



Clinical Paper

Errors in the management of cardiac arrests: An observational study of patient safety incidents in England[☆]



Sukhmeet S. Panesar^a, Agnieszka M. Ignatowicz^b, Liam J. Donaldson^{c,*}

^a Centre for Population Health Sciences, The University of Edinburgh, Doorway 3, Teviot Place Edinburgh, EH8 9AG, UK

^b Division of Health Sciences, Warwick Medical School, The University of Warwick, Coventry, CV4 7AL, UK

^c Institute of Global Health Innovation, Imperial College London, W2 1NY, UK

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ABSTRACT

Objective: The aim of this qualitative study is to better understand the types of error occurring during the management of cardiac arrests that led to a death.

Methods: All patient safety incidents involving management of cardiac arrests and resulting in death which were reported to a national patient safety database over a 17-month period were analysed. Structured data from each report were extracted and these together with the free text, were subjected to content analysis which was inductive, with the coding scheme emerged from continuous reading and re-reading of incidents.

Results: There were 30 patient safety incidents involving management of cardiac arrests and resulting in death. The reviewers identified a main shortfall in the management of each cardiac arrest and this resulted in 12 different factors being documented. These were grouped into four themes that highlighted systemic weaknesses: miscommunication involving crash number (4/30, 13%), shortfalls in staff attending the arrest (4/30, 13%), equipment deficits (11/30, 36%), and poor application of knowledge and skills (11/30, 37%).

Conclusion: The factors identified represent serious shortfalls in the quality of response to cardiac arrests resulting in death in hospital. No firm conclusion can be drawn about how many deaths in the study population would have been averted if the emergency had been managed to a high standard. The effective management of cardiac arrests should be considered as one of the markers of safe care within a healthcare organisation.

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1. Introduction

Cardiac arrests in hospital are an extreme medical emergency. Death or permanent brain injury can result from delayed or sub-standard cardiopulmonary resuscitation (CPR). This procedure is an essential intervention used to restore cardiopulmonary function and prolong life. A high proportion of hospital deaths involve CPR attempts, even when the condition and general health of the patient makes success unlikely.¹ The United States of America (USA) has a long-standing register of in-hospital cardiac arrests. Reports based on this show that between 370,000 and 750,000

in-hospital resuscitation attempts are made in the USA each year. In the United Kingdom (UK), a similar register, the National Cardiac Arrest Audit has been operating since 2009²; the incidence of adult in-hospital cardiac arrests has been estimated at 1.6 per 1000 hospital admissions.³

In both countries, there are few patient safety indicators that can be derived from the data that are collected on cardiac arrests. In the USA, only one in five adult hospital patients survive to be discharged. The prognosis in such circumstances has changed little over the last 30 years.⁴ The coverage of the UK register does not yet allow prognosis to be estimated.

In the UK, in 2012, the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) reported on the management of in-hospital cardiac arrests, and recommended action to encourage safer practice. Deficiencies were found at several levels: in the admission process; inadequate involvement and input from senior doctors; misinformed decisions about the cardiopulmonary resuscitation status; and failure to recognise the deteriorating patient and escalate the severity of the patient's condition appropriately.⁵

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* Corresponding author at: Liam J. Donaldson, Chair in Health Policy, Institute of Global Health Innovation, 1024b 10th Floor, Queen Elizabeth the Queen Mary Wing (QEQM), St. Mary's Campus, Imperial College London, London W2 1NY, UK.

E-mail address: l.donaldson@imperial.ac.uk (L.J. Donaldson).

Table 1
Shortfalls in the management of cardiac arrests where the patient died.

Systemic theme	Main shortfall	Frequency
Miscommunication involving crash number	Emergency call number (2222) delayed, not put out or missed by switchboard	1
	Wrong information given by emergency call number (2222)	1
	Emergency call number (2222) ignored	2
Shortfalls in staff attending the arrest	Lack of staff	1
	No senior staff present	1
	Staff busy with other patients	2
Equipment deficits	Equipment failure	3
	Vital equipment missing or unavailable	6
	Wrong equipment	1
	Access to resuscitation location not possible	1
Poor application of knowledge and skills	Poor advanced life support (ALS) management	6
	Failure to adhere to clinical guidelines	5
Total		30

Few studies have sought to explore in depth, the reasons for unsafe management of arrests. Instead, scope for preventive action has been the main focus of attention.^{6,7}

The aim of this qualitative study is to better understand the types of errors seen in the NHS in England during the management of cardiac arrests that led to a death.

2. Methods

Since 2004, NHS staff in England and Wales have been encouraged to make incident reports of any situation in which they believe that a patient's safety has been compromised. A 'patient safety incident' is defined as: "Any unintended or unexpected incident which could have, or did, lead to harm for one or more patients receiving NHS care."⁸ Most reports are first made to a local NHS organisation and then sent in batch returns by the organisation's risk manager to national level. A small number are made by staff directly. The information required in each incident report covers: demographic and administrative data; the circumstances of occurrence; a categorisation of causation; an assessment of the degree of harm into 'no', 'low', 'moderate', 'severe' or 'death'; and action taken or planned to investigate or prevent a recurrence. These data are captured in a structured reporting form, but there is also a section of free text where the reporter is asked to describe what happened and why they think it happened. Data are anonymised to remove the names of patients and staff members. The detailed structure of the database has been described elsewhere.⁹ The national database of patient safety incidents now contains around nine million reports. For most of its existence, this database, the National Reporting and Learning System (NRLS), was managed by an independent agency within the NHS called the National Patient Safety Agency (NPSA). The Agency was abolished in mid-2010 by the UK Government as part of a cost-cutting policy to reduce the number of bodies operating at arms length from government.^{10,11} However, the NRLS has continued to function as before, managed by the same team of staff in a temporary home until the Government decides on its long-term location.

The study population was inclusive of all adult deaths resulting from the unsafe management of cardiac arrests and that had been reported by NHS staff as patient safety incidents from NHS hospitals in England over the period 1 June 2010 to 31 October 2012 (17 months in total). This population was part of a larger dataset of deaths ($n=2010$) used in the previous analysis.¹² This period was chosen because the first of these dates was when reporting of deaths in the NHS became mandatory.¹³ Prior to that, all patient safety incidents, whether causing death or otherwise, were reported on a voluntary basis (this remains the case for incidents

involving no, low or moderate harm). The inclusion criteria were any incident mentioning: 'cardiopulmonary resuscitation', 'CPR', 'crash', 'crash-call', '2222' (the national crash call number) or 'cardiac arrest'.

Structured data from each report were extracted and these, together with the free text, were subjected to content analysis. Through this process, two of the authors (AMI and SSP) identified recurrent terms and phrases related to shortfalls in the management of cardiac arrests. The first (SSP) and second (AMI) authors coded the incidents separately. The analysis of text was inductive, with the coding scheme emerging from continuous reading and re-reading of incidents.¹⁴ The reviewers discussed any coding ambiguities, and refined codes until any discrepancies were resolved. The whole process was an iteration of coding a sample of text, testing inter-coder agreement, and revising the codes into categories.^{15,16} The final categories were verified by the third author (LJD).

3. Results

There were 30 patient safety incidents involving management of cardiac arrests and resulting in death. The reviewers identified a main shortfall in the management of each cardiac arrest and this resulted in 12 different factors being documented. These were grouped into four themes that highlighted systemic weaknesses in this process of emergency care (Table 1).

The most common weaknesses in the management of the arrests were poor application of knowledge and skills (11/30, 37%) and equipment deficits (11/30, 37%). The detailed factors identified in the cluster of incident reports relating to poor application of knowledge and skills were varied. For example, within the category 'poor advanced life support (ALS) management' were: lack of urgency in life-saving decisions; indecisiveness by senior clinicians; inexperience of junior doctors and nurses in recognising a deteriorating situation, and managing the subsequent cardiac arrest.

Within the category 'failure to adhere to clinical guidelines', the individual circumstances reported included: failure to comply with, or incorrect, do-not-attempt-to-resuscitate (DNAR) instructions; and audible alarms on equipment being turned off.

Equipment deficits included those relating to equipment failure; missing or unavailable vital equipment; wrong equipment; and a lack of access to the resuscitation location.

Miscommunication involving the crash number occurred in almost one in 10 incidents (4/30, 13%). Of the systemic themes, 13% (4/30) were associated with shortfalls in staff attending the arrest.

Examples of incidents within the systemic themes are given in Table 2.

Table 2
Examples of free-text extracts from patient safety incident reports.^a

Incident A: Miscommunication involving crash number

"Switchboard received a call via the 2222 phone. Telephonist answered the call and took instruction to fast bleep the anaesthetist to A&E [Accident and Emergency] Resus [resuscitation area]. The telephonist did notice that there was a lot of background noise and the call was muffled. The fast bleep was carried out and the anaesthetist attended A&E Resus. Approximately 4 min later the 2222 phone rang again. This time it was theatre recovery stating they had put out a cardiac arrest 4 min ago and no one had attended. It was clear at this point that there had been two calls at once and because the cardiac arrest phone has been set up to never be engaged the second call from theatres was missed. The telephonist put out a cardiac arrest call at this point but unfortunately the patient had died."

Incident B: Shortfalls in staff attending the arrest

"I was the second SHO [Senior House Officer] on nights called to an EMRT [Emergency Medical Resuscitation] call on the ward. I was the first member of the EMRT team to arrive. I estimate that it takes 3–4 min to run from the main hospital to the ward block following an emergency call. When I got there, I found the patient in cardiorespiratory arrest with no basic life support in progress. On my initial arrival, there was not even a nurse near the patients bedside. I immediately started CPR and requested the nurses to put out a 2222 cardiac arrest call, and asked that all staff come to assist. Until the remainder of the team arrived I was only able to perform chest compressions while a nurse attempted to sort out the oxygen supply and equipment to allow artificial ventilation in some form. The remainder of the team arrived and full advanced life support was provided."

Incident C: Equipment deficits

"Patient in cardiac arrest. No suction equipment at bedside vacuum present but no vacuum suction holder or tubing or yankauer. Poor suction via portable machine. Poor suction via hand held pump."

Incident D: Poor application of knowledge and skills

"Patient arrived within the department critically unwell. Within a few minutes of arrival, ECG [electrocardiogram] and observations were taken. Immediately referred to the medical registrar on call. A lack of decision and later apparent lack of knowledge on his part led to the gentleman being poorly managed. When the patient deteriorated and then went on to arrest it was obvious that the registrar could not 'run a cardiac arrest.'"

^a Identification details are removed when text is cleansed as part of data entry. Extracts are in their original form with no correction to grammar or punctuation. Acronyms have been spelled out in square brackets by the authors.

4. Discussion

Rates of survival and complete physiological recovery following in-hospital cardiac arrests are poor in all age groups; fewer than 20% of adult patients having an in-hospital cardiac arrest will survive and go home.¹⁷ Prevention of in-hospital cardiac arrest requires staff education, monitoring of patients, recognition of patient deterioration, a system to call for help and an effective response.¹⁸ Errors in these crucial areas represent an avoidable burden of harm due to unsafe cardiac arrest management. It has been shown that the occurrence of resuscitation system errors reduces the survival of inpatients who experience a cardiac arrest in the United States of America. The most frequent system errors included delays in administering the required medication, defibrillation, airway management and chest compression errors, most of which have an element of human factors.¹⁹

Our results indicate that almost four in 10 incidents are related to deficits in equipment. A similar proportion (38%) was reported in a review of 122 incidents in the Danish Patient Safety Database.²⁰ However, the studies were not strictly comparable because there were no reported deaths in the Danish series, while our total numbers, were smaller. Equipment errors, although of lower magnitude (4%) have been reported by NCEPOD.²¹ In a modern healthcare system, there is no reason why vital equipment should be missing or unavailable (6/30, 20% of our incidents). A simple measure to eliminate harm of this kind would be to introduce cardiac arrest equipment checklists that can be used by staff on a daily basis to assess whether they are prepared, from an equipment point of view, to deal with any emergency. Standardised checking procedures have successfully reduced risk in surgery.²² Another approach would be to create a 'Never Event', which penalises organisations for a lack of vital equipment during an emergency.²³

Poor application of knowledge and skills was the other major systemic weakness in our study, affecting one in three of the cardiac arrests; slightly higher than the finding of NCEPOD. This national audit found that almost one in five patients in whom defibrillation was indicated did not receive a shock within 3 min of recognition of cardiac arrest.¹⁶ The lack of a standardised approach to managing patients who were experiencing a cardiac arrest heralded a major milestone in advanced life support. The Advanced Cardiac

Life Support (ACLS) course was launched in the USA in the late 1970s and subsequently the Advanced Life Support (ALS) course was launched in the UK in the 1980s.²⁴ Healthcare professionals dealing with critically ill patients are required to undertake this course and revalidate their skills after four years. There is a need for organisations to continue developing high-fidelity simulation training, which has been shown to improve confidence in managing cases requiring advanced life support.²⁵ Further regular scenario-based life support training should be provided to teams to assess their ability to retain and apply knowledge gained during the ALS course, most of which begins to dissipate if not used on a frequent basis.²⁶

The management of cardiac arrests represents a high-risk situation with poor patient prognosis. It is also one of the few conditions where members from different medical and surgical disciplines come together for a fixed period of time to work as a high-performing team. They must adhere to standard operating procedures. Deficits or dysfunction in, leadership, equipment, communication or choreography can create an unsafe situation that can cost the life of a patient who would otherwise have survived. The template for such emergency team working is well established, understood and regularly rehearsed in other high-risk industries. That it is not yet in healthcare is another reason why the safety record of this sector compares so badly with other modern industries and services. In the field of cardiac arrest management, human factors have been recognised; a review of 29 studies indicated that deficits in team dynamics, lack of stress management, poor resolution of conflicting decisions and the lack of debriefing were all key safety concerns in the management of cardiac arrests.²⁷ Barriers to effective teamwork have also been identified: inexperienced team leaders, task overload and hierarchic structure in the teams' inability to maintain focus on chest compressions.²⁸

In 2002, the National Patient Safety Agency (NPSA) issued a standard crash call number across England and Wales to minimise delays and subsequent errors in managing cardiac arrests.²⁹ Despite this attempt to design-out a safety vulnerability, the small number of incidents in our study makes the case for better training of administrative staff in recognising the urgency of the 2222 call and transmitting the correct information.

In some specialties, such as emergency medicine, unacceptable staff shortages have been reported.³⁰ It is also not uncommon for junior members of staff to be managing entire wards by themselves out of hours. The use of rapid response teams or critical care outreach teams remains key to minimising avoidable harm due to mismanaged cardiac arrests. These have been shown to reduce hospital mortality in deteriorating patients.³¹

4.1. Strengths and limitations

We have studied one of the few databases internationally with the ability to identify rare safety events in healthcare. Furthermore, by scrutinising the free text (narrative) section of the incident reports, our analysis takes account of reporter perceptions. While we acknowledge that the 'true' cause of an incident is multifactorial (including the highly complex field of human factors) and a patient safety incident may not lead to a cardiac death, we believe that our approach is of practical value and has yielded actionable findings in that it has identified major systemic themes and shortfalls in the management of cardiac arrests.

Reporting bias, data quality and under-reporting are pitfalls of any incident reporting system.³² However, our study covered a period after which reporting of incidents associated with death and severe harm became mandatory in the NHS. Moreover, the aim of our study was not to determine the absolute incidence of cardiac arrest-related deaths, but to identify the factors associated with mismanagement of the event.

5. Conclusions

The effective management of cardiac arrests should be considered as one of the markers of safe care within a healthcare organisation. We cannot be sure how many deaths in our study population would have been averted if the arrest response had been delivered to a high standard. However, the systemic failures that we identified were clear and consistent with other studies of this aspect of emergency care. Unlike some other aspects of healthcare safety, the action necessary to address them is well defined. While the goal of zero harm is not realistic across all fields of care, it is surely not too idealistic to set this as a challenge for the management of cardiac arrest in a 21st Century.³³

Conflict of interest statement

All authors have completed the ICMJE uniform disclosure form at: www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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Ethics approval

This study was part of a research programme funded at Imperial College London by NHS England to develop incident reporting in the NHS. Ethical approval is in place for this programme from the Health Research Authority.

Contribution

L.J.D. conceived the idea for this paper and acquired the data. A.M.I., S.S.P. and L.J.D. analysed the data and A.M.I., S.S.P. and L.J.D. interpreted them and drew out the policy implications. S.S.P. and A.M.I. drafted earlier versions of the manuscript. L.J.D. drafted later versions and provided important intellectual content. All authors approved the final version to be published.

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