receive an appropriate level of care.’

5.3.6 Moving to a standardised triage tool would remove current inconsistencies in the PAIs given across the two current triage CDSS. However, there is no ‘requirement’ for ambulance trusts to use a ‘standardised’ triage CDSS, and neither has one been specified. The investigation heard that changing from one CDSS to another would bring a number of challenges including significant cost implications, training requirements, and infrastructure and IT upgrades.

5.3.7 To ensure an end-to-end healthcare system – that is, a system with a seamless patient pathway across different types of care – is fully integrated and consistent, all aspects of self-care advice (such as PAIs), pre-hospital clinical care (delivered by paramedics) and in-hospital care, would need to be considered during guidance development.

5.3.8 During the investigation’s stakeholder engagement, England’s recognised bodies for maternity care, including the Royal College of Obstetricians and Gynaecologists (RCOG) and Royal College of Midwives (RCM), alongside pre-hospital experts including the Association of Ambulance Chief Executives (AACE), NHS England and NHS Improvement, NHS Digital, and England ambulance trust representatives, acknowledged a gap in maternity guidance relating to the non-visual, non-clinician-attended environment. Stakeholders indicated that they would support development work in this area with the aim of providing consistent and safe instructions and advice for women and pregnant people in NHS-funded care in England.

5.3.9 Either the AMPDS or NHS Pathways could be providing the most appropriate PAIs in one or more areas identified in the reference event. However, as there is no definitive non-visual, non-clinician-attended maternity guidance, there is also the possibility that neither system is providing the most appropriate PAIs.

5.3.10 The investigation engaged extensively with the National Institute for Health and Care Excellence (NICE) as the recognised authority for guidance in England. NICE’s role is to improve outcomes for people who use the NHS and other public health and social care services.

5.3.11 The NHS Constitution states that:

‘The National Institute for Health and Care Excellence (NICE) supports the NHS to understand what high-quality care looks like through the development of robust evidence-based guidance and quality standards. These can be used by health and care practitioners, commissioners and providers to assess and improve the quality of the services that they offer.’
(Department of Health and Social Care/Public Health England, 2021)

This helps to reduce any ‘postcode lottery’ of care across the NHS.

5.3.12 The NHS Constitution also states that:

‘You have the right to expect NHS bodies to monitor, and make efforts to improve continuously, the quality of healthcare they commission or provide. This includes improvements to the safety, effectiveness and experience of services.’

It also says:

‘Those provisions also place a duty on the Secretary of State … in discharging those duties, to have regard to any quality standards prepared by NICE’.
(Department of Health and Social Care/Public Health England, 2021)

5.3.13 In June 2014, NICE provided detail on the implications of a court judgment for healthcare ‘commissioners and providers’ in relation to following NICE guidance (National Institute for Health and Care Excellence, 2014). NICE stated that the court judgment meant that ‘if organisations refuse to put NICE clinical guidelines in place because they disagree with them, this could leave them open to challenge’. NICE summarised that organisations ‘could be open to challenge if you choose not to put [NICE] guidance into practice because you disagree with the recommendation in a clinical guideline’.

5.3.14 NICE indicated to the investigation that if commissioned to do so, it would be able to lead the development of guidance for maternity PAIs, with support from appropriate maternity stakeholders (RCOG, RCM) and appropriate experts in the non-visual, non-clinician-attended environment (triage CDSS providers).

5.3.15 The development of NICE guidance specific to PAIs for maternity would be a ‘new programme of work’ requiring associated resourcing and funding as appropriate for the level of guidance to be developed.

5.3.16 As a minimum, new non-visual, non-clinician-attended maternity emergency guidance should consider the maternity PAIs of both of the current triage CDSS providers to provide definitive guidance where there are inconsistencies, aiming to address the current ‘postcode lottery’ situation.

5.3.17 Consideration of all aspects of triage CDSS maternity protocols, to ensure safe and consistent guidance is given across all maternity emergencies, would have the greatest benefit to the healthcare system.

5.3.18 An additional benefit, outside the scope of this investigation, may be realised across the wider healthcare system. In a maternity emergency, a member of the public could choose one of numerous ways to access the healthcare system for advice, including calling 999 or NHS 111, calling a midwife in a labour ward or the community, searching the NHS website, or many other means.

5.3.19 The advice given on the NHS website is to ‘Call your midwife or GP immediately if: you have any bleeding from your vagina’ (NHS, 2021). If a woman or pregnant person is at home on their own without a clinician present, as happened in the reference event, it would be beneficial to ensure consistency of initial self-care advice for the same reported symptoms. The advice given by a midwife or GP should be the same as the PAIs given by a 999 call handler while a woman/pregnant person waits for an ambulance to arrive.

5.3.20 A recently published HSIB national learning report about stillbirths that occur during labour or immediately after birth highlighted inconsistency in the advice given to women by hospital maternity units across England. The report stated that:

‘The evidence from the review identifies the critical importance of a pre-admission telephone triage service and the provision of consistent assessment and advice.’ (Healthcare Safety Investigation Branch, 2020)

5.3.21 The benefit of NICE guidance is that it can be used to inform guidance and practice across the healthcare system. This means that it can ‘help patients … know that they will be cared for in a consistently evidence-based way’ (National Institute for Health and Care Excellence, n.d.) irrespective of which part of the

healthcare system they contact for advice. Newly developed NICE guidance for maternity emergencies in the non-visual, non-clinician-attended environment could be used across many parts of the healthcare system.

HSIB makes the following safety recommendation

Safety recommendation R/2022/180:

HSIB recommends that the Department of Health and Social Care commissions the National Institute for Health and Care Excellence to work with relevant stakeholders to develop guidance for maternity eme

5.3.22 Many stakeholders discussed the issue of guidance for the non-visual, non-clinician-attended environment for other clinical specialties (protocols) in addition to maternity.

5.3.23 The investigation learned that some triage CDSS protocols, such as those for cardiopulmonary resuscitation (CPR), have robust consideration of PAIs in the non-visual, non-clinician-attended environment. It was acknowledged that this type of consideration had not been undertaken for some protocols, in addition to maternity, and further work to understand the implications of this may be beneficial.

5.4 Assurance, governance and regulation of CDSS PAIs

5.4.1 The inconsistency of PAIs in England is partly due to the endorsement of two triage CDSS, with differing clinical governance arrangements. The healthcare landscape has changed considerably since the two CDSS were endorsed by the Secretary of State for Health for use in the NHS. This was in the period from around 2000 (for AMPDS) to 2013 (for NHS Pathways).

5.4.2 The investigation requested through the Department of Health and Social Care (DHSC) details of how current triage CDSS were evaluated and endorsed. This was so that the investigation could understand the governance and assurance agreements for CDSS content, including requirements for ongoing alignment to guidance updates and changes.

5.4.3 Many of the DHSC’s operational functions transferred to NHS England and NHS Improvement (NHSE/I) in 2012/13, including the responsibility for evaluation and endorsement of any future CDSS. As such the investigation was informed that

related records for previously endorsed CDSS would have been transferred from the DHSC to NHSE/I or destroyed. A search for records specific to ongoing governance and assurance of previously endorsed CDSS proved unsuccessful.

5.4.4 The AMPDS is hosted in the US and governed and assured internationally through the IAED's Medical Council of Standards, which has a specialist high-risk obstetrics subcommittee. The IAED's clinical focus group has representation from its member countries; the UK's representatives are senior NHS clinicians. The UK is further supplemented by IAED's UK clinical focus group, on which all UK ambulance trusts using the AMPDS have representation.

5.4.5 NHS Pathways is governed and assured in the UK through NHS Digital via the National Clinical Governance Group (NCGG), members of which are from UK royal colleges. Members would be fully aware of developments in UK research and national guidance.

5.4.6 NHS England and NHS Improvement's Central Ambulance Team, through the Emergency Call Prioritisation Advisory Group (ECPAG), considers that it provides a method of informal oversight of the AMPDS. This informal oversight consists of being aware of new versions of the AMPDS that are released and ensuring ambulance response categories are appropriate.

5.4.7 There is no formal oversight of the PAIs of either triage CDSS. Any requirement for a clinical view of PAIs, relating to ambulance categorisation, is met by the National Ambulance Services Medical Directors' Group (NASMeD – see 1.5.2) and then approved by the ECPAG.

5.4.8 The investigation found no evidence of an identified regulator for 999 PAIs. The investigation engaged with the Medicines and Healthcare products Regulation Agency (MHRA) and the Care Quality Commission, neither of which had a regulatory remit for the content of triage CDSS PAIs. CDSS PAIs are derived from clinical guidance; there is no regulator for clinical guidance.

5.4.9 Under the MHRA's classification system for medical devices, the AMPDS is a 'Class 1' device. This means the company that provides it, Priority Dispatch Corporation, is required to register with the MHRA. This is an administrative requirement of the UK's medical device regulations. The MHRA does not review, approve, or authorise the device.

5.4.10 A Class 1 device must function and perform as the manufacturer intends; this is reflected by the AMPDS algorithms aligning to IAED clinical governance mechanisms, which may differ to UK clinical guidance.

5.4.11 There is a regulatory gap in relation to maternity PAIs. If NICE were to develop maternity guidance specific to the non-visual, non-clinician-attended environment, the investigation did not identify a regulatory mechanism that would ensure that the content of the guidance would be observed.

HSIB makes the following safety recommendation

Safety recommendation R/2022/181:

HSIB recommends that the Department of Health and Social Care identifies a suitable regulatory mechanism to provide formal oversight of 999 maternity pre-arrival instructions across NHS-funded care in England.

5.4.12 Stakeholders discussed a regulatory mechanism for 999 PAIs for protocols outside of maternity. Should a regulatory mechanism be identified for maternity PAIs, it was considered that this may be relevant across all triage CDSS PAIs.

5.5 Healthcare system investigations and awareness of outcomes

5.5.1 Maternity protocol data was provided by the IAED for the six ambulance trusts in England that use AMPDS. The data covered a 3-month period from 1 January to 31 March 2021 (see table 2).

Table 2 Use of the AMPDS maternity protocol, 1 January to 31 March 2021

Female cases (calls)	532,372	
Maternity protocol cases	8,856	1.66% of female cases
Cases that advised a woman/pregnant person to lie on their back	1,773	20.02% of maternity protocol cases

5.5.2 The AMPDS data provided did not show at what gestation women/pregnant people were when they were advised to lie on their back. We do know that in the reference event, Amy was at 39 weeks and 4 days gestation.

5.5.3 The proportion of the 1,773 cases where a woman/pregnant person was susceptible to the risks associated with aortocaval compression (from around 20 weeks of gestation onwards according to the RCOG (2011)) following AMPDS instructions to lie on their back is unclear.

5.5.4 The IAED commented that the advice for a woman/pregnant person to lie on their back had ‘been in the AMPDS for decades with no reported complications’. Without data spanning this period, the investigation used the figure provided of 1,773 cases over a 3-month period to calculate an average for a 10-year period. According to this calculation, the instruction for a woman/pregnant person to lie on their back would have been given 70,920 times with no reported complications.

5.5.5 The investigation did not identify evidence of reported complications relating to the AMPDS advice for women/pregnant people to lie on their back, or that it has ever been raised as a proposal for change. The risk of aortocaval compression and its safety implications for a woman/pregnant person and/or their baby is well documented in research and guidance. There is a mismatch between a recognised safety risk and the outcome evidence to substantiate the risk materialising in practice, regarding the AMPDS PAI for a woman/pregnant person to lie on their back.

5.5.6 The investigation learned from engagement across the healthcare system that local (hospital/trust level) investigations into poor outcomes for either a woman/ pregnant person or baby, do not routinely consider the clinical impact of the PAIs given by ambulance trust call handlers.

5.5.7 Local (hospital/trust) level investigations routinely consider care provided by the hospital trust; ambulance trust PAIs would only be considered by a hospital trust on an ad hoc basis if something mentioned by a family raised concerns.

5.5.8 The investigation learned that if a poor outcome for a woman/pregnant person or baby occurred after they had arrived at a hospital trust, the ambulance trust that provided PAIs and transported the patient would not routinely be made aware of the poor outcome. Therefore, it is not possible to determine the extent of cases where the AMPDS PAI for a woman/pregnant person to lie on their back could have contributed to a poor outcome. This also represents a potential missed opportunity for learning.

5.5.9 To fully understand the possible contribution to a poor outcome by any aspect of an end-to-end healthcare system requires investigation and consideration of the whole patient pathway. This allows a holistic, collaborative and system-wide approach to the identification of possible contributory causes, and potential for learning and improvement.

5.5.10 NHSE/I has developed national standards for patient safety investigations (NHS England and NHS Improvement, 2020). The standards support collaborative cross-boundary (across multiple care settings/care providers) investigation of patient safety incidents and the enabling of information sharing across the healthcare system.

5.5.11 The standards are however limited in explaining how this should be applied by investigators, stating that ‘PSIIs [patient safety incident investigations] involve other providers in all cross-pathway/boundary incidents’.

5.5.12 When there has been a poor outcome in hospital, as there was in the reference event, understanding when investigations need to be cross boundary is challenging. Guidance to support routine consideration of recent and relevant care by additional healthcare organisations that could have contributed to an outcome would enable patient safety issues in an end-to-end healthcare system to be identified. It would also provide the opportunity for these issues to be addressed.

5.5.13 Making this a requirement in the patient safety investigation standards (NHS England and NHS Improvement, 2020) would allow for holistic, cross-boundary local investigations as a matter of routine where care has recently been provided by additional healthcare organisations.

HSIB makes the following safety recommendation

Safety recommendation R/2022/182:

HSIB recommends that NHS England and NHS Improvement develops the content of the patient safety incident investigation (PSII) standards to further support cross-boundary investigations.

6 Summary of findings and safety recommendations

6.1 Findings

- There are two triage clinical decision support systems in use in England which provide different pre-arrival instructions for the same maternity clinical scenario for women/pregnant people who are waiting for an ambulance to arrive.

- Specific to a woman/pregnant person describing their symptoms as per the reference event, the two triage clinical decision support systems would provide noticeably different pre-arrival instructions for:
    - the collection of items in preparation for birth
    - how a woman/pregnant person should position them self (with regard to aortocaval compression, where the weight of the baby in the uterus presses on the main blood vessels in the woman's/pregnant person's abdomen, which can cause a restriction in oxygen supply to the baby)
    - umbilical cord clamping (if a woman/pregnant person gave birth before an ambulance arrived).
- Pre-arrival instructions used for triage of maternity emergencies are derived from guidance that has been developed by clinicians for clinicians working in a clinical environment, or from expert consensus of maternity specialists familiar with the pre-arrival environment.
- The different pre-arrival instructions across triage clinical decision support systems, for the same reported symptoms, have different clinical implications/ risks, creating a 'postcode lottery' of care.
- Where there is no definitive guidance to inform maternity pre-arrival instructions in the non-visual, non-clinician-attended environment (that is, where guidance is given over the phone, and there is no healthcare professional with the patient), expert opinion has been used.
- Stakeholders acknowledged a gap in maternity emergency guidance relating to the non-visual, non-clinician-attended environment.
- The investigation found no evidence of a regulatory mechanism for 999 call handler pre-arrival instructions.
- The investigation did not identify any 'poor outcome' evidence linking pre-arrival instructions given in the Advanced Medical Priority Dispatch System (AMPDS) clinical decision support system (for a woman/pregnant person to lie on their back) to a recognised patient safety risk (aortocaval compression).
- Local (hospital/trust level) investigations into poor outcomes for either a woman/ pregnant person or baby, do not routinely consider the clinical impact of pre-arrival instructions given by ambulance trust call handlers.

HSIB makes the following safety recommendations

Safety recommendation R/2022/180:

HSIB recommends that the Department of Health and Social Care commissions the National Institute for Health and Care Excellence to work with relevant stakeholders to develop guidance for maternity emergencies in the non-visual, non-clinician-attended environment.

Safety recommendation R/2022/181:

HSIB recommends that the Department of Health and Social Care identifies a suitable regulatory mechanism to provide formal oversight of 999 maternity pre-arrival instructions across NHS-funded care in England.

Safety recommendation R/2022/182:

HSIB recommends that NHS England and NHS Improvement develops the content of the patient safety incident investigation (PSII) standards to further support cross-boundary investigations.

7 References

Association of Ambulance Chief Executives. (n.d.a) National workstreams [Online]. Available at **https://aace.org.uk/national-programme/national-workstreams-programmes/** (Accessed October 2021).

Association of Ambulance Chief Executives. (n.d.b) JRCALC clinical practice guidelines [Online]. Available at **https://aace.org.uk/clinical-practice-guidelines/** (Accessed October 2021).

Association of Ambulance Chief Executives. (2019) JRCALC clinical guidelines. Cited from: iCPG (2016) (Version 1.3.11) [Mobile application software]. Bridgwater: Class Publishing Ltd. (Accessed December 2020).

Australian Transport Safety Bureau. (2008) Analysis, causality and proof in safety investigations [Online]. Available at **https://www.atsb.gov.au/media/27767/ar2007053.pdf** (Accessed January 2021).

Carbonne, B., Benachi, A., Lévèque, M. L., Cabrol, D. and Papiernik E. (1996) Maternal position during labor: effects on fetal oxygen saturation measured by pulse oximetry. Obstetrics and Gynecology, 88 (5), 797-800.

Department of Health and Social Care/Public Health England. (2021) Handbook to the NHS Constitution for England. Updated February 2021. [Online]. Available at **https://www.gov.uk/government/publications/supplements-to-the-nhs-constitution-for-england/the-handbook-to-the-nhs-constitution-for-england** (Accessed June 2021).

Healthcare Safety Investigation Branch. (n.d.) Maternity investigations – what we investigate [Online]. Available at **https://www.hsib.org.uk/what-we-do/maternity-investigations/what-we-investigate/** (Accessed September 2021).

Healthcare Safety Investigation Branch. (2020) National learning report. Intrapartum stillbirth: learning from maternity safety investigations that occurred during the COVID-19 pandemic, 1 April to 30 June 2020 [Online]. Available at **https://hsib-kqcco125-media.s3.amazonaws.com/assets/documents/HSIB_Intrapartum_Stillbirth_Report_web.pdf** (Accessed September 2021).

International Academies of Emergency Dispatch. (n.d.a) Homepage [Online]. Available at **https://www.emergencydispatch.org/home** (Accessed October 2021).

International Academies of Emergency Dispatch. (n.d.b) The medical priority dispatch system [Online]. Available at **https://www.emergencydispatch.org/what-we-do/emergency-priority-dispatch-system/medical-protocol** (Accessed October 2021).

Lee, S. W. Y., Khaw, K. S., Kee, W. D., Leung, T. Y. and Critchley, L. A. H. (2021) Haemodynamic effects from aortocaval compression at different angles of lateral tilt in non-labouring term pregnant women. British Journal of Anaesthesia, 109 (6), 950-956 [Online]. DOI: 10.1093/bja/aes349.

Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK. (2019) Saving lives, improving mothers' care [Online]. Available at **https://www.npeu.ox.ac.uk/assets/downloads/mbrrace-uk/reports/MBRRACE-UK%20Maternal%20Report%202019%20-%20WEB%20VERSION.pdf** (Accessed October 2021).

National Institute for Health and Care Excellence. (n.d.) Benefits of implementing NICE guidance [Online]. Available at **https://www.nice.org.uk/about/what-we-do/into-practice/benefits-of-implementing-nice-guidance** (Accessed October 2021).

National Institute for Health and Care Excellence. (2011) Caesarean birth. Clinical guideline [CG132] [Online]. Available at **https://www.nice.org.uk/guidance/cg132** (Accessed December 2020).

National Institute for Health and Care Excellence. (2014) Court judgement: what it means for commissioners and providers [Online]. Available at **https://www.nice.org.uk/news/feature/court-judgement-what-it-means-for-commissioners-and-providers-and-using-nice-guidance-and-standards** (Accessed October 2021).

National Institute for Health and Care Excellence. (2017) Intrapartum care for healthy women and babies. Clinical guideline [CG190] [Online]. Available at **https://www.nice.org.uk/guidance/cg190/resources/intrapartum-care-for-healthy-women-and-babies-pdf-35109866447557** (Accessed September 2021).

NHS. (2020) Signs that labour has begun [Online]. Available at **https://www.nhs.uk/pregnancy/labour-and-birth/signs-of-labour/signs-that-labour-has-begun/** (Accessed September 2021).

NHS. (2021) Vaginal bleeding [Online]. Available at **https://www.nhs.uk/pregnancy/related-conditions/common-symptoms/vaginal-bleeding/** (Accessed September 2021).

NHS Digital. (n.d.) NHS Pathways [Online]. Available at **https://digital.nhs.uk/services/nhs-pathways** (Accessed October 2021).

NHS England. (2018a) Commissioning framework: a framework for the commissioning of ambulance services [Online]. Available at **https://www.england.nhs.uk/wp-content/uploads/2018/09/commissioning-framework-and-national-urgent-and-emergency-ambulance-services-specification.pdf** (Accessed October 2021).

NHS England. (2018b) Ambulance Response Programme review [Online]. Available at **https://www.england.nhs.uk/wp-content/uploads/2018/10/ambulance-response-programme-review.pdf** (Accessed October 2021).

NHS England and NHS Improvement. (2020) National standards for patient safety investigation [Online]. Available at **https://www.england.nhs.uk/wp-content/uploads/2020/08/Standards_for_PSI_Investigation.pdf** (Accessed June 2021).

Pre-hospital Practical Obstetric Multi-Professional Training. (2020) Managing normal birth in pre-hospital settings.

Royal College of Midwives. (2018) Midwifery care in labour guidance for all women in all settings [Online]. Available at **https://www.rcm.org.uk/media/2539/professionals-blue-top-guidance.pdf** (Accessed September 2021).

Royal College of Obstetricians and Gynaecologists. (2011) Antepartum haemorrhage. Green-top guideline no. 63 [Online]. Available at **https://www.rcog.org.uk/globalassets/documents/guidelines/gtg_63.pdf** (Accessed September 2021).

Royal College of Obstetricians and Gynaecologists. (2015) Clamping of the umbilical cord and placental transfusion. Scientific impact paper no. 14 [Online]. Available at **https://www.rcog.org.uk/globalassets/documents/guidelines/scientific-impact-papers/sip-14.pdf** (Accessed September 2021).

Royal College of Obstetricians and Gynaecologists. (2019) Maternal collapse in pregnancy and the puerperium. Green-top guideline no. 56 [Online]. Available at **https://obgyn.onlinelibrary.wiley.com/doi/epdf/10.1111/1471-0528.15995** (Accessed September 2021).

Toivonen, S., Heinonen, S., Anttila, M., Kosma, V. M. and Saarikoski S. (2002) Reproductive risk factors, Doppler findings, and outcome of affected births in placental abruption: a population-based analysis. American Journal of Perinatology, 19 (8), 451-460.

Woolf, S. H., Grol, R., Hutchinson, A., Eccles, M. and Grimshaw, J. (1999) Potential benefits, limitations, and harms of clinical guidelines. BMJ, 318 (7182), 527-530 [Online]. Available at **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1114973/pdf/527.pdf** (Accessed September 2021).

World Health Organization. (n.d.) Optimal timing of cord clamping for the prevention of iron deficiency anaemia in infants [Online]. Available at **https://www.who.int/elena/titles/full_recommendations/cord_clamping/en/** (Accessed September 2021).

World Health Organization. (2014) Guideline: delayed umbilical cord clamping for improved maternal and infant health and nutrition outcomes [Online]. Available at **https://www.ncbi.nlm.nih.gov/books/NBK310511/pdf/Bookshelf_NBK310511.pdf** (Accessed September 2021).

8 Appendix

The investigation used the following diagrammatic method (see figure A), which is based on an Australian Transport Safety Bureau (2008) technique, to analyse the dynamics within the reference event and the wider healthcare system. The technique considers the vertical interaction among levels of a sociotechnical system (a system that involves people and technology), encompassing decision making through the levels of management and governance, as well as economic considerations and workload pressures.

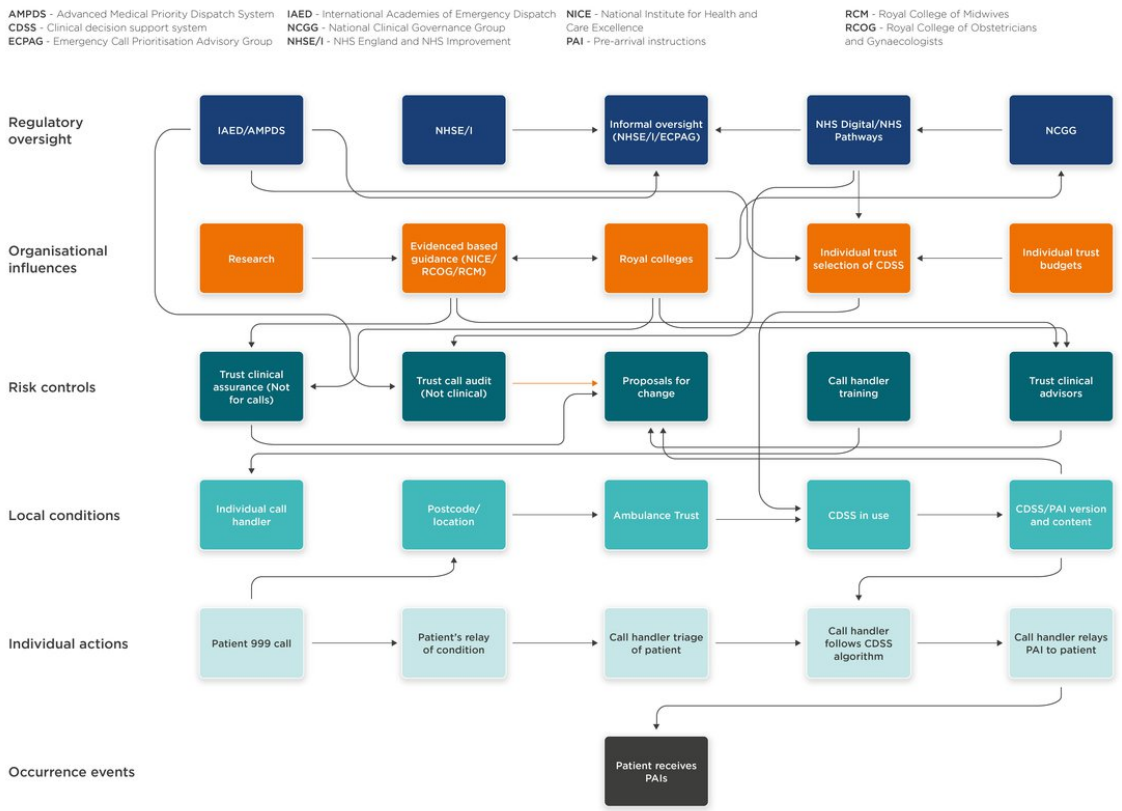


Figure A Analysis of the reference event using the Australian Transport Safety Bureau (2008) technique

Providing feedback and comment on reports

We welcome feedback on our investigation reports. Please complete our online feedback form or email enquiries@hssib.org.uk.

We aim to provide a response to all correspondence within five working days.