Time Matters

A review of the quality of care provided to patients aged 16 years and over who were admitted to hospital following an out-of-hospital cardiac arrest

NCEPOD

Improving the quality of healthcare

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A review of the quality of care provided to patients aged 16 years and over who were admitted to hospital following an out-of-hospital cardiac arrest

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Foreword

Rightly, our minds have been focussed in recent times on the terrible global pandemic, which has claimed so many lives. However, it is now more important than ever that we continue to consider the quality of care for the common every day conditions which continue throughout, and in the aftermath, of the emergency.

On the face of it, the UK does not perform as well as other countries when it comes to saving the lives of patients who suffer an out-of-hospital cardiac arrest. The authors point out the importance of a strong chain of survivability, starting with prompt recognition, early effective cardiopulmonary resuscitation (CPR), early shock for shockable rhythms, and ultimately, a structured approach to in-hospital care, as the last link in the chain. Warwick University have generously provided us with data from the Out-of-Hospital Cardiac Arrest Outcomes (OHCAO) Registry for the pre-hospital phase to help set the scene for this NCEPOD report.

This NCEPOD report focusses on that last link, in-hospital care, and identifies a number of areas for potential improvement. This includes some simple clinical issues such as temperature management, and some organisational issues such as prompt access to cardiologists and interventional cardiology procedures where appropriate.

There is a sense that some carers adopt a pessimistic approach from the outset, because of the poor overall survival of this group of patients. However, if prompt bystander CPR, prompt defibrillator shock and a systematic approach in hospital are achieved, outcomes improve markedly. This is important, because as this study shows, over half of the patients included were fit with a low frailty score at the time of their cardiac arrest.

As ever, I must thank all those involved in undertaking this study, which represents an enormous combined effort: our local reporters, the treating clinicians, the NCEPOD Steering Group and Trustees, and of course, the NCEPOD Clinical Co-ordinators who authored the report and the non-clinical staff who ultimately compiled the report.

I do hope that this report will stimulate those involved in caring for this group of patients to consider adopting the report's recommendations, so that we can aspire to improve outcomes in line with the best in the world.

Ian C Martin, Chair

Executive summary

Aim

The aim of this study was to identify variation and remediable factors in the processes of care provided to patients over the age of 16 years admitted to hospital following an out-of-hospital cardiac arrest (OHCA).

Method

Data were collected to review the clinical care delivered to patients from the time of an OHCA to discharge from hospital or death. Only patients with a sustained return of spontaneous circulation (ROSC) for at least 20 minutes, were included. Review of the clinical pathway included the community and emergency service response, hospital admission, and inpatient care, in particular cardiac and critical care services. Data were also collected to assess organisational aspects of care within acute hospitals.

Key messages

The five key messages here, agreed as the primary focus for action, have been derived from the report's recommendations (see pages 16-18 and Appendix 1).

1. Bystander Cardiopulmonary Resuscitation (CPR)
Ongoing strategies are needed at a population level to ensure that people who sustain an OHCA are treated rapidly with high quality resuscitation, including defibrillation, through a co-ordinated network of accessible and identifiable public access devices.

2. Advance treatment plans
When advance treatment plans are in place, they should be documented using a standard process (such as the ReSPECT form) to ensure that people receive treatments based on what matters to them and what is realistic. Effective communication between all parts of the healthcare system, including, primary care, community services, ambulance services and acute hospitals is then needed to ensure that appropriate decisions are made, irrespective of time or location.

3. Prediction of survival
No single factor is accurate enough for clinical decision-making at the time of admission to hospital following an OHCA. Time is needed to ensure an accurate assessment of prognosis can be made. Neurological prognosis is particularly difficult to assess, and this should be delayed for at least 72 hours after return of spontaneous circulation.

4. Targeted temperature management
Elevated temperature is common following an OHCA and is associated with a worse prognosis, but this can be improved by accurate, active temperature control. The current approach in clinical practice appears to be inconsistent and a more active approach is needed.

5. Rehabilitation
Physical, neurological, cardiac and emotional impairment following an OHCA can all affect quality of survival, and patients benefit from targeted rehabilitation and support. In some areas of the UK there is no provision of these services. These gaps should be closed by local clinical teams and commissioners working together.

Key messages aimed at improving the care of people admitted to hospital, with a return of spontaneous circulation, following an out-of-hospital cardiac arrest (OHCA)

PRE-HOSPITAL CARE

MESSAGE 1. BYSTANDER CARDIOPULMONARY RESUSCITATION, INCLUDING USE OF PUBLIC ACCESS DEFIBRILLATORS, IMPROVES OUTCOME

Patients whose OHCA was **witnessed** had a **2.5x greater chance of survival to hospital discharge** compared with an unwitnessed OHCA	**35.5%** (145/409) patients in this study who received **bystander CPR survived** to **hospital discharge** compared with **20.0%** (21/105) patients who did not	A **public access defibrillator** was used on **16.9%** (28/166) of the patients where a defibrillator was used. 18 of the 28 patients were discharged home

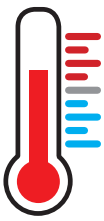
IN-HOSPITAL CARE

MESSAGE 2. STANDARDISING ADVANCE TREATMENT PLANS HELPS PATIENTS RECEIVE REALISTIC TREATMENT BASED ON THEIR WISHES E.G. 'DO NOT ATTEMPT CARDIOPULMONARY RESUSCITATION' (DNACPR) DECISIONS

3.2% (21/661) of patients had a **DNACPR** decision in place **prior** to the admission and a further **48.9%** (323/661) had a DNACPR decision made **during** the **admission**	An **electronic system** for **advanced care directives that included DNACPR** decisions was in place in **36.5%** (65/178) of hospitals	**Integration** of electronic systems with **ambulance** services was in place in **23/65** hospitals and with **general practice** in **36/65** hospitals

MESSAGE 3. DELAYING THE ASSESSMENT OF NEUROLOGICAL PROGNOSIS BY AT LEAST 72 HOURS AFTER THE RETURN OF SPONTANEOUS CIRCULATION AIDS DECISION-MAKING

Formal prognostication took place in **48.0%** (134/279) of patients where it was indicated	**Timing** of neuroprognostication was **not appropriate** for **19.8%** (26/131) of patients in the view of the case reviewers	The final assessment of **neurological prognosis** was made **<72 hours** after hospital admission for **57/84** patients



MESSAGE 4. ENSURE GOOD TEMPERTATURE CONTROL IS USED FOLLOWING AN OHCA AS UNCONTROLLED TEMPERATURE IS ASSOCIATED WITH A WORSE OUTCOME

A **policy** for **targeted temperature management** was available in **77.8%** (130/167) of hospitals	**41.4%** (104/253) patients admitted to **intensive care** within 24 hours of return of spontaneous circulation, **did not receive targeted temperature management** when it was indicated	**Temperature management** was rated as **'good'** in only **18.7%** (41/219) of patients and as **'poor or unacceptable'** in **57.5%** (126/219) patients

ONGOING CARE

MESSAGE 5. PROVIDE ONGOING PHYSICAL, NEUROLOGICAL, CARDIAC AND EMOTIONAL SUPPORT TO ENSURE GOOD QUALITY OF LIFE FOR SURVIVORS OF AN OHCA

71.1% (133/187) of OHCA survivors were assessed for **physical rehabilitation**	**29.4%** (55/187) of OHCA survivors were assessed for **neurological rehabilitation**	**59.0%** (72/122) of OHCA survivors were offered **cardiac rehabilitation** (where applicable)	**20.0%** (21/105) of OHCA survivors were offered **psychological review**

Recommendations

These recommendations have been formed by a consensus exercise including all those listed in the acknowledgements. Please see Appendix 1 for how the key findings in the report support the recommendations. In addition the recommendations have been independently edited by medical editors experienced in developing recommendations for healthcare audiences to act on.

The recommendations highlight a number of areas that are suitable for regular local clinical audit and quality improvement initiatives by services providing care to patients admitted after an out-of-hospital cardiac arrest (OHCA), to address any areas of care that are below the expected standard.

The result of local audits or quality improvement initiatives should be presented at quality or governance meetings. Action plans to improve OHCA care should be shared with executive boards.

Executive boards are ultimately responsible for supporting the implementation of these recommendations. Suggested target audiences to action recommendations are listed in italics under each recommendation. The primary target audience/audiences are in bold.
The term 'healthcare professionals' includes, but is not limited to, doctors, surgeons, nurses, general practitioners, physiotherapists, speech and language therapists and occupational therapists

	RECOMMENDATIONS
1	Implement whole population strategies to increase the rate of cardiopulmonary resuscitation (CPR) by bystanders and the use of public access defibrillators. ***Target audiences: Public health departments of all UK countries and Crown Dependencies**, with support from the Resuscitation Council UK*
2	Put effective systems in place to share existing advance treatment plans (such as ReSPECT*) between primary care services, ambulance trusts and hospitals so that people receive treatments based on what matters to them and what is realistic in terms of their care and treatment. ***Target audiences: Local commissioners,** with support from primary care, ambulance trusts and care home providers* ** www.resus.org.uk/respect*
3	Do not use a single factor such as time to the return of spontaneous circulation, blood lactate or pH to make decisions about organ support or interventions in critical care. No single factor on admission accurately predicts survival after an out-of-hospital cardiac arrest. ***Target audiences: All clinicians** who see patients after an out-of-hospital cardiac arrest and relevant clinical directors*

4	Optimise oxygenation for patients with a return of spontaneous circulation as soon as possible after hospital admission, by: • Measuring arterial blood gasses • Prescribing oxygen • Documenting inspired oxygen concentration (or flow rate) and • Monitoring oxygen saturation • Adjusting inspired oxygen concentration to achieve an arterial oxygenation saturation target of 94–98% ***Target audiences: All clinicians*** *who see patients after an out-of-hospital cardiac arrest and relevant clinical directors*
5	On admission after an out-of-hospital cardiac arrest, prioritise patients for coronary intervention, in line with the European Society of Cardiology current guidelines, because a primary cardiac cause for their cardiac arrest is likely. ***Target audiences: All clinicians*** *who see patients after an out-of-hospital cardiac arrest and cardiology leads*
6	Use active targeted temperature management during the first 72 hours in critical care to prevent fever (temperature over 37.5°C) in unconscious patients after an out-of-hospital cardiac arrest. ***Target audiences: Critical care leads*** *and critical care clinical staff* *See also the Resuscitation Council UK guidelines* *www.resus.org.uk/library/2015-resuscitation-guidelines/guidelines-post-resuscitation-care#1-the-guidelines*
7	Assess neurological prognosis in unconscious patients after an out-of-hospital cardiac arrest, using at least two of the following methods: • Clinical assessment • Imaging • Neurophysiological assessment (including electroencephalogram, to exclude subclinical seizures and improve accuracy) • Biomarkers ***Target audiences: Critical care leads*** *and critical care clinical staff*
8	Delay the final assessment of neurological prognosis after an out-of-hospital cardiac arrest until AT LEAST 72 hours after return of spontaneous circulation AND the effects of sedation and temperature management can be excluded. This will ensure a reliable assessment. Repeat the assessment if there is any doubt. ***Target audiences: Critical care leads*** *and critical care clinical staff* *See also the Resuscitation Council UK guidelines* *www.resus.org.uk/library/2015-resuscitation-guidelines/guidelines-post-resuscitation-care#1-the-guidelines*
9	Actively explore the potential for organ donation in all patients after an out-of-hospital cardiac arrest and return of spontaneous circulation, who have a planned withdrawal of life sustaining treatment. ***Target audiences: Critical care leads*** *and critical care clinical staff* **Note the different legal positions in the UK countries*

10	Identify all survivors of an out-of-hospital cardiac arrest who would benefit from physical rehabilitation before hospital discharge and ensure this is offered to them. ***Target audiences: The clinical team caring for the patient after an out-of-hospital cardiac arrest,*** *supported by the physiotherapy service lead*
11	Identify all inpatient survivors of an out-of-hospital cardiac arrest who would benefit from **cardiac** rehabilitation before hospital discharge and ensure this is offered to them. ***Target audiences: The clinical team caring for the patient after an out-of-hospital cardiac arrest,*** *supported by the cardiac rehabilitation service lead.* ***Commissioners****, where these services are not already in place*
12	Identify all inpatient survivors of an out-of-hospital cardiac arrest who would benefit from **neurological** rehabilitation before hospital discharge and ensure this is offered to them. ***Target audiences: The clinical team caring for the patient after an out-of-hospital cardiac arrest,*** *supported by the neurological rehabilitation service lead.* ***Commissioners****, where these services are not already in place*
13	Identify all inpatient survivors of an out-of-hospital cardiac arrest who would benefit from **psychological** intervention before hospital discharge and support and ensure this is offered to them. ***Target audiences: The clinical team caring for the patient after an out-of-hospital cardiac arrest,*** *supported by the clinical psychology service lead.* ***Commissioners****, where these services are not already in place*

Introduction

Reducing deaths from cardiovascular disease is a key NHS priority[1-5] and NCEPOD has previously reported on the care of people with in-hospital cardiac arrests in the 2012 report '*Time to Intervene?*'.[6]

The incidence of out-of-hospital cardiac arrest (OHCA) in the UK is approximately 60,000 per year[7] and UK ambulance services attempt resuscitation in an estimated 30,000 people per year.[8] Figures from England alone have shown considerable variation in both the rate of return of spontaneous circulation (ROSC) at hospital handover (13-27%) and the rate of survival to hospital discharge (2.2%-12%).[9] This means that, on average, fewer than one in ten people in the UK survive an OHCA. When compared with the performance reported by international exemplar healthcare systems (where OHCA survival rates include 21% [Seattle, USA], 21% [Netherlands], and 25% [Norway]), even the best UK-reported outcomes could be improved.[10-12]

In the 2013 Department of Health Cardiovascular Disease Outcomes Strategy, it was estimated that if the survival rate in England could be increased to between 10% and 11%, more than 1,000 lives would be saved each year. If survival rates could be improved to match Norway's healthcare system, for example, a further 3,250 lives could be saved annually.[13,14]

The four links in the OHCA 'Chain of Survival'[15] are:

1. Early recognition of cardiac arrest and call for help
2. Early bystander cardiopulmonary resuscitation (CPR)
3. Early defibrillation
4. Early advanced life support and standardised post-resuscitation care

Since 2013, the Out-of-Hospital Cardiac Arrest Outcomes (OHCAO) Registry has been collecting comprehensive data annually covering the first three links in the 'Chain of Survival' from ambulance services in England for both children and adults.[14] Registry data have shown improvements over time in the rates of bystander CPR and early defibrillation. These remain important targets for improvement in OHCA survival, particularly in the context of the COVID-19 pandemic where data from countries that experienced an early surge in cases shows an increased frequency of OHCA, a reduction in bystander CPR, longer delays to intervention and worse hospital outcomes.[16,17] Data from the registry have been provided to NCEPOD, and are presented later in this section to set the scene for the in-hospital care that has been reviewed by NCEPOD.

The fourth link in the 'Chain of Survival' requires trained individuals to provide advanced life support and includes the subsequent in-hospital care of OHCA once ROSC has been achieved. The lack of an ICD-10 code for OHCA makes it difficult to identify this group of patients retrospectively on routine national data collections.

The fourth link in the chain also includes percutaneous coronary intervention (PCI) for acute coronary syndromes (ST-elevation [STEMI] and non-ST-elevation [nSTEMI] myocardial infarction).[18] Improved access to PCI is one factor that has resulted in more people surviving an OHCA, but not all hospitals where patients with an OHCA are admitted have PCI services.[19] The British Cardiovascular Intervention Society (BCIS) data from 2016, recorded that 1,558 people who were ventilated following OHCA, underwent primary PCI.[19] Furthermore, data from the Intensive Care National Audit & Research Centre (ICNARC) indicate that around 5,000 patients are admitted to intensive care units (ICU) in England, Wales and Northern Ireland following an OHCA, spending an average of five days there. PCI may occur before ICU admission or while on ICU, with variation in practice between centres.[20]

Non-cardiac causes of cardiac arrest must also be considered, investigated and treated. Patients without coronary artery disease may require assessment by a heart rhythm specialist and some will receive implantable cardioverter-defibrillators (ICDs).[21]

In the ICU, targeted temperature management is recommended for at least 24 hours after OHCA and hyperthermia (temperature greater than 37.5°C) should be avoided for 72 hours after ROSC.[15,22]

For patients who are comatose, neurological prognosis should be assessed using a multi-modal approach, and decisions regarding neurological prognosis deferred until at least 72 hours after ROSC.[15] Some survivors have neurological impairment and require early neurorehabilitation to maximise their functional status. The median length of stay in hospital for survivors of OHCA admitted to ICU is 20 days.[23] It has been recommended that there should be protocols for OHCA available in hospitals, including decision aids for when and where to admit, duration of ICU stay, prognostication, withdrawal of life-sustaining treatment and organ donation.[24] Increases in survival rates and improvements in the quality of life after surviving an OHCA, can be realised by better immediate responses to OHCA and optimal early hospital treatment.[25] This NCEPOD study was therefore designed to identify opportunities to improve the organisation of services and the clinical care of patients following an OHCA, to enhance the overall quality of care they receive.

Out-of-Hospital Cardiac Arrest Outcomes Registry

Data provided by Warwick University

These registry data were analysed for data collected between 1st January and 31st December 2018, the same study period as the data for the NCEPOD in-hospital review. In 2018, there were 30,829 emergency service (EMS) attempted resuscitations reported to the Out-of-Hospital Cardiac Arrest Outcomes (OHCAO) Registry (Figure A). Of these patients, 15,869/30,829 (51.5%) were transferred to hospital and 9,019/15,869 (56.8%) patients had a return of spontaneous circulation (ROSC) at hospital handover (these were also used as inclusion criteria in the NCEPOD review).

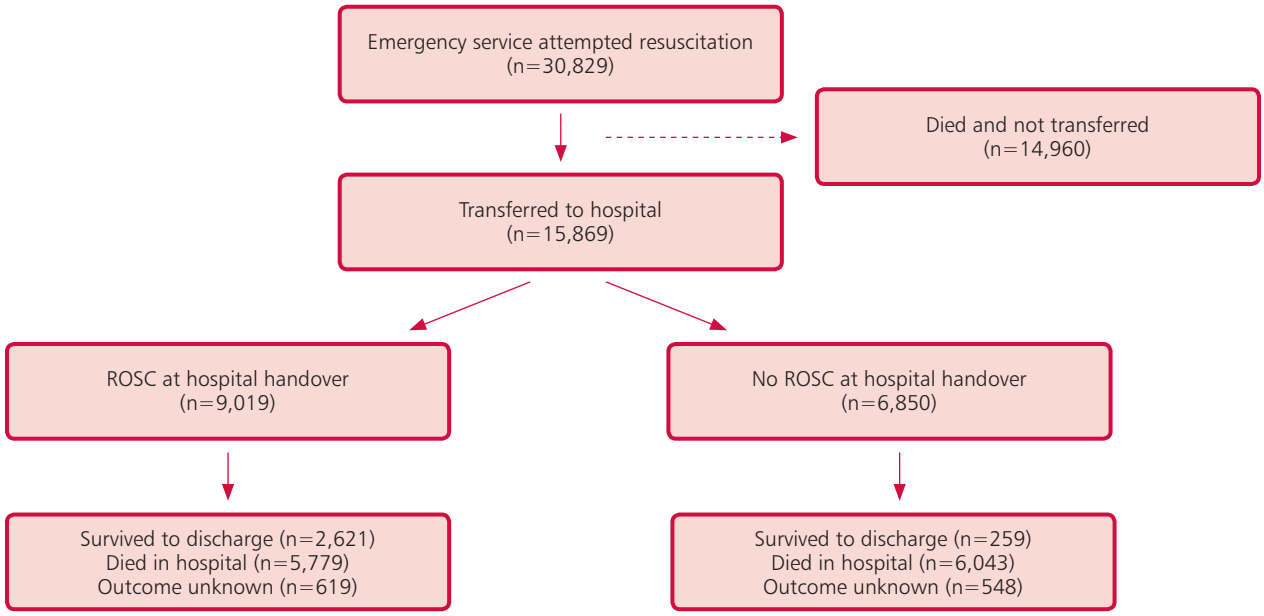


Figure A Out-of-Hospital Cardiac Arrest Outcomes Registry patient data

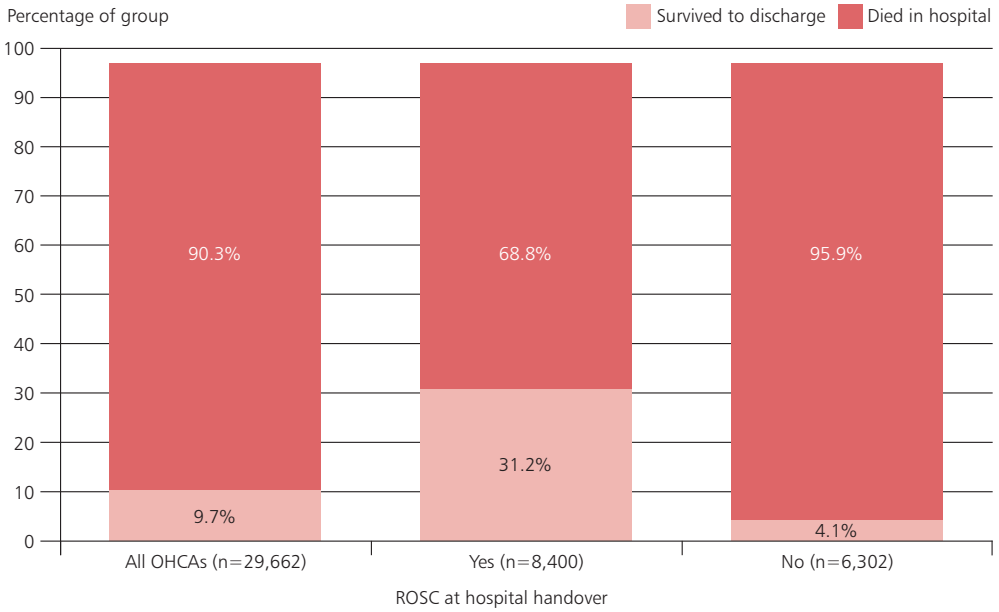


Figure B Restoration of circulation and outcome
Registry data

The first priority in resuscitation attempts is to restore the circulation. The importance of this is illustrated by the overall outcome. The overall survival to discharge for all patients with OHCA reported to the registry was 2,880/29,662 (9.7%). Of the patients with ROSC at hospital handover, 2,621/8,400 (31.2%) survived to discharge from hospital. It is, however, important to note that 259/6,302 (4.1%) patients where ROSC had not been achieved at hospital handover, survived to hospital discharge (Figure B).

Early recognition of cardiac arrest

The chance of rapid-onset basic life support and access to additional treatments is increased if the cardiac event is witnessed. In the complete dataset, 18,928/30,829 (61.4%) cardiac arrests were witnessed. A greater proportion of patients with ROSC at hospital handover had a witnessed (bystander or EMS) cardiac arrest (6,868/9,019; 76.2%) (Figure C).

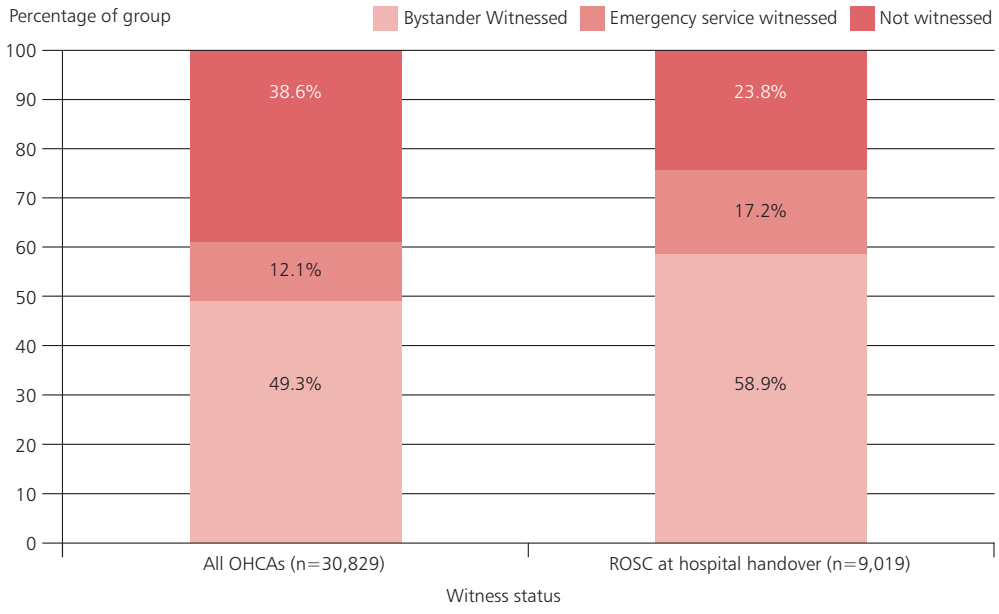


Figure C Return of spontaneous circulation (ROSC) and out-of-hospital cardiac arrest (OHCA) witness status
Registry data

Early bystander cardiopulmonary resuscitation (CPR)

Once a cardiac arrest has been recognised, the next link in the 'Chain of Survival' is early CPR. Of the cardiac arrests that were witnessed, 11,195/15,184 (73.7%) people received bystander CPR. In contrast, if the cardiac arrest was not witnessed, bystander CPR was commenced in 7,526/11,901 (63.2%) of people (Figure D). The equivalent data for patients with ROSC at hospital handover showed a slightly higher percentage of people (4,015/5,313; 75.6%) received bystander CPR when the arrest was witnessed and a slightly lower percentage (1,301/2,151; 60.5%) when the arrest was not witnessed. The effectiveness of rapid access to treatment for witnessed cardiac arrests and the importance of bystander CPR was illustrated by the outcome in these groups (Figures E and F overleaf).

For unwitnessed OHCAs, 499/11,901 (4.2%) patients survived to hospital discharge compared with 1,645/15,184 (10.8%) for bystander-witnessed OHCAs. When the OHCA was witnessed by the EMS, the survival rate was even higher (736/3,744; 19.7%). This further illustrates the importance of rapid access to high quality CPR and defibrillation.

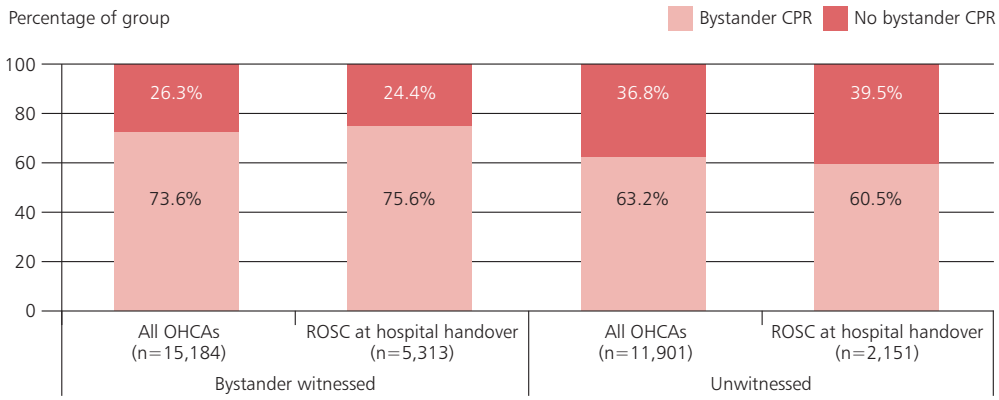


Figure D Return of spontaneous circulation (ROSC) and out-of-hospital cardiac arrest (OHCA) witnessed status and bystander cardiopulmonary resuscitation (CPR)
Registry data

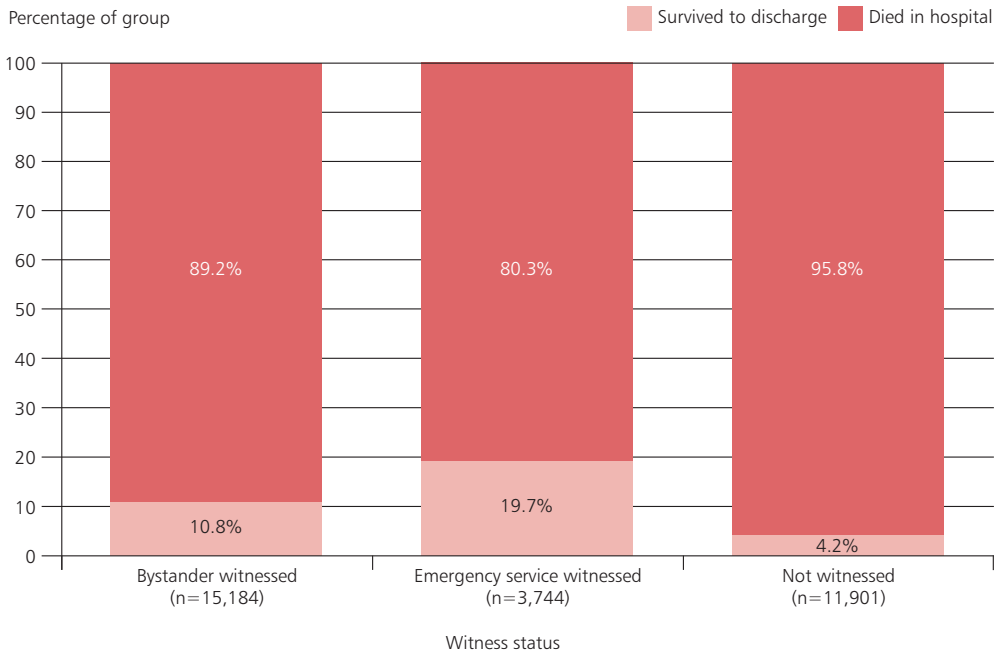


Figure E Out-of-hospital cardiac arrest witness status and outcome
Registry data

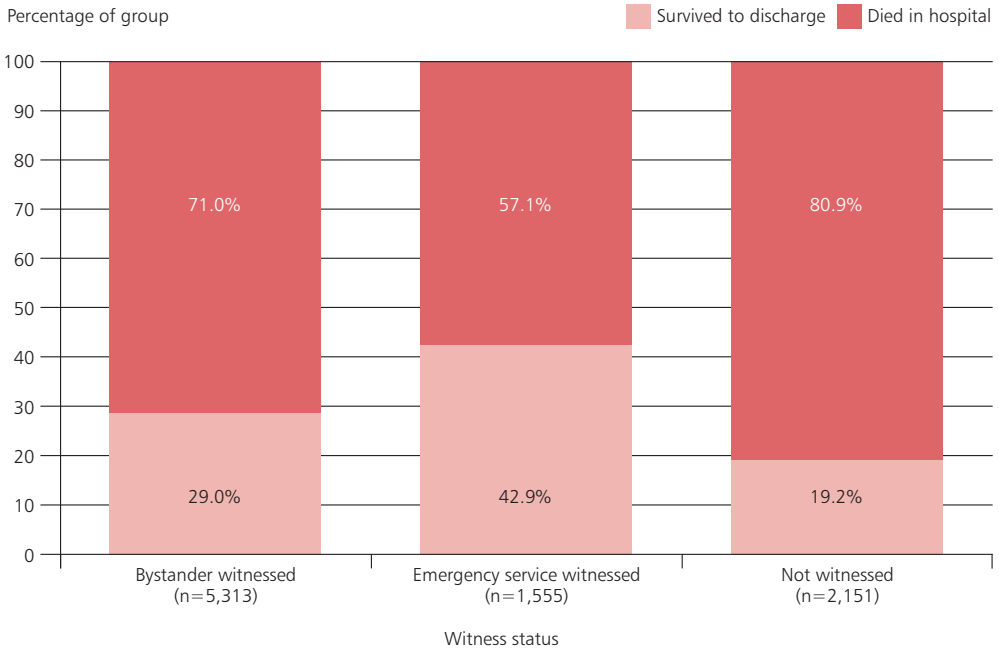


Figure F Witness status and outcome for out-of-hospital cardiac arrests with return of spontaneous circulations at hospital handover
Registry data

A similar pattern was seen for the ROSC at hospital handover (Figure F), but with better outcomes as would be expected for the sub-population of patients in whom ROSC was achieved. Survival rates in the group with ROSC at hospital handover were: unwitnessed, 412/2,151 (19.2%); bystander witnessed, 1,542/5,313 (29.1%); and EMS witnessed, 667/1,555 (42.9%).

Survival to discharge was also higher if bystander CPR was commenced (1,618/18,721; 8.6% vs 526/8,364; 6.3%). This was also true for the sub-population of patients who had ROSC at hospital handover (1,492/5,337; 28.0% vs 471/2,152; 21.9%) (Figure G).

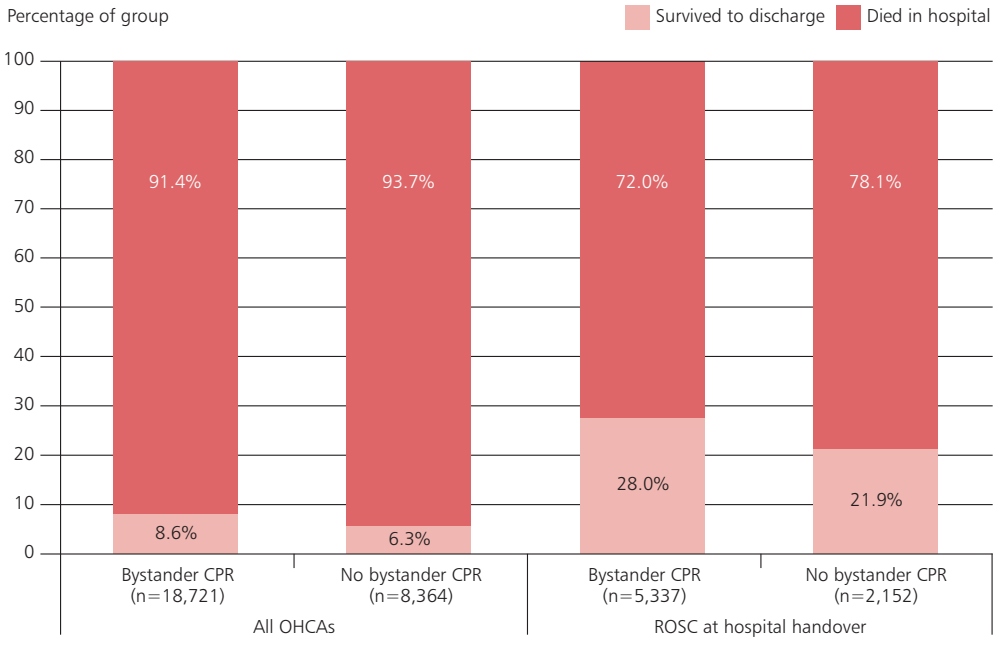


Figure G Return of spontaneous circulation, bystander cardiopulmonary resuscitation and outcome
Registry data

Early defibrillation

Once a cardiac arrest has been recognised and CPR has been started, the next important step in the 'Chain of Survival' for those with a shockable rhythm, is early defibrillation. Registry data showed that the initial rhythm was shockable in 6,722/29,508 (22.8%) people sustaining an OHCA. The corresponding figure for the patients who had ROSC at hospital handover was 3,482/8,430 (41.3%), reflecting the impact of shockable rhythm and achievement of ROSC (Figure H).

The importance of identifying the initial rhythm and early defibrillation was further emphasised by the outcome data. Survival to discharge was ten times greater in patients who had a shockable rhythm compared with patients who had a non-shockable rhythm (1,984/6,722; 29.5% vs 636/22,786; 2.8%) (Figure I). For patients with ROSC at hospital handover, survival to discharge was 1,863/3,482 (53.5%) vs 533/4,948 (10.8%) for shockable compared to non-shockable rhythms.

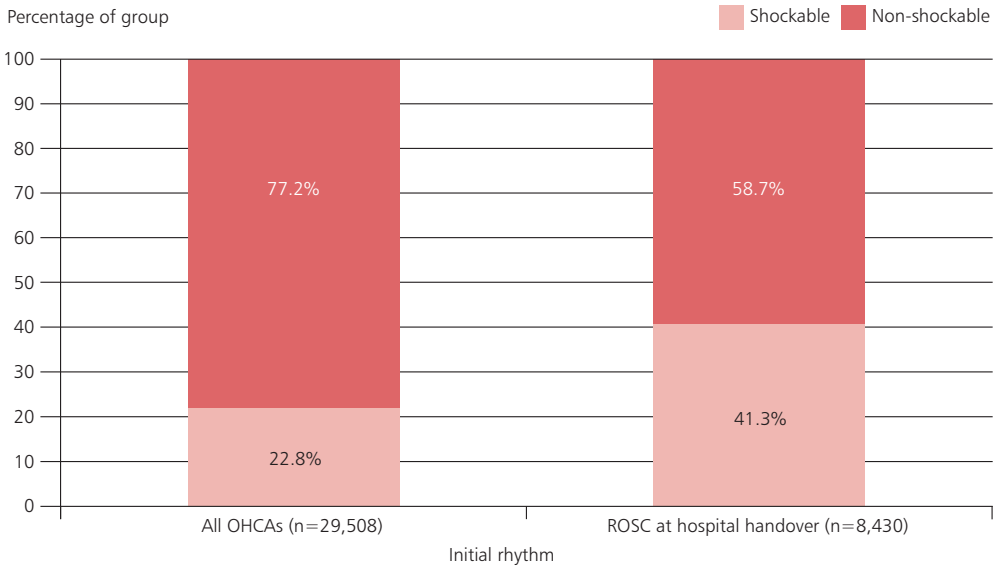


Figure H Return of spontaneous circulation (ROSC) after out-of-hospital cardiac arrest (OHCA) and initial rhythm
Registry data

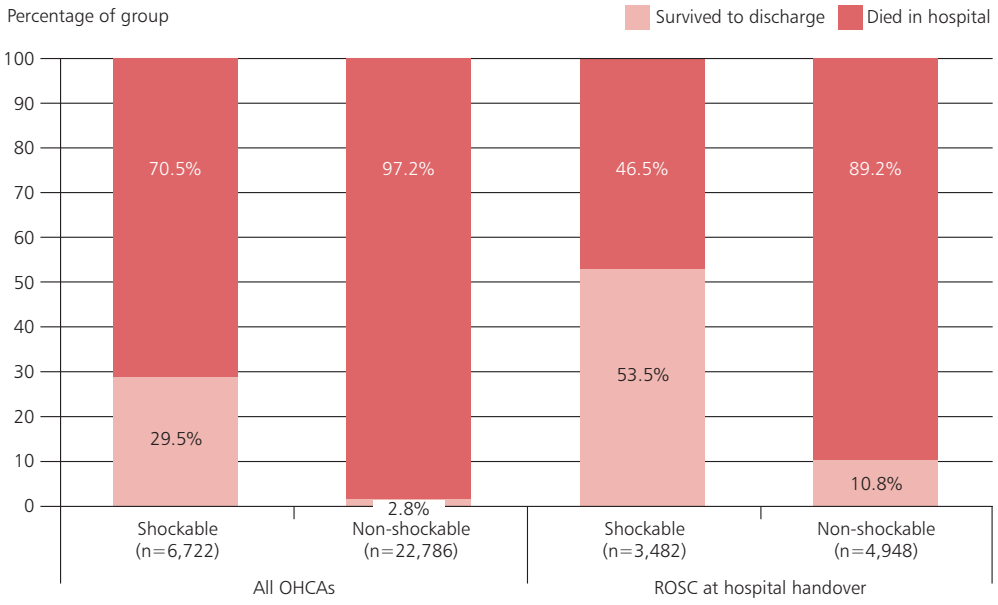


Figure I Initial rhythm and survival to hospital discharge for all out-of-hospital cardiac arrests (OHCA) and for people who had a return on spontaneous circulation (ROSC)
Registry data

1

Method and data returns

Study Advisory Group

A multidisciplinary group of clinicians was convened to define the objectives of the study and advise on the key questions. The Study Advisory Group (SAG) comprised healthcare professionals in emergency medicine, cardiology, acute medicine, critical care, anaesthetics and paramedics, and lay/patient representatives. This group steered the study from design to completion.

Study aim

To identify variation and remediable factors in the processes of care provided to patients over the age of 16 years admitted to hospital following an out-of-hospital cardiac arrest (OHCA).

Objectives

The SAG identified a number of objectives that would address the primary aim of the study. These included:

- Phases and consistency of care
- Pre-hospital, emergency department and cardiac pathways
- Critical care
  - Method/frequency of temperature control
  - How and when prognostication was undertaken
  - Withdrawal of treatment
- Assessment by heart rhythm specialists
- Availability of rehabilitation support
- Agreed management protocols and adherence to them

Study population and sampling criteria

Inclusion

- Adult patients (aged 16 years and older) who arrived in hospital after sustaining an OHCA and achieved subsequent sustained return of spontaneous circulation (ROSC) for more than 20 minutes.

Exclusion

- Patients admitted to hospital following an OHCA and ROSC, but where the OHCA was due to trauma, drowning, drug overdose or poisoning.
- Patients whose cardiac arrest occurred during inter-hospital transfers or on acute NHS hospital premises.

Sampling criteria

- All patients meeting the inclusion criteria from 1st January to 31st December 2018, inclusive, were notified to NCEPOD.
- From the whole group, a maximum of nine patients per hospital were randomly selected and data on their care collected.

Hospital participation

NHS hospitals in England, Scotland, Wales and Northern Ireland were expected to participate, as well as public hospitals in the Isle of Man, Guernsey and Jersey.

Data collection

Spreadsheet

A pre-set spreadsheet was provided to every local reporter to identify all patients meeting the study inclusion criteria during the defined time period. From this initial cohort, the sampling for inclusion into the study took place.

Questionnaires
Two questionnaires were used to collect data for this study: a clinician questionnaire for each patient and an organisational questionnaire for each participating hospital.

Clinician questionnaire
This questionnaire was sent to the named consultant caring for the patient at the time of their admission to hospital/ emergency department episode, post-OHCA. Information was requested on the patient's presenting features, initial response, management in critical care (including temperature management and prognostication), cardiology input, discharge, follow-up and organ donation.

Organisational questionnaire
The data requested in this questionnaire included information on the services provided for patients post-OHCA, guidelines and policies relevant to the care of patients sustaining an OHCA, and the availability of specific investigations and interventions.

Case notes
Copies of case note extracts were requested for peer review:

- Ambulance service notes / patient report form (PRF)
- Emergency department clerking proforma / records
- All inpatient annotations including medical and nursing notes
- Critical care notes / charts
- Operation/procedure notes
- Computed tomography (CT) / magnetic resonance imaging (MRI) scans / electrocardiogram (ECG) reports
- Anaesthetic charts
- Observation, fluid balance and drug charts
- Haematology / biochemistry / microbiology results
- Blood gas reports
- Consent forms
- Datix or other serious incident reports
- Autopsy report if applicable
- Do not attempt cardiopulmonary resuscitation forms/ treatment escalation forms
- Discharge letter / summary

Peer review of the case notes and questionnaire data

A multidisciplinary group of case reviewers comprising consultants, trainees and clinical nurse specialists from: cardiology, anaesthesia, intensive care medicine, acute medicine, emergency medicine, interventional radiology and specialist nursing was recruited to peer review the case notes and associated clinician questionnaires.

Questionnaires and case notes had all patient identifiers removed by non-clinical staff at NCEPOD before being presented to the group. Each set of case notes was reviewed by at least one reviewer within a small multidisciplinary meeting using a semi-structured electronic questionnaire. At regular intervals throughout the meeting, the Chair allowed a period of discussion for each reviewer to summarise their cases and ask for opinions from other specialties or raise aspects of the case for discussion.

The grading system below was used by the case reviewers to grade the overall care each patient received:

- **Good practice:** A standard that you would accept from yourself, your trainees and your institution
- **Room for improvement:** Aspects of **clinical** care that could have been better
- **Room for improvement:** Aspects of **organisational** care that could have been better
- **Room for improvement:** Aspects of both **clinical and organisational** care that could have been better
- **Less than satisfactory:** Several aspects of clinical and/or organisational care that were well below the standard that you would accept from yourself, your trainees and your institution
- **Insufficient data:** Insufficient information submitted to NCEPOD to assess the quality of care

Information governance

All data received and handled by NCEPOD complied with all relevant national requirements, including General Data Protection Regulation 2016 (Z5442652), Section 251 of the NHS Act 2006 (PIAG 4-08(b)/2003, App No 007), PBPP (1718-0328) and the Code of Practice on Confidential Information.

Each patient was allocated a unique NCEPOD number. The data from all questionnaires were submitted through a dedicated online application. Prior to any analysis taking place, the data were cleaned to ensure that there were no duplicate records and that erroneous data had not been entered. Any fields that contained data that could not be validated were removed.

Data analysis

Following cleaning of the quantitative data, descriptive data summaries were produced. Qualitative data collected from the case reviewers' opinions and free-text answers in the clinician questionnaires were coded, where applicable, according to content to allow quantitative analysis. The data were reviewed by NCEPOD clinical co-ordinators and a clinical researcher and researcher to identify the nature and frequency of recurring themes.

Data analysis rules

Small numbers were supressed if they risked identifying an individual.
Any percentage under 1% has been presented as <1%.
Percentages were not calculated if the denominator was less than 100 except for comparison of percentage across a group.
If data were not displayed in a table or figure the text has been referenced with '(data not shown)'
Anonymised case studies have been used to illustrate particular themes.

The findings of the report were reviewed by the SAG, case reviewers, NCEPOD Steering Group including clinical co-ordinators, trustees and lay representatives prior to publication. In addition the recommendations were independently edited and the report proofread by two external proof readers.

Data returns

Clinical data

In total 9,422 patients were identified as meeting the study inclusion criteria (Figure 1.1). Up to nine patients per hospital were randomly selected for review of their care. This resulted in 1,469 patients being included in the initial sample. A total of 423/1,469 (28.8%) patients were excluded as they did not meet the study inclusion criteria when the case notes were reviewed locally. The most common reason for exclusion was that sustained ROSC was not achieved. For the remaining sample, 699/1,046 (66.8%) completed clinician questionnaires were included in the analysis and a representative sample of 416/1,046 (39.8%) sets of notes were peer reviewed by the case reviewers.

Organisational data

Organisational questionnaires were returned from 182/220 (82.7%) hospitals.

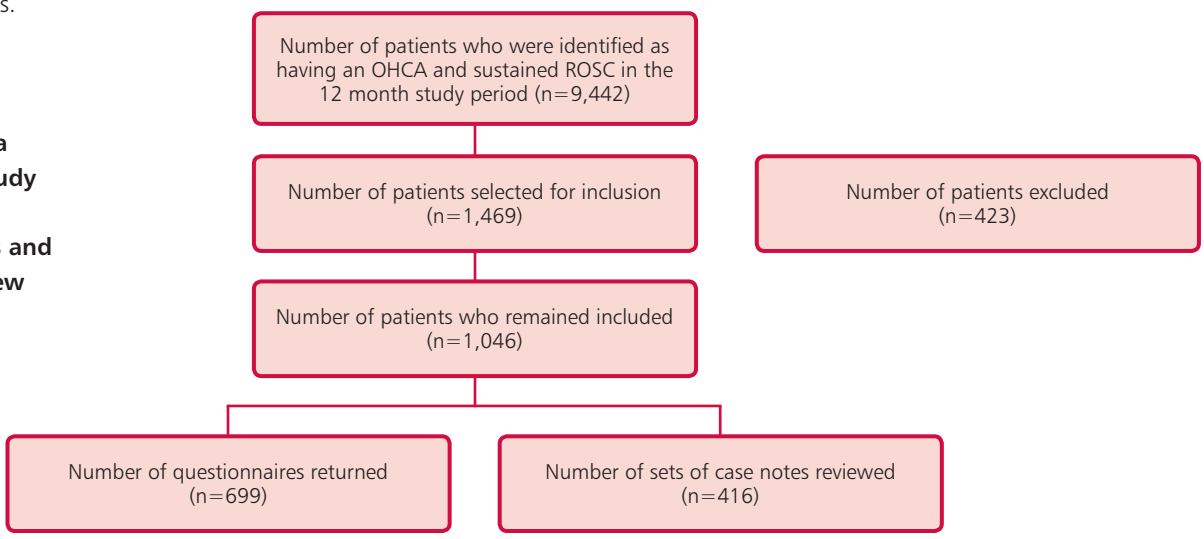


Figure 1.1 Data returns and study inclusion for questionnaires and case note review

2

Study population

The mean age of the patients included in the study was 63.5 years (male 63.3 and female 64.0); 81/416 (19.5%) were 50 years or younger. Of the group 271/416 (65.1%) patients were male and 145/416 (34.9%) were female (Figure 2.1).

The Rockwood Clinical Frailty Scale was originally validated in the assessment of frailty in those aged 65 years or older.[26] This scale was used to obtain a global assessment of the functional status of all patients in the study prior to their out-of-hospital cardiac arrest (OHCA). The majority of patients in the study (204/357; 57.1%) were very fit, well or managing well. In the fittest three categories with no or minimal functional impairment, 133/177 (75.1%) patients were under 65 years and 71/180 (39.4%) patients were 65 years or older.

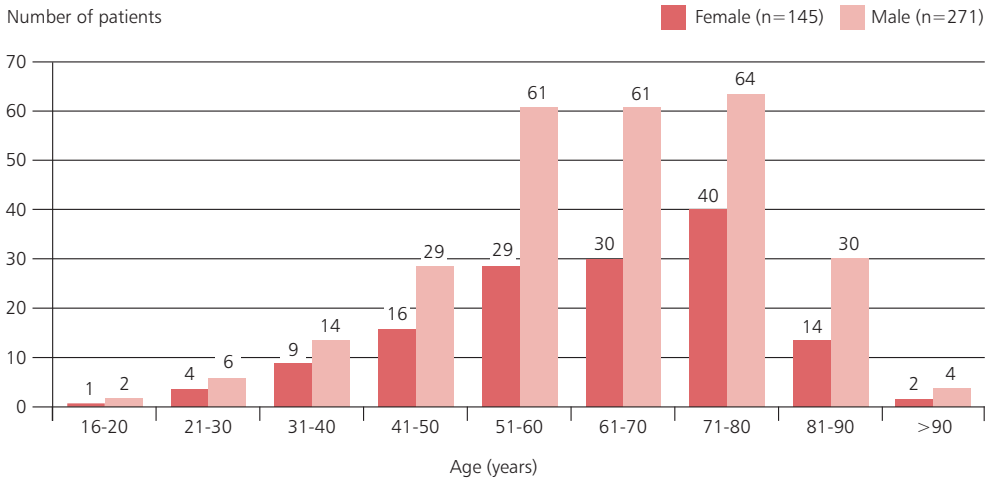


Figure 2.1 Age distribution of the study sample population
Case reviewer data

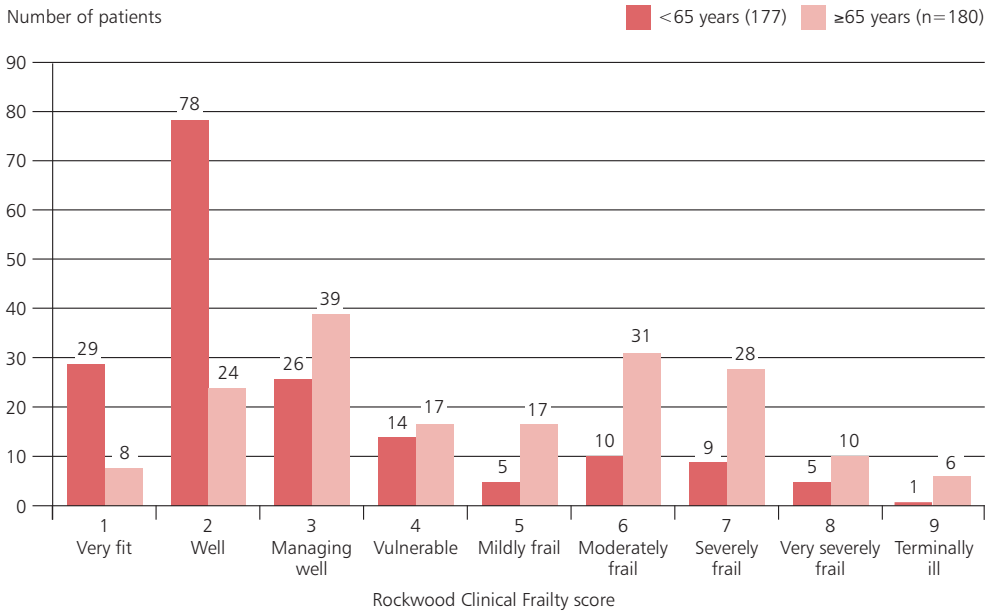


Figure 2.2 Rockwood Clinical Frailty Score of patients prior to the out-of-hospital cardiac arrest, by age
Case reviewer data

The majority of patients (357/415; 86.0%) had a previous medical history that the reviewers considered was relevant to the cardiac arrest (Table 2.1).

Table 2.1 Past medical history relevant to the out-of-hospital cardiac arrest

	Number of patients	%
Yes	357	86.0
No	58	14.0
Subtotal	**415**	
Unknown	1	
Total	**416**	

Case reviewer data

The most common specific conditions were hypertension, ischaemic heart disease, diabetes and chronic respiratory disease (Table 2.2).

Table 2.2 Past medical history

	Number of patients	%
Hypertension	129	31.1
Ischemic heart disease	105	25.3
Diabetes mellitus	93	22.4
Chronic respiratory disease	81	19.5
Smoking	63	15.2
Cardiac failure	34	8.2
Alcohol abuse	33	8.0
Previous percutaneous coronary intervention	27	6.5
Stroke	27	6.5
Previous coronary surgery	22	5.3
Implantable pacemaker	20	4.8
Epilepsy	16	3.9
Previous cardiac arrest	15	3.6
Dementia	13	3.1
Other drug abuse	11	2.7
Venous thromboembolism	10	2.4
Previous cardiac surgery	10	2.4
Implantable defibrillator	8	1.9
Cocaine abuse	5	1.2
Renal dialysis	4	1.0

Answers may be multiple; n=415
Case reviewer data

A small subset of patients (21/661; 3.2%) of patients already had a 'do not attempt cardiopulmonary resuscitation' (DNACPR) decision in place prior to the admission. Of the various strategies known to have previously been tried to communicate this information between ambulance services, primary care and secondary care, the SAG considered electronic recording of the DNACPR decision to be the most reliable. An electronic system was used in 65/178 (36.5%) hospitals (Table 2.3). Where electronic systems did exist, integration with ambulance services was included in 23/65 hospital systems and with general practice in 36/65 (Table 2.4).

Table 2.3 Electronic system used for advanced care directives that includes DNACPR decisions

	Number of hospitals	%
Yes	65	36.5
No	113	63.5
Subtotal	**178**	
Unknown	4	
Total	**182**	

Organisational data

Table 2.4 Who 'do not attempt cardiopulmonary resuscitation' decisions were shared with

	Number of hospitals	%
Emergency department	60	36.5
General practitioner	36	63.5
Ambulance service	23	
Other	8	

Answers may be multiple; n=65
Organisational data

A further 323/661 (48.9%) patients subsequently had a DNACPR decision made during the admission (data not shown).

There were 103/671 (15.4%) patients who received further CPR following their admission to hospital (Table 2.5).

Table 2.5 Further cardiopulmonary resuscitation received in hospital

	Number of patients	%
Yes	103	15.4
No	568	84.6
Subtotal	**671**	
Unknown	28	
Total	**699**	

Clinician questionnaire data

Key Findings

1. The median age of the study population was 63.5 years
2. 271/416 (65.1%) patients were male and 145/416 (34.9%) were female
3. 204/357 (57.1%) patients were very fit, well or managing well according to the Rockwood Clinical Frailty Score prior to their OHCA
4. 133/177 (75.1%) patients under 65 years and 71/180 (39.4%) patients 65 years or older were in the fittest three Rockwood Clinical Frailty Score categories, with no or minimal functional impairment prior to their out-of-hospital cardiac arrest
5. 357/415 (86.0%) patients had a previous medical history that the case reviewers considered was relevant to the cardiac arrest
6. 21/661 (3.2%) patients had a 'do not attempt cardiopulmonary resuscitation' (DNACPR) decision in place prior to the admission
7. At 65/178 (36.5%) hospitals an electronic system was in place for advanced care directives that included DNACPR decisions
8. Where electronic systems existed, integration with ambulance services was included in 23/65 hospital systems and with general practice in 36/65
9. 103/671 (15.4%) patients received further CPR following their admission to hospital

3

Pre-hospital care

Early, minimally interrupted, resuscitation (and defibrillation in those with a shockable rhythm) after cardiac arrest, is the key to improving survival. The survival rate after an out-of-hospital cardiac arrest (OHCA) has consistently been 7-8% in the UK, where ambulance services start or continue resuscitation.[13,14]

The Out-of-Hospital Cardiac Arrest Outcomes (OHCAO) Registry data presented in the introduction, shows that for 2018,[27] almost half (15,184/30,829; 49.3%) of OHCAs were bystander witnessed. Of these, 11,195/15,184 (73.7%) patients received bystander cardiopulmonary resuscitation (CPR). Survival was higher after an OHCA when bystander CPR was used compared with when it was not (1,618/18,721; 8.6% vs 526/8,364; 6.3%). In the countries where higher survival rates have been achieved, this is associated with higher rates of bystander CPR.[28] Bystander CPR has been shown to improve the chance of survival by as much as two-fold.[29]

Based on the national data, initiatives to increase both bystander CPR rates and the delivery of high quality CPR therefore, have the potential to improve outcome from OHCA in the UK.

Early recognition of cardiac arrest and call for help

Of the patients in this study, 466/690 (67.5%) OHCAs occurred in the person's place of residence and 179/690 (25.9%) occurred in public place or workplace (Table 3.1).

In the 2018 OHCAO registry data, 6,868/9,019 (76.2%) patients with ROSC at hospital handover had a witnessed OHCA rate, compared with 18,928/30,829 (61.4%) across the entire OHCA population. Figure 3.1 overleaf shows the equivalent, witness status data, for the sampled population in this study.

Table 3.1 Location where the cardiac arrest occurred

	Number of patients	%
Own home	430	62.3
Public place	146	21.2
Workplace	25	3.6
Residential home	18	2.6
Nursing home	18	2.6
Ambulance	10	1.4
Transport hub (e.g. station)	8	1.2
Car/taxi/bus	8	1.2
Other	27	3.9
Subtotal	**690**	
Unknown	9	
Total	**699**	

Clinician questionnaire data

In this study of patients who achieved ROSC after an OHCA, a patient who had a witnessed OHCA had a 2.5 times greater chance of survival to hospital discharge compared with an unwitnessed OHCA (234/556; 42.1% vs 20/116; 17.1%) who also achieved ROSC. No difference was observed in survival to discharge if the witness was a bystander or emergency medical services (Figure 3.2 overleaf).

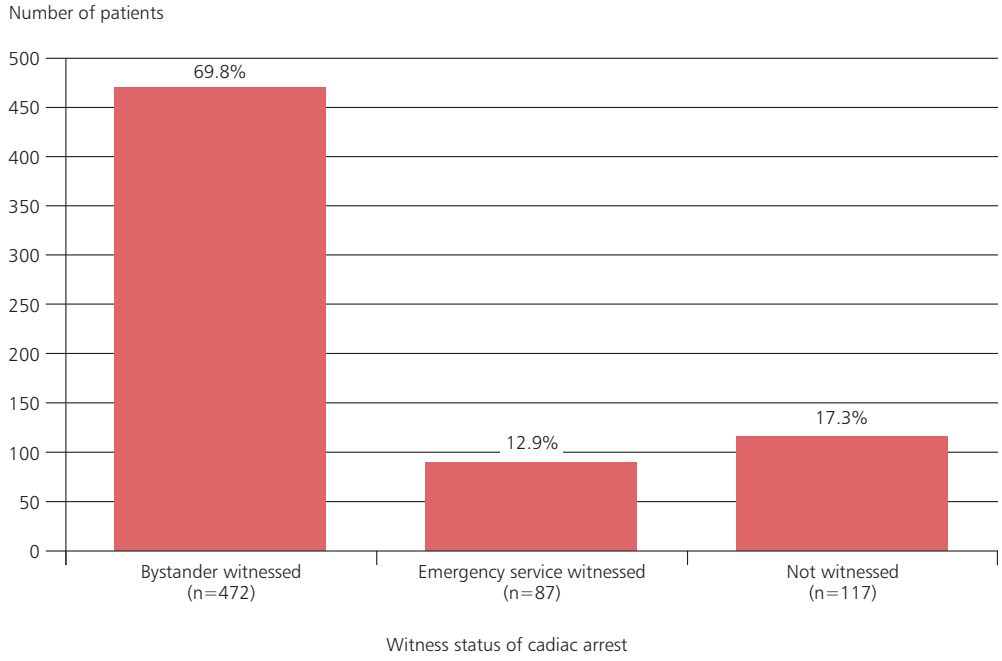


Figure 3.1 Out-of-hospital cardiac arrest witness status
Clinician questionnaire data

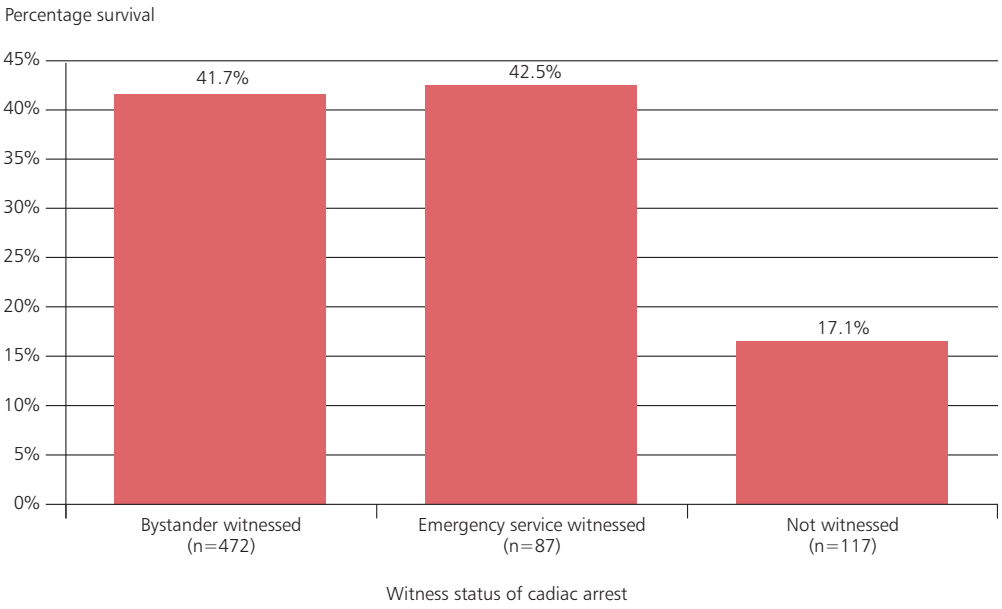


Figure 3.2 Witnessed status and survival to discharge
Clinician questionnaire data

Table 3.2 Location of cardiac arrest and witness status

	Own home		Public place	
	Number of patients	%	Number of patients	%
Witnessed (bystander)	285	68.5	117	81.8
Witnessed (emergency medical service present)	52	12.5	6	4.2
Not witnessed	79	19.0	20	14.0
Subtotal	**416**		**143**	
Unknown	14		3	
Total	**430**		**146**	

Clinician questionnaire data

Table 3.3 Witness status and bystander cardiopulmonary resuscitation (CPR)

	CPR given by a bystander					
	Yes	No	Bystander CPR %	Subtotal	Unknown	Total
Witnessed (bystander)	362	79	82.1	441	28	469
Not witnessed	75	32	70.1	107	9	116
Total	**437**	**111**	**79.7**	**548**	**37**	**585**

Clinician questionnaire data

The location of the OCHA did not appear to have an impact on the percentage of OHCAs that were witnessed and unwitnessed (noting that the study included only those with ROSC): 123/143 (86.0%) of OHCAs in a public place and 337/416 (81.0%) of OHCAs in the home were witnessed (Table 3.2).

Early bystander CPR

Early CPR improves the chance of survival. In the UK, the OHCAO registry data showed that bystander CPR rates for people who had a non-emergency service-witnessed OHCA have improved from 55.2% in 2014, to 18,721/27,085 (69.1%) in 2018.[14] This includes witnessed 11,195/15,184 (73.7%) and unwitnessed 7,526/11,901 (63.2%) OHCAs. The registry, found an associated improved overall survival to discharge for OHCAs where bystander CPR was administered (2,880/29,662; 9.7%). This link in the 'Chain of Survival' has taken on even greater importance during the COVID-19 pandemic, as concern about cross infection during resuscitation attempts has led to a reluctance to deliver bystander CPR and a greater delay when it is provided.[16,17]

In this study, which only included those with sustained ROSC, 437/548 (79.7%) patients received bystander CPR (Table 3.3). In these patients, the CPR administered by a bystander achieved ROSC in 36/231 (15.6%) patients (Table 3.4).

Table 3.4 Bystander cardiopulmonary resuscitation (CPR) and achievement of return of spontaneous circulation

	Number of patients	%
Return of spontaneous circulation achieved by bystander CPR	36	15.6
Return of spontaneous circulation not achieved by bystander CPR	195	84.4
Subtotal	**231**	
Unknown	4	
Total	**235**	

Case reviewer data

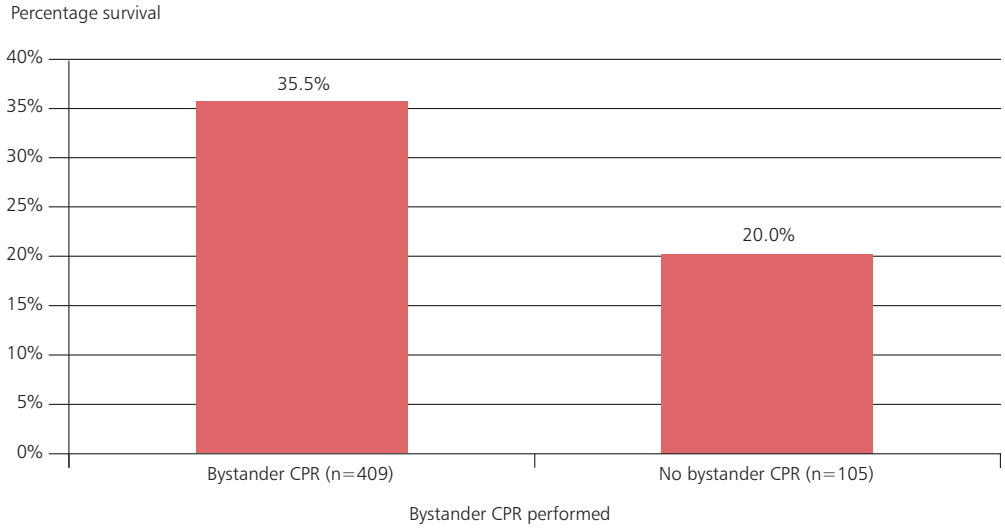


Figure 3.3 Bystander cardiopulmonary resuscitation (CPR) and survival
Clinician questionnaire data

The data presented from this NCEPOD study are comparable with the OHCAO registry data for patients with ROSC at hospital handover. Of those receiving bystander CPR, 145/409 (35.5%) (registry data 1,492/5,337; 28.0%) patients survived to hospital discharge compared with 21/105 (20.0%) (registry data 471/2,152; 21.9%) patients where bystander CPR was not administered (Figure 3.3). The ambulance service documented a delay in starting CPR in 43/319 (13.5%) patients (data not shown).

Combined 2017 data from 28 European countries showed variation in CPR rates between 13% and 82%.[30] Alongside strategies to increase bystander CPR rates further in the UK, initiatives to improve the quality of CPR are required. Survival to hospital discharge is higher in patients when a bystander performs CPR with ventilations, compared with compression-only CPR (14% vs 8% respectively),[30] but ventilation is not routinely taught to UK members of the public. Initiatives to improve the quality of initial CPR include electronic systems for the ambulance services to alert a network of medical professionals who can act as first responders before the ambulance arrives.[31] This study was unable to distinguish between expert first responder CPR and that performed by a member of the public.

Early defibrillation

After early CPR, for patients with a shockable rhythm (ventricular fibrillation or pulseless ventricular tachycardia), defibrillation is the next important link in the 'Chain of Survival.' The chance of survival falls by approximately 10% for every minute of delay in defibrillation in those with a shockable rhythm.[32]

OHCAO registry data showed that the overall incidence of a shockable rhythm in people who suffered an OHCA, was 6,722/29,508 (22.8%). In this study of patients who achieved ROSC, the initial rhythm was shockable in 149/330 (45.2%) patients (Table 3.5).

Table 3.5 Initial rhythm pre-hospital

	Number of patients	%
Non-shockable	181	54.8
Shockable	149	45.2
Subtotal	**330**	
Unknown	4	
Total	**334**	

Case reviewer data

Table 3.6 Defibrillator shock delivered

	Number of patients	%
Yes	173	51.8
No	161	48.2
Total	**334**	

Case reviewer data

A defibrillator shock was delivered in a slightly greater proportion of patients (173/334; 51.8%) (Table 3.6). In those patients who initially have a non-shockable rhythm (asystole or pulseless electrical activity (PEA)), data related to in-hospital cardiac arrest shows that a shockable rhythm (ventricular fibrillation or pulseless ventricular tachycardia) will occur at some time during resuscitation in 25%.[33]

In this study, 24/181 (13.3%) patients with an initial non-shockable rhythm, had a defibrillator shock (data not shown). This reflects either the development of a shockable rhythm during the resuscitation attempt, or inappropriate use of defibrillation.

One strategy used to improve rates of early defibrillation, has been to place defibrillators in locations where they can be accessed by members of the public. A public access defibrillator (PAD) was used in 28/166 (16.9%) instances where a defibrillator was used. Although this is a minority of cases overall, the importance of rapid access is highlighted by the outcome for this group. When a PAD shock was delivered, 18/28 patients were discharged to their usual place of residence (Table 3.7). A further 6/28 patients were transferred to another hospital for ongoing care. As there were no records available for patients in this study who were transferred for ongoing care, the outcomes in this group were not known.

As described in the introduction, the majority of OHCAs occur in the home, but a significant proportion occur at work or in a public place. PADs are automated so that defibrillation can be delivered following instructions from a 999-call handler. To optimise both the use of and the impact on survival of PADs, they should be registered, and easy to identify and locate.

Emergency service (EMS) defibrillators were used in more cases than PADs. The proportion of patients who survived and were discharged to their usual place of residence following use of an EMS defibrillator was 44/135 (32.6%), lower than when a PAD was used (18/28; 64.3%) (Table 3.7). This is likely to reflect a longer time interval between the OHCA and defibrillation in this group. Open access mobile phone applications which identify the location of PADs may allow more favourable outcomes to be delivered to a higher number of people with OHCA.

CASE STUDY 1

A person collapsed while at work. Colleagues immediately started basic life support and used a workplace (public access) defibrillator to deliver a single shock. Their colleague had regained consciousness before arrival of an emergency ambulance. In hospital, a primary arrhythmia was diagnosed and after insertion of an implantable cardioverter defibrillator, they were discharged home.

The case reviewers considered this was a case that illustrated the benefits of early recognition, early bystander CPR and early defibrillation, including the effectiveness of a public access defibrillator in the workplace.

Table 3.7 Type of defibrillator used and outcome

	Discharged to usual place of residence		Transferred to another hospital		Died during admission		Total
Type of defibrillator	**Number of patients**	**%**	**Number of patients**	**%**	**Number of patients**	**%**	**Number of patients**
Public access	18	64.3	6	21.4	4	14.3	28
Emergency service	44	32.6	11	8.1	80	59.3	135
Total	**62**	**38**	**17**	**10.4**	**84**	**51.5**	**163**

Case reviewer data

CASE STUDY 2

A person collapsed in a public place. The event was witnessed, and the emergency services were called. No bystander CPR was delivered. On arrival, paramedics defibrillated a shockable rhythm successfully. The patient was admitted to intensive care but they had sustained major brain injury and did not survive.

The case reviewers considered that, in the context of an initial shockable rhythm, delay in starting CPR made a significant contribution to the poor outcome.

Age was not a strong determinant of whether the initial rhythm was shockable (Figure 3.4). For individuals who were aged 60 years or younger, the initial rhythm was shockable in 66/138 (47.8%) patients. This was only slightly more frequently than in those over 60 years of age (shockable rhythm in 83/192; 43.2%).

However, a relationship was observed between the degree of frailty and the likelihood of a shockable rhythm (Figure 3.5 overleaf). The fittest patients, those with Rockwood Clinical Frailty Scores of 1-3, were three times more likely to have a shockable rhythm than the most frail patients with scores of 7-9 (99/163; 60.7% vs 10/49; 20.4%).

There were 145/688 (21.1%) patients who were transported to hospital before they had achieved ROSC, 87/688 (12.6%) patients in cardiac arrest during their transfer and 58/688 (8.4%) patients achieving ROSC whilst in transit (Table 3.8). These patients were on average younger (mean 58.8, median 60 years) than those where ROSC was achieved before transfer (mean 63.2, median 66 years) (data not shown).

Table 3.8 Return of spontaneous circulation status during transport to hospital

	Number of patients	%
With return of spontaneous circulation	531	77.2
In cardiac arrest	87	12.6
Return of spontaneous circulation achieved in transit	58	8.4
Other	12	1.7
Subtotal	**688**	
Unknown	11	
Total	**699**	

Clinician questionnaire data

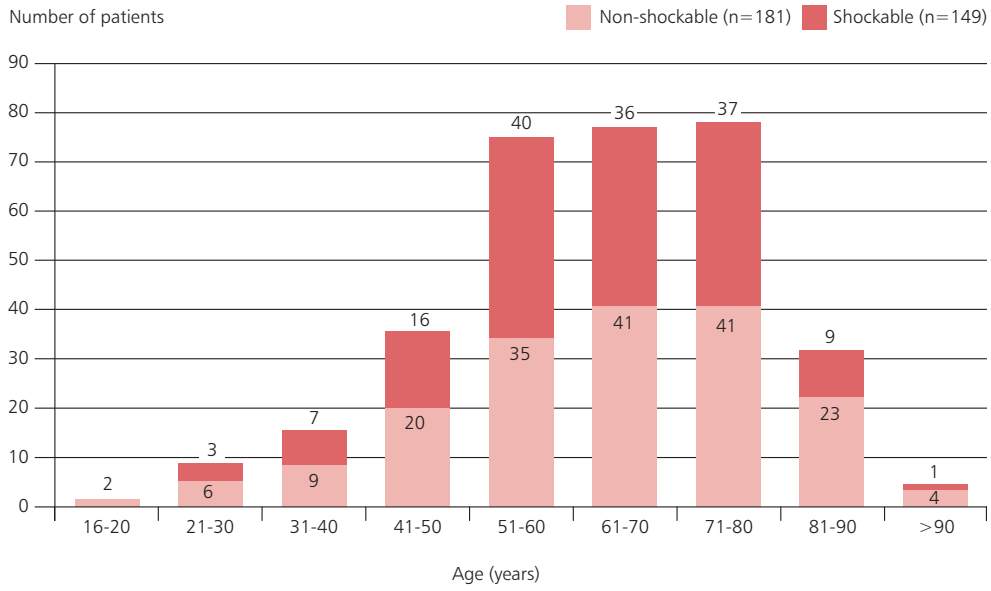


Figure 3.4 Age vs shockable rhythm

Case reviewer data

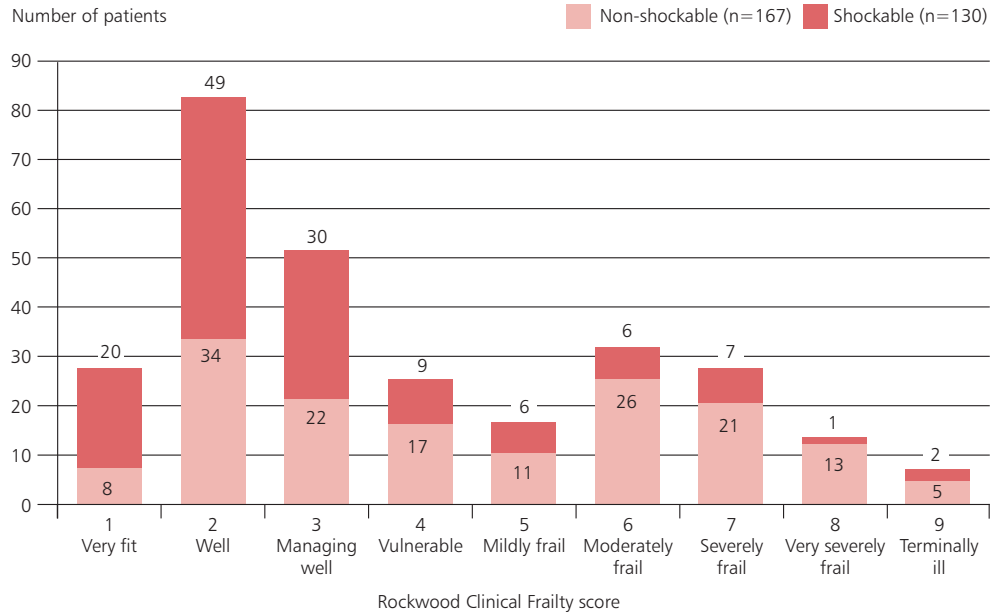


Figure 3.5 Rockwood Clinical Frailty Score and initial rhythmn
Case reviewer data

Patients who achieved ROSC before transfer, and were transported with ROSC, had a higher survival to hospital discharge rate (191/529; 36.1%) than those who achieved ROSC in transit (16/58; 27.6%) or were transported in cardiac arrest to the emergency department (8/86; 9.3%) (Figure 3.6). There were 24 patients who survived after achieving ROSC in the ambulance or arrival in the emergency department, all of whom were discharged to their usual place of residence. The absence of ROSC at the scene of an OHCA does not preclude a good functional outcome. The slightly younger age of the group transported to hospital before ROSC was achieved, suggested that a patient's age may have influenced the decision to transfer while CPR was still in progress.

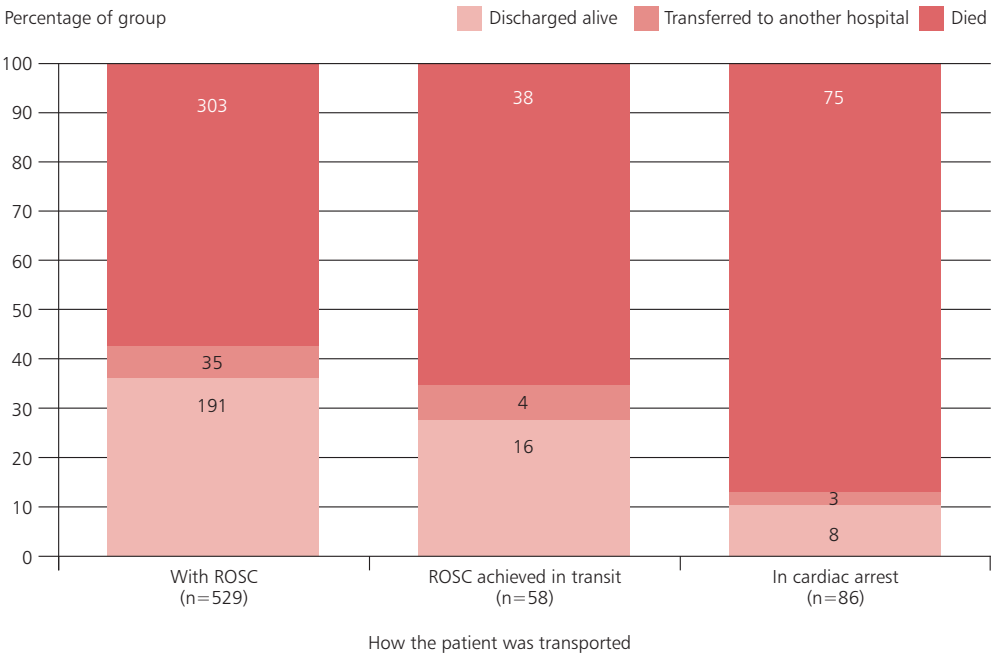


Figure 3.6 Patient status during transport to hospital and survival
Clinician questionnaire

Three large randomised trials have shown no benefit from mechanical chest compression devices.[34-36] The routine use of mechanical devices is therefore not recommended.[37] However, such devices have not been shown to worsen outcomes, so where ambulance trusts already own them, it is recommended that their use is restricted to patients who require on-going CPR or prolonged CPR in transit, such as those with refractory dysrhythmias and suspected acute coronary syndrome (ACS) who require a longer transfer to a 'cardiac arrest centre'.

A mechanical CPR device was used in 34/308 (11.0%) patients as noted during review of the case notes, nine of whom were transported with CPR in progress (data not shown).

Pre-hospital, a small number of individuals regained consciousness and were documented as being alert (27/303; 8.9%), whereas 247/303 (81.5%) patients remained unresponsive (Table 3.9).

Table 3.9 Best post-arrest consciousness level pre-hospital

	Number of patients	%
Alert	27	8.9
Confusion	11	3.6
Voice	8	2.6
Pain	10	3.3
Unresponsive	247	81.5
Subtotal	**303**	
Not recorded	31	
Total	**334**	

Case reviewer data

Table 3.10 Invasive airway management pre-hospital

	Number of patients	%
Supraglottic airway	161	48.9
Tracheal tube	106	32.2
Own	48	14.6
Nasopharyngeal airway	14	4.3
Subtotal	**329**	
Unknown	5	
Total	**334**	

Case reviewer data

Those caring for patients being transported after ROSC has been achieved, or in cardiac arrest, must follow the ABC algorithm of airway, breathing and circulation. The majority of patients (267/329; 81.1%) required airway support pre-hospital, either with a tracheal tube (106/329; 32.2%) or a supraglottic airway (161/329; 48.9%) (Table 3.10).

A smaller number of patients (14/329; 4.3%) received a nasopharyngeal airway. Assisted ventilation was required pre-hospital in 257/303 (84.8%) patients, with a self-inflating bag more commonly used (189/303; 62.4%) than mechanical ventilation (68/303; 22.4%) (Table 3.11).

Table 3.11 Invasive ventilation management pre-hospital

	Number of patients	%
Assisted (self-inflating bag)	189	62.4
Assisted (mechanical)	68	22.4
Self	46	15.2
Subtotal	**303**	
Unknown	31	
Total	**334**	

Case reviewer data

Pre-hospital drugs

Drugs are of secondary importance compared with high-quality and minimally uninterrupted CPR and, when indicated, defibrillation. However, the pre-hospital use of intravenous or intraosseous adrenaline, significantly improves 30-day survival when compared with saline placebo. Neurological outcome is however, not improved.[38] At least one drug was administered in the pre-hospital phase of care in 268/334 (80.6%) patients (Table 3.12). The most commonly used drug was adrenaline. One or more doses of adrenaline was received by 228/334 (68.3%) patients.

Shock-refractory ventricular fibrillation or pulseless ventricular tachycardia is difficult to manage. In 2015, the Resuscitation Council guideline observed that no anti-arrhythmic drug had been shown to improve survival to discharge from hospital or functional survival quality in OHCA, but that amiodarone increased the chances of surviving to hospital with ROSC.[37] A 2016 randomised double-blind trial compared amiodarone vs placebo and lidocaine vs placebo in patients with initial shock-refractory ventricular fibrillation or pulseless ventricular tachycardia. Patients randomised to either amiodarone or lidocaine, were more likely to achieve ROSC but there was no difference in survival to hospital discharge or favourable neurologic outcome between treatment and placebo groups.[39] Amiodarone was administered pre-hospital in 34/334 (10.6%) patients, all of whom had an initial shockable rhythm (Table 3.12). No administration of lidocaine was recorded.

One or more drugs was used in 210/237 (88.6%) patients who were unresponsive post-OHCA. No drugs were used in half of the alert patients (13/25; 52%; data not shown). Drugs were more commonly used in those with tracheal tubes (97/105; 92.4%) and supraglottic airways (128/151; 84.8%) than in those with no airway intervention (21/45; 46.7%; data not shown).

Adrenaline use to support blood pressure following resuscitation was reported in 63/222 (28.4%) patients who had received adrenaline during CPR (Table 3.13) and in a further two patients who did not receive it during CPR.

The initial rhythm following ROSC was sinus rhythm in 159/260 (61.2%) patients (Table 3.14).

Table 3.12 Pre-hospital drugs

	Number of patients	%
Adrenaline	228	68.3
Atropine	36	10.8
Amiodarone	34	10.2
Benzodiazepine	24	7.2
Anaesthetic induction agents	15	4.5
Morphine	13	3.9
Salbutamol	8	2.4
Glucose/Dextrose	6	1.8
Naloxone	5	1.5
Answers may be multiple; n=334		
None	66	19.8

Case reviewer data

Table 3.13 Adrenaline use post-resuscitation

	Number of patients	%
Yes	63	28.4
No	159	71.6
Subtotal	**222**	
Unknown	6	
Total	**228**	

Case reviewer data

Table 3.14 Initial rhythm on sustained ROSC

	Number of patients	%
Sinus	159	61.2
Unclear (e.g. bundle branch block)	28	10.8
Atrial fibrillation	26	10.0
Narrow complex tachycardia	13	5.0
Heart block	9	3.5
Broad complex tachycardia	9	3.5
Bradycardia	8	3.1
Other	8	3.1
Subtotal	**260**	
Unknown	37	
Total	**297**	

Case reviewer data
NB: 37 patients were transported in cardiac arrest or ROSC status pre-hospital unknown

Unless there is an obvious non-cardiac cause, 59-71% of patients with OHCA will have had an acute coronary artery event and 80% of those with ST segment elevation (STE) on the post-ROSC ECG, or left bundle branch block where STE cannot be ascertained, will have an acute coronary lesion.[40] Observational studies favour primary coronary intervention (PCI) in this group of patients, which has been shown to improve survival with favourable neurological function.

There were 80/236 (33.9%) patients in this study who had ECG changes suggestive of a ST elevation myocardial infarction (STEMI) (Table 3.15). NICE CG167 states that the level of consciousness should not be a determinant of suitability for PCI (see Chapter 5).[18]

Of the 80 patients with ECG changes suggesting PCI was appropriate, only six were alert, seven were classed as confused or responsive to voice or pain, and 65 were unconscious on the Alert, Confusion, Voice, Pain, Unresponsive (ACVPU) scale pre-hospital (two unknown).

The time to ROSC (TTR) is defined as the time from a witnessed collapse, or emergency telephone call for an unwitnessed OHCA, to sustained ROSC. TTR may include both a no-flow period if there is any delay in starting CPR and a low-flow period between the commencement of CPR and sustained ROSC.

Table 3.15 Presence of ST elevation/bundle branch block

	Number of patients	%
Yes	80	33.9
No	156	66.1
Subtotal	**236**	
Unknown	61	
Total	**297**	

Case reviewer data
NB: 37 patients were transported in cardiac arrest or ROSC status pre-hospital unknown

Of those who achieved sustained ROSC, and were included in this study, the mean TTR was 25.4 minutes with a median of 20.5 minutes (Figure 3.7). The case reviewer data identified 74/300 (24.7%) patients with a TTR of ten minutes or less. When combined with ambulance patient report form data, 53/58 OHCAs were witnessed arrests (16 witnessed by emergency services and 32 witnessed by a bystander).

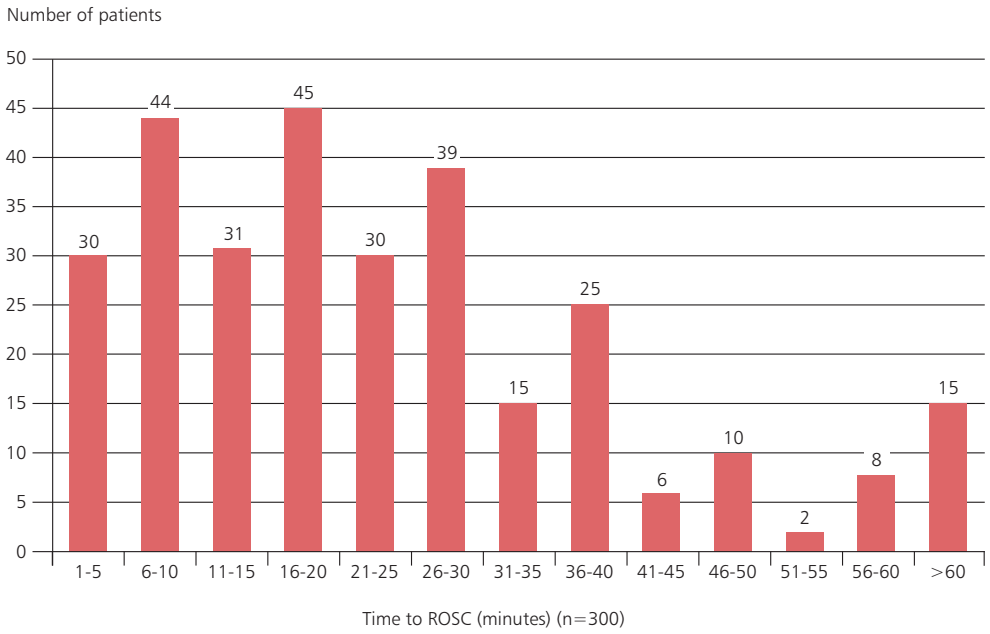


Figure 3.7 Time to return of spontaneous circulation (ROSC)
Case reviewer data

While increasing TTR is associated with poorer neurological outcomes, there is no cut-off under an hour at which a poor neurological recovery is inevitable. TTR should not be used as a determinant of outcome, particularly in younger patients (under 65 years) with a shockable rhythm.[41]

It is of note that in this study, the documented TTR changed during the hospital admission in 46/385 (11.9%) patients (31 unknown). The range that this changed by, was from 38 minutes shorter to 54 minutes longer than originally documented, emphasising the inaccuracy of this as a measure on which to base clinical decisions (data not shown).

Transport to hospital

Organisational data showed that admissions via air ambulance were possible to 112/182 (61.5%) hospitals, although the absence of an on-site helipad would have required the use of an additional land ambulance to complete the transfer at 55/182 (30.2%) hospitals (Figure 3.8). The majority of patients (382/402; 95.0%) were transported by land ambulance (Table 3.16). A helicopter transfer was used for 20/402 (5.0%) patients, and the majority of hospitals (18/20) had an on-site helipad (data not shown).

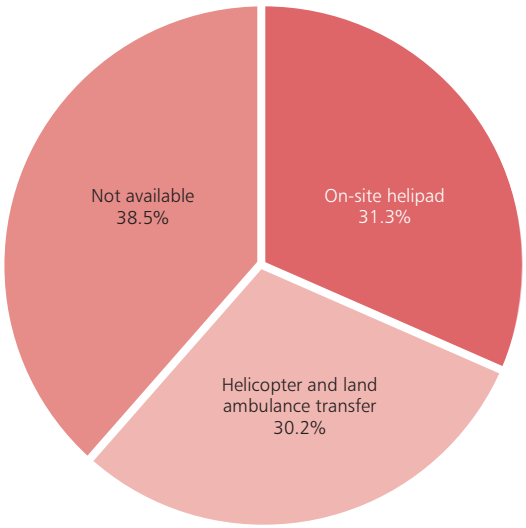


Figure 3.8 Air ambulance admissions (n=182)
Organisational questionnaire data

Table 3.16 Transport of patients to hospital

	Number of patients	%
Land ambulance	382	95.0
Air ambulance	18	4.5
Air and land ambulance	2	<1
Subtotal	**402**	
Unknown	14	
Total	**416**	

Case reviewer data

Pre-hospital quality of care

The case reviewers provided an overall assessment of the quality of care in the pre-hospital phase of care with 212/319 (66.5%) cases rated as 'good' (Table 3.17).

Table 3.17 Case reviewer rating of the pre-hospital care

	Number of patients	%
Good	212	66.5
Adequate	93	29.2
Poor	14	4.4
Unacceptable	0	0
Subtotal	**319**	
Unable to rate	15	
Total	**334**	

Case reviewer data

The two most common reasons for rating the care as 'poor', were a delay in transfer without a documented reason (3/14) and pulseless electrical activity (PEA) with no pre-hospital adrenaline administration (4/14), which is contrary to the 2015 Resuscitation Council UK guidelines.[37]

Key Findings

10. A patient who had a witnessed OHCA had a 2.5 times greater chance of survival to hospital discharge compared with an unwitnessed OHCA (234/556; 42.1% vs 20/116; 17.1%)
11. 437/548 (79.7%) patients received bystander CPR
12. 145/409 (35.5%) patients who received bystander CPR survived to hospital discharge compared with 21/105 (20.0%) patients where bystander CPR was not administered
13. The initial rhythm was shockable in 149/330 (45.2%) patients
14. A defibrillator shock was delivered to 173/334 (51.8%) patients
15. A public access defibrillator (PAD) was used in 28/166 (16.9%) instances where a defibrillator was used
16. When a public access defibrillator (PAD) shock was delivered, 18/28 patients were discharged to their usual place of residence with a further 6/28 transferred to another hospital for ongoing care
17. Where an emergency service defibrillator was used, survival to discharge to the usual place of residence was 44/135 (32.6%)
18. The fittest patients, those with Rockwood Clinical Frailty Scores of 1-3, were three times more likely to have a shockable rhythm than the most frail patients with scores of 7-9 (99/163; 60.7% vs 10/49; 20.4%)
19. Patients who achieved sustained ROSC pre-hospital had a higher survival to hospital discharge rate (191/529; 36.1%) than those who achieved ROSC in transit (16/78; 20.5%) or in the emergency department (8/86; 9.3%)
20. The mean time to ROSC was 25.4 minutes with a median of 20.5 minutes
21. The documented time to ROSC changed during the hospital admission in 46/385 (11.9%) patients
22. The range that time to ROSC changed by was from 38 minutes shorter to 54 minutes longer than originally documented

4

Arrival and admission to hospital

Following admission to hospital for an out-of-hospital cardiac arrest (OHCA), care must focus on the identification and treatment of the cause of the cardiac arrest and the assessment and mitigation of ischaemia-related reperfusion injury to multiple organs, including the brain.

International guidelines follow an ABC (airway, breathing, circulation) approach as well as neurological and metabolic assessment. After stabilisation, further investigation and decision-making about ongoing organ support is usually required. Sufficient notice of the arrival of a patient in cardiac arrest or return of spontaneous circulation (ROSC), should be sent to the hospital to allow the assembly of a co-ordinated and appropriately skilled team to care for the patient.[37] This pre-alert most commonly follows the ATMIST (age, time, mechanism, injuries, signs, treatment) structured system (Appendix 2). In 169/172 (98.3%) emergency departments, there was a pre-alert system for OHCA. In 17/162 (10.5%) EDs the pre-alerted team configuration differed depending on whether the patient achieved ROSC or not (data not shown).

Where it could be determined, a pre-alert was issued prior to the arrival at hospital for 539/557 (96.8%) patients (Table 4.1). In 142/699 (20.3%) clinician questionnaires, the clinician caring for the patient could not determine if a pre-alert was issued, suggesting the need to improve documentation of pre-alerts in the medical records.

Table 4.1 Use of a pre-alert system

	Number of patients	%
Yes	539	96.8
No	18	3.2
Subtotal	**557**	
Unknown	142	
Total	**699**	

Clinician questionnaire data

The clinician caring for the patient could identify a co-ordinated team response on arrival for 579/594 (97.5%) patients (Table 4.2).

Table 4.2 Co-ordinated team response on arrival

	Number of patients	%
Yes	579	97.5
No	15	2.5
Subtotal	**594**	
Unknown	105	
Total	**699**	

Clinician questionnaire data

Case reviewers were also of the opinion that the appropriate team members, by specialty and seniority, were present at the time of the arrival for 264/291 (90.7%) patients (Table 4.3). However, the composition of this receiving team could not be determined for 125/416 (30.0%) patients, meaning they could not make an opinion on appropriateness of the initial response on arrival at the hospital (Table 4.3). This suggests a need to improve documentation of the presence of members of the receiving team. A minority of hospitals (47/147; 32.0%) had an emergency department protocol for the assessment of patients with OHCA who achieve pre- or in-hospital ROSC was available (data not shown).

Table 4.3 Appropriate specialty /seniority of the receiving team

	Number of patients	%
Yes	264	90.7
No	27	9.3
Subtotal	**291**	
Unknown	125	
Total	**416**	

Case reviewer data

Admission via the emergency department occurred for 663/698 (95.0%) patients and 31/698 (4.4%) patients were admitted directly to the cardiac catheterisation laboratory (Table 4.4).

Table 4.4 Where the patient was first received in hospital

	Number of patients	%
Emergency department	663	95.0
Direct to percutaneous coronary intervention service	31	4.4
Other	4	<1
Subtotal	**698**	
Unknown	1	
Total	**699**	

Clinician questionnaire data

Table 4.5 Airway device changed on arrival to hospital

	Number of patients	%
Yes	208	50.6
No	203	49.4
Subtotal	**411**	
Unknown	5	
Total	**416**	

Case reviewer data

Airway and breathing management

Following their arrival at hospital, 208/411 (50.6%) patients had a change in their pre-hospital airway device (Table 4.5). In those patients for whom pre-hospital notes were available, and the airway was changed, 149/170 (87.6%) had a tracheal tube placed; most commonly this was a conversion from a pre-hospital supraglottic airway to a tracheal tube in 112 patients (data not shown). In seven patients, a supraglottic airway was inserted in hospital (six were changed from of an existing supraglottic airway), and 5/7 patients died. In ten patients an airway adjunct was removed in hospital (3/7 patients died) (data not shown).

There were 54/288 (18.8%) patients where there was a clinical suspicion of tracheo-pulmonary aspiration on arrival at hospital, based on gastric contents seen below the vocal cords or within the airway lumen of the tracheal tube or supraglottic airway (Table 4.6). In this study, tracheo-pulmonary aspiration was noted slightly more frequently with the use of a tracheal tube (20/87; 23.0%) than with the use of a supraglottic airway (25/141; 17.7%). This may have been because a tracheal tube was preferentially used in those with suspected, or confirmed, tracheo-pulmonary aspiration, or simply that the process of tracheal tube placement involves direct visualisation of the larynx and therefore improves detection of aspiration.

Table 4.6 Clinical suspicion of aspiration upon arrival at hospital

	Clinical suspicion of aspiration				
	Yes	No			
Pre-hospital (most invasive) airway	**Number of patients**	**Number of patients**	**Subtotal**	**Unknown**	**Total**
Own	6	38	44	4	48
Supraglottic	25	116	141	20	161
Tracheal tube	20	67	87	19	106
Nasopharyngeal	2	11	13	1	14
Subtotal	**53**	**232**	**285**	**44**	**329**
Unknown	1	2	3	2	5
Total	**54**	**234**	**288**	**46**	**334**

Case reviewer data

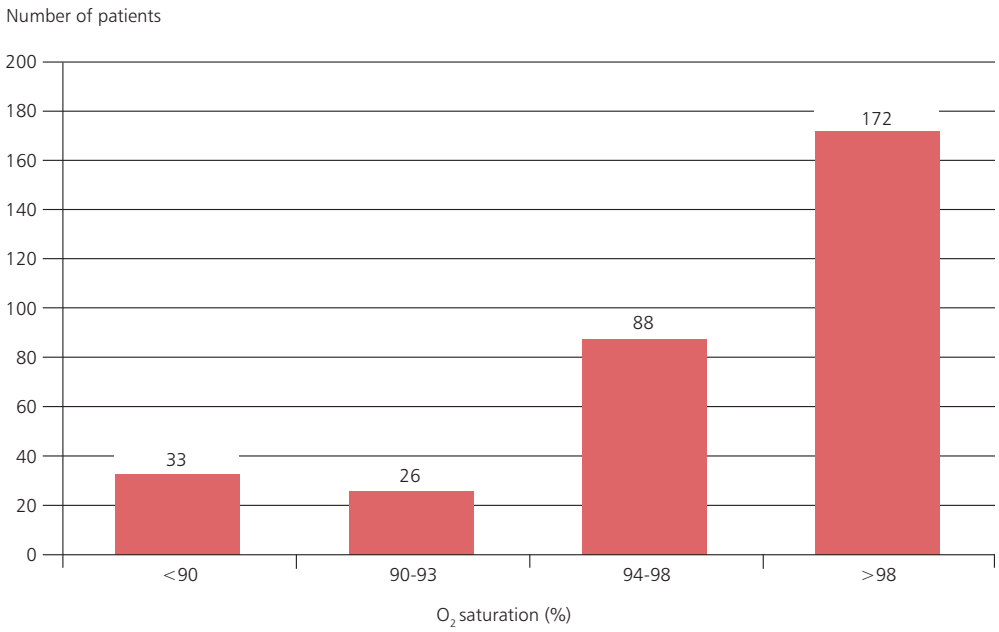


Figure 4.1 Arrival oxygen saturation (n=319)
Case reviewer data

The recommended pre-hospital oxygen saturation (SpO_2) range is 94-98%.[42] Titration of oxygen is more challenging in the pre-hospital setting than in the hospital. The oxygen saturation on arrival was ≥94% in 260/319 (81.5%) patients. In 26/319 (8.2%) patients, oxygen saturation was 90-93% and in 33/319 (10.3%) patients it was below 90% (Figure 4.1). While the detrimental effects of low oxygen saturation are well recognised, experimental and observational data have also raised concerns that the administration of 100% oxygen with high oxygen saturations (98-100%) in the early period after cardiac arrest may adversely affect neurological outcome.[42]

There were 172/319 (53.9%) patients who were hyperoxaemic on their arrival to the emergency department with an oxygen saturation of >98% (Figure 4.1). A randomised trial monitoring SpO_2 levels and modifying oxygen delivery in the pre-hospital and emergency department phase of care, was still in progress at the time that this report was written.[43]

Accurate titration of inspired oxygen (FiO_2) should be based on arterial blood gas measurement. Oxygen saturation (SpO_2) is often used but can be misleading. A blood gas analysis was performed in 383/416 (92.1%) patients in the emergency department. In 236/383 (61.6%) patients, this was an arterial blood gas and in 97/383 (25.3%) patients, it was a venous blood gas analysis (Table 4.7).

Table 4.7 Arterial or venous blood gas analysis in the emergency department

	Number of patients	%
Arterial	236	61.6
Venous	97	25.3
Unknown	50	13.1
Subtotal	**383**	
Not done	33	
Total	**416**	

Case reviewer data

Case reviewers found that documentation was often incomplete or absent and they were rarely able to determine the inspired oxygen percentage or the oxygen flow rate.

The impact of initial hyperoxaemia has yet to be determined in a randomised trial, but persistent hyperoxaemia in the first 24 hours post-OHCA, has been shown to be associated with increased mortality.[44,45]

Partial pressure of oxygen (PaO_2; kPa) on arrival for those patients who had an arterial blood gas measurement is shown in Table 4.8. On arrival at hospital, hypoxaemia (PaO_2 <8.0 kPa) was present in 19/226 (8.4%) patients and hyperoxaemia (PaO_2 >40.0 kPa) was recorded in 66/226 (29.2%) patients (Table 4.8).

Circulation management

Following cardiac arrest, a period of haemodynamic instability resulting in low blood pressure commonly occurs. Guidelines recommend aiming for a systolic blood pressure of at least 100 mmHg. The systolic blood pressure ranges of patients on arrival at hospital are shown in Figure 4.2. There were 106/360 (29.4%) patients with a systolic blood pressure of <100 mmHg on arrival at hospital. Management of blood pressure / circulation is discussed in more detail in Chapter 6.

Table 4.8 PaO_2 on arrival at hospital

	Number of patients	%
< 8.0 kPa	19	8.4
8.0 - 11.0 kPa	39	17.3
11.1 - 13.5 kPa	23	10.2
13.6 - 40.0 kPa	79	35.0
> 40.0 kPa	66	29.2
Total	**226**	

Case reviewer data

Metabolic assessment

When the circulation is interrupted at the time of cardiac arrest, poor tissue perfusion leads to anaerobic metabolism and a build-up of lactic acid (and a fall in blood pH). A number of studies have shown a broad association between lactate levels and outcome following cardiac arrest.[46] However, lactate levels are a poor prognostic indicator in individual patients.[47] Figure 4.3 overleaf shows the range of serum lactate measurements from the first blood gas analysis obtained in the emergency department.

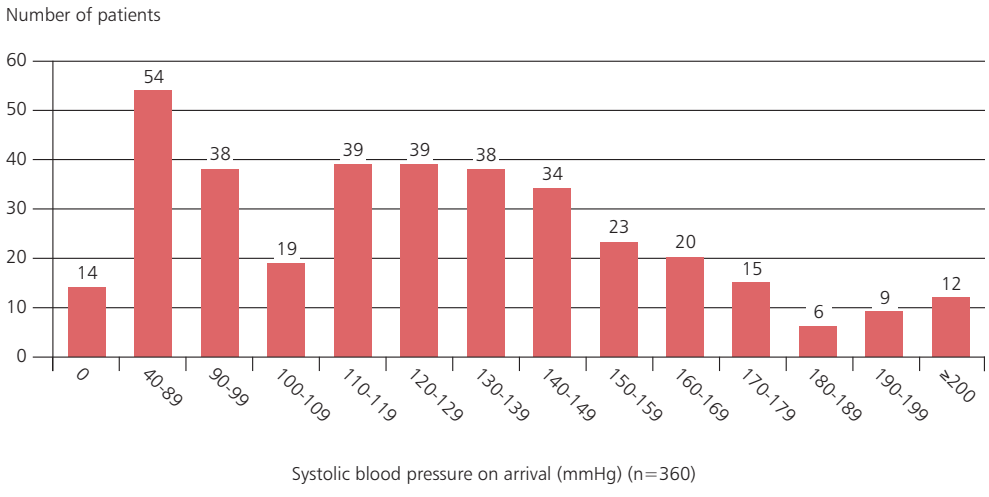


Figure 4.2 Systolic blood pressure on arrival
Case reviewer data

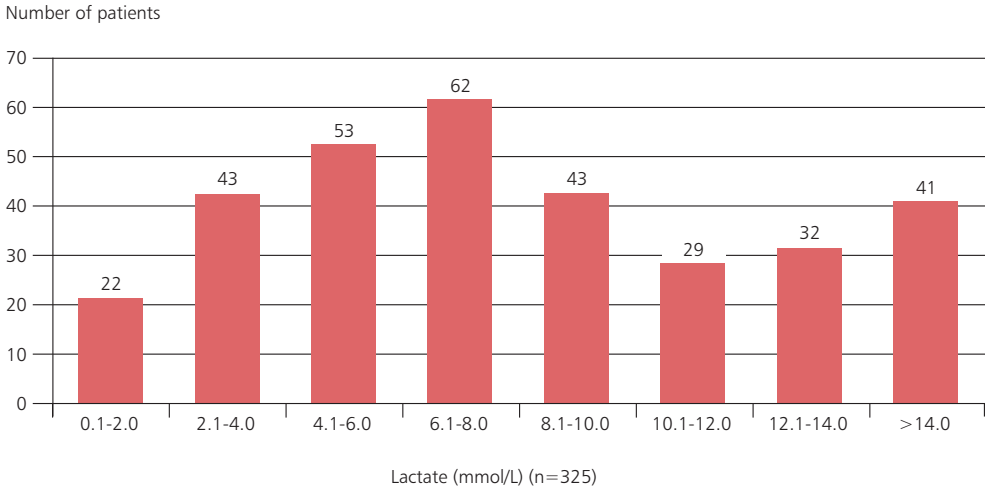


Figure 4.3 First serum lactate level following arrival at the emergency department
Case reviewer data

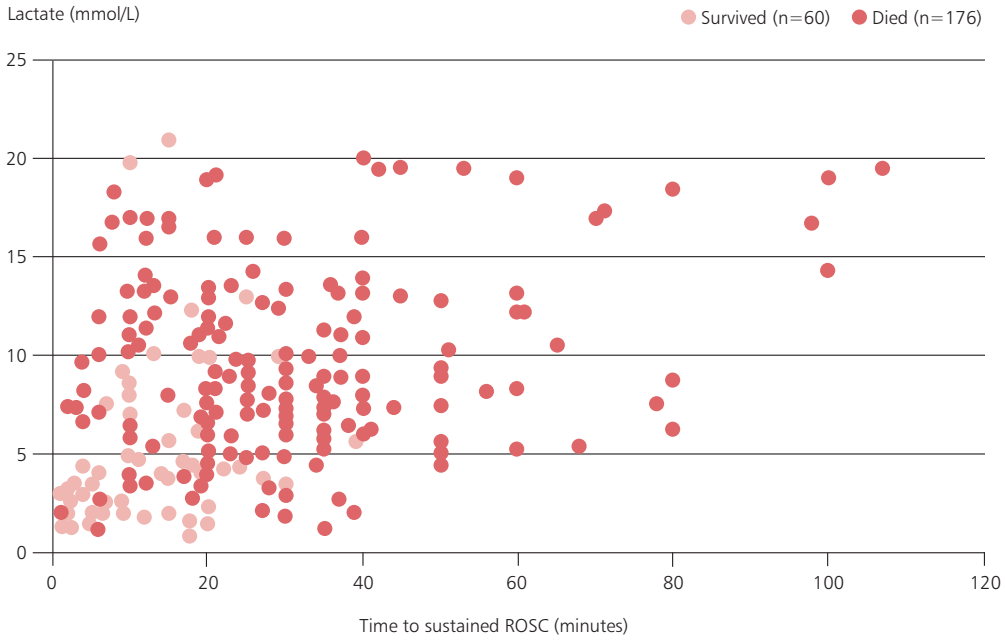


Figure 4.4 Time to return of spontaneous circulation (ROSC) and the serum lactate concentration at initial measurement
Case reviewer data

Figure 4.4 illustrates the poor correlation between the lactate concentration determined by the initial measurement at arrival, and the documented time to ROSC for those patients where both values were available.

Blood pH levels upon admission are shown in Figure 4.5. The mean pH on arrival was 7.10 (median 7.13).

Figure 4.6 shows pH levels plotted against the time to ROSC, illustrating separately, survivors and those who died. This again shows considerable variation between individual patients and a poor correlation between time to ROSC and pH level upon admission. Outcome is discussed further in Chapter 7.

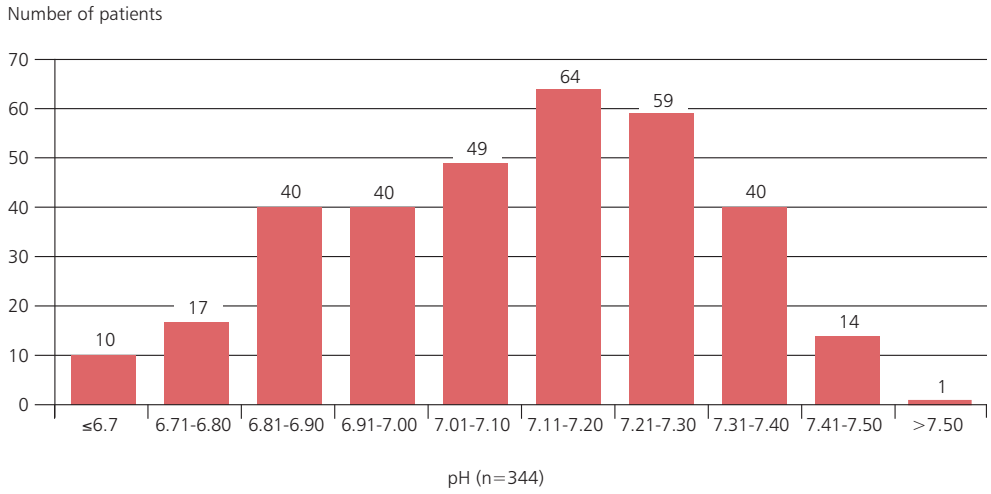


Figure 4.5 Blood pH at initial measurement

Case reviewer data

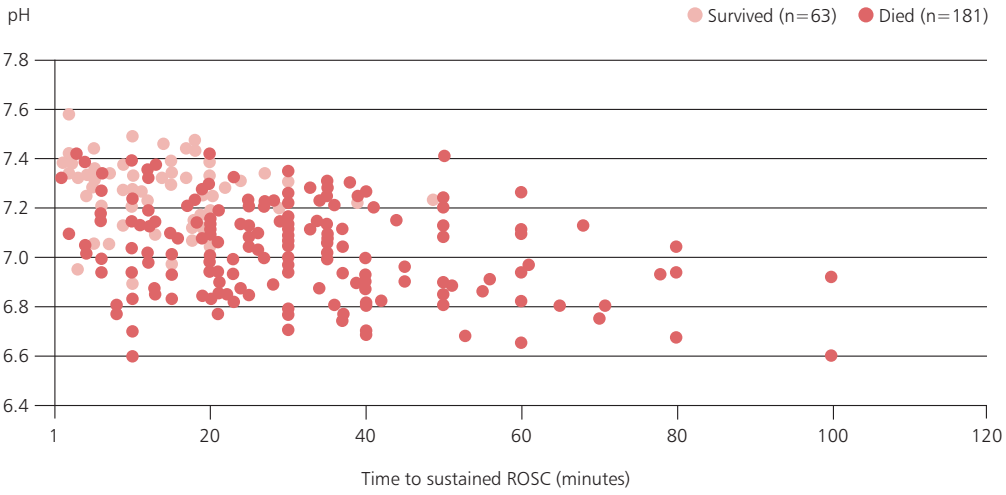


Figure 4.6 Time to ROSC and pH at initial measurement

Case reviewer data

Drug administration in the emergency department

Treatments administered to patients on arrival to the emergency department are shown in Table 4.9. The use of prophylactic antibiotics following cardiac arrest is not recommended,[48,49] but antibiotics were given to 64/384 (16.7%) patients; the indication for their use or if the case reviewers considered the use indicated was not recorded. There were 13/384 (3.4%) patients who were treated for hyperkalaemia; 7/384 (1.8%) patients had a history of chronic kidney disease, 5/384 (1.3%) had treatment for acute gastrointestinal bleeding, 4/384 (1.0%) for anaphylaxis and 7/384 (1.8%) received a thrombolytic drug (data not shown).

Table 4.9 Treatments administered on arrival

	Number of patients	%
Sedative	167	43.5
Muscle relaxant	116	30.2
Analgesia	78	20.3
Antibiotics	64	16.7
Anti-platelet agents	58	15.1
Antiarrhythmic agents	28	7.3
Magnesium	20	5.2
Bronchodilators	19	4.9
Anticoagulants	17	4.4
Calcium gluconate/chloride	16	4.2
Inotropes/vasopressors	15	3.9
Anticonvulsants	10	2.6
Beta blockers	7	1.8
Answers may be multiple; n=384	7	1.8
None	90	23.4

Case reviewer data

Quality of care in the emergency department

Care received in the emergency department was rated as 'good' by the case reviewers for 196/368 (53.3%) patients but for 24/368 (6.5%), it was rated as 'poor' or 'unacceptable' care (Table 4.10). Death occurred in the emergency department in 29/397 (7.3%) patients (Table 4.11). In 25/29 patients this was due to a planned withdrawal of treatment. Where it could be determined, the case reviewers rated the quality of care as 'good' for 14/26 of these patients and room for clinical or organisational improvement for 11/26 patients (data not shown).

Table 4.10 Overall rating of the care received in the emergency department

	Number of patients	%
Good	196	53.3
Adequate	148	40.2
Poor	21	5.7
Unacceptable	3	<1
Subtotal	**368**	
Unable to assign grade	31	
Total	**399**	

Case reviewer data

Table 4.11 The patient died in the emergency department

	Number of patients	%
Yes	29	7.3
No	368	92.7
Subtotal	**397**	
Unknown	2	
Total	**399**	

Case reviewer data

Investigations and transfer from emergency department (or after PCI)

The case reviewers commented on investigations that were used during the patient's whole admission. The comments made by the reviewers mainly related to investigations that were performed during the admission pathway. There were 76/386 (19.7%) patients who survived to hospital admission and had an investigation omitted which the case reviewers considered should have been performed (Table 4.12).

Table 4.12 Omitted investigations that should have been performed

	Number of patients	%
Yes	76	19.7
No	310	80.3
Subtotal	**386**	
Unknown	30	
Total	**416**	

Case reviewer data

In the opinion of the case reviewers, an echocardiogram (point of care and/or cardiology) was omitted in 48 patients. A CT pulmonary angiogram should have been performed in 27/73 patients and a CT scan of the head in 14/73 patients (data not shown).

On discharge from the emergency department, or following PCI, the majority of patients (440/591; 74.5%) were admitted to a unit with level 3 (intensive care) beds (Table 4.13). There were 40/591 (6.8%) patients admitted to a coronary care unit and 67/591 (11.4%) patients to level 0 or 1 (ward care). Critical care is discussed further in Chapter 6.

Table 4.13 Where the patient was admitted after the emergency department and/or percutaneous coronary intervention (PCI)

	Number of patients	%
General critical care (level 3)	312	52.8
General critical care (mixed level 2/3)	93	15.7
Cardiac critical care (level 3)	35	5.9
Coronary care unit (level 2)	40	6.8
General critical care (level 2)	12	2.0
Cardiac critical care (level 2)	8	1.4
General/acute medical ward (level 0/1)	53	9.0
Cardiology ward (level 0/1)	14	2.4
Other	24	4.1
Subtotal	**591**	
Patient died in the emergency department or PCI service	102	
Unknown	6	
Total	**699**	

Clinician questionnaire data

Key Findings

23. In 169/172 (98.3%) emergency departments, there was a pre-alert system for OHCA
24. Where it could be determined, a pre-alert was issued prior to the arrival at hospital for 539/557 (96.8%) OHCAs
25. In 142/699 (20.3%) cases the clinician caring for the patient could not determine if a pre-alert was issued
26. In 125/416 (30.0%) cases the case reviewer could not determine the composition of the receiving team
27. Admission via the emergency department occurred for 663/698 (95.0%) patients
28. 31/698 (4.4%) patients were admitted directly to the cardiac catheterisation laboratory
29. 172/319 (53.9%) patients were hyperoxaemic on their arrival to the emergency department with an oxygen saturation of >98%
30. A blood gas analysis was performed in 383/416 (92.1%) patients in the emergency department - in 236/383 (61.6%) patients, this was an arterial blood gas and in 97/383 (25.3%) patients, it was a venous blood gas analysis
31. Care received in the emergency department was rated as 'good' by the case reviewers for 196/368 (53.3%) patients
32. Care in the emergency department was rated as 'poor' or 'unacceptable' by the case reviewers for 24/368 (6.5%) patients

5

Cardiac care

For the majority of patients who have an out-of-hospital cardiac arrest (OHCA), the primary cause of the arrest is an abnormality of the heart. Once return of spontaneous circulation (ROSC) has been achieved, after immediate stabilisation, it is a priority to consider coronary angiography to optimise cardiac outcome in patients with acute coronary insufficiency. Some services, particularly, in large urban cities, have been designed to reflect this priority with arrangements in place to divert ambulances straight to cardiology services. This enables direct access to the cardiac catheter laboratory for percutaneous coronary intervention (PCI) at a 'cardiac arrest centre'. This type of arrangement is particularly important for patients with ECG changes (such as ST elevation or new onset bundle branch block) suggesting acute coronary insufficiency.

Organisational data showed that a PCI service was available on-site at 88/182 (48.4%) hospitals (Figure 5.1). For 53/88 of these services, PCI was available 24 hours. Where PCI was either not available on-site, or not for the full 24 hours, formal network arrangements were in place for PCI in 117/122 (95.9%) hospitals.

Of the cases reviewed, excluding patients who died in the emergency department, 223/381 (58.5%) patient were discussed with a cardiologist (Table 5.1).

Table 5.1 Documented discussion of patient with a cardiologist

	Number of patients	%
Yes	223	58.5
No	158	41.5
Subtotal	**381**	
Unknown	6	
Total	**387**	

Case reviewer data

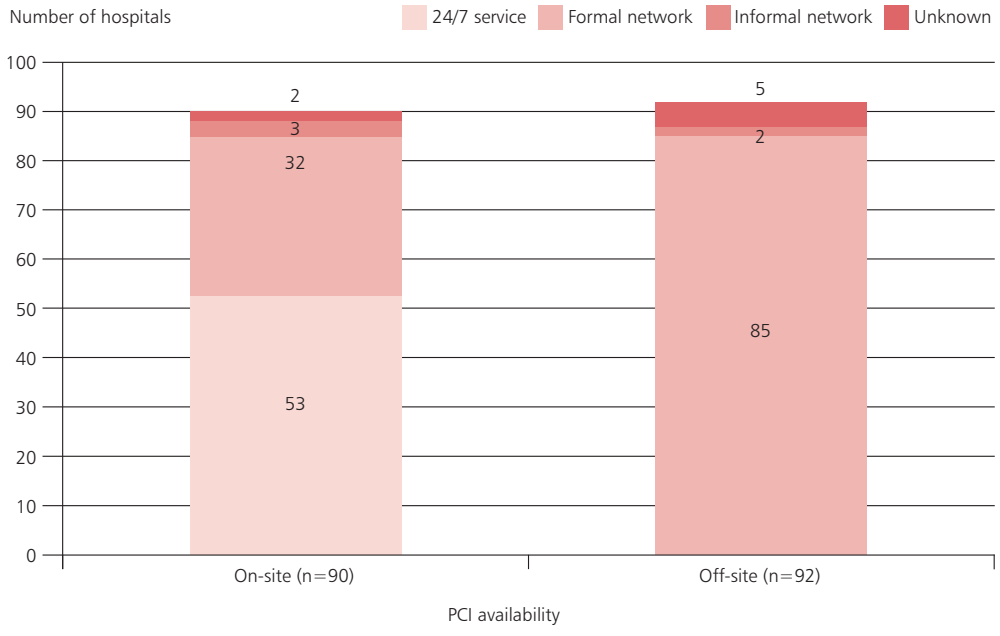


Figure 5.1 Availability of percutaneous coronary intervention (PCI)
Organisational questionnaire data

Table 5.2 First ECG findings on arrival to hospital

	Discussed with a cardiologist				
	Yes		No	Total	
	Number of patients	% discussed	Number of patients	Number of patients	% of all patients
ST elevation/bundle branch block	87	75.0	29	116	31.2
Normal	35	38.5	56	91	24.5
ST depression	58	71.6	23	81	21.8
Atrial fibrillation	23	53.5	20	43	11.6
Other	18	62.1	11	29	7.8
Narrow complex tachycardia	9	37.5	15	24	6.5
Bradycardia	4	50	4	8	2.2
Heart block	6	85.7	1	7	1.9
Broad complex tachycardia	4	66.7	2	6	1.6
Asystole	2	50	2	4	1.1
Paced	1	33.3	2	3	<1.0
Agonal rhythm	0	<1.0	2	2	<1.0
Answers may be multiple; n=372 for all patients					
Not applicable ECG not done on arrival	5	27.8	13	18	4.8

Case reviewer data

The presence of ST elevation or new onset bundle branch block on an ECG, supports a diagnosis of acute myocardial infarction. Rapid access to coronary angiography is indicated in these patients and discussion with a cardiologist to decide on how to proceed would be expected.

There were 116/372 (31.2%) cases reviewed in which the patient had these ECG changes. Of these, 87/116 (75%) patients were discussed with a cardiologist (Table 5.2). There were an additional 81/372 (21.8%) patients with an ECG compatible with myocardial ischaemia (Table 5.2) and 58/81 of these were discussed with a cardiologist. Overall, this meant that of the 186 patients with ECG changes compatible with myocardial ischaemia or infarction, 47/186 (25.3%) were not discussed with a cardiologist (data not shown).

Of the patients who were not discussed with a cardiologist, the case reviewers considered that an additional 31/157 (19.7%) patients should have been discussed (Table 5.3). This meant that in total, 254/381 (66.7%) patients were discussed, or should have been discussed, with a cardiologist.

Table 5.3 The patient should have been discussed with a cardiologist

	Number of patients	%
Yes	31	19.7
No	126	80.3
Subtotal	**157**	
Unknown	1	
Total	**158**	

Case reviewer data

There were 126 patients who were not discussed with a cardiologist during the admission, and the case reviewers did not consider review by a cardiologist was needed. These patients were more likely to have a short length of stay: 69/126 (54.8%) had a length of stay of 0-1 days (length of stay 0–1 days for all patients who died 103/255; 40.4%). The average length of stay for these patients was 2.5 days (median 1 day). A 'do not attempt cardiopulmonary resuscitation' (DNACPR) decision was made in 110/126 (87.3%) patients. There was no relationship between the Rockwood Clinical Frailty Score and whether review by a cardiologist was thought to be needed. Twenty of these patients died in the emergency department and a further 25 were admitted to a general ward rather than to critical care (data not shown).

As already noted, discussion with a cardiologist for advice on both coronary intervention and wider aspects of care is important in patients with a high risk of cardiac disease. The timing of this discussion is also important, as early intervention has the potential to improve outcome.

When patients were discussed with a cardiologist, the case reviewers frequently commented that this discussion was delayed and earlier discussion would have improved care.

The case reviewers considered that there was room for improvement in cardiac care in 78/404 (19.3%) patients (Table 5.4), of whom 47 were discussed with a cardiologist (data not shown). Free text comments noted delays in the care for 34 patients.

There were 111/412 (26.9%) patients taken to the cardiac catheter laboratory during the admission (Table 5.5). The case reviewers considered that there was a delay in 26/105 (24.8%) patients going to the catheter laboratory (Table 5.6). The delay was considered to be for clinical reasons in 17 patients and non-clinical in 13 patients (data not shown).

Table 5.4 Room for improvement in cardiac management

	Number of patients	%
Yes	78	19.3
No	326	80.7
Subtotal	**404**	
Unknown	12	
Total	**416**	

Case reviewer data

Table 5.5 The patient was taken to the cardiac catheter laboratory

	Number of patients	%
Yes	111	26.9
No	301	73.1
Subtotal	**412**	
Unknown	4	
Total	**416**	

Case reviewer data

Table 5.6 A delay in the patient going to the cardiac catheter laboratory

	Number of patients	%
Yes	26	24.8
No	79	75.2
Subtotal	**105**	
Unknown	6	
Total	**111**	

Case reviewer data

Data from the clinical questionnaire showed that of 180 patients taken to the catheter laboratory, the clinician responsible for their care considered that there was a delay intervention for 20/180 (11.1%) patients (data not shown).

Of the patients taken to the cardiac catheter laboratory, the case reviewers considered that there were 57/107 (53.3%) patients where coronary vascularisation was indicated (Table 5.7). Of these, ECG changes were present in 48 patients; 28 had ST elevation or bundle branch block and 13 had ST depression. Revascularisation was attempted in 46 patients and was successful in 41 (data not shown).

Table 5.7 Coronary revascularisation indicated

	Number of patients	%
Yes	57	53.3
No	50	46.7
Subtotal	**107**	
Unknown	4	
Total	**111**	

Case reviewer data

CASE STUDY 3

A person described chest pain before losing consciousness and receiving bystander CPR. ROSC was achieved after two shocks for ventricular fibrillation. An echocardiogram did not show wall motion abnormality and angiography was therefore delayed until day four of admission. The patient had two vessel coronary disease requiring stenting.

The case reviewers reported that the decision not to perform angiography immediately had been inappropriately influenced by the normal echocardiogram in a context where there was a high probability of coronary disease.

Cardiac rhythm management

Patients who present following cardiac arrest due to a life-threatening abnormal heart rhythm, or who have underlying cardiac disease including cardiomyopathy, can benefit from insertion of an implantable cardioverter-defibrillator. These devices are able to restore a normal heart rhythm and prevent, or treat, further cardiac arrest.

Figure 5.2 shows that implantable defibrillators could be inserted on-site in 84/175 (48.0%) hospitals, with formal network arrangements available at a further 84 hospitals.

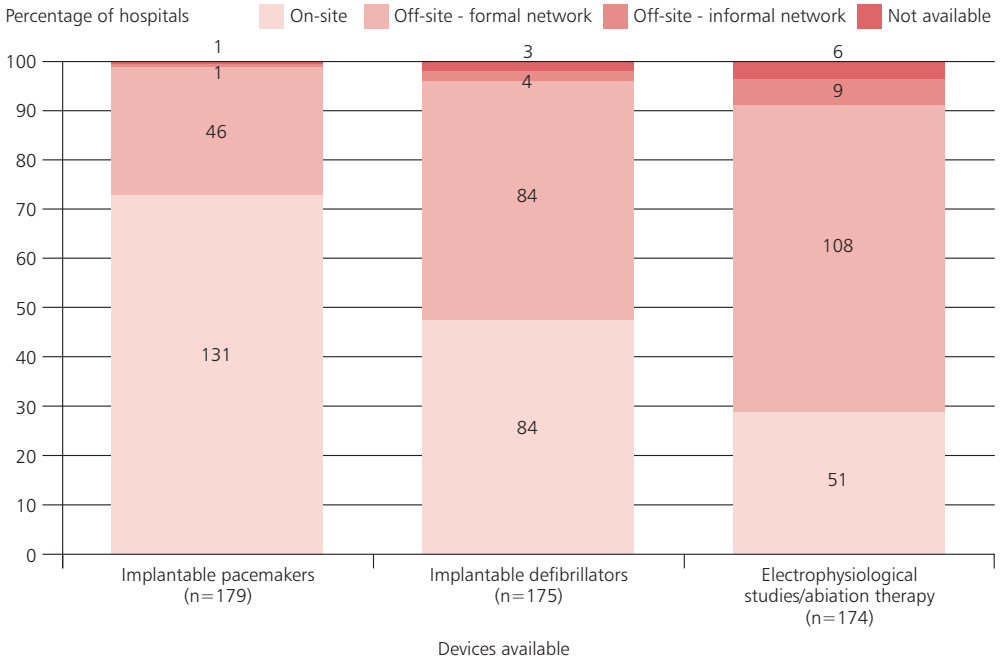


Figure 5.2 Availability of complex devices/ electrophysiology
Organisational questionnaire

Organisational data also showed that in 130/151 (86.1%) hospitals, survivors of OHCA were routinely assessed by a heart rhythm specialist prior to discharge (Table 5.8). In clinical practice, however, case reviewers found that 56/96 survivors were reviewed by such a specialist, and clinicians reviewing the records in their own hospital, found this was the case in 131/196 (66.8%) (Table 5.9).

Table 5.8 When indicated, patients were routinely assessed by a heart rhythm specialist prior to discharge

	Number of hospitals	%
Yes	130	86.1
No	21	13.9
Subtotal	**151**	
Unknown	31	
Total	**182**	

Organisational data

Table 5.9 Patient was reviewed by a heart rhythm specialist prior to discharge

	Case reviewers		Clinicians	
	Number of patients	%	Number of patients	%
Yes	56	58.3	131	66.8
No	40	41.7	65	33.2
Subtotal	**96**		**196**	
Unknown	13		22	
Total	**109**		**218**	

Case reviewer data and clinician questionnaire data

Table 5.10 Reviewers' opinion on whether cardiac care could be improved for patients who were, or were not, discussed with a cardiologist

	Documented discussion with a cardiologist					
	Yes		No		Unknown	
	Number of patients	%	Number of patients	%	Number of patients	Total
Yes	47	21.6	30	16.5	1	**78**
No	171	78.4	152	83.5	3	**326**
Subtotal	**218**		**182**		**4**	**404**
Unknown	8		2		2	**12**
Total	**226**		**184**		**6**	**416**

Case reviewer data

The case reviewers considered that there was room for improvement in the cardiac care of 72/389 (18.5%) patients. Clinicians reviewing the care delivered in their own hospitals thought there was room for improvement in cardiac care in 44/665 (6.6%) patients (data not shown).

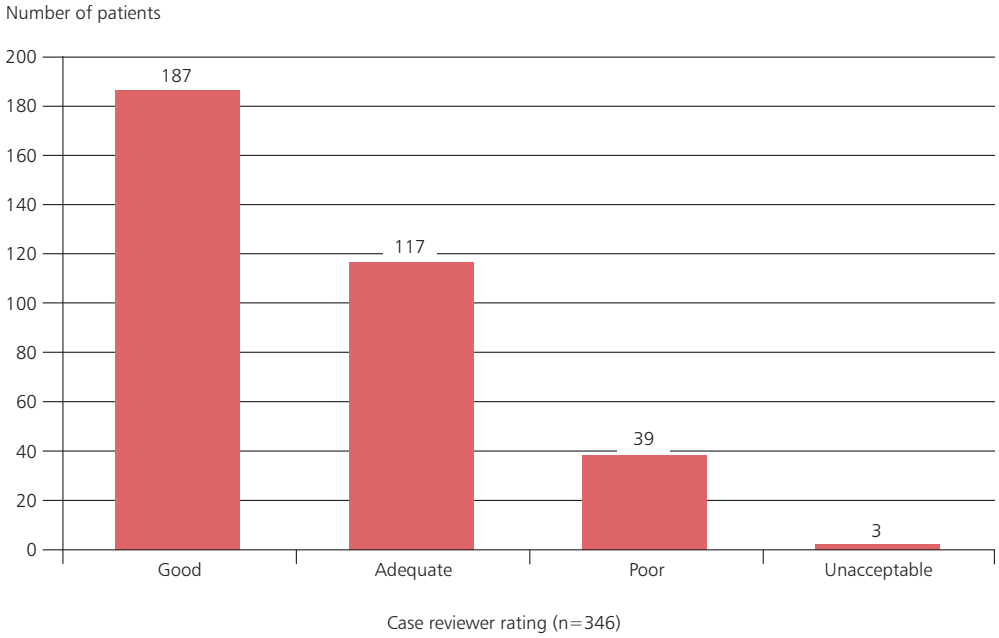


Figure 5.3 Case reviewers' opinion on the patient's cardiac care
Case reviewer data

CASE STUDY 4

A person had a witnessed collapse at a social event. They achieved a rapid recovery of consciousness after receiving bystander CPR with early defibrillation, using a public access defibrillator. The patient was taken directly to the catheter laboratory, but had no evidence of coronary disease. A primary rhythm disturbance was diagnosed, they had an implantable cardioverter-defibrillator inserted on day three of the admission, with discharge home the following day.

The case reviewers considered that this was an example of excellence with early decision-making and intervention optimising the 'Chain of Survival.'

Case reviewers rated the cardiac care received as 'good' in 187/346 (54.0%) patients (Figure 5.3). There was room for improvement in the cardiac care in a greater proportion of patients who were discussed with a cardiologist (47/218; 21.6%) than of those who were not (30/182; 16.5%) (Table 5.10).

This shows that simply involving a cardiologist in care decisions, did not have an impact on how case reviewers assessed the overall quality of cardiac care. Other factors such as earlier review and rapid access to revascularisation, were also important.

Key Findings

33. A PCI service was available on-site at 88/182 (48.4%) hospitals - for 53/88 of these services, PCI was available 24 hours. Where PCI was either not available on-site, or not for the full 24 hours, formal network arrangements were in place for PCI in 117/122 (95.9%) hospitals
34. 116/372 (31.2%) patients had the presence of ST elevation or new onset bundle branch block on their ECG suggesting the diagnosis of acute myocardial infarction, of which 87/116 (75%) were discussed with a cardiologist
35. 81/372 (21.8%) patients had ST depression on their ECG compatible with myocardial ischaemia, and 58/81 of these were discussed with a cardiologist
36. 47/186 (25.3%) patients with ECG changes compatible with myocardial infarction or ischaemia, were not discussed with a cardiologist
37. Of the patients who were not discussed with a cardiologist, the case reviewers considered that an additional 31/157 (19.7%) patients should have been discussed
38. 111/412 (26.9%) patients were taken to the cardiac catheter laboratory during their admission
39. The case reviewers considered that there was a delay in the patient going to the catheter laboratory in 26/105 (24.8%) instances
40. For 57/107 (53.3%) patients taken to the cardiac catheter laboratory, coronary revascularisation was indicated
41. The case reviewers considered that there was room for improvement in cardiac care in 78/404 (19.3%) patients
42. In 130/151 (86.1%) hospitals, survivors of OHCA were routinely assessed by a heart rhythm specialist prior to discharge
43. Clinicians reviewing the records in their own hospital found evidence of a heart rhythm specialist review in 131/196 (66.8%) patients
44. There was room for improvement in the cardiac care in a greater proportion of patients who were discussed with a cardiologist (47/218; 21.6%) than of those who were not (30/182; 16.5%)

6

Critical care

Following return of spontaneous circulation (ROSC) after out-of-hospital cardiac arrest (OHCA), a minority of patients regain consciousness immediately. The majority either remain unconscious, or are confused. In these patients, admission to critical care is necessary for neuroprotective measures, airway protection and to allow more formal neurological assessment. Some patients will require additional organ support.

In this study, 322/385 (83.6%) patients were admitted to critical care (Table 6.1). Of the patients not admitted to critical care, the reviewers considered this to be appropriate for all but 2/63 patients (data not shown).

Table 6.1 Admission of patient to critical care

	Number of patients	%
Yes	322	83.6
No	63	16.4
Subtotal	**385**	
Not applicable - patient died	31	
Total	**416**	

Case reviewer data

The case reviewers considered that clinical care, in critical care, could have been improved for 109/311 (35.0%) patients (Table 6.2). The reasons for this are outlined in the following sections.

Table 6.2 Room for improvement in the critical care of the patient

	Number of patients	%
Yes	109	35.0
No	202	65.0
Subtotal	**311**	
Unknown	11	
Total	**322**	

Case reviewer data

Respiratory support

Of the patients admitted to critical care, 286/322 (88.8%) were treated with invasive ventilation (Figure 6.1). These patients remained intubated for an average of 73.5 hours (based on 218 patients for whom it was possible to determine the length of intubation time from the case notes) (Figure 6.2 overleaf).

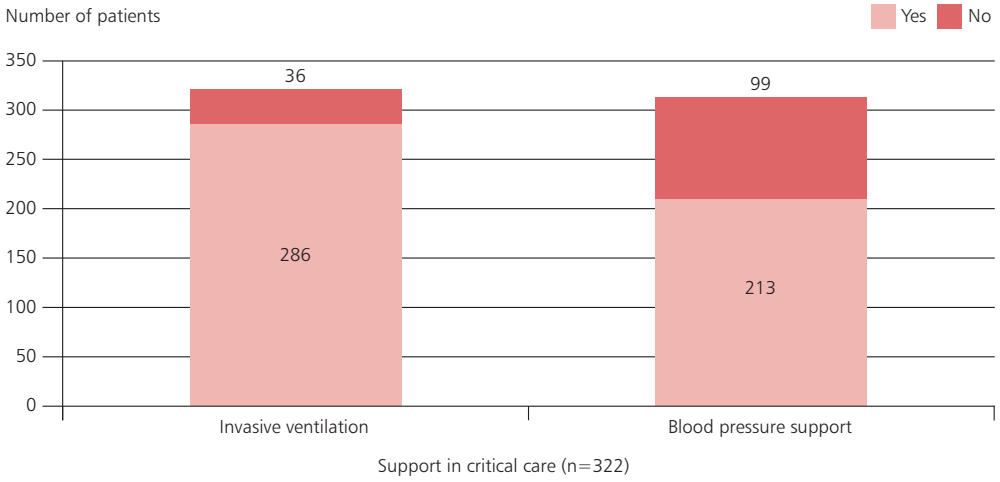


Figure 6.1 The use of invasive ventilation and blood pressure support in critical care
Case reviewer data

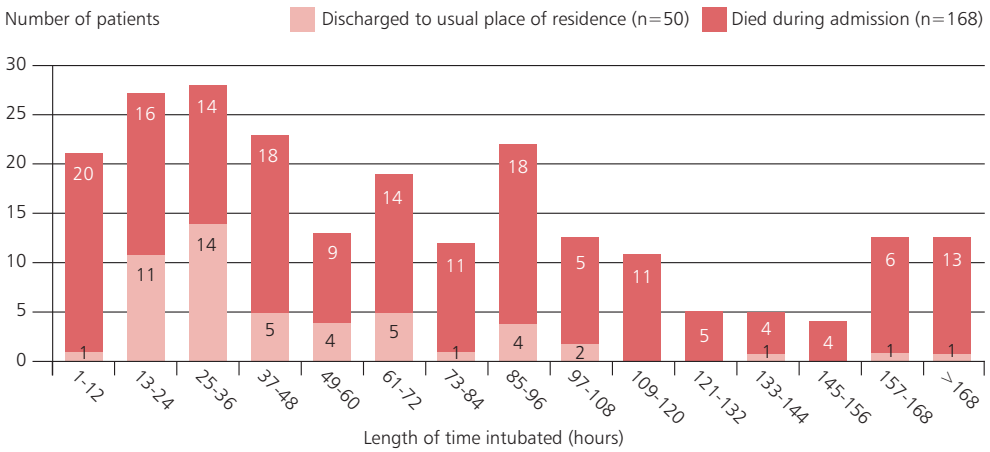


Figure 6.2 Length of time intubated and survival
Case reviewer data

There were 99 patients who were intubated for less than 48 hours and of these, 31/99 (31.3%) were discharged home. Of the 119 patients intubated for more than 48 hours, 19/119 (16.0%) were discharged home.

Where respiratory support is required for a prolonged period, or when slow neurological improvement is anticipated, tracheostomy can be used to facilitate ongoing ventilation, without the need for sedation. Six patients included in this study had a tracheostomy formed.

Cardiovascular management

Following resuscitation, there is often a degree of haemodynamic instability. As noted in Chapter 4, 106/360 (29.4%) patients had a systolic blood pressure of <100 mmHg on arrival at hospital. Low blood pressure often necessitates drug administration to maintain blood supply to vital organs, in particular the brain and kidneys. Current guidelines suggest using a blood pressure target that achieves an adequate urine output (1mL/kg/hr) and a normal or decreasing plasma lactate value, both of which are measures of adequate tissue perfusion.[50]

There were 213/312 (68.3%) patients treated in critical care who received blood pressure support (Figure 6.1). While there is overlap in the cardiovascular effects (vasoconstriction and inotropic effect) of drugs used to support blood pressure, the case reviewers considered that support was provided with vasoconstrictors in 135/213 (63.4%) patients and inotropes in 27/213 (12.7%). These were used in combination for 51/213 (23.9%) patients (Table 6.3). There were no patients included in this study who required mechanical support by a ventricular assist device.

For patients who require blood pressure support, monitoring of cardiac output and of other cardiovascular indices can be used to guide treatment. Despite the frequent use of drugs to support blood pressure, and the relative ease of non-invasive cardiac output monitoring, this was used in only 39/294 (13.3%) patients (Table 6.4). Of these, 33 required blood pressure support (data not shown).

Table 6.3 Type of blood pressure support

	Number of patients	%
Vasoconstrictors	135	63.4
Vasoconstrictors and inotropes	47	22.1
Inotropes	27	12.7
Vasoconstrictors/inotropes/ balloon/pump/other	4	<1.0
Total	**213**	

Case reviewer data

Table 6.4 Cardiac output monitoring was used

	Number of patients	%
Yes	39	13.3
No	255	86.7
Subtotal	**294**	
Unknown	28	
Total	**322**	

Case reviewer data

Table 6.5 Blood pressure support and target blood pressure (BP)

	Target BP (mean arterial or systolic) was used					
	Yes	**No**	**%**	**Subtotal**	**Unknown**	**Total**
Yes	134	56	70.5	**190**	23	**213**
No	31	58	34.8	**89**	10	**99**
Subtotal	**165**	**114**		**279**	**33**	**312**
Unknown	2	4		**6**	4	**10**
Total	**167**	**118**		**285**	**37**	**322**

Case reviewer data

Although there is uncertainty about the control of systolic blood pressure and outcome,[51] current guidelines suggest aiming for a systolic blood pressure of more than 100 mmHg. The case reviewers frequently commented that physiological targets were not documented or used. A blood pressure target was used in 167/285 (58.6%) patients admitted to critical care (Table 6.5). It was more common for a blood pressure target to be used for patients who required blood pressure support (134/190; 70.5%) than for those in whom blood pressure support was not required (31/89; 34.8%) (Table 6.5).

Neurology and seizures

Rapid return of circulation is the primary goal of resuscitation attempts. This improves both survival rates and long term neurological function. In the absence of sedation, a persistently reduced consciousness level can be due to hypoxic brain injury or seizures. Where there is doubt about neurological function on admission, short acting sedatives are commonly used both to facilitate the delivery of organ support and to implement neuroprotective measures, including targeted temperature management (TTM) (see later in this chapter).

In the first 24 hours following admission, 83/391 (21.2%) patients had regained consciousness to a Glasgow Coma Scale (GCS) score 13 or greater (Table 6.6). Of these, 66 had a GCS score of 15 (data not shown).

Of the 322 patients admitted to critical care, 256/318 (80.5%) received sedation (data not shown). The time on sedation was recorded for 166 of these patients. The average time on sedation was 49.6 hours (median 36 hours) and for 110/166 (66.3%) patients, continuous sedation was stopped within 48 hours (Figure 6.3 overleaf). The sedatives used are shown in Table 6.7.

Table 6.6 Highest Glasgow Coma Scale score within 24 hours of return of spontaneous circulation

	Number of patients	**%**
3-8	294	75.2
9-12	14	3.6
13-15	**83**	**21.2**
Subtotal	391	
Unknown	**25**	
Total	**416**	

Case reviewer data

Table 6.7 Drugs used for sedation

	Number of patients	**%**
Propofol	239	96.0
Alfentanil	81	32.5
Fentanyl	71	28.5
Remifentanil	66	26.5
Midazolam	27	10.8
Morphine	10	4.0
Dexmedetomidine	7	2.8
Other	9	3.6
Answers may be multiple, n=249		
Unknown	7	2.8

Case reviewer data

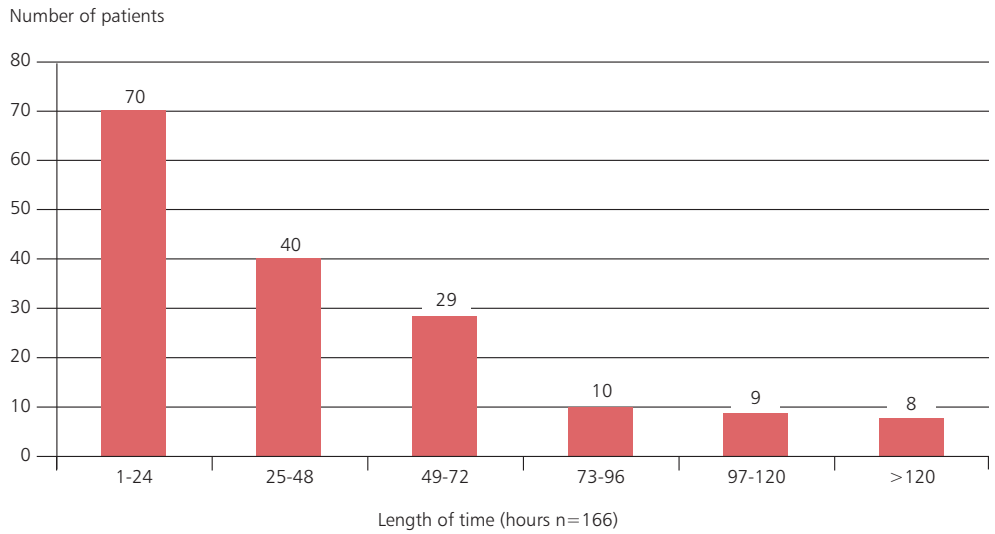


Figure 6.3 Length of time on continuous sedation

Case reviewer data

Of the patients who remained unconscious (best GCS score 3-8) in the first 24 hours after ROSC, 224/290 (77.2%) were sedated (Figure 6.4). The outcome was known for the 65/66 patients who remained unconscious (best GCS score in first 24 hours 3-8), and who did not receive any sedation (one transferred to another hospital). All of these patients died. Fourteen of these deaths occurred in the emergency department.

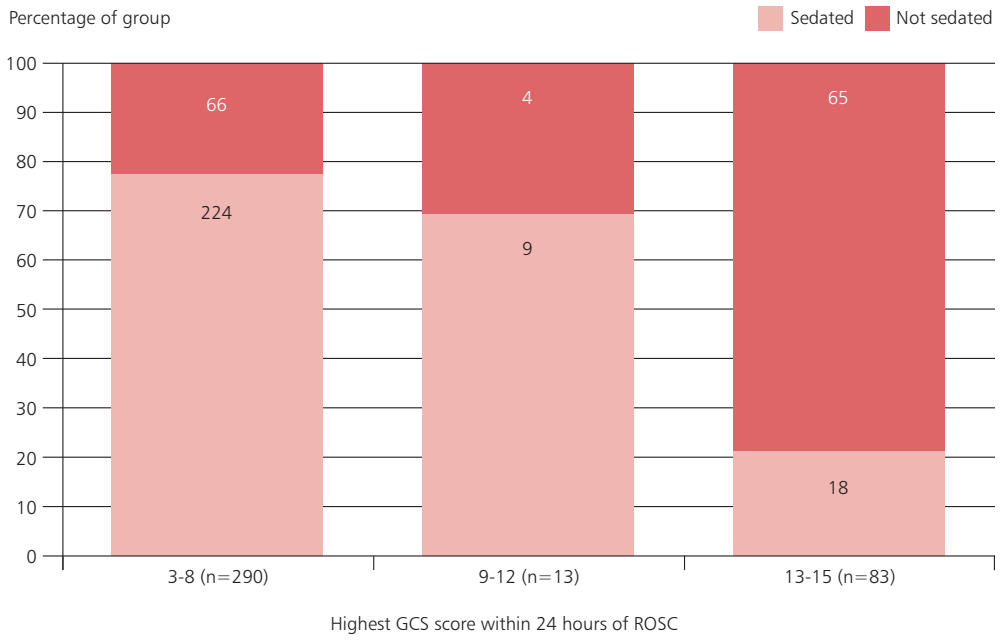


Figure 6.4 Highest Glasgow Coma Scale (GCS) score within 24 hours of return of spontaneous circulation (ROSC) and sedation

Case reviewer data

Neurological care in critical care is focussed on neuroprotection to improve the number of patients who regain consciousness. There were 151/381 (39.6%) patients who case reviewers identified had a GCS score of 13 or greater at some point during the admission (Table 6.8). There were 157/412 (38.1%) patients with a GCS score of nine or over, who were able to obey commands during the admission and of these, 13 died (Table 6.8).

Table 6.8 Highest Glasgow Coma Score during admission

	Number of patients	%
3-8	224	58.8
9-12	6	1.6
13-15	151	39.6
Subtotal	**381**	
Unknown	35	
Total	**416**	

Case reviewer data

Seizures occur in approximately a third of patients following cardiac arrest, myoclonus being the most common activity noted.[50] Similar numbers were seen in this study, with seizures documented in 108/407 (26.5%) of the case notes reviewed (Table 6.9). These were most commonly noted in the first 24 hours after cardiac arrest (88/108; 81.5%) (Table 6.10). Myoclonic seizures was the pattern noted in 65 patients (Table 6.11).

Due to the frequency with which seizure activity occurs in this clinical situation, and the difficulty in assessing sedated (and sometimes medically paralysed) patients for seizure activity, an electroencephalogram (EEG) may be required to detect (or exclude) seizure in unconscious patients. EEG was used as part of the prognostication process for 56/128 (43.8%) patients and in 43/67 patients where seizure activity was noted (data not shown).

Table 6.9 Documented seizure activity

	Number of patients	%
Yes	108	26.5
No	299	73.5
Subtotal	**407**	
Unknown	9	
Total	**416**	

Case reviewer data

Table 6.10 When seizure activity was noted after cardiac arrest

	Number of patients	%
< 24 hours	88	26.5
24-48 hours	16	73.5
> 48 hours	12	
Time unknown	2	

Case reviewer data

Table 6.11 Type of seizure

	Number of patients	%
Myoclonic	65	60.2
Generalised	24	22.2
Focal/partial	21	19.4
Non-convulsive (EEG diagnosed)	5	4.6
Other	7	6.5

Answers may be multiple, n=108
Case reviewer data

Temperature management

Fever commonly occurs in the first 48 hours after cardiac arrest and is associated with a poorer outcome. An increase in body temperature will result in an increase in metabolic rate and this has the potential to increase the brain damage that results from the absence of blood supply to the brain at the time of cardiac arrest. Measures to protect the brain are therefore of great importance following OHCA. These measures include temperature management that reduces or prevents a rise in body temperature. TTM is indicated in comatose patients who are ventilated in critical care following OHCA with ROSC.

Clinical studies have examined mild therapeutic hypothermia post-cardiac arrest. The exact temperature target and the optimal duration of temperature management remain the subject of some debate, but it is clear that treatment should be given that prevents a rise in body temperature above normal (37°C).

The most recent guidelines recommend TTM for at least 24 hours, for all patients after OHCA who remain unresponsive after ROSC (acknowledging that the evidence for its use is better for those with an initial shockable rhythm).[50] Fever (>37.5°C) should be avoided for the first 72 hours.

A policy for TTM was available from 130/167 (77.8%) hospitals (Table 6.12). Of the patients in the study, clinicians reported that 441/541 (81.5%) were from hospitals in which there was such a policy (Table 6.13). It was notable that for 158/699 (22.6%) patients, the clinician completing the questionnaire did not know if such a policy was in place in their hospital (Table 6.13).

Effective control of body temperature is best achieved using devices that actively feed back core body temperature to adjust their performance. Where an answer was provided, there were 67/137 (48.9%) hospitals from which it was reported that a device which used a 'feedback loop' was available (Table 6.14).

Table 6.12 Hospital policy for targeted temperature management was available

	Number of hospitals	%
Yes	130	77.8
No	37	22.2
Subtotal	**167**	
Unknown	15	
Total	**182**	

Organisational questionnaire

Table 6.13 Clinician reported local policy/procedure that includes targeted temperature management following return of spontaneous circulation

	Number of patients	%
Yes	441	81.5
No	100	18.5
Subtotal	**541**	
Unknown	158	
Total	**699**	

Clinician questionnaire

Table 6.14 Availability of a targeted temperature management device with feedback loop system

	Number of hospitals	%
Yes	67	48.9
No	70	51.1
Subtotal	**137**	
Unknown	45	
Total	**182**	

Organisational questionnaire

Data from the clinical questionnaire showed that of the patients who were admitted to critical care, TTM was used in 172/350 (49.1%) (Table 6.15).

Table 6.15 Targeted temperature management was used in critical care

	Number of patients	%
Yes	172	49.1
No	178	50.9
Subtotal	**350**	
Unknown	73	
Total	**423**	

Clinician questionnaire

In the case notes that were peer reviewed, TTM was not indicated in 114/403 (28.3%) patients (Figure 6.5). In the remaining 289 patients, TTM was used in 131/289 (45.3%).

CASE STUDY 5

A patient was admitted to critical care following an OHCA and ROSC. The admitting doctor documented that temperature management was indicated. There was no evidence in the case notes that active measures were taken to manage the patient's temperature. Persistent fever up to 38°C developed from day two of the admission. Assessment on day four suggested a likely poor neurological outcome and treatment was withdrawn.

The case reviewers considered that a more active approach to temperature management was needed as this could have improved the neurological outcome in this case.

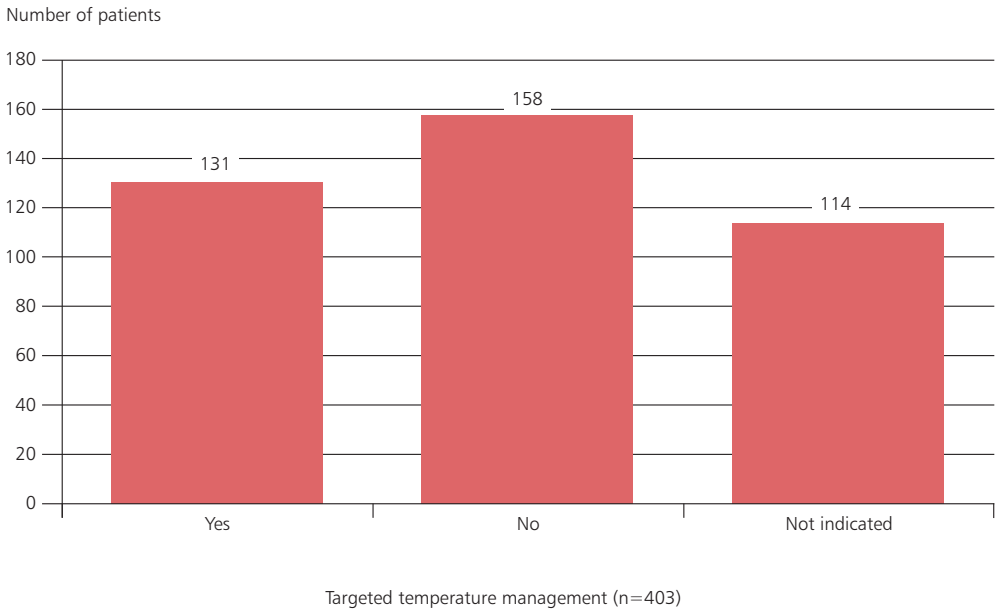


Figure 6.5 The use of targeted temperature management
Case reviewer data

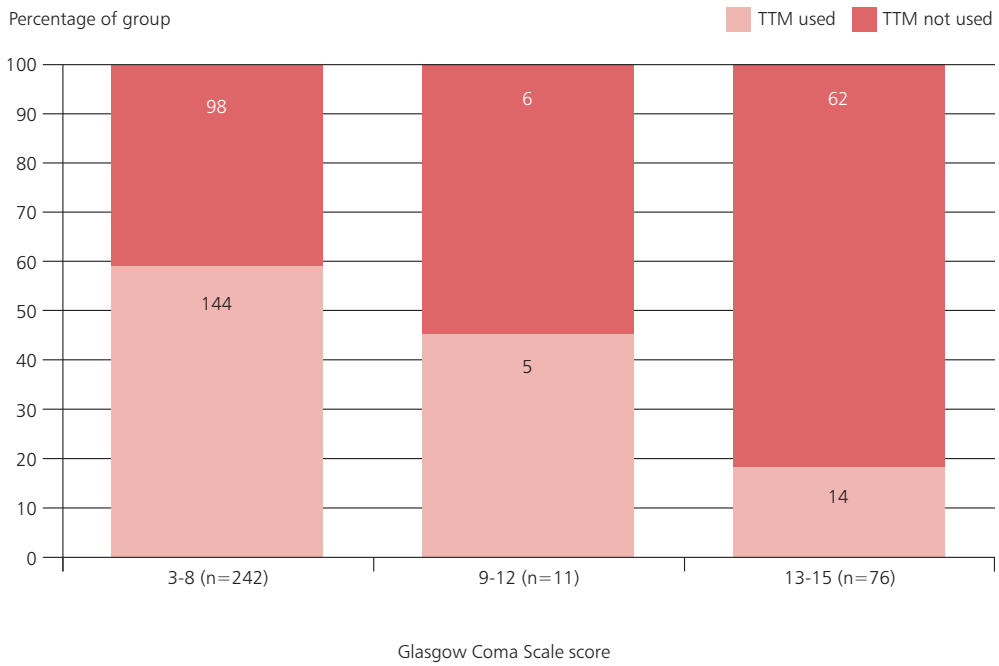


Figure 6.6 Targeted temperature management (TTM) and best Glasgow Coma Scale score within 24 hours of return of spontaneous circulation

Clinician questionnaire

Data from the clinical questionnaire showed that of 253/329 (76.9%) patients admitted to critical care and with a best GCS score lower than 13 within 24 hours of ROSC, TTM was not used in 104/253 (41.1%) (Figure 6.6). Although there may have been other clinical factors such as advanced organ failure and co-morbid conditions, that influenced the decision about offering TTM, the group of patients where TTM was not used, represents an opportunity to improve care and deliver improved neurological outcome.

Where temperature management was used, the plan including duration of temperature management was clearly documented for 67/130 (51.5%) patients (Table 6.16). The target temperature range was documented for 101/131 (77.1%) patients (Table 6.17).

Table 6.16 A clearly documented plan for the temperature and duration of targeted temperature management was in place

	Number of patients	%
Yes	67	51.5
No	63	48.5
Subtotal	**130**	
Unknown	1	
Total	**131**	

Case reviewer data

Table 6.17 Target temperature range was documented

	Number of patients	%
Yes	101	77.1
No	30	22.9
Total	**131**	

Case reviewer data

In the 101 patients where a temperature target was used and the target was documented, this target was always below 37°C. The most frequent temperature targets used are listed in Table 6.18. This reflects the uncertainty about the most appropriate target temperature that should be used, but at the same time, acknowledges the importance placed on preventing a rise in body temperature.

Table 6.18 Target temperature range

	Number of patients
<36°C	53
<37°C	14
32°C-36°C	9
34°C-36°C	7
Other	18

Case reviewer data

The type of device used in individual patients was rarely documented in the case notes. Data from the clinician questionnaire showed that in 140/172 (81.4%) cases where it was known, the approach to temperature management involved an external cooling device in 82/140 (58.6%) patients, an intravascular device in 14/140 (10.0%), ice packs alone in 14/140 (10.0%) and cold intravenous fluids in 11/140 (7.9%). There were 26/140 (18.6%) patients where a temperature management approach was used, but the patient did not require any intervention to maintain their temperature within the required range (data not shown). This shows that in the majority of patients, where temperature management was appropriate, active measures were needed to keep the temperature from rising above the target range.

The temperature management device was controlled using feedback of temperature measurement in 86/134 (64.2%) patients (unknown in 38 - clinician questionnaire data not shown). For those patients who had a temperature management approach used, the temperatures during each 24 hour period are presented in Table 6.19 and Figure 6.7. This shows that temperature control was frequently not achieved even when it was planned.

The temperature rose above 37.5°C in 16/75 patients in the first 24 hours, 19/64 between 24 and 48 hours and 19/46 between 48 and 72 hours. Of the 46 patients where data were available for all three time points, there were 21 where their temperature never rose above 37.5°C.

Table 6.19 Average temperature during targeted temperature management

	First 24 hours n=75	24-48 hours n=64	48-72 hours n=46	72-96 hours n=46
Average temperature (°C)	36.6	37.0	37.3	37.3
> 36°C	53	56	41	28
> 37°C	27	29	29	21
> 37.5°C	16	19	19	16

Case reviewer data

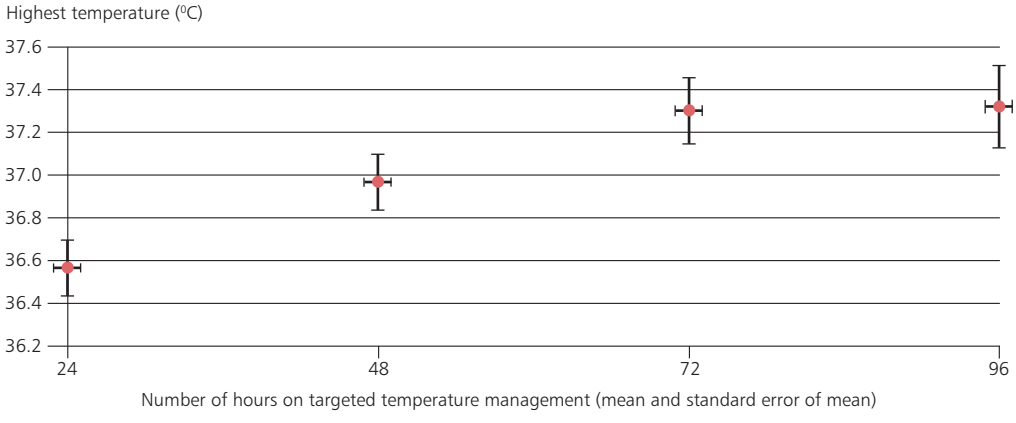


Figure 6.7 Highest temperature during each 24 hour period
Case reviewer data

Figure 6.7 shows that, as a group, the highest temperature rose progressively on each of the first three days. This highlights the importance of active and continued measures to control temperature and of using the most effective approach to control temperature.

The data in Figure 6.7 and Table 6.19 shows that although it is clear that temperature control below 37.5ºC is important to improve neurological outcome, the approach used in clinical practice frequently does not achieve control of temperature to the desired target. The case reviewers considered that the approach to temperature management in the cases reviewed could have been improved. They rated the temperature management as 'good' for only 41/219 (18.7%) patients and as 'poor' or 'unacceptable' for 126/219 (57.5%) patients (Figure 6.8).

When this rating was split, comparing those in whom a temperature management was used and those where it was not used but was indicated, the case reviewers considered that the approach to temperature management was 'poor' or 'unacceptable' in a greater proportion of patients when TTM was not used (48/113; 42.5% vs 78/106; 73.6%) (Figure 6.9).

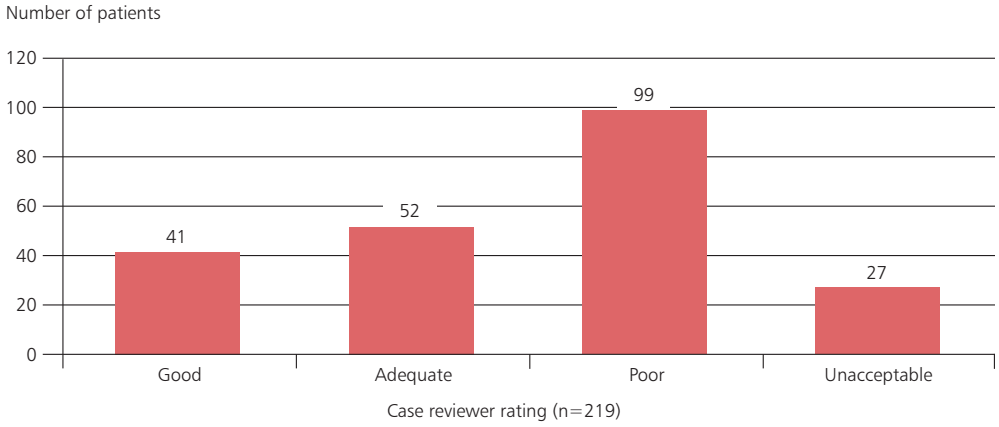


Figure 6.8 Case reviewers' opinion on the patient's temperature management
Case reviewer data

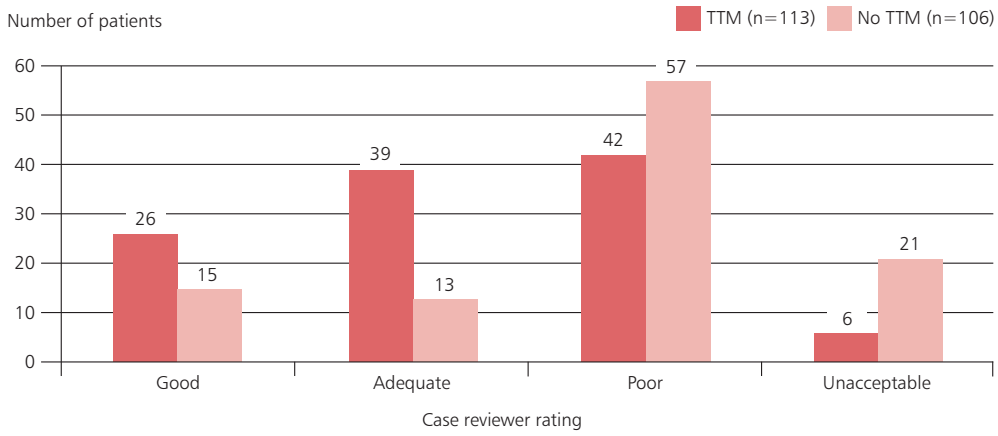


Figure 6.9 Case reviewers' opinion on the patient's temperature management and whether or not targeted temperature management (TTM) was used
Case reviewer data

The clinicians who completed a questionnaire at their own hospital, considered that there was room for improvement in the temperature management for 24/125 (19.2%) patients (Table 6.20).

Table 6.20 Room for improvement in the targeted temperature management of the patient

	Number of patients	%
Yes	24	19.2
No	101	80.8
Subtotal	**125**	
Unknown	27	
Total	**152**	

Clinician questionnaire

Neuroprognostication

Brain injury is the major cause of death in patients with ROSC after an OHCA. It is known that two-thirds of patients die due to perceived neurological injury after being admitted to intensive care following an OHCA.[51] The majority of deaths actually occur after an assessment which suggests poor neurological prognosis leading to a decision to withdraw life sustaining treatment.[52]

In order to optimise survival rates following an OHCA, it is important to use active measures to protect patients from brain injury (such as TTM as discussed in the previous section). It is also important that individuals with the potential for survival, are identified as accurately as possible and that inappropriate withdrawal of life-sustaining treatment in those with potential for survival is avoided. Early withdrawal of organ support may be appropriate in patients with multi-organ failure or cardiogenic shock. In patients who remain unconscious, the reliability of assessment improves over several days after ROSC.

The key to accurate prognostication is to use assessments with the lowest possible false positive rate. The approach to assessment can include clinical examination, brain imaging, electrophysiological tests and measurement of biomarkers in the blood. Each approach is discussed in more detail below. The accuracy of each of these assessment modalities has recently been reviewed.[53] No individual test is 100% specific for a poor neurological prognosis. A multi-modality approach to neuroprognostication is therefore recommended.[50]

The use of sedatives in intensive care can also make clinical assessment difficult and temperature management approaches can complicate this by affecting drug metabolism as well as neurological function. The timing of assessment is therefore important to ensure that the tests that are used are as reliable as possible.

Organisational data shown in Tables 6.21 and 6.22 overleaf is cross-referenced in the individual sections where it applies.

Table 6.21 Prognostic assessments and tests that are available and routinely used

	Number of hospitals	%
Motor response to pain	153	96.2
Pupillary light reflexes	152	95.6
CT scan of the brain / CT angiography	146	91.8
Corneal reflexes	139	87.4
Seizure activity / myoclonus	129	81.1
Electroencephalogram - intermittent	93	58.5
MRI scan of the brain / diffusion weighted imaging	81	50.9
Short-latency somatosensory evoked potentials (SSEPs)	36	22.6
Electroencephalogram - continuous	24	15.1
Electroencephalogram with bispectral (BIS) monitoring	14	8.8
Biomarkers - neuron specific enolase (NSE), S-100B, other	14	8.8
Four vessel cerebral catheter angiography	13	8.2
Other	4	2.5

Answers may be multiple; n=159
Organisational questionnaire

Table 6.22 Availability of prognostic assessments and test within the hospital

	Number of hospitals	%
Formal ECG	179	98.4
CT scan of the chest	179	98.4
CT scan of the brain	178	97.8
CT scan of the abdomen	178	97.8
MRI scan of the brain	171	94.0
Point of care ECG	152	83.5
CT coronary angiogram	140	76.9
Electroencephalogram	120	65.9
On-site neurologist	101	55.5
Cardiac MRI scan	100	54.9

Answers may be multiple; n=182
Organisational questionnaire

Table 6.23 Local policy/procedure that includes neurological prognostication following return of spontaneous circulation

	Number of patients	%
Yes	282	60.5
No	184	39.5
Subtotal	**466**	
Unknown	233	
Total	**699**	

Clinician questionnaire

Data from the clinical questionnaire showed that 282/466 (60.5%) patients were seen in hospitals in which there was a policy for neurological prognostication (Table 6.23). In the case notes that were reviewed, neurological prognostication was considered not to be applicable for 132/411 (32.1%) patients. In the remaining patients, prognostication took place in 134/279 (48.0%) (Figure 6.10).

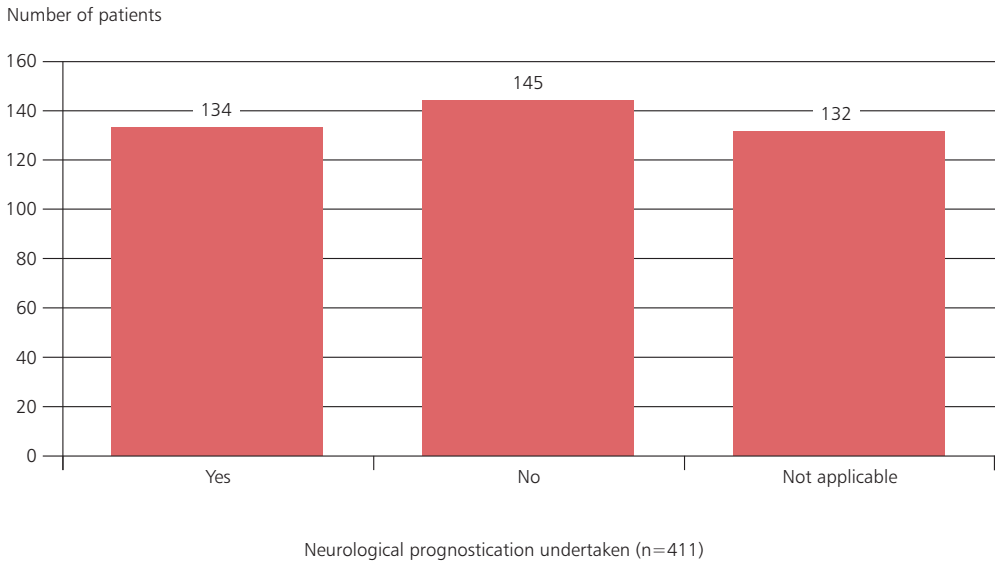


Figure 6.10 Neurological prognostication undertaken
Case reviewer data

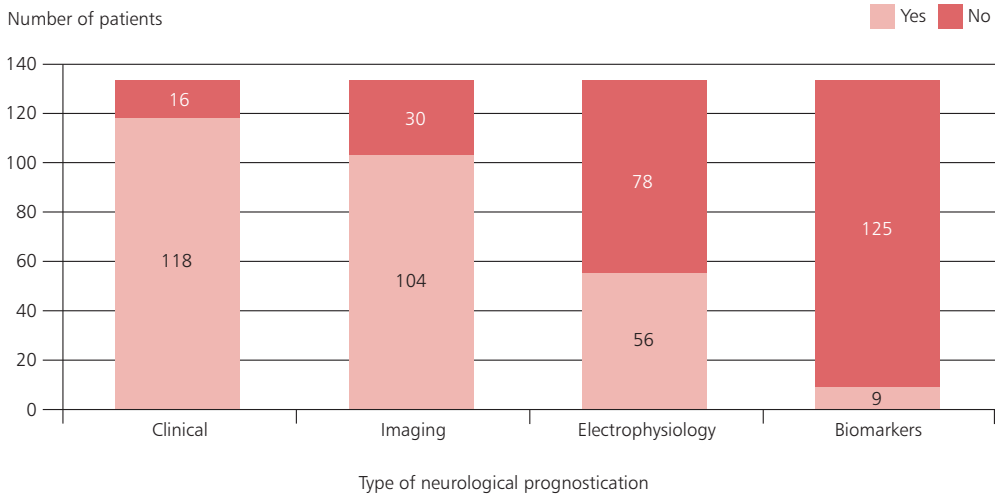


Figure 6.11 Type of neurological prognostication undertaken (n=134)

Case reviewer data

The use of biomarkers as a mode of assessment was uncommon in practice, being used in only 9/134 (6.7%) patients (Figure 6.11). This is therefore not discussed further in this report.

Clinical assessment

Clinical assessment after ROSC must take into account the effects of sedative drugs which impair responses, and care must be taken to make an assessment at a long enough interval after these have been discontinued. At 72 hours after ROSC, and in the absence of the effects of sedation, the bilateral absence of both pupillary light reflexes and corneal reflexes have a very low false positive rate and can therefore be used to predict poor prognosis. An absent or extensor response to pain at 72 hours has good sensitivity for poor neurological prognosis, but a higher false positive rate.

Organisational data showed that clinical assessment was used to assess neurological prognosis in 153/159 (96.2%) hospitals (Table 6.21). In practice, clinical assessment was used in 118/134 (88.1%) patients whose case notes were reviewed and where neurological prognosis was assessed.

The approach to clinical assessment was found to be inconsistent in the case notes reviewed. The most frequent clinical test documented in the records of the patients reviewed was the motor response to pain (109/134; 81.3%). Pupillary light reflexes were less frequently documented (94/134; 70.1%). Corneal reflexes were tested in 38/134 (28.4%) patients (Table 6.24).

Table 6.24 Type of clinical prognostication documented

	Number of patients	%
Motor response to pain	109	81.3
Pupillary light reflexes	94	70.1
Corneal reflexes	38	28.4
Other	11	8.2
Answers may be multiple; n=134	699	
No clinical prognostication	16	11.9

Case reviewer data

Imaging

Brain imaging is commonly used to look for evidence of global hypoxic-ischaemic brain injury. CT scanning can reveal a loss of grey-white differentiation. The ideal interval between ROSC and CT to optimise diagnostic accuracy has not been defined. MRI is more sensitive than CT for the identification of brain injury, but is less commonly used as it is often more difficult to scan clinically unstable or intubated patients. Guidelines recommend performing an MRI scan 2-5 days post-ROSC. It is also recommended that brain imaging should only be used in combination with other assessment modalities for neuroprognostication after ROSC.[53-55]

Organisational data showed that CT scans of the brain were used in 146/159 (91.8%) hospitals and MRI scans were used in 81/159 (50.9%) hospitals (Table 6.21).

In the cases reviewed, there was an inconsistent approach to imaging to assess neurological prognosis. Overall, at least one form of imaging was used for 104/134 (77.6%) patients. CT was the most common imaging modality used (97/134; 72.4%). MRI scanning was used for only 12/134 (9.0%) patients (seven had both CT and MRI). In 30/134 (22.4%) of the cases reviewed, no imaging modality was used for neuroprognostication (Table 6.25).

Table 6.25 Imaging undertaken

	Number of patients	%
CT brain/CT Angiography	97	72.4
MRI brain/Diffusion Weighted Imaging	12	9.0
Four vessel cerebral catheter angiography	0	0.0
Other	2	1.5
Answers may be multiple; n=134	*699*	
No imaging	30	22.4

Case reviewer data

Electrophysiology

Electrophysiological testing using an EEG can be used in comatose patients after cardiac arrest and ROSC, both to provide prognostic information and also to detect sub-clinical seizure activity as an explanation for persistent unconsciousness. Some EEG patterns have been shown to be associated with a poor neurological outcome.[54] As with clinical assessment and brain imaging, it is recommended that EEG is used for neuroprognostication in combination with other assessment modalities.[51]

Organisational data showed that EEG was available in 120/182 (65.9%) hospitals (Table 6.22) and was routinely used to assess neurological prognosis in 93/159 (58.5%) (Table 6.21).

Of the case notes that were peer reviewed, EEG was used in the assessment of neurological prognosis for 55/134 (41.0%) patients (Table 6.26).

Table 6.26 Electrophysiology undertaken

	Number of patients	%
Electroencephalogram - intermittent	54	40.3
Short-latency somatosensory evoked potentials (SSEPs)	9	6.7
Electroencephalogram with bispectral (BIS) monitoring	1	<1
Electroencephalogram - continuous	0	0
Other	1	<1
Answers may be multiple; n=134	30	22.4
No electrophysiology	78	58.2

Case reviewer data

Data from the clinical questionnaire showed that neuroprognostication was undertaken in 197/606 (32.5%) patients. Electrophysiology was used in 88/197 (44.7%); intermittent EEG in 75/197 (38.1%), continuous EEG in 13/197 (6.7%) and short-latency somatosensory evoked potentials (SSEPs) in 15/197 (7.6%) (data not shown).

Multi-modality assessment

Due to the poor reliability of a single approach to neuroprognostication, guidelines suggest using more than one approach to assessment.[51] Figure 6.12 shows that in the majority of cases reviewed (102/132; 77.3%) either two or three modalities were used in the assessment of neurological prognosis. There were 26/132 (19.4%) patients where only one modality was used and in 20/26 it was a clinical assessment.

Timing of assessment

As discussed previously, the timing of neuroprognostication is of vital importance if patients are to be given the best chance of survival. The time from arrival in hospital to neuroprognostication was documented for 84 patients. The average time to the first assessment was 55.5 hours (median 49.9 hours) (data not shown).

In 36/84 patients, neuroprognostication was repeated. The average time to the final assessment of neurological prognosis was 72 hours (median 70.3 hours) (Figure 6.13). In 57/84 patients, the final assessment was made less than 72 hours after hospital admission.

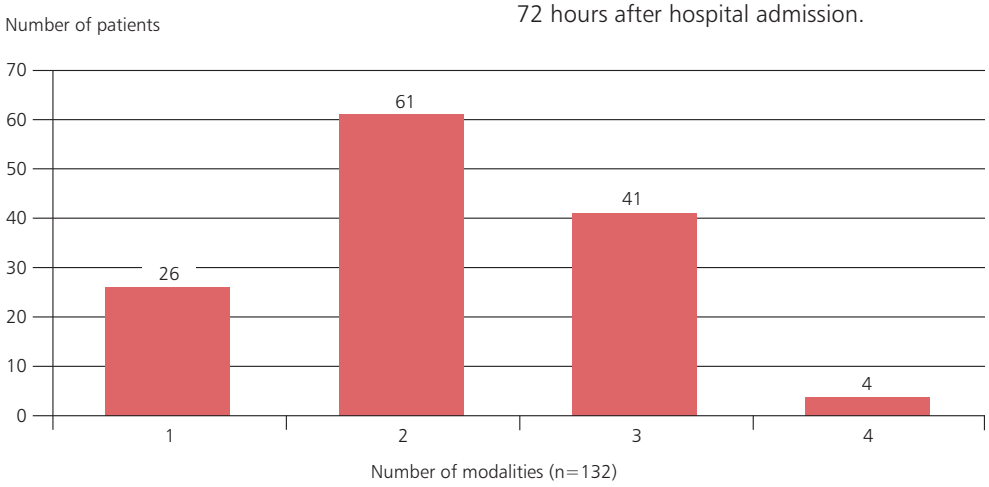


Figure 6.12 Number of modalities used for neurological prognostication
Case reviewer data

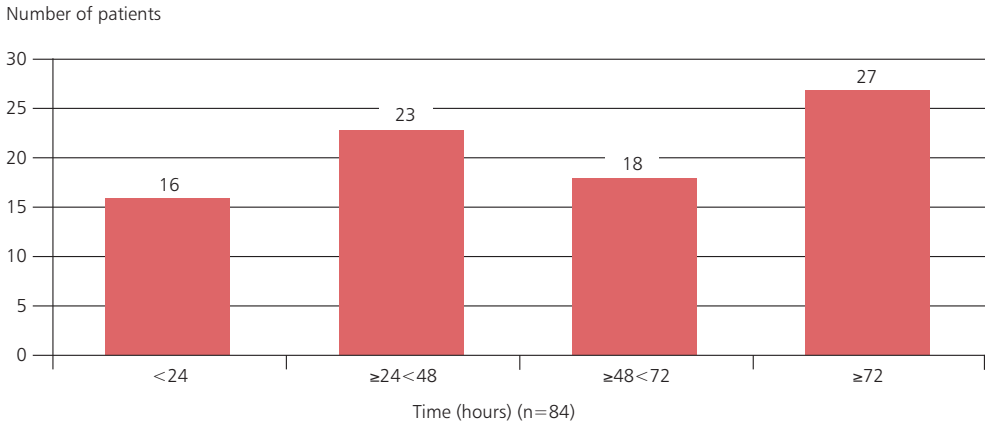


Figure 6.13 Time between arrival and final assessment of neurological prognostication
Case reviewer data

Case reviewers considered that the timing of neuroprognostication was not appropriate for 26/131 (19.8%) patients (Table 6.27). This was due to a combination of prognostication done too early after ROSC and also too soon after sedation had been stopped.

Table 6.27 Timing of neurological prognostication was appropriate

	Number of patients	%
Yes	105	80.2
No	26	19.8
Subtotal	**131**	
Unknown	3	
Total	**134**	

Case reviewer data

CASE STUDY 6

A patient was admitted to intensive care for respiratory support and temperature management following an OHCA and ROSC. After three days of sedation and active cooling, treatment was withdrawn based on clinical assessment suggesting a poor prognosis. The patient had warmed to 36.6^{o}C and sedation had been stopped less than four hours before this assessment.

The case reviewers considered that neuroprognostication should have been delayed for a longer period to ensure there was no residual sedative effect and that including additional modalities such as imaging or electrophysiology would have improved the reliability of the assessment.

Assessment can be useful to predict poor prognosis, but if assessment does not provide conclusive evidence, it is unhelpful and guidelines recommend repeating the assessment after a time interval. For example, in this study, 30 patients who had had an unclear neurological prognosis at the time it was assessed, were discharged home.

Overall, the case reviewers considered that for the neurological prognostication process used, timing and process of assessment, was not appropriate for 38/130 (29.2%) patients.

CASE STUDY 7

A patient was admitted to intensive care for airway protection, temperature management and neuroprognostication following an OHCA and ROSC. After 72 hours using an intravascular cooling device, and 12 hours of re-warming, sedation was stopped. When the patient remained unconscious the following day, a combination of clinical examination, CT imaging and an electroencephalogram did not confirm brain injury. After a further 48 hours the patient showed signs of a purposeful response and went on to make a good neurological recovery.

The case reviewers considered that this was an example of good practice in neuroprotection and neuroprognostication with a resulting good outcome for the patient.

Table 6.28 An appropriate process of neurological prognostication

	Number of patients	%
Yes	92	70.8
No	38	29.2
Subtotal	**130**	
Unknown	4	
Total	**134**	

Case reviewer data

Limitation and withdrawal of life sustaining treatment

For survivors of OHCA admitted to intensive care, a major aim of treatment is to improve neurological outcome. When assessment suggests that ongoing treatment is unlikely to be of benefit, it is appropriate to set limits on the level of further organ support. When patients are clearly dying as a result of their illness, life sustaining treatment may be actively withdrawn. Poor neurological prognosis is often the reason for active withdrawal. The data on limitation and withdrawal of life sustaining treatment is therefore presented in this section along with additional data on how this related to neuroprognostication.

Of the case notes reviewed for this study, it was documented that life-sustaining treatment was limited in 159/387 (41.1%) patients and was withdrawn in 194/397 (48.9%) patients (data not shown). Of the patients who died, treatment was limited in 154/259 (59.5%) (Table 6.29). Withdrawal of life- sustaining treatment occurred in 203/266 (76.3%) patients who died (Table 6.30). For 236 patients who died, treatment was withdrawn after neurological prognostication in 108/236 (45.8%) (data not shown).

The importance of the combination of neurological prognostication related to treatment withdrawal, was demonstrated when both of these processes were examined for all patients who died (Figure 6.14). Of the patients who died following withdrawal of treatment, there were 41 where neuroprognostication was not applicable, as they died for other reasons. For the remaining patients, 52/160 (32.5%) had treatment withdrawn without neuroprognostication.

Table 6.29 Life-sustaining treatment was limited at any stage

	Number of patients	%
Yes	154	59.5
No	105	40.5
Subtotal	**259**	
Unknown	10	
Total	**269**	

Case reviewer data

Table 6.30 Decision made to withdraw life-sustaining treatment in patients who died

	Number of patients	%
Yes	203	76.3
No	63	23.7
Subtotal	**266**	
Unknown	3	
Total	**269**	

Case reviewer data

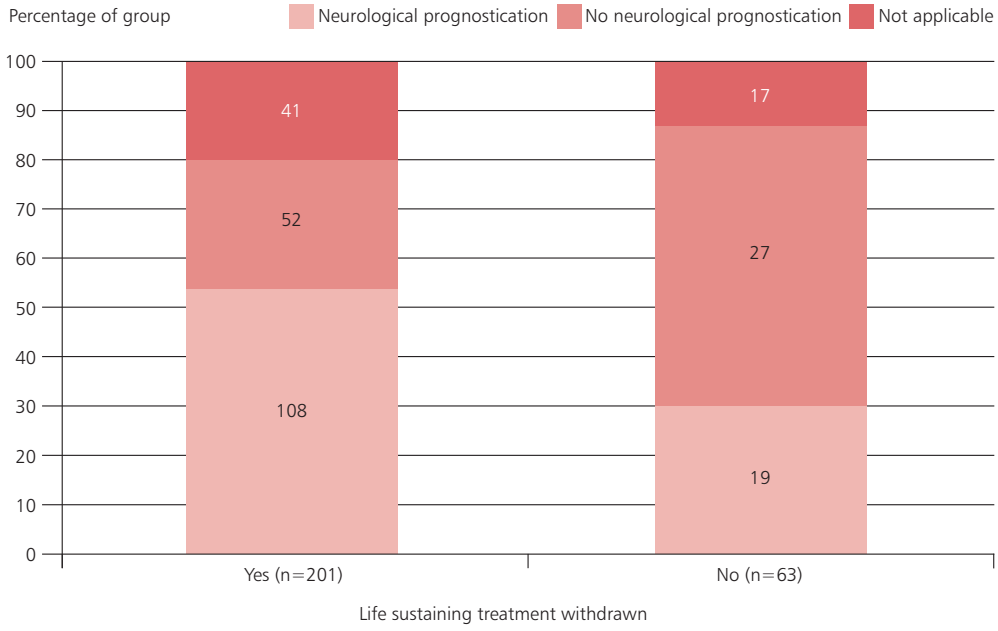


Figure 6.14 Neurological prognostication and treatment withdrawal in patients who died
Case reviewer data

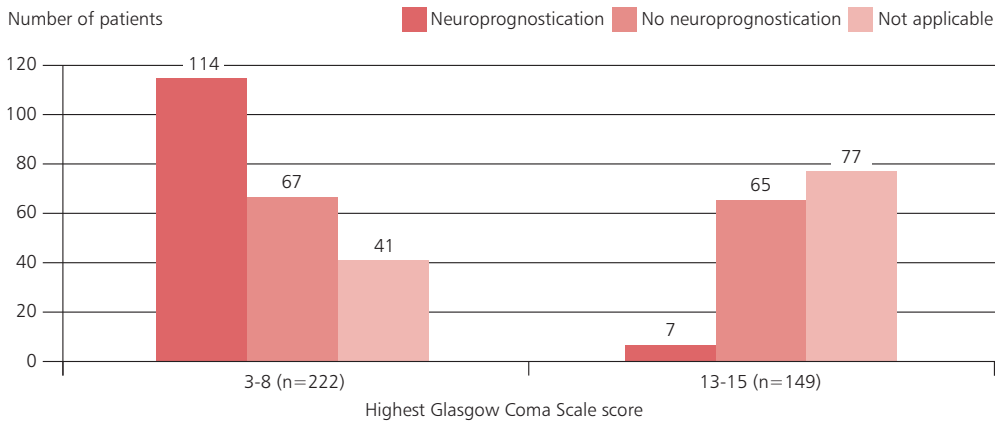


Figure 6.15 Highest Glasgow Coma Scales (GCS) score and neurological prognostication

Case reviewer data

Figure 6.15 shows that of the 222 patients who remained unconscious during the whole admission (best Glasgow Coma Scale score 3-8), an assessment of neurological prognosis was made in 114/222 (51.4%). There were 67/222 (30.2%) patients, who remained unconscious, where no assessment of neurological prognosis was made.

Of 113 patients who remained unconscious and had an assessment of neurological prognosis made, treatment was withdrawn in 96/113 (85.0%) (Figure 6.16). There were 46/66 patients where no neurological prognostication was done and where treatment was withdrawn. This number excludes 41 patients where the case reviewers considered that neurological assessment was not applicable.

The data presented in this section highlights that both continued treatment and formal assessment of neurological prognosis in this group of patients, is likely to have identified some individuals with the potential for survival.

The case reviewers considered that decisions about treatment limitation and withdrawal were appropriate for 351/378 (92.9%) patients. Of the 27 patients where the case reviewers considered that these decisions were not appropriate, there were 19 where they considered that a treatment escalation plan was needed, but no plan had been made (data not shown).

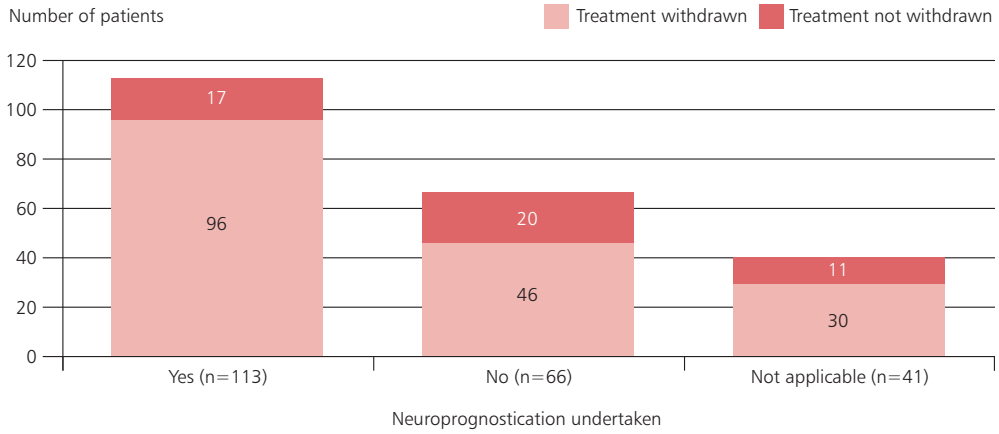


Figure 6.16 Treatment withdrawal and neurological prognostication in patients with a GCS score of 3-8

Case reviewer data

Key Findings

45. 322/385 (83.6%) patients were admitted to a critical care ward
46. The case reviewers considered that clinical care, in critical care, could have been improved for 109/311 (35.0%) patients
47. 286/322 (88.8%) patients admitted to critical care were treated with invasive ventilation and 213/312 (68.3%) received blood pressure support
48. 39/294 (13.3%) patients admitted to critical care had non-invasive cardiac output monitoring
49. A blood pressure target was used in 167/285 (58.6%) patients admitted to critical care. It was more common for a blood pressure target to be used for patients who required blood pressure support (134/190; 70.5%) than for those in whom blood pressure support was not required (31/89; 34.8%)
50. Of the 322 patients admitted to critical care, 256/318 (80.5%) received sedation. The average time on sedation was 49.6 hours (median 36 hours) and for 110/166 (66.3%) patients where it could be determined, continuous sedation was stopped within 48 hours
51. 108/407 (26.5%) patients had documentation of a seizure
52. EEG was used as part of the prognostication process for 56/128 (43.8%) patients and in 43/67 patients where seizure activity was noted
53. A policy for targeted temperature management was available from 130/167 (77.8%) hospitals
54. A temperature control device which uses a feedback loop was available at 67/137 (48.9%) hospitals
55. Clinicians reported that 172/350 (49.1%) patients admitted to critical care had TTM
56. In the case notes that were peer reviewed, TTM was not indicated in 114/403 (28.3%) patients
57. 104/253 (41.4%) patients admitted to intensive care with a best GCS lower than 13 within 24 hours of ROSC, did not receive TTM
58. When TTM was used, the patient's temperature still rose above 37.5^{o}C in 16/75 patients in the first 24 hours, 19/64 between 24 and 48 hours and 19/46 between 48 and 72 hours
59. Case reviewers rated the temperature management as 'good' in only 41/219 (18.7%) patients and as 'poor' or 'unacceptable' in 126/219 (57.5%)
60. Case reviewers considered that the approach to temperature management was 'poor' or 'unacceptable' in a greater proportion of patients when TTM was not used (48/113; 42.5% vs 78/106; 73.6%)
61. Formal prognostication took place in 134/279 (48.0%) patients
62. The average time to the final assessment of neurological prognosis was 72 hours (median 70.3 hours)
63. In 57/84 patients, the final assessment of neurological prognostication was made less than 72 hours after hospital admission
64. CT was the most common imaging modality used for neurological prognostication (97/134; 72.4%)
65. In 30/134 (22.4%) patients, no imaging modality was used for neuroprognostication
66. EEG was used for neurological prognostication in 55/134 (41.0%) patients
67. Case reviewers considered that the timing of neuroprognostication was not appropriate for 26/131 (19.8%) patients
68. There were 46/66 patients where no neurological prognostication was done and where treatment was withdrawn
69. The case reviewers considered that decisions about treatment limitation and withdrawal were appropriate for 351/378 (92.9%) patients

7

Outcome

Survival

Improving outcomes in survivors of out-of-hospital cardiac arrest (OHCA) will involve giving each patient the benefit of optimal care. This section summarises data related to survival rates, much of which supports previously published data. The Out-of-Hospital Cardiac Arrest Outcomes (OHCAO) registry data outlined in the introduction, is designed to give additional context. It is worth noting that no single factor can be used on admission to identify patients who will die following an OHCA. It is also worth noting, that where the destination on discharge was known, this was to the patient's usual place of residence for 113/117 (96.6%) patients.

Table 7.1 shows that of the case notes reviewed it could be determined that 117/386 (30.3%) patients survived to discharge, although 24/410 (5.8%) patients were transferred to another hospital for ongoing care, and so the outcome in these patients was not known. The survival to discharge was similar to the registry data for ROSC patients presented in the introduction (2,621/8,400, 31.2%).

Table 7.1 Discharge location

	Number of patients	%
Not applicable patient died during this admission	269	65.6
Usual place of residence	113	27.6
Transferred to another hospital	24	5.9
Other	4	<1
Subtotal	**410**	
Unknown	6	
Total	**416**	

Case reviewer data

Initial rhythm

Since rapid return of spontaneous circulation (ROSC) is the most important predictor of survival following cardiac arrest, the initial rhythm is a strong predictor of outcome. The data in Figure 7.1 shows that when the initial rhythm was shockable, 62/122 (50.8%) patients survived. For patients presenting initially with a non-shockable rhythm, 24/171 (14%) patients survived.

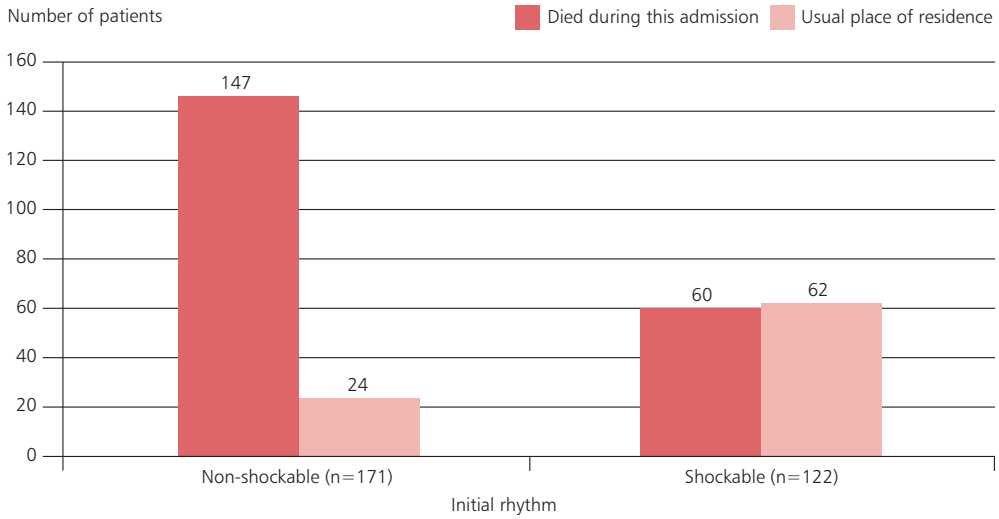


Figure 7.1 Outcome for patients with non-shockable and shockable rhythms

Case reviewer data

Circulation

Loss of consciousness, at the time of cardiac arrest, occurs when the blood supply to the brain is reduced to a level which is inadequate to maintain brain activity. Rapid restoration of the circulation is key to the 'Chain of Survival'. This can be measured as the time between cardiac arrest and ROSC. Where it was documented, the time from OHCA to sustained ROSC is shown in Figure 7.2. The mean time to ROSC for OHCA survivors was 12.6 minutes (78 patients). For those who died, the mean time to ROSC was 31.4 minutes (202 patients). For those patients who achieved ROSC in less than 20 minutes, 68/136 (50.0%) patients survived. For those patients in which sustained ROSC took longer than 20 minutes to achieve, 9/143 (6.3%) survived.

The longest interval between OHCA and sustained ROSC in a survivor in this study, was 39 minutes. This highlights the importance of restoring spontaneous circulation as rapidly as possible, but also shows that following an extended period of resuscitation, survival is still possible.

Figure 3.6 in Chapter 3 showed the impact of achieving ROSC at the scene of the cardiac arrest (patient survival, 191/494; 38.7%) compared with achieving ROSC in transit (patient survival, 16/54; 29.6%) and transporting the patient to hospital under continued cardiac arrest (survival 8/83; 9.6%). It is again worth noting, that survival was achieved for some patients in all of these scenarios.

When the body's circulation is interrupted, the absence of oxygen delivery results in anaerobic metabolism. This results in a build-up of lactic acid and a fall in blood pH (increased acidity). Patients with a raised arterial lactate concentration following cardiac arrest due to ventricular fibrillation, are more likely to have a poor neurological outcome, but high lactate alone is not a useful predictor of outcome.[47]

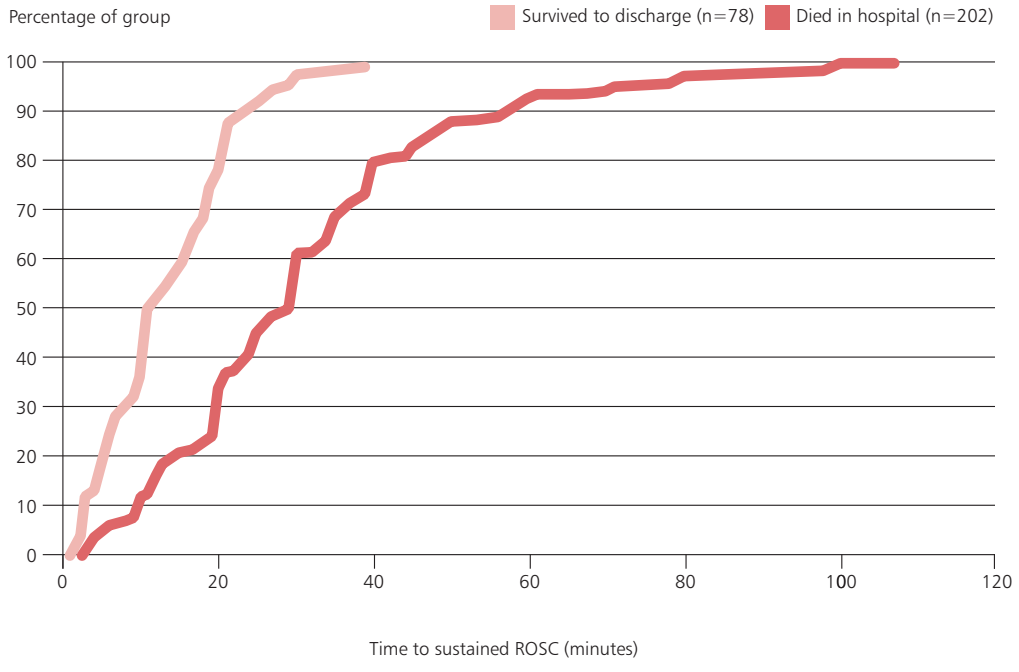


Figure 7.2 Time to sustained return of spontaneous circulation (ROSC) and patient outcome

Case reviewer data

Figures 7.3 and 7.4 show the blood pH and lactate levels on the first blood gas after admission for all patients where this result was available. This was analysed from an arterial sample in 228/323 (70.6%) patients, and a venous sample in 95/323 (29.4%) patients. Survival was more common in patients with an initial lactate level of 6 mmol/L or below (survival, 55/103; 53.4%), than in those with a higher lactate level over 6 mmol/L (survival, 28/196; 14.3%).

Survival was however possible, even with very high lactate levels; 4/35 patients with an initial lactate of >14 mmol/L survived. The highest lactate level noted in a survivor was 19.8 mmol/L.

The pattern was similar for pH. When the initial pH was above 7.2, 53/97 (54.6%) patients survived and when the initial pH was 7.2 or lower, 34/209 (16.3%) patients survived. There were 10/104 (9.6%) survivors where the initial pH was less than or equal to seven.

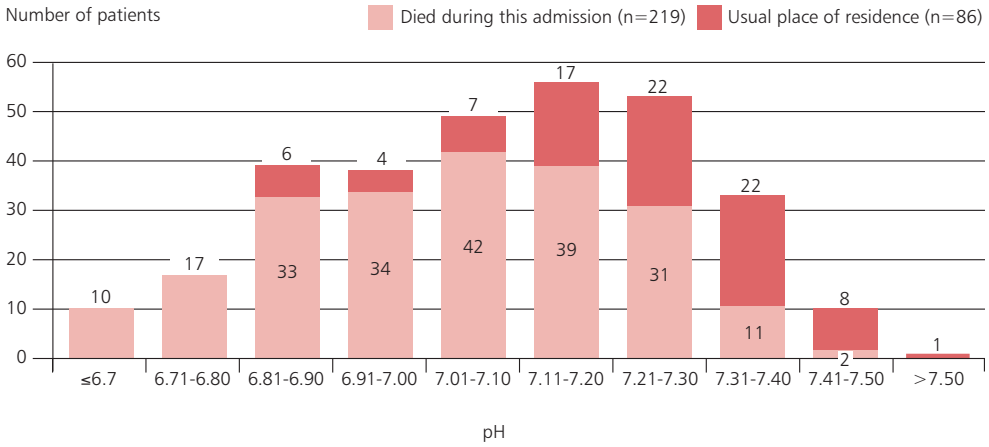


Figure 7.3 First blood pH and outcome
Case reviewer data

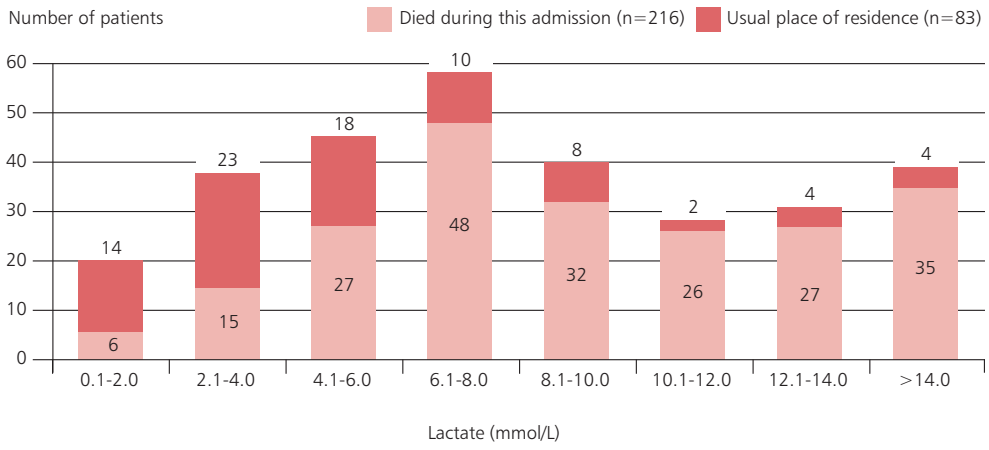


Figure 7.4 First blood lactate and outcome
Case reviewer data

Temperature management

As discussed in Chapter 6, the strategy to improve neurological outcome in patients admitted to critical care, includes targeted temperature management (TTM). This study has identified room for improvement in this area of clinical practice. In the group of peer reviewed cases, where temperature management was not indicated, 39/101 (38.6%) patients survived, compared with 32/122 (26.2%) in the group who received temperature management and 38/148 (25.7%) when temperature management was indicated, but not done.

Neurological outcome in survivors

Once ROSC has been achieved following cardiac arrest, the primary focus for improving outcomes is on neurological recovery. A number of scales have been used to record neurological outcome in cardiac arrest survivors. It was reported from 70/106 (66.0%) of hospitals (that routine assessment of neurological outcome was undertaken prior to a patient being discharged following admission for an OHCA. However, an answer to this question was not provided by respondents from 76 hospitals (Table 7.2).

In the 70 hospitals where it was routine to make an assessment, the scales and approaches used are listed in Table 7.3.

Table 7.2 Neurological functional outcome assessment routinely performed before discharge

	Number of hospitals	%
Yes	70	66.0
No	36	34.0
Subtotal	**106**	
Unknown	76	
Total	**182**	

Organisational data

Table 7.3 Types of neurological assessments used in hospitals

	Number of hospitals	%
Cerebral performance category (CPC)	18	25.7
Modified Rankin Scale (mRS)	18	25.7
Glasgow Outcome Scale Extended (GOSE)	18	25.7
Cognitive function tests	30	42.9
Other	21	30.0

Answers may be multiple; n=70
Organisational data

In practice, neurological functional outcome was recorded in the case notes for only 24/111 (21.6%) patients discharged from hospital (Table 7.4), although clinicians in their own hospitals were more frequently able to identify a functional outcome scale recorded for survivors (63/162; 38.9%).

Table 7.4 Scale of neurological functional outcome recorded in the case notes

	Case reviewer data		Clinician questionnaire	
	Number of patients	%	Number of patients	%
Yes	24	21.6	63	38.9
No	87	78.4	99	61.1
Subtotal	**111**		**162**	
Unknown/not applicable	2		56	
Total	**113**		**218**	

Case reviewer and clinician questionnaire data

The case reviewers found that there was room for improvement in the assessment of functional status prior to discharge for 29/110 (26.4%) patients (Table 7.5).

Table 7.5 Room for improvement in the assessment of the patient's functional status/needs prior to discharge

	Number of patients	%
Yes	29	26.4
No	81	73.6
Subtotal	**110**	
Unknown	3	
Total	**113**	

Case reviewer data

Follow-up arrangements

Survivors of an OHCA require a tailored package of follow-up care. Those with neurological impairment may require a period of neurological rehabilitation, those who spend a prolonged time immobilised in the critical care unit, may require physical rehabilitation and those with a primary cardiac problem in particular following myocardial infarction, may require cardiac rehabilitation. Other specific services required to support selected survivors include electrophysiological assessment and psychological or counselling support.

Figure 7.5 shows that cardiac rehabilitation was available for patients in 142/144 (98.6%) hospitals, and was located on-site in 97 of these. It was not known if neurorehabilitation (61/182; 33.5%) or psychological support (59/182; 32.4%) was available in these hospitals. In hospitals from which an answer was received, neurorehabilitation was not available in 22/121 (18.2%) hospitals and psychological support was not available in 63/123 (51.2%).

Arrangements for cardiac follow-up for patients requiring electrophysiology assessment by a heart rhythm specialist, are described in Chapter 5.

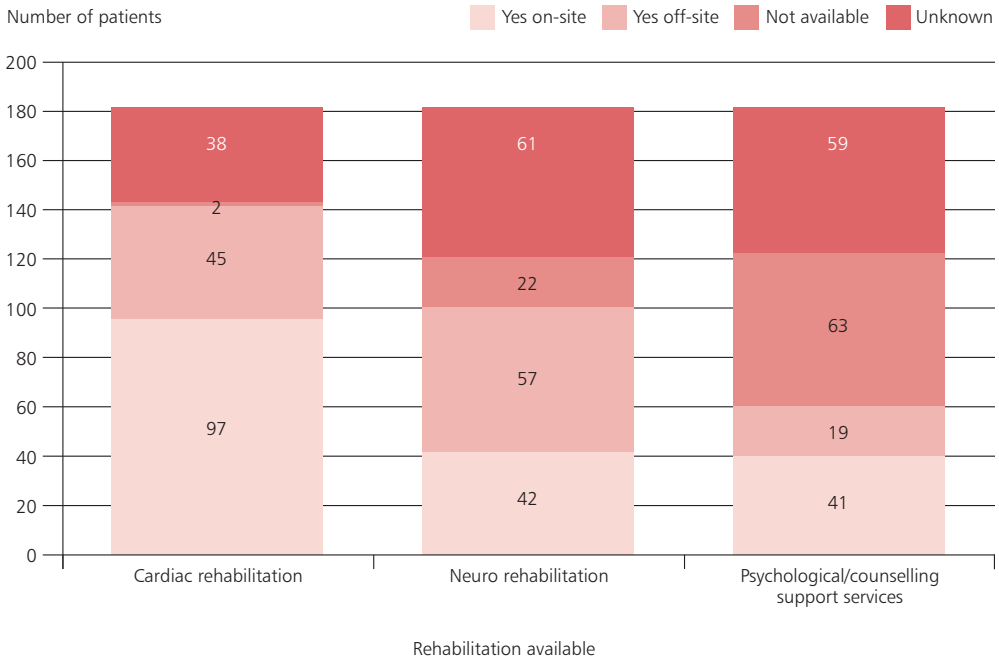


Figure 7.5 The availability of rehabilitation and support services for OHCA survivors (n=182)

Organisational data

Table 7.6 Assessments prior to discharge of survivors as reported by clinicians completing questionnaires

	Physical rehabilitation assessment		Neurological rehabilitation assessment	
	Number of patients	%	Number of patients	%
Yes	133	71.1	55	29.4
No	54	28.9	132	70.6
Subtotal	**187**		**187**	
Unknown	31		31	
Total	**218**		**218**	

Clinician questionnaire

Data from the clinician questionnaire showed that 133/187 (71.1%) survivors were assessed for physical rehabilitation, and 55/187 (29.4%) survivors were assessed for neurological rehabilitation (Table 7.6).

Cardiac rehabilitation was offered, where this was applicable, to 72/122 (59.0%) survivors within three months of discharge (Table 7.7). Psychological review was offered less frequently, being offered to 21/105 (20.0%) survivors (Table 7.8). Notably, it was not known if psychological review was offered to 92/218 (42.2%) survivors.

The case reviewers found evidence that the scale of functional outcome, at discharge, was recorded in the case notes of 24/111 (21.6%) survivors (Table 7.9).

Table 7.7 Cardiac rehabilitation was offered within the first three months after discharge

	Number of patients	%
Yes	72	59.0
No	50	41.0
Subtotal	**122**	
Not applicable	53	
Unknown	43	
Total	**218**	

Clinician questionnaire

Table 7.8 Psychological review was offered within the first six months after discharge

	Number of patients	%
Yes	21	20.0
No	84	80.0
Subtotal	**105**	
Not applicable	21	
Unknown	92	
Total	**218**	

Clinician questionnaire

Table 7.9 Assessments of functional outcome in survivors, prior to discharge

	Number of patients	%
Yes	24	21.6
No	87	78.4
Subtotal	**111**	
Unknown	2	
Total	**113**	

Case reviewer data

In 77/94 cases reviewed, the case reviewers considered that follow-up arrangements were appropriate (Table 7.10). They thought that better follow-up arrangements were needed for 17/94 patients. This suggests there is room to improve follow-up arrangements for survivors, in particular the provision of cardiac rehabilitation and psychological support.

Table 7.10 Adequate follow-up for the patient

	Number of patients	%
Yes	77	21.6
No	17	78.4
Subtotal	**94**	
Unknown	19	
Total	**113**	

Case reviewer data

Organ donation

Although the focus of this study was to identify areas of practice that could be improved to increase survival rates, even after receiving the best possible treatment, a large number of patients will die. In all cases where death occurs, either following active withdrawal of life sustaining treatment (circulatory death), or where death is confirmed by brainstem testing (death by neurological criteria/brain death), there is an opportunity for discussion to consider organ donation.

At the time that patients included in this study were treated, UK laws about organ donation differed between countries. In Wales, since 2015, 'deemed consent' has meant that those who have not registered a decision about organ or tissue donation, are considered to have no objection to becoming a donor. In England, a similar 'opt out' system was introduced in May 2020. In Scotland, there is a plan to introduce this system in March 2021. The law in Northern Ireland still remains an 'opt in' system where individuals are required to join the organ donation register (or record a decision not to be a donor) and are encouraged to share this decision with their family.[54] There are no known plans to change the law in Northern Ireland.

Organ donation was considered and documented for 127/255 (49.8%) patients who died (Table 7.11). For 114/124 (91.9%) patients, a specialist nurse in organ donation was involved (data not shown) and in the instances where donation was considered, it occurred in 28/125 (22.4%) patients (Tables 7.12).

There were 21/122 (17.2%) sets of case notes reviewed where the case reviewers considered that organ donation could have been considered, but it was not (Table 7.13).

Table 7.11 Organ donation was considered

	Number of patients	%
Yes	127	49.8
No	128	50.2
Subtotal	**255**	
Unknown	14	
Total	**269**	

Case reviewer data

Table 7.12 Occurrence of organ donation

	Number of patients	%
Yes	28	22.4
No	97	77.6
Subtotal	**125**	
Unknown	2	
Total	**127**	

Case reviewer data

Table 7.13 Organ donation should have been considered

	Number of patients	%
Yes	21	17.2
No	101	82.8
Subtotal	**122**	
Unknown	6	
Total	**128**	

Case reviewer data

Overall quality of care

The case reviewers rated the overall quality of care reviewed in this study as 'good' for 208/416 (50.0%) patients. There was room for improvement in 'clinical care' for 152/416 (36.5%) patients and in the 'organisation of care' for 65/416 (15.6%) patients. There were 19 cases reviewed where the case reviewers rated that care as less than satisfactory (Figure 7.6)

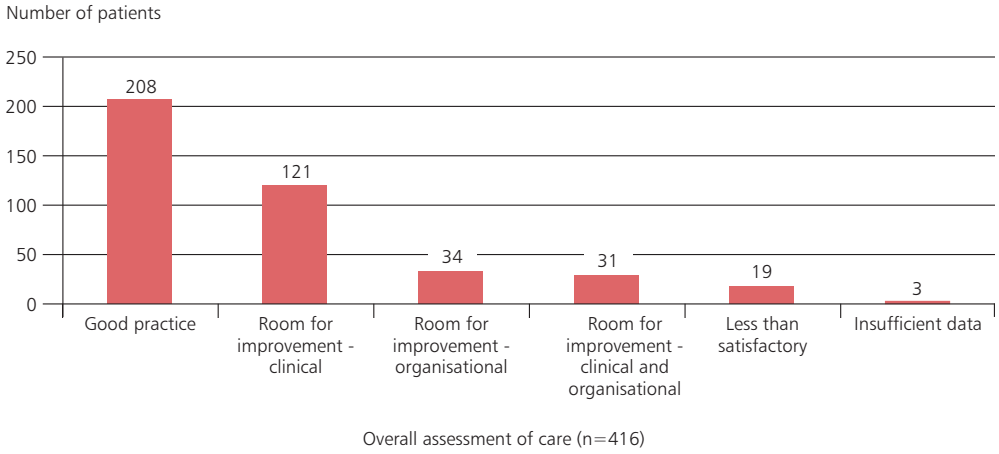


Figure 7.6 Overall quality of care
Case reviewer data

Key Findings

70. Of the case notes reviewed it could be determined that 117/386 (30.3%) patients survived to discharge, although 24/410 (5.8%) patients were transferred to another hospital for ongoing care, and so the outcome in these patients was not known
71. 113/117 (96.6%) patients who survived to hospital discharge returned to their usual place of residence
72. 62/122 (50.8%) patients with a shockable rhythm survived to discharge compared with 24/171 (14%) patients presenting initially with a non-shockable rhythm
73. The mean time to ROSC for OHCA survivors was 12.6 minutes (78 patients). For those who died it was 31.4 minutes (202 patients)
74. For those patients who achieved ROSC in less than 20 minutes, 68/136 (50.0%) patients survived. For those patients in which sustained ROSC took longer than 20 minutes to achieve, 9/143 (6.3%) survived
75. 4/35 patients with an initial lactate of >14 mmol/L survived. The highest lactate level noted in a survivor was 19.8 mmol/L
76. It was reported from 70/106 (66.0%) of hospitals (that routine assessment of neurological outcome was undertaken prior to a patient being discharged following admission for an OHCA
77. In hospitals from which an answer was received, neurorehabilitation was not available in 22/121 (18.2%) hospitals and psychological support was not available in 63/123 (51.2%)
78. The case reviewers found evidence that the scale of functional outcome, at discharge, was recorded in the case notes of 24/111 (21.6%) survivors
79. 133/187 (71.1%) survivors were assessed for physical rehabilitation
80. 55/187 (29.4%) survivors were assessed for neurological rehabilitation
81. Cardiac rehabilitation was offered, where this was applicable, to 72/122 (59.0%) survivors within three months of discharge
82. 21/105 (20.0%) survivors were offered psychological review. Notably it was not known if psychological review was offered to 92/218 (42.2%) survivors
83. Organ donation was considered and documented for 127/255 (49.8%) patients who died
84. For 114/124 (91.9%) patients, a specialist nurse in organ donation was involved
85. In the instances where organ donation was considered, it occurred in 28/125 (22.4%) patients
86. There were 21/122 (17.2%) sets of case notes reviewed where the case reviewers considered that organ donation could have been considered, but it was not
87. The case reviewers rated the overall quality of care reviewed in this study as 'good' for 208/416 (50.0%) patients. There was room for improvement in 'clinical care' for 152/416 (36.5%) patients and in the 'organisation of care' for 65/416 (15.6%) patients. There were 19 cases reviewed where the case reviewers rated that care as less than satisfactory

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Glossary

Term		Definition
Advanced treatment decisions		An advance decision to refuse treatment to let a healthcare team know your wishes if you are not able to communicate them
Agonal rhythm		Occurs in dying patients. It is characterised by the presence of slow, irregular, wide ventricular complexes
Analgesia		Medication to relieve pain
Antiarrhythmic agents		Medications used to suppress abnormal rhythms of the heart, such as atrial fibrillation, atrial flutter, ventricular tachycardia, and ventricular fibrillation
Anticoagulants		Medicines that prevent the blood from clotting as quickly or as effectively as normal
Anti-platelet agents		Medicines used to stop platelets in the blood sticking together and causing a blood clot
Asystole		This is the most serious form of cardiac arrest and is usually irreversible. It is the state of total cessation of electrical activity from the heart, which means no tissue contraction from the heart muscle and therefore no blood flow to the rest of the body.
ATMIST		See Appendix 2
Atrial fibrillation	AF	A heart condition that causes an irregular and often abnormally fast heart rate.
Bradycardia		A slower than normal heart rate
Broad complex tachycardia		Either caused by the ventricular conducting system not working (bundle branch block) or the electrical circuit not involving the atrioventricular (AV) node correctly
Bronchodilators		Medication that make breathing easier by relaxing the muscles in the lungs and widening the airways (bronchi)
Bundle branch block	BBB	A condition in which there is a delay or blockage along the pathway that electrical impulses travel to make the heart beat
Bystander cardiopulmonary resuscitation		Chest compressions performed by a member of the public rather than medical services
Calcium gluconate/chloride		A medication to treat low blood calcium, high blood potassium, and magnesium toxicity
Cardiac catheterisation laboratory		Also known as a "cardiac cath lab," is a special hospital room where doctors perform minimally invasive tests and procedures to diagnose and treat cardiovascular disease

Term		Definition
Cardiopulmonary resuscitation	CPR	An emergency lifesaving procedure performed when the heart stops beating designed to temporarily circulate oxygenated blood through the body of a person whose heart has stopped
Cerebral Performance Category Scale	CPC	Used to assess neurologic outcome following cardiac arrest
Chain of Survival		See Appendix 4
Cognitive function tests		Tests to measure memory, language skills, visual and spatial skills, and other abilities to diagnose cognitive impairment
Corneal reflexes		Also known as the blink reflex, is an involuntary blinking of the eyelids elicited by stimulation of the cornea (such as by touching or by a foreign body)
Defibrillation/defibrillator		A defibrillator gives a jolt of energy to the heart, which can help restore the heart's rhythm, and get it beating normally again
Do not attempt cardiopulmonary resuscitation form	DNACPR	A document issued and signed by a doctor, which tells the medical team not to attempt cardiopulmonary resuscitation
Echocardiogram		A test that uses ultrasound to show how the heart muscle and valves are working
Electroencephalogram	EEG	A recording of brain activity. During the test, small sensors are attached to the scalp to pick up the electrical signals produced when brain cells send messages to each other
Electroencephalogram with Bispectral (BIS) monitoring		An EEG with an assessment of anaesthetic depth
Electrocardiogram	ECG	A test that measures the heart's electrical activity
Electrophysiology		A branch of physiology that pertains broadly to the flow of ions (ion current) in biological tissues and, in particular, to the electrical recording techniques that enable the measurement of this flow
Focal/partial seizure		Occurs when there is a disruption of electrical impulses in one part of the brain. A person may be aware that they are having a seizure, in this case, a simple focal seizure, or they may not be aware, which is a complex focal seizure
Generalised seizure		Occurs when the abnormal electrical activity causing a seizure begins in both halves (hemispheres) of the brain at the same time
Glasgow Coma Scale	GCS	A medication to treat low blood calcium, high blood potassium, and magnesium toxicity

Term		Definition
Glasgow Outcome Scale Extended	GOSE	A global scale for functional outcome that rates patient status into one of five categories: Dead, Vegetative State, Severe Disability, Moderate Disability or Good Recovery. The Extended GOS (GOSE) provides more detailed categorization into eight categories by subdividing the categories of severe disability, moderate disability and good recovery into a lower and upper category
Haemodynamic instability		Defined as perfusion failure, represented by clinical features of circulatory shock and advanced heart failure. It may also be defined as 1 or more out-of-range vital sign measurements, such as low blood pressure
Hyperoxaemic		Defined as an increase in arterial oxygen partial pressure (PaO_2) to a level greater than 120 mmHg (16 kPa)
Hypoxaemia		Defined as the inability to maintain the Pa^O2 above 8kPa
Hypoxic brain injury		Form due to a restriction on the oxygen being supplied to the brain. The restricted flow of oxygen causes the gradual death and impairment of brain cells
Inotropes/vasopressors		Medicines that change the force of the heart's contractions
Intubation		The process of inserting a tube, called an endotracheal tube (ET), through the mouth and then into the airway. This is done so that a patient can be placed on a ventilator to assist with breathing during anaesthesia, sedation, or severe illness
Modified Rankin Scale	mRS	A commonly used scale for measuring the degree of disability or dependence in the daily activities of people who have suffered a stroke or other causes of neurological disability
Myocardia ischaemia		Occurs when blood flow to the heart is reduced, preventing the heart muscle from receiving enough oxygen. The reduced blood flow is usually the result of a partial or complete blockage of the heart's arteries
Myoclonus/myoclonic seizure		Brief shock-like jerks of a muscle or group of muscles. They occur in a variety of epilepsy syndromes that have different characteristics. During a myoclonic seizure, the person is usually awake and able to think clearly
Narrow complex tachycardia		Supraventricular tachycardias, meaning only that they originate above the ventricles
Nasopharyngeal airway		A flexible rubber tube which goes through the nose ends at base of tongue
Neuroprognostication		Aims to identify those patients likely to have a poor neurological prognosis, i.e., a Cerebral Performance Category (CPC) score of 3 to 5 or a modified Rankin Scale score of 3 to 6, as opposed to a CPC score of 1–2 or a modified Rankin Scale score of 0 to 2
Non-shockable rhythm		This means there is quite a small chance of defibrillation working. The only treatment for non-shockable rhythms, in the initial stages, is to do good quality chest compressions and ventilations.

Term		Definition
Non-ST-elevation myocardial infarction	Non-STEMI	A type of heart attack that is typically less damaging to the heart.
Out-of-hospital cardiac arrest		A cardiac arrest occurring outside of the hospital setting
Oxygen saturation/ concentration		The amount of oxygen in the bloodstream. The normal range of oxygen saturation for adults is 94 to 99%
Percutaneous coronary intervention	PCI	A non-surgical procedure that uses a catheter (a thin flexible tube) to place a small structure called a stent to open up blood vessels in the heart
Public access defibrillator	PAD	Defibrillators that are located in workplaces and public spaces like airports, shopping centres, community centres, and train stations
Pulseless electrical activity	PEA	The electrocardiogram (ECG) shows a heart rhythm that should produce a pulse, but does not
Pulseless ventricular tachycardia		A life-threatening cardiac arrhythmia in which coordinated ventricular contractions are replaced by very rapid but ineffective contractions, leading to insufficient organ perfusion and heart failure
Pupillary light reflexes	PLR	A reflex that controls the diameter of the pupil, in response to the intensity (luminance) of light
ReSPECT		See Appendix 3
Return of spontaneous circulation	ROSC	Resumption of sustained cardiac activity associated with significant respiratory effort after cardiac arrest
Sedative		A medicine that promotes calm or induces sleep
Serum lactate		The amount of lactic acid in the blood. Any disorder that causes an imbalance between lactate production and clearance can lead to lactic acidosis, a serious and sometimes life-threatening condition
Shockable rhythm		Rhythms which are appropriate to receive defibrillation, including ventricular fibrillation and pulseless ventricular tachycardia, by emergency medical services or a bystander with a public automated external defibrillator
Short-latency somatosensory evoked potentials	SSEPs	A test for determining electrical activity in the brain
ST-elevation myocardial infarction	STEMI	A very serious type of heart attack during which one of the heart's major arteries (one of the arteries that supplies oxygen and nutrient-rich blood to the heart muscle) is blocked
Subclinical seizures		A seizure that, being subclinical, does not present any clinical signs or symptoms. Such seizures are often experienced by people with epilepsy, in which an electroencephalogram (EEG) trace will show abnormal brain activity, usually for a short time, but level of consciousness is normal

Term		Definition
Supraglottic airway		Airway devices that can be inserted into the pharynx
Targeted temperature management	TTM	Previously known as therapeutic hypothermia or protective hypothermia is an active treatment that tries to achieve and maintain a specific body temperature in a person for a specific duration of time in an effort to improve health outcomes during recovery after a cardiac arrest
Titration of oxygen		Evaluates oxygen needs at rest and during exercise
Tracheo-pulmonary aspiration		The entry of material such as pharyngeal secretions, food or drink, or stomach contents from the oropharynx or gastrointestinal tract, into the larynx (voice box) and lower respiratory tract, the portions of the respiratory system from the trachea (windpipe) to the lungs
Tracheostomy/tracheal tube		An opening created at the front of the neck so a tube can be inserted into the windpipe (trachea) to help someone breathe
Vasoconstrictors		Medicines used to increase blood pressure
Venous thromboembolism	VTE	A condition in which a blood clot forms most often in the deep veins of the leg, groin or arm (known as deep vein thrombosis, DVT) and travels in the circulation, lodging in the lungs (known as pulmonary embolism, PE)
Ventricular fibrillation	VF	A heart rhythm problem that occurs when the heart beats with rapid, erratic electrical impulses. This causes pumping chambers in your heart (the ventricles) to quiver uselessly, instead of pumping blood

Appendices

Appendix 1 – Line of sight between the recommendations, key findings and existing supporting evidence

Suggested groups to action the recommendation are shown in italics after each one, this is a guide only, not exhaustive. ***The term 'healthcare professionals' includes but is not limited to: doctors, surgeons, nurses, general practitioners, physiotherapists, speech and language therapists and occupational therapists***		**# represents the number of the supporting key finding**	**Associated guidelines and other related evidence**
1	Implement whole population strategies to increase the rate of cardiopulmonary resuscitation (CPR) by bystanders and the use of public access defibrillators. ***Target audiences: Public health departments of all UK countries and Crown Dependencies****, with support from the Resuscitation Council UK*	**CHAPTER 2 – PAGE 29** #12. 145/409 (35.5%) patients who received bystander CPR survived to hospital discharge compared with 21/105 (20.0%) patients where bystander CPR was not administered **CHAPTER 2: PAGE 31** #15. A public access defibrillator (PAD) was used in 28/166 (16.9%) of the patients where a defibrillator was used **CHAPTER 2: PAGE 31** #16. When a public access defibrillator (PAD) shock was delivered, 18/28 patients were discharged to their usual place of residence with a further 6/28 transferred to another hospital for ongoing care	*https://www.resus.org.uk/library/2015-resuscitation-guidelines/adult-basic-life-support-and-automated-external* *https://www.resus.org.uk/about-us/news-and-events/rcuk-statement-covid-19-guidance-bystander-cpr* *https://www.bhf.org.uk/how-you-can-help/how-to-save-a-life* *https://gov.wales/public-attitudes-towards-bystander-cpr-and-defibrillation-preliminary-findings* *https://gov.wales/out-hospital-cardiac-arrest-plan*

2	Put effective systems in place to share existing advance treatment plans (such as ReSPECT*) between primary care services, ambulance trusts and hospitals so that people receive treatments based on what matters to them and what is realistic in terms of their care and treatment. ***Target audiences: Local commissioners**, with support from primary care, ambulance trusts and care home providers*	**CHAPTER 2: PAGE 24** #6. 21/661 (3.2%) patients had a 'do not attempt cardiopulmonary resuscitation' (DNACPR) decision in place prior to the admission **CHAPTER 2: PAGE 25** #7. At 65/178 (36.5%) hospitals an electronic system was in place for advanced care directives that included DNACPR decisions #8. Where electronic systems existed, integration with ambulance services was included in 23/65 hospital systems and in general practice in 36/65	
3	Do not use a single factor such as time to the return of spontaneous circulation, blood lactate or pH to make decisions about organ support or interventions in critical care. No single factor on admission accurately predicts survival after an out-of-hospital cardiac arrest. ***Target audiences: All clinicians** who see patients after an out-of-hospital cardiac arrest and relevant clinical directors*	**CHAPTER 7: PAGE 84** #74. For those patients who achieved ROSC in less than 20 minutes, 68/136 (50.0%) patients survived. For those patients in which sustained ROSC took longer than 20 minutes to achieve, 9/143 (6.3%) survived **CHAPTER 7: PAGE 85** #75. 4/35 patients with an initial lactate of >14 mmol/L survived. The highest lactate level noted in a survivor was 19.8 mmol/L	
4	Optimise oxygenation for patients with a return of spontaneous circulation as soon as possible after hospital admission, by: • Measuring arterial blood gasses • Prescribing oxygen • Documenting inspired oxygen concentration (or flow rate) and • Monitoring oxygen saturation • Adjusting inspired oxygen concentration to achieve an arterial oxygenation saturation target of 94–98% ***Target audiences: All clinicians** who see patients after an out-of-hospital cardiac arrest and relevant clinical directors*	**CHAPTER 4: PAGE 43** #29. 172/319 (53.9%) patients were hyperoxaemic on their arrival to the emergency department with an oxygen saturation of >98% **CHAPTER 4: PAGE 44** #30. A blood gas analysis was performed in 383/416 (92.1%) patients in the emergency department - in 236/383 (61.6%) patients, this was an arterial blood gas and in 97/383 (25.3%) patients, it was a venous blood gas analysis	
5	On admission after an out-of-hospital cardiac arrest, prioritise patients for coronary intervention, in line with the European Society of Cardiology current guidelines, because a primary cardiac cause for their cardiac arrest is likely. ***Target audiences: All clinicians** who see patients after an out-of-hospital cardiac arrest and cardiology leads*	**CHAPTER 5: PAGE 54** #38. 111/412 (26.9%) patients were taken to the cardiac catheter laboratory during their admission #39. The case reviewers considered that there was a delay in the patient going to the catheter laboratory in 26/105 (24.8%) instances #40 For 57/107 (53.3%) patients taken to the cardiac catheter laboratory, coronary revascularisation was indicated	*https://cprguidelines.eu/sites/573c777f5e61585a053d7ba5/content_entry5f8e9d3b4c848637d1e4d1a5/5f8f00124c848608eee4d1cd/files/Draft_ERC-ESICM_GL2020_PostResusCare_for_posting.pdf*

6	Use active targeted temperature management during the first 72 hours in critical care to prevent fever (temperature over 37.5°C) in unconscious patients after an out-of-hospital cardiac arrest. ***Target audiences: Critical care leads*** *and critical care clinical staff* *See also the Resuscitation Council UK guidelines*	**CHAPTER 6: PAGE 66** #53. A policy for targeted temperature management was available from 130/167 (77.8%) hospitals #54. A temperature control device which uses a feedback loop was available at 67/137 (48.9%) hospitals **CHAPTER 6: PAGE 67** #55. Clinicians reported that 172/350 (49.1%) patients admitted to critical care had TTM #57. 104/253 (41.4%) patients admitted to intensive care with a best GCS lower than 13 within 24 hours of ROSC, did not receive TTM **CHAPTER 6: PAGE 70** #58. When TTM was used, the patient's temperature still rose above 37.5°C in 16/75 patients in the first 24 hours, 19/64 between 24 and 48 hours and 19/46 between 48 and 72 hours #59. Case reviewers rated the temperature management as 'good' in only 41/219 (18.7%) patients and as 'poor' or 'unacceptable' in 126/219 (57.5%) **CHAPTER 6: PAGE 71** #60. Case reviewers considered that the approach to temperature management was 'poor' or 'unacceptable' in a greater proportion of patients when TTM was not used (48/113; 42.5% vs 78/106; 73.6%)	*www.resus.org.uk/library/2015-resuscitation-guidelines/guidelines-post-resuscitation-care#1-the-guidelines*
7	Assess neurological prognosis in unconscious patients after an out-of-hospital cardiac arrest, using at least two of the following methods: • Clinical assessment • Imaging • Neurophysiological assessment (including electroencephalogram, to exclude subclinical seizures and improve accuracy) • Biomarkers ***Target audiences: Critical care leads*** *and critical care clinical staff*	**CHAPTER 6: PAGE 64** #51. 108/407 (26.5%) patients had documentation of a seizure **CHAPTER 6: PAGE 65** #52. EEG was used as part of the prognostication process for 56/128 (43.8%) patients and in 43/67 patients where seizure activity was noted **CHAPTER 6: PAGE 75** #64. CT was the most common imaging modality used for neurological prognostication (97/134; 72.4%) **CHAPTER 6: PAGE 76** #65. In 30/134 (22.4%) patients, no imaging modality was used for neuroprognostication #66. EEG was used for neurological prognostication in 55/134 (41.0%) patients	*www.resus.org.uk/library/2015-resuscitation-guidelines/guidelines-post-resuscitation-care#1-the-guidelines*
8	Delay the final assessment of neurological prognosis after an out-of-hospital cardiac arrest until AT LEAST 72 hours after return of spontaneous circulation AND the effects of sedation and temperature management can be excluded. This will ensure a reliable assessment. Repeat the assessment if there is any doubt. ***Target audiences: Critical care leads*** *and critical care clinical staff* *See also the Resuscitation Council UK guidelines*	**CHAPTER 6: PAGE 73** #61. Formal prognostication took place in 134/279 (48.0%) patients **CHAPTER 6: PAGE 77** #62. The average time to the final assessment of neurological prognosis was 72 hours (median 70.3 hours) #63. In 57/84 patients, the final assessment of neurological prognostication was made less than 72 hours after hospital admission **CHAPTER 6: PAGE 78** #67. Case reviewers considered that the timing of neuroprognostication was not appropriate for 26/131 (19.8%) patients	*www.resus.org.uk/library/2015-resuscitation-guidelines/guidelines-post-resuscitation-care#1-the-guidelines*

9	Actively explore the potential for organ donation in all patients after an out-of-hospital cardiac arrest and return of spontaneous circulation, who have a planned withdrawal of life sustaining treatment. ***Target audiences: Critical care leads*** *and critical care clinical staff* ****Note the different legal positions in the UK countries***	**CHAPTER 7: PAGE 91** #83. Organ donation was considered and documented for 127/255 (49.8%) patients who died #84. For 114/124 (91.9%) patients, a specialist nurse in organ donation was involved #85. In the instances where organ donation was considered, it occurred in 28/125 (22.4%) patients #86. There were 21/122 (17.2%) sets of case notes reviewed where the case reviewers considered that organ donation could have been considered, but it was not	*https://www.organdonation.nhs.uk/uk-laws/*
10	Identify all survivors of an out-of-hospital cardiac arrest who would benefit from **physical** rehabilitation before hospital discharge and ensure this is offered to them. ***Target audiences: The clinical team caring for the patient after an out-of-hospital cardiac arrest****, supported by the physiotherapy service lead*	**CHAPTER 7: PAGE 89** #79. 133/187 (71.1%) survivors were assessed for physical rehabilitation	*https://cprguidelines.eu/sites/573c777f5e61585a053d7ba5/content_entry5f8e9d3b4c848637d1e4d1a5/5f8f00124c848608eee4d1cd/files/Draft_ERC-ESICM_GL2020_PostResus Care_for_posting.pdf* *https://www.nice.org.uk/guidance/CG83/chapter/1-Guidance#23-months-after-discharge-from-critical-care*
11	Identify all inpatient survivors of an out-of-hospital cardiac arrest who would benefit from **cardiac** rehabilitation before hospital discharge and ensure this is offered to them. ***Target audiences: The clinical team caring for the patient after an out-of-hospital cardiac arrest****, supported by the cardiac rehabilitation service lead.* ***Commissioners****, where these services are not already in place*	**CHAPTER 5: PAGE 53** #41. The case reviewers considered that there was room for improvement in cardiac care in 78/404 (19.3%) patients **CHAPTER 5: PAGE 55** #42. In 130/151 (86.1%) hospitals, survivors of OHCA were routinely assessed by a heart rhythm specialist prior to discharge **CHAPTER 5: PAGE 56** #43. Clinicians reviewing the records in their own hospital found evidence of a heart rhythm specialist review in 131/196 (66.8%) patients **CHAPTER 7: PAGE 89** #81. Cardiac rehabilitation was offered, where this was applicable, to 72/122 (59.0%) survivors within three months of discharge	*https://cprguidelines.eu/sites/573c777f5e61585a053d7ba5/content_entry5f8e9d3b4c848637d1e4d1a5/5f8f00124c848608eee4d1cd/files/Draft_ERC-ESICM_GL2020_PostResus Care_for_posting.pdf* *https://www.nice.org.uk/guidance/CG83/chapter/1-Guidance#23-months-after-discharge-from-critical-care*
12	Identify all inpatient survivors of an out-of-hospital cardiac arrest who would benefit from **neurological** rehabilitation before hospital discharge and ensure this is offered to them. ***Target audiences: The clinical team caring for the patient after an out-of-hospital cardiac arrest****, supported by the neurological rehabilitation service lead.* ***Commissioners****, where these services are not already in place*	**CHAPTER 7: PAGE 87** #76. It was reported from 70/106 (66.0%) of hospitals (that routine assessment of neurological outcome was undertaken prior to a patient being discharged following admission for an OHCA **CHAPTER 7: PAGE 89** #80. 55/187 (29.4%) survivors were assessed for neurological rehabilitation	*https://cprguidelines.eu/sites/573c777f5e61585a053d7ba5/content_entry5f8e9d3b4c848637d1e4d1a5/5f8f00124c848608eee4d1cd/files/Draft_ERC-ESICM_GL2020_PostResus Care_for_posting.pdf* *https://www.nice.org.uk/guidance/CG83/chapter/1-Guidance#23-months-after-discharge-from-critical-care*

13	Identify all inpatient survivors of an out-of-hospital cardiac arrest who would benefit from **psychological** intervention before hospital discharge and support and ensure this is offered to them. ***Target audiences: The clinical team caring for the patient after an out-of-hospital cardiac arrest***, *supported by the clinical psychology service lead.* ***Commissioners****, where these services are not already in place*	**CHAPTER 7: PAGE 88** #77. In hospitals from which an answer was received, neurorehabilitation was not available in 22/121 (18.2%) hospitals and psychological support was not available in 63/123 (51.2%) **CHAPTER 7: PAGE 89** #82. 21/105 (20.0%) survivors were offered psychological review. Notably it was not known if psychological review was offered to 92/218 (42.2%) survivors	*https://cprguidelines.eu/sites/573c777f5e61585a053d7ba5/content_entry5f8e9d3b4c848637d1e4d1a5/5f8f00124c848608eee4d1cd/files/Draft_ERC-ESICM_GL2020_PostResus Care_for_posting.pdf* *https://www.nice.org.uk/guidance/CG83/chapter/1-Guidance#23-months-after-discharge-from-critical-care*

Appendix 2 – ATMIST

Resuscitation & First Aid Training Ltd

ATMIST Handover

The introduction of ATMIST significantly improves communication with medical practitioners, ambulance crews and emergency departments.

A	**Age, name and date of birth of patient**	Age:	Date of Birth:			
		Name:				
T	**Time of incident or onset of symptoms**					
M	**Mechanism of injury or medical complaint**					
I	**Injuries/exam findings**					
S	**Signs**	GCS:		AVPU:		
		Blood Glucose mmol/l:		Respiratory Rate:		
		Blood Pressure:		Heart Rate:		
		Temperature:		O2 Saturations:		
		NEWS Score:		ECG Attached: (please tick)	Yes ☐	No ☐
T	**Treatment given**	Drugs given:				
		Amount:				
		Time Given:				
Clinician		Name:				
		Surgery:			Date:	
		Tel Number:			Time:	

Source: www.resus.org.uk/resuscitation-guidelines/prehospital-resuscitation/#handover

The personal data we collect here will only be used in relation to this form, and will not be added to any mailing lists or passed on to any third parties. Please review our full Privacy Policy here: www.firstresponse.org.uk/privacy-policy

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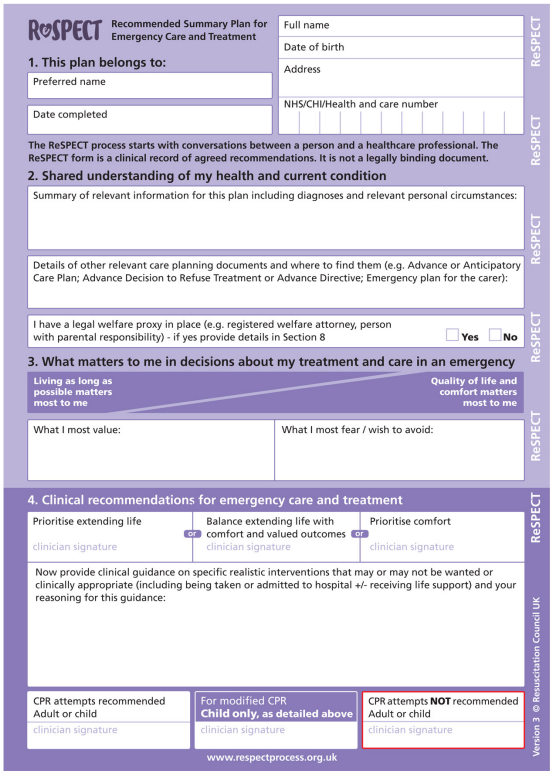
Appendix 3 – ReSPECT



ReSPECT Recommended Summary Plan for Emergency Care and Treatment

1. This plan belongs to:

Preferred name

Date completed

Full name

Date of birth

Address

NHS/CHI/Health and care number

The ReSPECT process starts with conversations between a person and a healthcare professional. The ReSPECT form is a clinical record of agreed recommendations. It is not a legally binding document.

2. Shared understanding of my health and current condition

Summary of relevant information for this plan including diagnoses and relevant personal circumstances:

Details of other relevant care planning documents and where to find them (e.g. Advance or Anticipatory Care Plan; Advance Decision to Refuse Treatment or Advance Directive; Emergency plan for the carer):

I have a legal welfare proxy in place (e.g. registered welfare attorney, person with parental responsibility) - if yes provide details in Section 8 ☐ Yes ☐ No

3. What matters to me in decisions about my treatment and care in an emergency

Living as long as possible matters most to me — Quality of life and comfort matters most to me

What I most value:

What I most fear / wish to avoid:

4. Clinical recommendations for emergency care and treatment

Prioritise extending life — clinician signature

Balance extending life with comfort and valued outcomes — clinician signature

Prioritise comfort — clinician signature

Now provide clinical guidance on specific realistic interventions that may or may not be wanted or clinically appropriate (including being taken or admitted to hospital +/- receiving life support) and your reasoning for this guidance:

CPR attempts recommended Adult or child — clinician signature

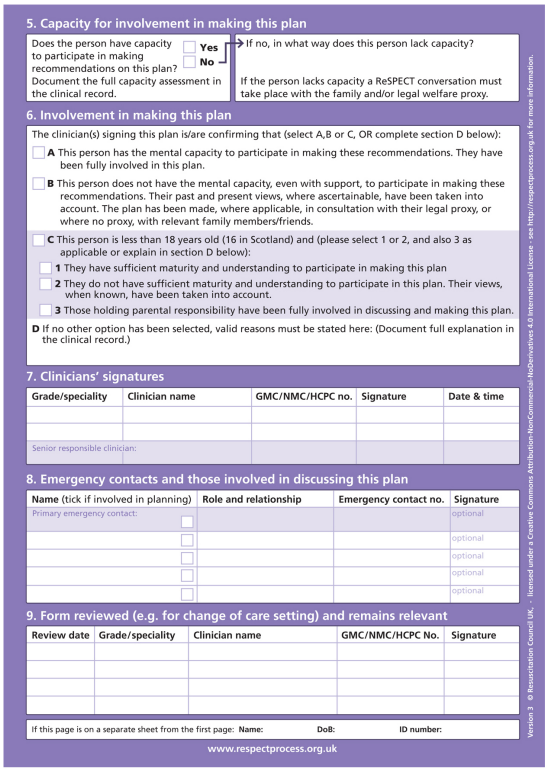
For modified CPR **Child only, as detailed above** — clinician signature

CPR attempts **NOT** recommended Adult or child — clinician signature

www.respectprocess.org.uk

ReSPECT

Version 3 © Resuscitation Council UK



5. Capacity for involvement in making this plan

Does the person have capacity to participate in making recommendations on this plan? Document the full capacity assessment in the clinical record. ☐ Yes ☐ No → If no, in what way does this person lack capacity?

If the person lacks capacity a ReSPECT conversation must take place with the family and/or legal welfare proxy.

6. Involvement in making this plan

The clinician(s) signing this plan is/are confirming that (select A,B or C, OR complete section D below):

☐ **A** This person has the mental capacity to participate in making these recommendations. They have been fully involved in this plan.

☐ **B** This person does not have the mental capacity, even with support, to participate in making these recommendations. Their past and present views, where ascertainable, have been taken into account. The plan has been made, where applicable, in consultation with their legal proxy, or where no proxy, with relevant family members/friends.

☐ **C** This person is less than 18 years old (16 in Scotland) and (please select 1 or 2, and also 3 as applicable or explain in section D below):

☐ **1** They have sufficient maturity and understanding to participate in making this plan

☐ **2** They do not have sufficient maturity and understanding to participate in this plan. Their views, when known, have been taken into account.

☐ **3** Those holding parental responsibility have been fully involved in discussing and making this plan.

D If no other option has been selected, valid reasons must be stated here: (Document full explanation in the clinical record.)

7. Clinicians' signatures

Grade/speciality	Clinician name	GMC/NMC/HCPC no.	Signature	Date & time
Senior responsible clinician:				

8. Emergency contacts and those involved in discussing this plan

Name (tick if involved in planning)	Role and relationship	Emergency contact no.	Signature
Primary emergency contact: ☐			optional
☐			optional
☐			optional
☐			optional
☐			optional

9. Form reviewed (e.g. for change of care setting) and remains relevant

Review date	Grade/speciality	Clinician name	GMC/NMC/HCPC No.	Signature

If this page is on a separate sheet from the first page: **Name:** **DoB:** **ID number:**

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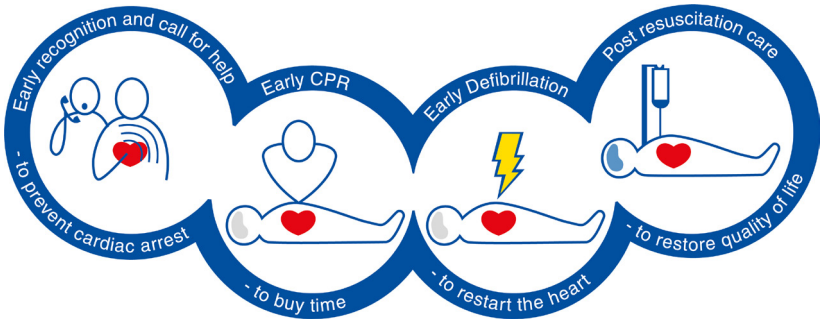
Appendix 4 – Chain of survival



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Appendix 5 – Participation

Trust/Health Board	Number of participating hospitals	Number of organisational questionnaires returned	Number of cases selected	Number of clinician questionnaires returned	Number of case notes returned
Aintree Hospitals NHS Foundation Trust	1	1	2	1	2
Airedale NHS Foundation Trust	1	1	4	4	2
Aneurin Bevan University Health Board	2	0	16	0	5
Ashford & St Peter's Hospitals NHS Trust	1	1	5	6	5
Barking, Havering & Redbridge University Hospitals NHS Trust	2	2	9	9	9
Barnsley Hospital NHS Foundation Trust	1	1	5	4	0
Basildon & Thurrock University Hospitals NHS Foundation Trust	1	1	6	3	6
Belfast Health and Social Care Trust	2	0	12	0	3
Betsi Cadwaladr University Local Health Board	2	2	14	3	11
Blackpool Teaching Hospitals NHS Foundation Trust	1	1	7	5	7
Bolton Hospital NHS Foundation Trust	1	1	4	3	3
Bradford Teaching Hospitals NHS Foundation Trust	1	1	6	6	6
Brighton and Sussex University Hospitals NHS Trust	2	2	9	9	9
Buckinghamshire Healthcare NHS Trust	2	2	10	7	10
Calderdale & Huddersfield NHS Foundation Trust	2	2	15	13	11
Cambridge University Hospitals NHS Foundation Trust	1	1	6	5	6
Cardiff and Vale University Health Board	1	1	5	3	5
Chelsea & Westminster NHS Foundation Trust	2	2	5	5	5
Chesterfield Royal Hospital NHS Foundation Trust	1	1	4	4	4
Countess of Chester Hospital NHS Foundation Trust	1	1	7	7	7
County Durham and Darlington NHS Foundation Trust	2	2	8	5	8
Croydon Health Services NHS Trust	1	1	9	6	9
Cwm Taf University Health Board	3	0	9	5	9
Doncaster and Bassetlaw Hospitals NHS Foundation Trust	2	2	8	4	5
Dorset County Hospital NHS Foundation Trust	1	1	0	0	0
East & North Hertfordshire NHS Trust	1	1	6	6	6
East Cheshire NHS Trust	1	1	2	0	0
East Kent Hospitals University NHS Foundation Trust	1	1	13	6	6
East Lancashire Hospitals NHS Trust	1	1	2	2	2
East Suffolk and North Essex NHS Foundation Trust (ESNEFT)	2	2	9	9	0

Trust/Health Board	Number of participating hospitals	Number of organisational questionnaires returned	Number of cases selected	Number of clinician questionnaires returned	Number of case notes returned
East Sussex Healthcare NHS Trust	2	2	18	14	18
Epsom and St Helier University Hospitals NHS Trust	2	2	9	1	2
Frimley Health NHS Foundation Trust	2	2	10	10	10
Gateshead Health NHS Foundation Trust	1	1	3	1	3
George Eliot Hospital NHS Trust	1	1	5	2	5
Gloucestershire Hospitals NHS Foundation Trust	2	2	7	4	5
Government of Jersey Health & Community Services	1	1	5	5	5
Great Western Hospitals NHS Foundation Trust	1	1	6	6	6
Guy's & St Thomas' NHS Foundation Trust	1	1	5	5	5
Hampshire Hospitals NHS Foundation Trust	2	2	7	1	5
Harrogate and District NHS Foundation Trust	1	1	6	3	6
Hillingdon Hospitals NHS Foundation Trust (The)	1	1	7	7	7
Homerton University Hospital NHS Foundation Trust	1	1	6	6	6
Hull University Teaching Hospitals NHS Trust	2	2	8	5	8
Hywel Dda University Health Board	1	1	16	9	15
Imperial College Healthcare NHS Trust	3	3	10	10	9
Isle of Man Department of Health & Social Security	1	1	8	0	6
Isle of Wight NHS Trust	1	1	5	5	5
James Paget University Hospitals NHS Foundation Trust	1	1	5	5	5
Kettering General Hospital NHS Foundation Trust	1	1	4	4	4
King's College Hospital NHS Foundation Trust	2	2	17	6	17
Kingston Hospital NHS Trust	1	1	6	6	6
Lancashire Teaching Hospitals NHS Foundation Trust	2	2	13	8	13
Lewisham and Greenwich NHS Trust	2	2	8	6	7
Liverpool Heart and Chest Hospital NHS Trust	1	1	0	0	0
London North West Healthcare NHS Trust	2	2	4	4	4
Luton and Dunstable Hospital NHS Foundation Trust	1	1	7	0	0
Maidstone and Tunbridge Wells NHS Trust	2	2	6	4	4
Manchester University NHS Foundation Trust	2	2	12	12	11
Medway NHS Foundation Trust	1	1	6	6	6
Mid Cheshire Hospitals NHS Foundation Trust	1	0	6	3	6
Mid Essex Hospitals NHS Trust	1	1	9	6	3
Mid Yorkshire Hospitals NHS Trust	2	2	4	0	4

Trust/Health Board	Number of participating hospitals	Number of organisational questionnaires returned	Number of cases selected	Number of clinician questionnaires returned	Number of case notes returned
Newcastle upon Tyne Hospitals NHS Foundation Trust	2	2	15	12	15
NHS Grampian	2	2	10	6	10
NHS Highland	1	1	16	4	5
NHS Lanarkshire	3	3	17	4	2
NHS Orkney	1	0	1	0	1
NHS Western Isles	1	1	3	2	3
Norfolk & Norwich University Hospital NHS Trust	1	1	7	6	6
North Bristol NHS Trust	1	1	2	2	2
North Cumbria Integrated Care NHS Foundation Trust	1	1	8	4	0
North Middlesex University Hospital NHS Trust	1	1	5	3	3
North Tees and Hartlepool NHS Foundation Trust	1	1	8	9	8
North West Anglia NHS Foundation Trust	2	2	10	8	10
Northampton General Hospital NHS Trust	1	1	9	9	9
Northern Devon Healthcare NHS Trust	1	1	5	4	5
Northern Health & Social Care Trust	2	2	11	8	11
Northern Lincolnshire & Goole NHS Foundation Trust	2	2	10	10	10
Northumbria Healthcare NHS Foundation Trust	1	1	9	5	4
Nottingham University Hospitals NHS Trust	1	1	18	18	15
Oxford University Hospitals NHS Foundation Trust	2	2	12	12	12
Pennine Acute Hospitals NHS Trust (The)	3	3	10	8	10
Plymouth Hospitals NHS Trust	1	1	6	3	6
Poole Hospital NHS Foundation Trust	1	0	5	0	0
Portsmouth Hospitals NHS Trust	1	1	5	5	4
Royal Berkshire NHS Foundation Trust	1	1	6	6	6
Royal Bournemouth and Christchurch Hospitals NHS Trust	1	1	8	6	8
Royal Cornwall Hospitals NHS Trust	0	0	9	6	5
Royal Devon and Exeter NHS Foundation Trust	1	1	6	6	6
Royal Free London NHS Foundation Trust	2	2	10	7	10
Royal Liverpool & Broadgreen University Hospitals NHS Trust	1	1	4	3	4
Royal Surrey County Hospital NHS Trust	1	1	2	2	2
Royal United Hospitals Bath NHS Foundation Trust	1	1	4	4	4
Salford Royal Hospitals NHS Foundation Trust	1	1	6	1	0
Salisbury NHS Foundation Trust	1	1	8	8	8

Trust/Health Board	Number of participating hospitals	Number of organisational questionnaires returned	Number of cases selected	Number of clinician questionnaires returned	Number of case notes returned
Sandwell and West Birmingham Hospitals NHS Trust	2	2	6	7	6
Sheffield Teaching Hospitals NHS Foundation Trust	1	1	7	5	7
Sherwood Forest Hospitals NHS Foundation Trust	1	1	6	6	6
Shrewsbury and Telford Hospitals NHS Trust	1	1	7	7	7
South Eastern Health & Social Care Trust	2	2	3	3	3
South Tees Hospitals NHS Foundation Trust	1	1	1	1	1
South Tyneside and Sunderland NHS Foundation Trust	2	2	11	9	11
South Warwickshire NHS Foundation Trust	1	1	2	1	2
Southend University Hospital NHS Foundation Trust	1	1	8	8	8
Southern Health & Social Care Trust	2	2	7	7	7
Southport & Ormskirk Hospitals NHS Trust	1	1	1	1	1
St George's University Hospitals NHS Foundation Trust	1	1	7	7	7
St Helens and Knowsley Teaching Hospitals NHS Trust	1	1	7	6	5
States of Guernsey Committee for Health & Social Care	1	1	9	4	9
Stockport NHS Foundation Trust	1	1	3	0	3
Surrey & Sussex Healthcare NHS Trust	1	1	6	0	0
Swansea Bay University Local Health Board	1	1	5	5	5
Tameside and Glossop Integrated Care NHS Foundation Trust	1	1	5	5	5
Taunton & Somerset NHS Foundation Trust	1	1	8	8	8
The Dudley Group NHS Foundation Trust	1	1	9	2	7
The Leeds Teaching Hospitals NHS Trust	1	1	15	5	0
The Princess Alexandra Hospital NHS Trust	1	1	6	6	6
United Lincolnshire Hospitals NHS Trust	1	0	4	2	4
The Royal Wolverhampton Hospitals NHS Trust	1	1	9	2	9
The University Hospitals of the North Midlands NHS Trust	2	2	0	0	0
Torbay and South Devon NHS Foundation Trust	1	1	8	5	3
United Lincolnshire Hospitals NHS Trust	3	3	13	13	12
University College London Hospitals NHS Foundation Trust	1	1	2	2	2
University Hospital Southampton NHS Foundation Trust	1	1	6	5	6
University Hospitals Birmingham NHS Foundation Trust	3	3	19	17	8

Trust/Health Board	Number of participating hospitals	Number of organisational questionnaires returned	Number of cases selected	Number of clinician questionnaires returned	Number of case notes returned
University Hospitals of Bristol NHS Foundation Trust	1	1	9	1	3
University Hospitals of Derby and Burton NHS Foundation Trust	2	2	7	5	7
University Hospitals of Leicester NHS Trust	1	1	12	11	11
University Hospitals of Morecambe Bay NHS Trust	2	2	6	2	6
Walsall Healthcare NHS Trust	1	0	6	0	6
Warrington & Halton Hospitals NHS Foundation Trust	1	1	3	2	3
West Hertfordshire Hospitals NHS Trust	1	1	4	3	4
West Suffolk NHS Foundation Trust	1	1	6	2	0
Western Health & Social Care Trust	1	1	9	0	2
Western Sussex Hospitals NHS Foundation Trust	2	2	14	13	14
Whittington Health NHS Trust	1	1	5	0	5
Wirral University Teaching Hospital NHS Foundation Trust	1	0	4	1	0
Worcestershire Acute Hospitals NHS Trust	2	2	7	5	7
Wrightington, Wigan & Leigh NHS Foundation Trust	1	1	6	3	6
Wye Valley NHS Trust	1	1	7	7	7
Yeovil District Hospital NHS Foundation Trust	1	1	3	3	3
York Teaching Hospitals NHS Foundation Trust	2	2	14	3	13

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