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# Debriefing for cardiac arrest

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A thesis submitted in fulfilment of the requirements for the degree of  
Doctor of Philosophy

University of Warwick  
Warwick Medical School  
January 2015

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## List of Abbreviations

AHA	American Heart Association
ALS	Advanced Life Support
ANTS	Anaesthetists' Non-Technical Skills score
BLS	Basic Life Support
BHH	Birmingham Heartlands Hospital
BS	Dr Bilal Salman
CC	Chest compressions
CCO	Critical Care Outreach
CCP	Critical Care Practitioner
CI	Confidence Interval
CISD	Critical Incident Stress Debriefing
CODE study	Cardiopulmonary Resuscitation Debriefing study
CPC	Cerebral Performance Category
CPR	Cardiopulmonary Resuscitation
DNACPR	Do Not Attempt Cardiopulmonary Resuscitation
ECG	Electrocardiogram
ECMO	Extracorporeal membrane oxygenation
EMS	Emergency Medical Service
ERC	European Resuscitation Council
GDP	Professor Gavin Perkins
GHH	Good Hope Hospital
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HEFT	Heart of England NHS Foundation Trust
ILCOR	International Liaison Committee on Resuscitation
ILS	Immediate Life Support
IQR	Interquartile Range
LOE	Level of Evidence

KC	Keith Couper
MRC	Medical Research Council
NCAA	National Cardiac Arrest Audit
NCEPOD	National Confidential Enquiry in to Patient Outcome and Death
OR	Odds Ratio
PEA	Pulseless Electrical Activity
RAPID	Resuscitation with Actual Performance Integrated Debriefing
REC	Research Ethics Committee
RO	Resuscitation Officer
ROC	Resuscitation Outcomes Consortium
ROSC	Return of Spontaneous Circulation
SD	Standard Deviation
SH	Solihull Hospital
STD	Survival to Discharge
TDF	Theoretical Domains Framework
TIDieR	Template for Intervention Description and Replication
TTI	Transthoracic Impedance
UK	United Kingdom
VF	Ventricular Fibrillation
VT	Ventricular Tachycardia

# Acknowledgements

I am indebted to Professor Gavin Perkins, Dr Peter Kimani, and Professor Frances Griffiths for their support and guidance.

This thesis would not have been possible without the support and help of many individuals. In particular, I would like to thank the following.

Teresa Melody	Dr Joyce Yeung
Prof Fang Gao-Smith	Mehboob Chilwan
Robin Davies	Dr Richard Field
Michelle Davies	Dawn Hill
Natalie Hussellbee	Dr Jasmeet Soar
Annalie Baker	Professor Judith Finn
Chris O'Brien	Dr Christopher Bridle

I greatly appreciate the time and kindness shown by both the patients and staff who participated in studies described in this thesis.

Finally, I would like to thank my wife, Susan, for her love and patience.

## **Declaration**

This thesis is my own work except where it contains work based on collaborative research, in which case the nature and extent of the author's individual contribution will be indicated.

No part of this thesis has previously been submitted for the award of any degree from the University of Warwick, or any other university.

Where part of this thesis has been published prior to submission of thesis, it will be indicated before each chapter.

# Abstract

Early data from North America supports the use of educational cardiac arrest debriefing as a strategy to improve the quality of cardiopulmonary resuscitation (CPR) in the hospital setting. As some debriefing approaches are challenging to deliver in the NHS setting, there was a need to develop debriefing approaches that are both effective and suited to NHS working practices. This thesis is modelled on the Medical Research Council framework for the development and evaluation of complex interventions. Undertaken between October 2011 and January 2015, it describes the development and feasibility assessment of three cardiac arrest debriefing approaches, which were specifically designed to be deliverable in NHS hospitals.

Development work comprised three work packages (systematic review, process evaluation, qualitative study). These studies provided evidence to support the use of cardiac arrest debriefing, but showed that weekly group debriefing is undeliverable in many NHS hospitals. Through qualitative work, I identified six distinct mechanisms by which debriefing may affect clinical practice. Synthesis of these data led to the development of three cardiac arrest debriefing approaches (monthly group debriefing, individual oral debriefing, written feedback).

We tested the feasibility of delivering these interventions by implementing them in three NHS hospitals (one intervention per hospital). In a before/after study, it was demonstrated that, despite practical challenges, interventions were deliverable in NHS hospitals. However, they were found to have no effect on either CPR quality or patient outcome. This finding was attributed to high performance in study hospitals at baseline.

This thesis demonstrates that the developed cardiac arrest debriefing interventions are deliverable in NHS hospitals. It has also generated important new theory about the mechanisms by which debriefing may affect clinical practice. This thesis lays the foundation for future work to evaluate the clinical and cost-effectiveness of these cardiac arrest debriefing interventions.

# Chapter 1: Introduction

**Parts of this chapter have been published in:**

**Couper K**, Perkins GD. Debriefing after resuscitation. *Curr Opin Crit Care*. 2013;19(3):188-94.

Soar J, **Couper K**. Improving Outcomes from Cardiac Arrest– Quality, Education and Implementation. In: Soar J, Perkins GD, Nolan J, eds. *ABC of Resuscitation*. London: Wiley Press; 2012.

## 1.1 In-hospital cardiac arrest in context

Cardiac arrest describes the sudden cessation of heart function. This represents the endpoint of many conditions, including myocardial infarction, trauma, and sepsis.

Descriptions of the condition and its treatment can be found in ancient manuscripts.<sup>1</sup>

For example, the first book of Kings in the old testament of the bible describes how the prophet Elijah “stretched himself out on the boy three times” to resuscitate a child that had stopped breathing.<sup>2</sup>

Current treatment of cardiac arrest stems from the combined efforts of William Kouwenhoven, Guy Knickerbocker, James Jude, and Peter Safar in the 1950s and early 1960s. Kouwenhoven’s group, whilst undertaking experiments on dogs, made the chance discovery that pressure applied to the dog’s thorax by defibrillator paddles generated arterial blood flow.<sup>3</sup> This finding led to the development of external chest compressions. Use of this technique on a cohort of 20 patients in cardiac arrest at John Hopkins Hospital was associated with a survival rate of 70%.<sup>4</sup> In the context of a condition that had previously been universally fatal without immediate thoracotomy and internal chest compressions, this was a ground-breaking discovery. These authors declared that:

*“Anyone, anywhere, can now initiate cardiac resuscitative procedures. All that is needed are two hands.”<sup>4</sup>*

Around the same time, Peter Safar developed the concept of using expired air ventilation. Safar demonstrated the technique in a series of experiments in which untrained lay people delivered mouth-to-mouth ventilation successfully to 25 sedated and paralysed volunteers for up to three hours at a time.<sup>5</sup> In combination, external chest compressions and mouth-to-mouth ventilation form the basis of cardiopulmonary resuscitation (CPR).<sup>6-8</sup>

In cardiac arrest, cells rapidly die due to hypoxia. CPR provides an artificial way to deliver oxygenated blood to the brain and heart, as well as increasing the likelihood of



a return of spontaneous circulation (ROSC) by increasing coronary perfusion pressure.<sup>9</sup> This is demonstrated clinically by evidence that cardiac arrest survival declines when commencement of CPR is delayed for even brief periods of time.<sup>10</sup>

ILCOR (International Liaison Committee on Resuscitation) is an international body comprised of national and continental resuscitation organisations, including the American Heart Association (AHA), the European Resuscitation Council (ERC), and the Resuscitation Council of Asia.<sup>11</sup> Its establishment in 1992 has ensured that the science of cardiac arrest is evidence-based. One of its key roles is a five-yearly review of resuscitation science, which forms the basis of many national and continental resuscitation guidelines.<sup>12-14</sup>

### **1.1.1 Epidemiology of in-hospital cardiac arrest**

In-hospital cardiac arrest is a major health problem, which carries significant mortality burden. Whilst the exact incidence is unknown, the most reliable United Kingdom (UK) data comes from the National Cardiac Arrest Audit (NCAA) which collates data from 144 participating UK hospitals.<sup>15</sup> A recent NCAA publication reported an incidence of 1.5 events per 1,000 hospital admissions which equates to approximately 35,000 cases per year across the UK.<sup>15</sup> This figure slightly underestimates the true incidence as only events attended by the hospital resuscitation team are recorded by NCAA, thereby excluding some cardiac arrests that take place in specialist areas, such as the intensive care unit, where support from the resuscitation team is not required.

In-hospital cardiac arrest survival rates remain dismal, despite modest improvements over the last decade.<sup>16</sup> In the UK, only 18.4% of in-hospital cardiac arrest patients survive to leave hospital.<sup>15</sup> Similar survival rates are reported in North America.<sup>16-18</sup>

Cardiac arrest survival is influenced by a number of patient, cardiac arrest, and system factors.<sup>17,19-21</sup> These factors include the patient's age and co-morbid status, pre-

admission functional status, hospital size, cardiac arrest location, initial rhythm, reason for hospital admission, time to defibrillation, and time of day of the cardiac arrest.<sup>17,19-21</sup>

Data from NCAA shows that most (97.5%) in-hospital cardiac arrest survivors have good neurological function when they leave hospital.<sup>15</sup> This figure is higher than that reported by the American 'get with the guidelines' registry (75.1%), and there are some concerns that this difference may be due to missing data in the NCAA dataset.<sup>15-18</sup>

Other studies have shown that survivors have an acceptable long-term outcome, which has been compared to that of heart failure patients.<sup>22,23</sup>

### 1.1.2 The chain of survival and in-hospital cardiac arrest

The chain of survival describes a series of the processes that must be in place to achieve the best outcome following cardiac arrest.<sup>24</sup> Developed originally by the AHA in 1991, the chain was updated in 2005 to reflect the importance of both cardiac arrest prevention and post-resuscitation care (Figure 1-1).<sup>24-26</sup> Any link in the chain that is missed, delayed, or delivered ineffectively will significantly reduce the likelihood of patient survival. The UK Resuscitation Council has developed quality standards for CPR training and practice in acute care.<sup>27</sup> Compliance with these standards ensures organisations develop a robust system based on the principles of the chain of survival.

**Figure 1-1: Cardiac arrest chain of survival**



Reprinted from Resuscitation, Volume 67, Nolan J, European Resuscitation Council Guidelines for Resuscitation 2005 Section 1: Introduction, S3-S6, Copyright 2005, with permission from Elsevier

The first link in the chain describes the importance of early recognition of patient deterioration and initiation of treatment to prevent cardiac arrest. There is now substantial evidence that in-hospital cardiac arrests are often preceded by a period of physiological deterioration, which is frequently either not recognised or not managed appropriately.<sup>28-32</sup> Such data led to the development of national guidelines which recommend key interventions designed to improve the recognition of and response to deteriorating patients.<sup>33,34</sup> These include early warning score systems, training courses specific to the identification and management of deteriorating patients, and the use of critical care outreach teams.<sup>33,34</sup> Smith conceptualised these interventions in a chain of prevention, comprising five links: education, monitoring, recognition, call for help, and response.<sup>35</sup> Despite the widespread implementation of these interventions, there continues to be evidence of suboptimal care prior to in-hospital cardiac arrest.<sup>32</sup> In the recent National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report on in-hospital cardiac arrest, case assessors noted evidence of at least one marker of physiological deterioration in 72.5% of patients in the 48 hours preceding cardiac arrest and considered 37.8% of cardiac arrests to be avoidable.<sup>32</sup>

Early recognition of deterioration may also facilitate decision-making about the appropriateness of resuscitation.<sup>36</sup> The NCEPOD report found that victims of in-hospital cardiac arrest were often elderly patients (median age 77) with poor baseline functional status and underlying conditions likely to prove fatal within four years.<sup>32,37</sup> Such patients may not benefit from CPR. Do not attempt cardiopulmonary resuscitation orders may be considered in cases where resuscitation would be futile, the patient has refused resuscitation, or the benefits of resuscitation are outweighed by its burdens.<sup>38</sup> Recent guidance highlights the importance of frank and open discussions with patients about their wishes in the event of a cardiac arrest.<sup>38</sup>

The second and third links in the chain of survival describe the importance of early CPR and early defibrillation. A small delay in initiating these therapies is associated

with worse neurologically-intact survival.<sup>10,21</sup> Most hospitals employ a two tier response system to cardiac arrest.<sup>27,32</sup> The first tier consists of ward staff, trained in basic life support and automated external defibrillation, who are responsible for the identification of cardiac arrest, activation of the emergency team, initiation of CPR, and defibrillation. There is evidence that these initial tasks are often not performed promptly and effectively, which may be attributed partly to the infrequent exposure of ward staff to cardiac arrest and limitations of standard training methods.<sup>21,39-41</sup> This has led to the development of alternative training approaches such as regular in-situ CPR refreshers, whereby clinicians receive CPR refresher training in their own clinical setting.<sup>42</sup> The second tier consists of a multidisciplinary emergency team. Team composition varies between organisations.<sup>43,44</sup> The Resuscitation Council (UK) makes no specific recommendation regarding team composition, but advises that teams should have members competent in the use of basic airway devices including supraglottic airways, intravenous and intraosseous cannulation, manual defibrillation, drug administration, and post-resuscitation care.<sup>27</sup> The term human factors describes the way that clinicians interact with one other.<sup>45</sup> In recent years, there has been an increased recognition of the influence of human factors on CPR quality, although the principles of human factors are yet to become fully embedded in practice.<sup>45-48</sup> For example, it is recommended that cardiac arrest team members meet at the start of each shift to learn names and allocate team roles, but this most basic strategy is often neglected.<sup>27,44</sup>

The final link in the chain of survival is post-resuscitation care. Patients who survive cardiac arrest are frequently comatose and require tracheal intubation and mechanical ventilation. Post cardiac arrest syndrome describes the complex pathophysiological processes that result from systemic ischaemia followed by reperfusion.<sup>49</sup> It comprises four components: brain injury, myocardial dysfunction, a systemic inflammatory response, and the underlying pathology that caused the cardiac arrest. In the UK, the Intensive Care Society has developed a bundle of evidence-based interventions for the management of patients following cardiac arrest.<sup>50,51</sup> These therapies include controlled

oxygenation, maintenance of normocapnia, temperature management, glucose control, delayed prognostication, and cardiovascular support including consideration for percutaneous coronary intervention. The implementation of a post-arrest care bundle on an intensive care unit has been associated with a significant improvement in neurologically-intact survival.<sup>52</sup>

### **1.1.3 The importance of CPR quality**

In the event of cardiac arrest, effective delivery of CPR and defibrillation is the most important modifiable determinant of patient survival. The benefits of Advanced Life Support interventions, such as drug therapy and tracheal intubation, are unclear.<sup>53-57</sup> A large before/after study of 5,638 patients found that the implementation of advanced life support therapies in a Canadian Emergency Medical Service (EMS) system had no effect on patient survival to hospital discharge.<sup>55</sup>

The quality of CPR and defibrillation can be described using a number of metrics including chest compression depth, rate, flow-fraction, incomplete release, and peri-shock pause. Over the last decade, resuscitation guidelines have placed increasing emphasis on the importance of these metrics.<sup>58,59</sup> However, despite convincing evidence to support the importance of high-quality CPR and defibrillation, observational data show significant variability in care delivery with high-quality care being infrequently delivered.<sup>60-63</sup>

The importance of CPR quality was first demonstrated in animal models of cardiac arrest. For example, Babbs et al identified a positive correlation between chest compression depth and cardiac output in a canine model of cardiac arrest.<sup>64</sup> Similarly, Berg et al showed the adverse haemodynamic effects of chest compression interruptions in swine.<sup>65</sup> However, testing such data in humans was challenging and required significant manpower. In a human study which showed an association

between chest compression rate and ROSC, data were collected by researchers who attended 97 cardiac arrests and manually counted chest compressions.<sup>61</sup> Today, technological improvements enable defibrillators to automatically collect information on CPR quality metrics. This development has revolutionised our understanding of the importance of CPR quality.

In 2005, this technology was used in two landmark papers which highlighted the issue of delivery of suboptimal CPR.<sup>60,63</sup> In an analysis of 176 out-of-hospital cardiac arrest patients, 59% of compressions were too shallow and mean flow-fraction was only 52%. In a study of in-hospital cardiac arrest patients, received a slightly better quality of CPR.<sup>60</sup> Nevertheless, there was still marked variability in CPR quality, with 37% of chest compressions being too shallow and 65% of chest compressions delivered at an incorrect rate.

The Resuscitation Outcomes Consortium (ROC) has established a registry of out-of-hospital cardiac arrests in North America, which covers 264 EMS agencies and a population of 23 million people.<sup>66</sup> CPR quality metrics are collected as a non-mandatory item in the registry dataset. However, the collection of a large amount of data has enabled the group to produce a series of observational studies which examine the association between CPR quality metrics and patient outcomes.<sup>67-73</sup> Such studies are prone to selection bias and confounding, but they present two consistent findings.<sup>74</sup> Firstly, CPR quality often fails to adhere to published guidelines. Secondly, the delivery of high-quality CPR is associated with improved patient outcomes.

Flow-fraction is the proportion of a cardiac arrest for which the patient is receiving chest compressions. Christenson et al used data from the ROC registry to analyse the effect of this metric on survival to hospital discharge in a cohort of 506 out-of-hospital cardiac arrest patients who presented in a shockable rhythm.<sup>68</sup> The multivariable linear-regression model showed that each 10% increase in flow-fraction was associated with

improved hospital survival (adjusted odds ratio (OR) 1.11, 95% confidence interval (CI) 1.01–1.21). Equally important, though, was the observation that 291 patients (58%) received a flow-fraction of less than 60%. A similar message was presented in a paper examining the effect of chest compression depth on survival. This analysis of 9,136 out-of-hospital cardiac arrest patients found an association between each 5-mm increase in chest compression depth and hospital survival (adjusted OR 1.04, 95% CI 1.00-1.08,  $p=0.045$ ).<sup>71</sup> In this cohort, 3,334 (36%) patients received a chest compression depth less than that recommended by international guidelines.<sup>75</sup> Such findings are not isolated to the ROC group, with similar findings presented by several other resuscitation research groups.<sup>21,61,76-82</sup>

A key concern is that the quality of CPR delivered in these studies may be significantly better than that delivered in many organisations. Studies were produced by organisations with an interest in CPR quality and resuscitation research, so clinicians were more likely to be aware of the importance of high-quality CPR and this effect may have been accentuated by a Hawthorne effect. Furthermore, the defibrillator technology used to record CPR metrics can also provide real-time audiovisual feedback. Real-time audiovisual feedback technology uses a defibrillator sensor device to provide immediate information to the rescuer about the quality of CPR delivery. Use of the technology is itself associated with modest improvements in CPR quality, but is only used in a small minority of hospitals and EMS systems.<sup>43,44,83-85</sup>

It is likely that the suboptimal CPR delivery highlighted above represents a best-case scenario, and that many organisations actually fall short of the standard described in published studies. Failure to deliver high-quality CPR results in avoidable mortality. There is an urgent need to improve the translation of this evidence in to practice.

## 1.2 Strategies to improve quality in healthcare

Variability in care delivery and the failure by healthcare providers to deliver evidence-based care is not unique to cardiac arrest. This was one of the drivers for the commissioning of the 2001 American Institute of Medicine report on quality in the American health system.<sup>86</sup> The report's conclusion that 100,000 Americans die every year due to healthcare errors drew worldwide interest. In 2003, McGlynn et al compared the care delivered to 6,712 American patients to a series of quality indicators for a range of acute and chronic conditions.<sup>87</sup> In this cohort, patients received less than 55% of recommended care interventions. More recently, a systematic review of 35 pre-hospital and emergency care studies found considerable variability in adherence to guidelines, with median adherence ranging from 7.8 to 95% depending on the clinical condition.<sup>88</sup> In the light of such data, Pronovost et al advocated a need for an increased focus on research that examines the implementation of best practice, on the basis that:

*“One of the greatest opportunities to improve patient outcomes will probably come not from discovering new treatments but from more effective delivery of existing therapies.”<sup>89</sup>*

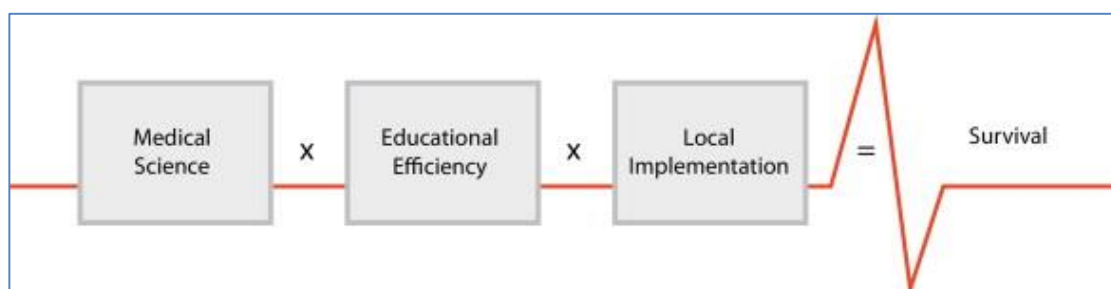
Studies identify a number of reasons why clinicians do not adhere to evidence-based guidelines.<sup>90</sup> These include a lack of awareness of the guideline, lack of belief that the guideline behaviour is achievable, and a belief that the guideline behaviour will not achieve its stated goal. A variety of strategies have been developed to improve adherence to best-practice by targeting these issues. Examples include outreach visits, checklists and reminder systems, educational material, and audit and feedback. The effectiveness of these approaches has been described in several systematic reviews.<sup>91-</sup>  
<sup>94</sup> However, as Oxman et al concluded, in their review of 102 studies, none of these strategies are “magic bullets” for changing clinician behaviour.<sup>91</sup> Subsequent reviews have reached similar conclusions.<sup>92-94</sup> A Health Technology Assessment programme review of 235 studies found that interventions often led to small to moderate



improvements in practice, but that effectiveness varied depending on the setting in which the intervention was implemented.<sup>92</sup>

In the context of cardiac arrest, the Utstein formula of survival describes cardiac arrest survival as a product of medical science, educational efficiency, and local organisation (Figure 1-2).<sup>95</sup> Of these components, local organisation, which incorporates guideline implementation, has proved the most challenging to optimise, but potentially produces the greatest benefit.<sup>95-97</sup> This concept is exemplified by the case of high-quality CPR. Bobrow et al developed a complex multi-faceted intervention designed to improve CPR delivery in an EMS system.<sup>98</sup> Implementation of the intervention was associated with marked improvements in CPR quality, which contributed to a significant improvement in survival to hospital discharge (adjusted odds ratio 2.72, 95% CI 1.15 to 6.41).

**Figure 1-2: Utstein formula of survival**



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In 2013, the AHA produced two important consensus statements on improving survival after in-hospital cardiac arrest and strategies to improve CPR quality.<sup>97,99</sup> Developed through expert consensus, both statements recommended that organisations develop a continuous quality improvement programme that incorporates cardiac arrest debriefing. This recommendation for the use of cardiac arrest debriefing reflects current ERC and AHA resuscitation guidelines.<sup>100,101</sup>

## 1.3 Feedback and debriefing

### 1.3.1 Defining debriefing

Definitions of debriefing in healthcare simulation describe a facilitated educational process in which a clinician reflects on an event, with a focus on improving subsequent practice.<sup>102-104</sup> Such definitions draw clear parallels with the concept of reflective practice theories, such as those described by Kolb and Schon.<sup>105,106</sup> There are, however, two key problems with these definitions.

Firstly, even in the simulation setting, the term debriefing is used inconsistently. For example, an intervention in which a clinician reviews a videotape recording of their performance has been described as both videotape feedback and self-debriefing.<sup>107,108</sup> Self-debriefing may also refer to interventions where teams debrief themselves without an external facilitator.<sup>102</sup> Fanning and Gaba's paper on simulation debriefing is itself an example of this inconsistency.<sup>102</sup> The paper starts by describing debriefing as "facilitated or guided reflection in the cycle of experiential learning," but subsequently discusses the use of 'written debriefing,' in which participants record events in a reflective diary, even though this process is neither facilitated nor guided.

Secondly, definitions from the simulation setting do not adequately capture the way that debriefing is delivered in the clinical setting. For example, some debriefing approaches in the clinical setting include the whole healthcare team.<sup>109-112</sup> In such cases, it is difficult to apply the concept of event reflection to debrief attendees who were not part of the care team at the event being reviewed. A further tension comes from the fact that, despite the best efforts of a facilitator, engaging participants to discuss and reflect on an event can be extremely challenging, such that debriefs may sometimes mimic a didactic teaching session.<sup>102,113,114</sup> Whilst this may still promote reflection, the reflective process will, as it is with written feedback, be individual and not externally facilitated. In such cases, there is little to separate debriefing from standard feedback.

The inconsistent use of the term debriefing and the lack of applicability of simulation definitions to the clinical setting makes it challenging to accurately identify and categorise clinical debriefing interventions. This is further complicated by incomplete reporting of interventions in journals.<sup>115,116</sup>

In view of these challenges, ILCOR made the pragmatic decision in 2010 to use the term debriefing to describe all types of feedback intervention.<sup>117</sup> This approach is supported by Fanning and Gaba's assertion that debriefing interventions are a sub-group of feedback interventions.<sup>102</sup> The approach also avoids the potential confusion that may arise between use of the terms post-event feedback and real-time audiovisual feedback.

Van de Ridder et al define feedback as, "Specific information about the comparison between a trainee's observed performance and a standard, given with the intent to improve the trainee's performance."<sup>118</sup> One limitation to this definition is an assumption that only the care provider benefits from the feedback, despite, as noted above, some debriefing approaches incorporating the wider care team on the basis that they may also benefit from the intervention. Nevertheless, when interpreted broadly, this definition covers all cardiac arrest debriefing approaches, ranging from facilitated group debriefing to the provision of written feedback. Throughout this thesis, the term debriefing is used to describe all types of post-event feedback. Use of the term feedback is limited to situations where the authors of a paper specifically use the word feedback (e.g. audit and feedback) and in the case of written feedback.

### **1.3.2 The impact of debriefing on practice**

Audit and feedback is often used in healthcare as a strategy designed to improve delivery of evidence-based healthcare.<sup>119</sup> The strategy has been the subject of numerous studies over the last century, which have been summarised in a series of

systematic reviews.<sup>103,119-121</sup> These reviews typically find an association between debriefing interventions and improvements care delivery, which in some cases has translated in to improvements in patient outcomes.

A Cochrane systematic review of the effect of feedback interventions on professional practice included 140 studies.<sup>119</sup> Interventions in included studies mainly targeted prescribing behaviour (39 studies), management of cardiovascular disease or diabetes (34 studies), and use of laboratory and radiological tests (31 studies). Most studies (121 studies) directed interventions at doctors. The review found moderate quality evidence that showed the use of audit and feedback led to moderate improvements in care delivery in relation to both continuous (median 4.3%, interquartile range (IQR) 0.5%-16.0%) and dichotomous (median 1.3%, IQR 1.3%-28.9%) outcomes. However, underpinning these median values was evidence of considerable variation in effect, with both types of outcome showing very large effect sizes at the upper end of the interquartile range. Evidence in relation to patient outcomes was low quality, and showed that audit and feedback had no effect in relation to dichotomous outcomes (median 0.4%, IQR -1.3%-1.6%), but led to modest improvements for continuous outcomes (median 17%, IQR 1.5%-17%).

Tannenbaum and Cerasoli examined the effect of debriefing on performance.<sup>103</sup> Debriefing interventions were categorised as an individual or team reflecting on a specific event with a focus on improvement. Studies were from a broad range of disciplines, including healthcare emergencies (simulation and clinical studies), organisational development, and the military. The meta-analysis of 46 studies found that debriefing improved performance by 20-25%, with some studies showing large effect sizes. However, the generalisability of this result is unclear given the heterogeneity of meta-analysed studies. The review also has some important methodological weaknesses, particularly around the process used to identify studies.

Debriefing is not always beneficial, and may contribute to a deterioration in care delivery. Kluger and Denisi meta-analysed 131 studies with 607 reported outcomes.<sup>120</sup> The review found that approximately a third of the time, debriefing seemed to negatively affect performance, although overall the intervention was associated with a modest positive effect on performance. However, the authors do not report how many studies contained negative results, so it is unclear whether a few studies that reported many negative effects were the driving force behind this finding. Furthermore, the histogram of effect sizes from included studies shows that the magnitude of negative results was consistently very small, whereas the magnitude of positive effects was variable with some studies reporting very large effect sizes. Finally, details of included studies were not detailed and searches focussed on psychology databases, and so the applicability of these findings to healthcare delivery are unclear. Nevertheless, the study highlights the need for some caution when implementing debriefing interventions.

A common feature in these three reviews is the large variability in positive effect sizes.<sup>103,119,120</sup> Foy et al suggest that this variability stems from a lack of certainty about what works best and in what circumstances.<sup>122</sup> To address this uncertainty, several reviews have used statistical techniques to identify factors associated with the increased effectiveness of debriefing interventions.<sup>103,119,121</sup> These are summarised in table 1-1, although it is unclear whether these can be reliably generalised to all debriefing interventions. Hysong et al used a qualitative approach to compare feedback delivery in high and low performing hospitals.<sup>123</sup> They found that, in contrast to low performing organisations, high performing organisations tended to provide non-punitive, timely feedback that was tailored to the needs of users.

**Table 1-1: Factors associated with increased effectiveness of debriefing interventions**

- Poor baseline performance.<sup>119</sup>
- Delivery by clinical colleagues.<sup>119,121</sup>
- Use of multiple formats, such as written and verbal.<sup>119</sup>
- Delivery on several occasions over a period of more than one year.<sup>119,121</sup>
- Inclusion of explicit targets<sup>119</sup>
- Align focus of debrief with attendees (i.e. team debriefs focus on team performance; individual debriefs focus on individual performance)<sup>103</sup>
- Facilitation of debriefs<sup>103</sup>

Recent reports have highlighted the perceived importance of feedback in healthcare organisations. The Francis report on the failings at Stafford Hospital made several recommendations relating to feedback including the need for nursing staff to receive regular performance feedback.<sup>124</sup> Similarly, a Health Foundation report which examined reliability in NHS organisations highlighted inadequate individual and system feedback mechanisms as a factor contributing to unreliable systems.<sup>125</sup>

### **1.3.3 Debriefing in other settings**

The use of debriefing as an educational intervention following clinical emergencies was first reported in the late 1980s.<sup>109</sup> However, it was not until 2006 that its use was formally recommended by a professional organisation.<sup>126</sup> This first recommendation came from the American College of Obstetricians and Gynaecologists.<sup>126,127</sup> In the field of resuscitation, ILCOR first recommended the use of clinical debriefing for cardiac arrest in 2010.<sup>117</sup> Debriefing in other fields, such as aviation and the military, can be traced back to the 1970s. Review of the use of debriefing in these other fields is instructive, due to their contribution to the development of clinical debriefing.

#### **1.3.3.1 Aviation**

There are clear parallels between resuscitation and aviation, particularly the need for an effective team response to emergency situations.<sup>128</sup> In the aviation industry, a series of airplane crashes in 1970s, that could not be attributed to mechanical failure,

highlighted the important contribution of human factors to aviation safety.<sup>129</sup> This led to the development of crew resource management, which incorporates the use of debriefing.<sup>129</sup> In aviation, debriefing is tailored to specific situations, so different approaches have been developed for simulation training, routine flights, and actual or near-miss incidents.<sup>114,130-132</sup> A key theme throughout all these models is the focus on using the debrief to discuss and learn lessons, rather than to apportion blame.

### 1.3.3.2 **The military**

A form of debriefing, termed the after-action review, has been used by the American army since the 1970s.<sup>133</sup> The after-action review has been described as “a professional discussion of an event that enables soldiers/ units to discover for themselves what happened and develop a strategy... for improvement.”<sup>134</sup> These debriefs evolved from the work of military historians who conducted post-battle interviews with soldiers during World War Two to create an accurate historical record.<sup>133</sup> Prior to the development of after-action reviews, performance critiques following exercises were based on subjective criteria and often negative in tone. Recognition that this approach was ineffective led to the development of after-action reviews, which are now considered a core component of army training and operations.<sup>134</sup>

### 1.3.3.3 **Critical incident stress debriefing**

In 1983, Mitchell developed the concept of critical incident stress debriefing (CISD), whereby emergency rescuers were routinely debriefed following significant events in an effort to reduce mental anguish.<sup>135</sup> Mitchell describes several versions of the intervention, but in essence it consists of an opportunity to review the event and discuss feelings, either individually or alongside the wider team, in a supportive setting. Despite widespread adoption, high-quality systematic reviews of CISD have found no evidence of benefit and some evidence of potential harm.<sup>136-138</sup> Supporters of CISD, criticise the index studies in these reviews for either implementing CISD poorly or with the wrong population.<sup>139</sup> Nevertheless, in 2005 the National Incident for Clinical

Excellence took the bold step of actively advising against the routine use of critical incident stress debriefing.<sup>140</sup>

Despite this recommendation, healthcare providers continue to provide debriefing for perceived psychological benefit, particularly in the paediatric emergency department.<sup>141,142</sup> In a survey of 144 UK senior paediatric and emergency medicine clinicians, most respondents reported that a debriefing regularly took place after a failed paediatric resuscitation and that this addressed both psychological issues and medical care.<sup>141</sup> A recent paper extended this concept of debriefing to bystanders following out-of-hospital cardiac arrests.<sup>143</sup>

#### 1.3.3.4 **Healthcare simulation**

Simulation has been used in the military as a training tool for several centuries, with the game of chess cited as an early example of war simulation.<sup>144</sup> Simulation in healthcare is a more recent development. The field of resuscitation was an early adopter of simulation, with the development of a resuscitation manikin in the early 1960s to facilitate practice of mouth-to-mouth ventilation.<sup>144-146</sup> Early attempts to develop more advanced simulators failed due to their prohibitive cost.<sup>144</sup> The development of high-fidelity simulation in the 1980s was driven by two key factors.<sup>144</sup> Firstly, technological improvements facilitated the development of cost-effective simulators by anaesthesia groups in North America. Secondly, opinion leaders recognised the need for more educationally sound approaches to clinical skills development.

Debriefing is a core component of the high-fidelity simulation educational process.<sup>102</sup> Indeed, a systematic review found that the debrief is one of the most educationally important parts of the simulation experience.<sup>147</sup> In the simulation setting, debriefs are typically held immediately after the event and consist of a confidential facilitated discussion where participants are encouraged to reflect on events and share their



experiences.<sup>102</sup> Nevertheless, the optimum approach remains unclear in relation to many aspects of the debriefing process.<sup>102,116</sup>

There are marked differences between debriefing in the clinical and simulation setting. For example, unlike the clinical setting, simulation debriefs take place in protected time and can utilise facilitator observations and video-recordings of events.<sup>102</sup> As such, evidence from the simulation setting cannot be readily applied in the clinical setting without further effectiveness testing.

## **1.4 Cardiac arrest debriefing**

The concept of cardiac arrest debriefing was first described in publications in the early 1990s, but received relatively little attention over the subsequent 15 years.<sup>148-150</sup> In 2007, a pre-hospital debriefing intervention was found to have no effect on CPR quality or patient outcome.<sup>151</sup> However, the following year, Edelson et al described how the implementation of cardiac arrest debriefing at a Chicago hospital was associated with significant improvements in CPR quality, which translated to a significant improvement in ROSC (45% v 59%,  $p=0.03$ ).<sup>152</sup> Against a backdrop of data highlighting suboptimal CPR delivery and failed experiments with real-time audiovisual feedback technology, this paper was something of landmark and led to renewed interest in cardiac arrest debriefing.<sup>60,63,77,153</sup>

### **1.4.1 Attitudes to cardiac arrest debriefing and its adoption**

Clinicians describe cardiac arrest as a challenging and stressful event.<sup>154-157</sup> In survey studies, clinicians report that they consider debriefing to be a valuable educational intervention, but few report actually receiving debriefing in practice.<sup>154,157-159</sup> In a Canadian survey of 289 doctors, only 5.9% of respondents had ever received a debrief, but there was evidence of a positive correlation between receiving a debrief and perceived competence in cardiac arrest team leadership.<sup>157</sup> Similarly, an Australian

survey of 470 junior doctors found respondents with less exposure to debriefing were less likely to feel prepared to lead emergencies.<sup>159</sup>

Recent organisational surveys provide up-to-date information on provision of debriefing. In a survey of 21 EMS systems that participate in the American CARES (Cardiac Arrest Repository to Enhance Survival) registry, 12 out of the 21 (57%) EMS systems reported providing feedback to ambulance staff, although the nature of the feedback is not defined.<sup>83</sup> This finding is particularly curious given that only two EMS systems reported using real-time audiovisual feedback systems as this technology is usually required for collecting the CPR quality data that forms the basis of debriefing interventions. As such, debriefing was likely limited to reporting survival data or self-reported timing data (e.g. time to defibrillation), both of which tend to be of limited value and the latter is particularly prone to reporting bias.<sup>160-162</sup>

Surveys of hospital practice suggest that debriefing is infrequently provided. A Finnish survey of 29 cardiac arrest teams found that only one (3%) team held structured debriefings after cardiac arrest events.<sup>43</sup> American hospitals seemingly fare slightly better, but still only 149 (34%) out of 439 surveyed hospitals reporting that they routinely debriefed following cardiac arrests.<sup>44</sup> However, as was the case with the CARES survey, only a minority (4%, n=17) of these hospitals used real-time audiovisual feedback devices, so it is unlikely that this debriefing incorporates CPR quality data.

### **1.4.2 Models of cardiac arrest debriefing**

Following on from the ILCOR recommendation in 2010, the AHA published a consensus statement in 2013 which recommended organisations select a debriefing approach that is tailored to the organisation's culture, resources, and method of data collection.<sup>97,163</sup> Underpinning this recommendation is an assumption that all debriefing

interventions are effective and that they are all potentially equally effective. However, cardiac arrest debriefing is a very heterogeneous intervention, with studies describing many different approaches.

The timing of the debrief is one of its most important characteristics as this determines several other components of the intervention (Table 1-2). Broadly, debriefing approaches can be categorised as either hot or cold. Hot debriefing takes place immediately after the cardiac arrest, whilst cold debriefing is delayed and usually takes place a few days to a few weeks after the cardiac arrest.

**Table 1-2: Characteristics of hot and cold debriefing**

	<b>Hot/Immediate debriefing</b>	<b>Cold/ delayed debriefing</b>
<b>Format</b>	Verbal	Verbal
		Written
		Performance summary
<b>Staff</b>	Immediate team	Immediate team
		Larger team
		Managers
<b>Data</b>	Clinician recall	Clinician recall
	Automatic Performance Summary	Download of defibrillator CPR data
		Video-recording
Originally published in Current Opinion in Critical Care: June 2013 - Volume 19 - Issue 3 - p 188-194. Wolters Kluwer Health Lippincott Williams & Wilkins© <sup>164</sup>		

Hot debriefing tends to be limited to verbal discussion which is restricted to the immediate care team. As CPR quality data cannot usually be downloaded from the defibrillator and reviewed in time for a hot debrief, discussion is often based on clinician recall of events. This approach, termed qualitative debriefing, therefore relies on clinicians identifying and recalling issues.<sup>165</sup> However, clinicians are generally poor at self-assessment and rarely recall suboptimal CPR delivery, even with the benefit of real-time audiovisual feedback technology.<sup>166,167</sup> Some defibrillators do produce an immediate performance summary, but these reports are limited to summary measures

of CPR quality and do not allow detailed analysis of performance. Hot debriefing may be particularly useful for the immediate identification and review of latent errors.<sup>168</sup>

A further problem with hot debriefing is that debriefs are often facilitated by a team leader with limited experience of facilitation. This creates a risk that the debrief may not focus on key learning points. This has been partly addressed by the development of hot debriefing tools, which provide a clear structure to the debrief.<sup>165,169</sup> The tool developed by Percarpio et al contains 20 closed questions (for example “was all of the equipment in good working condition?”) followed by a staff satisfaction score, and so provides little opportunity for staff to openly discuss the cardiac arrest.<sup>169</sup> In contrast, the tool developed by Mullan et al is framed around two open questions (“what went well during our care for the patient?” and “what could have gone better during our care for the patient?”) in order to generate open discussion.<sup>165</sup> Both tools facilitate a quick structured debrief that reviews performance and aims to identify areas for improvement, but their clinical effectiveness has not yet been formally tested.

Cold debriefings provide the opportunity for greater flexibility in format, staff recipients and use of data (Table 1-2). A commonly used cold debriefing approach is the Resuscitation with Actual Performance Integrated Debriefing (RAPID) model.<sup>110,152,170</sup> Originally developed by Edelson et al, RAPID consists of a 45-minute weekly meeting open to all resuscitation team members, where between two and four cardiac arrest cases are reviewed and discussed.<sup>152</sup> Case review may be supported by CPR quality data downloaded from a defibrillator or videotape recordings.<sup>110,152,170</sup> In small cohesive units with a relatively low incidence of cardiac arrests, it may be feasible to hold a cold debrief after every cardiac arrest. This approach was used on the paediatric intensive care unit of the Children’s Hospital in Philadelphia, where six debriefs were held between June 2010 and May 2011.<sup>111,112</sup>

In the pre-hospital setting, geography may make oral debriefing challenging to deliver. Whilst this has been achieved in some EMS systems, others have adopted alternative debriefing approaches.<sup>150,171,172</sup> Lyon et al implemented a system of written feedback in the Scottish Ambulance Service, which used case records and defibrillator data to generate a written feedback sheet for ambulance staff.<sup>172</sup> A potential limitation to this approach is that, as is the case with hot debriefing, learning opportunities may be restricted to the direct care team. In some studies, written summaries have been sent to the wider care team. For example, O'Connor and Megargel sent monthly summaries of key metrics to all ambulance staff in an EMS system.<sup>150</sup> It seems important that information be sent directly to frontline providers. In a study where CPR quality data were sent to CPR instructors, rather than directly to frontline providers, the intervention was found to have no effect on CPR quality.<sup>151</sup>

### **1.4.3 The effect of cardiac arrest debriefing on practice**

Since 2008, a number of papers have examined the effect of different models of cardiac arrest debriefing on practice. Most of these studies are single-centre before/after studies, whereby performance is measured before and after the implementation of the debriefing intervention. This approach is associated with a high risk of bias and limits study generalisability.<sup>173,174</sup> Furthermore, in only two papers was a survival outcome identified a priori as the primary outcome such that the study was adequately powered to detect a difference for this outcome.<sup>111,152</sup> Nevertheless, studies present a relatively consistent message that debriefing seems to have a positive effect on CPR quality, with some papers also reporting improvements in patient outcome. A summary of studies testing the effect of cardiac arrest debriefing strategies is included as table 1-3. Notably, whilst some studies have found no effect, no study has reported deterioration in CPR delivery associated with the implementation of debriefing.

**Table 1-3: Summary table of cardiac arrest debriefing studies**

	<b>Study design/ setting†</b>	<b>Intervention</b>	<b>CPR quality</b>	<b>Patient outcome</b>
<b>Whitcomb 1990<sup>148</sup></b>	CS (n= 424) Hospital. USA	Cold debrief Written feedback to team leader. Delivered as part of quality improvement bundle	Not measured	Not measured
<b>Weston 1992<sup>149</sup></b>	CS (n= 10) Emergency Department. Wales	Cold debrief* Review of videotape of resuscitation with senior member of staff	Not measured	Not measured
<b>O'Connor 1994<sup>150</sup></b>	BA (n=424) EMS system. USA	Cold debrief Monthly written feedback on organisational performance of key performance measures	Not measured	No effect on STA STA: 13.9% v 18.6%, NS
<b>Olasveegen 2007<sup>151</sup></b>	BA (n=143) EMS systems, England, Sweden, Norway	Cold debrief** CPR quality data provided to local CPR instructors Real-time feedback in both study phases.	No effect on CPR quality CC Depth (mm): 36 v 37, p= 0.56 NFF: 0.40 v 0.41, p=0.83	No effect on STA or STD STA: 16% v 13%, p= 0.66 STD: 5% v 2%, p= 0.42
<b>Edelson 2008<sup>152</sup> *</b>	BA (n=224) Hospital. USA	Cold debrief** Weekly group debrief meeting with review of 2-4 cardiac arrests. Open to all resuscitation team members. Real-time feedback in both study phases.	Improvement in CPR quality CC Depth (mm): 44 v 50, p<0.001 NFF: 0.20 v 0.13, p<0.001	Improvement in ROSC; No effect on STD ROSC: 45% v 59%, p=0.03 STD: 9% v 7%, 0=0.69
<b>Jiang 2010<sup>170</sup></b>	CS (n=45) Emergency Department. China	Cold debrief* Weekly group debrief meeting. Open to all staff.	Improvement in CPR quality No-flow time (median secs/min): 11 v 7, p<0.01	No effect on ROSC or STD ROSC: 33% v 13%, p=0.41 STD: 13% v 0%
<b>Percarpio 2010<sup>169</sup></b>	CS (n=30) Hospital. USA	Hot debrief Structured hot debrief held after cardiac arrest	Not measured	Not measured
<b>Lukas 2012<sup>171</sup></b>	Matched-pair registry (n=638) EMS system. Germany	Cold debrief** Chest compression quality management programme- Real-time feedback + specialist training + team debrief session after every cardiac arrest	Not measured	Improvement in ROSC; No effect on STD Actual ROSC in each group compared with expected ROSC- (Intervention: 52% v 45%, p=0.01 compared with Control: 47% v 45%, p=0.32) STA: 48.9% v 43.6%, p=0.15

	<b>Study design/ setting†</b>	<b>Intervention</b>	<b>CPR quality</b>	<b>Patient outcome</b>
<b>Lyon 2012</b> <sup>172</sup>	BA (n=111) EMS system. Scotland.	Cold debrief** Resuscitation classes and written feedback sent to providers after each cardiac arrest	Improvement in CPR quality NFF: 17 v 10.7, p=0.007	No effect on ROSC or STD ROSC: 32.4% v 40.3%, p= 0.56 STD: 11.8% v 11.7%, p=0.90
<b>Ong 2013</b> <sup>175</sup>	BA (n=248) Emergency Department. Singapore	Cold debrief* Team review and feedback using resuscitation videotape + mechanical CPR + pit-crew/ team training	Improvement in CPR quality NFF: 0.33 v 0.23. Difference 0.1 (95% CI 0.07-0.14)	No effect on ROSC or STD ROSC: adj OR 0.86 (95% CI 0.48-1.54) STD: adj OR 2.71 (95% CI 0.41-17.9)
<b>Mullan 2013</b> <sup>165</sup>	CS (n=241) Emergency Department (paediatric). USA	Hot debrief Structured hot debrief held after every cardiac arrest	Not measured	Not measured
<b>Zebuhr 2012/ Wolfe 2014</b> <sup>111,112</sup>	BA (n=94) Hospital (paediatric). USA	Cold debrief** Group debrief meeting following every cardiac arrest. Open to all staff. Real-time feedback in both study phases	Improvement in CPR quality Likelihood of delivering excellent CPR Excellent CPR: adj OR 5.0 (95% CI 2.2–11.4, p<0.02)	No effect on ROSC; Improvement in STD ROSC: adj OR 1.55 (95% CI 0.61–3.97) STD: adj OR 2.5 (95% CI 0.91–6.8)
<b>Knight 2014</b> <sup>176</sup>	BA (n=248) Hospital (paediatric). USA	Hot debrief Hot debrief held after cardiac arrest + in-situ simulation + development of code team roles and responsibilities + equipment familiarisation and training	Not measured	Improvement in STD STD: adj OR 2.06 (95% CI 1.02-4.25)
<p>Data presented as mean or percentage unless otherwise stated  †- n indicates sample size; *- Debriefing used video-tape recording; **- Debriefing used data downloaded from defibrillator  CS- case series; BA- before/after study; STA- survival to admission; STD- survival to discharge; ROSC- return of spontaneous circulation; NS- not significant; CC- chest compression; NFF- No flow-fraction; CI- confidence interval; adj OR- adjusted odds ratio</p>				

Some studies provided real-time audiovisual feedback alongside cardiac arrest debriefing.<sup>111,112,151,152</sup> On its own, use of this technology leads to small improvements in CPR quality, but appears to have no effect on patient outcome.<sup>85,177</sup> Interestingly, there may be an interaction between use of this technology and debriefing. In a randomised controlled manikin study, both real-time audiovisual feedback and debriefing used on their own improved CPR quality, but there was evidence of a cumulative effect on CPR quality when interventions were used in combination.<sup>178</sup>

Other studies have implemented debriefing, as part of a CPR quality improvement bundle.<sup>171,175,176</sup> These bundles incorporate several interventions designed to improve CPR quality, such as human factors training, high-fidelity simulation, use of mechanical CPR devices, changes to standard operating procedures, and real-time audiovisual feedback. These bundles have been associated with significant improvements in cardiac arrest survival to hospital discharge. Inevitably, a bundle of interventions is more expensive to deliver than debriefing alone, but to date, there are no data on the cost-effectiveness of cardiac arrest debriefing interventions, let alone quality improvement bundles.<sup>97</sup> A degree of caution is needed to prevent widespread adoption of these interventions without the clear understanding of risks and benefits that we demand of other healthcare interventions.<sup>179</sup>

#### **1.4.4 The CPR Quality Improvement Initiative study**

The literature provides a number of examples of debriefing approaches, and suggests that debriefing may be an effective method for improving CPR quality. However, the optimal debriefing approach remains unclear.<sup>97,163</sup> Furthermore, as most studies were undertaken in North America, the generalisability of these data to the UK setting is unclear.



One aim of the CPR Quality Improvement Initiative study was to evaluate the effect of the RAPID model of debriefing on practice in the UK setting.<sup>152,180</sup> The study was a two-phase prospective cohort study undertaken at Heart of England NHS Foundation Trust between November 2009 and May 2013. As part of this study, weekly group debriefing was delivered at one hospital during the second phase of the study.

Intervention delivery identified three key issues that would affect the long-term deliverability of this model of debriefing within the NHS. Firstly, delivery was labour-intensive, in relation to both meeting preparation and the need to release staff from clinical duties to attend. Secondly, reassembling the cardiac arrest team for debriefing proved to be challenging due to NHS staff working patterns. Finally, the meeting format required at least two cardiac arrest events per week. Due to seasonal variation in cardiac arrest incidence, delivery is likely to require at least 150 cardiac arrests per year.<sup>177,178</sup> However, NCEPOD data on in-hospital cardiac arrest incidence shows that only a quarter of NHS hospitals are likely to have the number of cardiac arrests required for effective delivery of this intervention.<sup>32</sup>

#### **1.4.5 Chapter summary: the need for further work**

This chapter has described in-hospital cardiac arrest as an important health problem. Whilst CPR quality is an important determinant of patient outcome, high-quality care is infrequently delivered in practice. This should be seen in the context of evidence that highlights wide variability in the quality of healthcare delivery more generally. Such findings have driven interest in developing strategies to improve the delivery of evidence-based care.

Cardiac arrest debriefing has shown initial promise as a strategy to improve CPR quality and has, in some cases, been associated with improvements in patient outcome. There are a number of different approaches to the delivery of cardiac arrest

debriefing. One of the more common approaches is a weekly meeting at which clinicians review recent cases. However, this approach is challenging to deliver and may not be deliverable in many NHS hospitals. There is a need to develop approaches to cardiac arrest debriefing that are better suited to NHS working practices.

## Chapter 2: Aims

This thesis reports the development and feasibility assessment of three cardiac arrest debriefing strategies that are tailored to NHS practice. The work is modelled on the first two stages of the Medical Research Council (MRC) framework for developing and evaluating complex interventions.<sup>181</sup>

The first section, comprising chapters four to seven, describes the development stage (stage one) of the MRC framework. It incorporates three work packages: a systematic review; a process evaluation of the delivery of weekly group cardiac arrest debriefing; and a qualitative study. These work packages are synthesised in chapter seven to develop three cardiac arrest debriefing interventions that are tailored to NHS working practices.

The second section, comprising chapter eight, describes the piloting/ feasibility stage of the MRC framework. The CODE (cardiopulmonary resuscitation debriefing) study tests the feasibility of delivering these interventions in the NHS setting.

The specific objectives of this thesis are:

1. To review current evidence regarding the use of debriefing following clinical emergencies.
2. To evaluate the delivery of weekly group debriefing.
3. To explore clinicians' perceptions of cardiac arrest debriefing.
4. To identify potential mechanisms by which cardiac arrest debriefing may affect professional practice.
5. To develop cardiac arrest debriefing strategies tailored to NHS working practices.
6. To assess the feasibility of delivering these cardiac arrest debriefing strategies in an NHS hospital.
7. To measure the effect of these cardiac arrest debriefing strategies on cardiopulmonary resuscitation quality and patient outcome.

## Chapter 3: General methods

### **3.1 Ethical approval**

The work contained in this thesis was undertaken in accordance with relevant United Kingdom (UK) legislation, local NHS policies and procedures, and principles of Good Clinical Practice.

### **3.2 Terminology and definitions**

Cardiac arrest is defined as “the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation” which is treated with chest compressions or defibrillation.<sup>15,182</sup> This definition combines the Utstein definition with that of the National Cardiac Arrest Audit in order to clearly distinguish cardiac arrests from deaths where cardiopulmonary resuscitation (CPR) is not attempted.

In-hospital cardiac arrest describes cardiac arrest events that occur within the grounds of a hospital. Typically, the victim will be a hospital in-patient, but may also be an out-patient, visitor or employee.

Out-of-hospital cardiac arrest describes cardiac arrests that occur in the community, outside of the hospital grounds. This includes events where a patient suffers a cardiac arrest in the community and is transferred to hospital in cardiac arrest.

### **3.3 Research setting**

#### **3.3.1 Heart of England NHS Foundation Trust**

The research that forms the basis of this thesis was undertaken at Heart of England NHS Foundation Trust (HEFT) between October 2011 and January 2015. HEFT is a large NHS trust with over 1400 in-patient beds across three hospitals: Birmingham Heartlands Hospital (BHH); Good Hope Hospital (GHH); and Solihull Hospital (SH).

BHH is a large tertiary teaching hospital with 703 beds. The hospital provides a broad range of medical services, as well as elective and emergency surgical services. The hospital hosts tertiary-level care services for respiratory medicine, haematology, thoracic surgery, vascular surgery, and infectious diseases. The emergency department saw 112,171 patients in 2013. The critical care unit has 19 beds.

GHH is a district general hospital with 480 beds. The hospital provides general medical and surgical services, including emergency general surgery. The emergency department saw 78,713 patients in 2013. The critical care unit has 10 beds.

SH is a district general hospital with 248 beds. The hospital provides general medical and elective surgical services. The Emergency Department saw 44,530 patients in 2013. The acute medical unit accepts adult non-surgical emergency ambulance alerts, such as out-of-hospital cardiac arrest patients. The hospital has no dedicated critical care facilities. Patients requiring intensive care are transferred to other hospitals.

### **3.3.2 Hospital adult emergency team**

#### **3.3.2.1 Role and composition of the hospital adult emergency team**

At each hospital site, an emergency team is tasked with responding to cardiac arrests and other medical emergencies on the hospital grounds. The core team operates both day and night and is composed of two medical doctors, an intensive care unit doctor, a critical care outreach nurse, a senior nurse, and a porter. They attend all emergency calls. Specialist cardiac nurses, resuscitation officers, and other key personnel form part of a non-core team and may attend in addition to the core team. All clinical team members hold either Advanced Life Support or Immediate Life Support certification. The team leader is usually the most senior doctor but may be any Advanced Life Support provider. Team composition is broadly reflective of practice in other local hospitals and adheres to Resuscitation Council (UK) guidelines.<sup>27,183</sup> The emergency

team is provided in addition to standard treatment escalation policies, which are guided by an early warning score system.<sup>27,34</sup>

### **3.3.2.2 Activation of the hospital adult emergency team**

Each emergency team member carries a pager. Core team member pagers must be carried by an appropriate clinician at all times. Pagers are tested on a daily basis.

To summon the emergency team, hospital staff call a dedicated emergency telephone number (2222).<sup>27,184</sup> The hospital switchboard activates the emergency team via the pager system. The emergency page consists of a loud alarm followed by an audible description of the location of the emergency, for example “adult emergency, Birmingham Heartlands, ward 4.” On arrival at the emergency, the team delivers care in accordance with Resuscitation Council (UK) guidelines.<sup>14</sup>

### **3.3.3 Cardiac arrest equipment**

Across Heart of England NHS Foundation Trust, there are 157 cardiac arrest trolleys.

Trolleys contain essential emergency equipment stored in sealed trays and a defibrillator.<sup>185</sup> A Phillips MRX QCPR defibrillator (Philips Healthcare, Andover, Massachusetts, USA) is located on most trolleys. Trolleys in low-risk areas may be equipped with a Phillips Heartstart XL defibrillator (Philips Healthcare, Andover, Massachusetts, USA) or a Phillips FR2 automated external defibrillator (Philips Healthcare, Andover, Massachusetts, USA). All trust defibrillators have a CE mark, and were used within their licence during this study.

#### **3.3.3.1 Phillips MRX QCPR defibrillators**

The Phillips MRX defibrillator (Philips Healthcare, Andover, Massachusetts, USA) has monitoring, defibrillation, pacing, and cardioversion functions. The device is licensed for adult, paediatric, and neonatal use. At HEFT, all Phillips MRX defibrillators have been



upgraded to incorporate QCPR technology. During CPR, a puck measuring 15cm by 7cm is placed on the patient's chest and chest compressions are delivered on top of the puck (Figure 3-1). The puck records force and acceleration. This technology enables the defibrillator to record CPR quality metrics during cardiac arrest events.

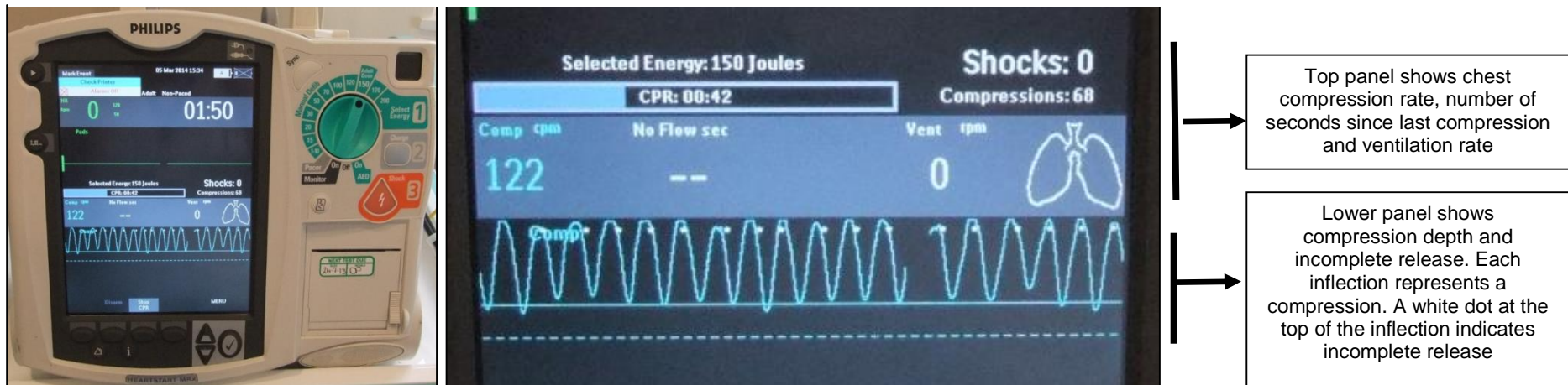
**Figure 3-1: The CPR puck and its use in cardiac arrest**



### 3.3.3.2 Real-time audiovisual feedback

The Phillips MRX QCPR defibrillator (Philips Healthcare, Andover, Massachusetts, USA) has the capability to provide real-time audiovisual feedback. Visual feedback is provided on the defibrillator display and on a small screen on the puck. The defibrillator display is split in two sections. The upper half displays the electrocardiogram (ECG). The lower half contains two panels that display visual information about CPR quality (Figure 3-2). Audio feedback is provided by voice prompts, such as “release pressure between compressions” and “compress deeper.” Where several CPR quality metrics require correction at the same time, the verbal prompts follow a system of prioritisation.

Figure 3-2: The real-time visual feedback display on Philips MRX QCPR defibrillator



### 3.3.4 Cardiac arrest incidence at HEFT

Cardiac arrest events attended by the hospital emergency team are routinely audited by the HEFT resuscitation service for audit and quality assurance purposes.<sup>15,186</sup>

Analysis of Trust data from the last four years (2010-2013) demonstrates a median of 40 (interquartile range (IQR): 32-46.5) cardiac arrests per month attended by hospital emergency teams. Birmingham Heartlands Hospital has the highest median incidence of cardiac arrest events per month (Table 3-1). Despite having the lowest overall median monthly cardiac arrest incidence, Solihull Hospital has the highest incidence of out-of-hospital cardiac arrest events. These differences reflect differences in hospital size, case-mix, and service configuration. Ambulance alerts at Good Hope Hospital and Birmingham Heartlands Hospital are usually managed by emergency department staff. In contrast, Solihull Hospital ambulance alerts are managed in the acute medical unit by the hospital emergency team.

**Table 3-1: Monthly cardiac arrest incidence at Heart of England NHS Foundation Trust: January 2010-December 2013**

	Total	Hospital site			p-value*
		BHH	GHH	SH	
Total CA per month- median (IQR)	40 (32-46.5)	19 (15.25-24)	11 (7.25-13)	9 (7-12)	p<0.01
In-hospital CA per month- median (IQR)	34 (28-40.75)	19 (15-23)	10 (7-12)	6 (3.25-8)	P<0.01
Out-of-hospital CA per month- median (IQR)	4.5 (3-7)	0 (0-0.75)	1 (0-1)	4 (2-6)	p<0.01

\*p-values calculated by Kruskal-Wallis test. CA- cardiac arrest. IQR- interquartile range. BHH- Birmingham Heartlands Hospital. GHH- Good Hope Hospital. SH- Solihull Hospital

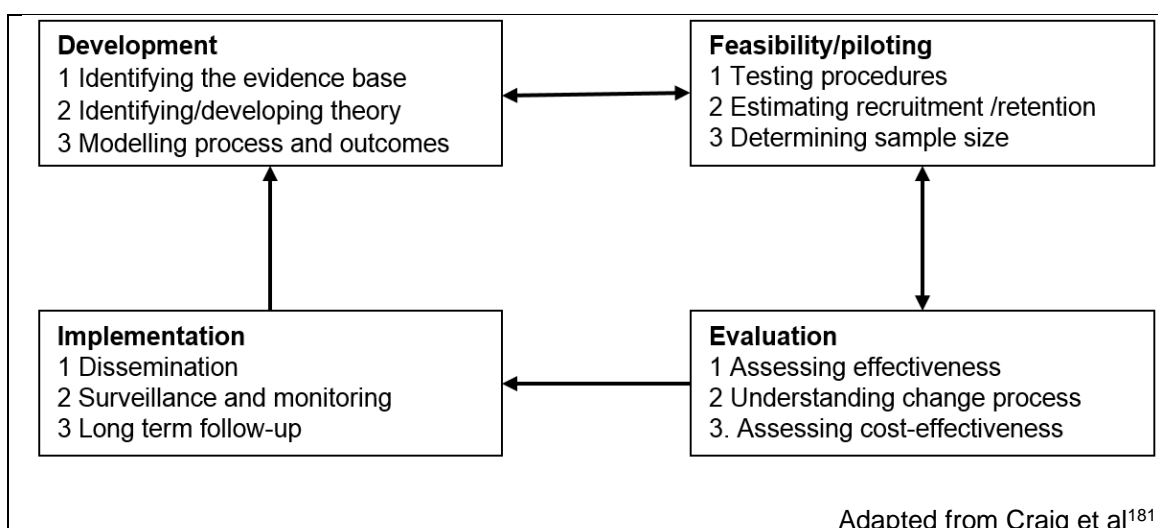
### 3.4 Thesis overview and complex interventions

In this thesis, cardiac arrest debriefing has been categorised as a complex intervention. The Medical Research Council (MRC) defines complex interventions as “interventions with several interacting components.”<sup>181</sup> This definition can be readily applied to many

healthcare interventions, although the MRC highlights that complexity represents a continuum, rather than a dichotomous distinction between simple and complex.<sup>181</sup> For cardiac arrest debriefing, this complexity derives from several components of the intervention, including the behaviour targeted by the intervention (delivery of care at a time-critical and complex healthcare event), the levels of the organisation targeted by the intervention (individual, team, and hospital), and the need to tailor the intervention to meet individual recipient needs. Interventions designed to affect health professional behaviour, such as cardiac arrest debriefing, have been specifically identified by the MRC as examples of complex interventions.<sup>187</sup>

The recognition that traditional methods of intervention development and evaluation cannot be readily applied to complex interventions led to the MRC devising a guidance framework for the development and evaluation of these particular interventions.<sup>181,187-189</sup> Originally developed in 2000, the framework was revised in 2008 in response to concerns that the 2000 framework was too linear and overly focussed on randomised controlled trials.<sup>181,189</sup> The current framework consists of four stages: development; feasibility/ piloting; evaluation; and dissemination (Figure 3-3).<sup>181,189</sup>

**Figure 3-3: Medical Research Council framework for the development and evaluation of complex interventions**



This thesis addresses the development and feasibility/ piloting stages of the MRC framework. Campbell et al state the importance of these early stages, but also highlight the need to distinguish stages due to the different research questions being asked.<sup>187</sup> Interestingly, a more recent BMJ paper, which similarly stresses the importance of this early work, suggests that these phases may be undertaken simultaneously.<sup>190</sup> However, it is somewhat unclear from the paper how interventions can be piloted without first being developed. As such, this thesis adopts the former approach by viewing the development and feasibility/ piloting stages as distinct stages to enable the process to be undertaken in a systematic manner.<sup>181,187</sup>

The development phase, described in chapters four to seven, consists of three work packages: a systematic review; a process evaluation of weekly group cardiac arrest debriefing; and a qualitative study of the mechanisms of debriefing. These work streams are then synthesised to develop cardiac arrest debriefing interventions that are tailored to NHS working practices. Methods for these chapters are described below in sections 3.5 to 3.8. The piloting/ feasibility stage is described in chapter eight, and consists of the CODE (cardiopulmonary resuscitation debriefing) study. Methods are described in section 3.9. The subsequent stages (evaluation and implementation) were not achievable within the context of this PhD.

A key decision made early on was to dovetail the CODE study with the CPR Quality Improvement Initiative study.<sup>180</sup> This enabled the creation of a before/ after study using the intervention phase of the CPR Quality Improvement Initiative study as the control period for the CODE study. The rationale for this is discussed below (section 3.9.1), but it should be noted that this required development work to be completed to a tight time-frame to enable interventions to be implemented as soon as possible following the completion of the CPR Quality Improvement Initiative study.

### **3.5 Systematic review of the effect of debriefing on clinician performance following clinical emergencies**

The MRC framework highlights the importance of undertaking systematic reviews during the development phase of complex intervention to describe the current evidence base supporting an intervention.<sup>181</sup> Previous systematic reviews of debriefing have not addressed its effect in the specific context of cardiac arrest or emergency care. To address this gap in the literature, a systematic review was undertaken.

The process for undertaking the systematic review adhered to best-practice guidelines described by the Cochrane collaboration and the University of York Centre for Reviews and Dissemination.<sup>191,192</sup> This included registration of the review protocol and the use of two people to independently assess titles, abstracts, and full papers against the review inclusion criteria. The review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.<sup>193</sup>

Initial literature scoping identified limited data in the specific field of cardiac arrest. The 'lumpers' and 'splitters' debate relates to whether systematic reviews should adopt a broad review question and consider sub-group analyses (the 'lumpers') or adopt a narrow approach (the 'splitters').<sup>194</sup> Gotzsche cautions against narrow questions due to the increased risk of bias associated with the exclusion of studies that, whilst pertinent to the review question, do not meet the strict inclusion criteria of a narrow review question.<sup>194</sup> Clinical emergencies, of which cardiac arrest is an example, require the effective delivery of time-critical interventions. Therefore, all clinical emergency studies were included as they were considered highly relevant to the review question.

The ILCOR (International Liaison Committee on Resuscitation) system was selected to assess bias within studies.<sup>195</sup> Numerous checklists and scoring systems have been developed to describe the risk of bias or quality of studies, but there is no evidence that

any approach is superior to any other.<sup>191,192,196,197</sup> The University of York Centre for Reviews and Dissemination recommends a pragmatic approach to tool selection based on the nature of the review.<sup>192</sup> On this basis, the ILCOR system was chosen as it can be used with all study designs and is familiar to resuscitation scientists, who were the primary audience of the review.

The GRADE (Grading of Recommendations Assessment, Development and Evaluation) system was chosen to describe risk of bias across studies and develop recommendations in relation to each outcome.<sup>198</sup> Developed by an international group, the system is now used by a number of international organisations in developing clinical guidelines.<sup>199</sup> For each outcome, evidence quality is graded on a four-point scale (high to very low). Preliminary evidence quality is generated by study methodology. This may then be upgraded or downgraded based on factors such as risk of bias, indirectness, and magnitude of effect. The system can be used irrespective of index study quality.

The nature of the review created a high likelihood of study heterogeneity in relation to study design, clinical condition, intervention, and outcomes. This was acknowledged in the review protocol.<sup>200</sup> To enable comparison of outcome across a range of clinical conditions, outcome measures were categorised using Kirkpatrick's evaluation model.<sup>201</sup> Developed to standardise evaluation of training interventions, the model contains four levels (reaction, learning, behaviour, and results). Descriptions of levels and example healthcare outcomes are included in table 3-2.

**Table 3-2: Kirkpatrick level descriptors with example outcomes**

	<b>Summary</b>	<b>Example outcome</b>
<b>Kirkpatrick Level I- Reaction</b>	Clinician response to debriefing interventions	Reported usefulness of debriefing
<b>Kirkpatrick Level II- Learning</b>	Effect of debriefing interventions on clinician knowledge	Knowledge of cardiac arrest guidelines
<b>Kirkpatrick Level III- Behaviour</b>	Effect of debriefing interventions on care delivery. Outcomes may be sub-divided as: technical; non-technical; or combined (technical and non-technical)	Technical: Chest compression depth (CPR); antibiotic administration (sepsis). Non-technical: Anaesthetists' Non-Technical Skills (ANTS) score Combined: Dichotomous score checklist
<b>Kirkpatrick Level IV- outcome</b>	Effect of debriefing on patient outcomes	Mortality; patient length of stay

Study heterogeneity was considered likely to preclude meta-analysis of most index studies, so a narrative review was identified as the most effective approach to summarise study results.<sup>202</sup> Where meta-analysis was considered appropriate, this was undertaken using a random-effects model. In contrast to fixed-effects models, random-effects models do not assume the same effect size across studies.<sup>203</sup> This makes the approach well-suited to meta-analyses of complex interventions, such as cardiac arrest debriefing, where the intervention effect-size may vary depending on the precise characteristics of the intervention and the location where it was delivered. Heterogeneity of study effect sizes was measured using the  $I^2$  statistic. Unlike other measures of heterogeneity such as Cochran's Q, the  $I^2$  statistic can reliably detect heterogeneity when the number of index studies is low.<sup>204</sup>

### **3.6 Process evaluation of weekly group debriefing**

The key driver behind this research was evidence generated during the CPR Quality Improvement Initiative study that weekly group debriefing was unlikely to be deliverable in most NHS hospitals outside of a clinical trial. The aim of this process evaluation was to review the delivery of the weekly group debriefing intervention that formed part of the CPR Quality Improvement Initiative study. It was anticipated that these data would be useful in assessing the long-term deliverability of weekly group debriefing and in



identifying challenges and barriers that may help to guide development of alternative debriefing approaches.

A process evaluation examines the interplay between an intervention, the context in which it is delivered, and how well it is delivered.<sup>205,206</sup> Although rarely undertaken, process evaluations fulfil two key roles.<sup>207-210</sup> Firstly, they avoid research wastage by ensuring that interventions are adequately described to enable replication in other institutions.<sup>211,212</sup> Despite such information being a requirement of study reporting guidelines, journal papers often do not include a detailed description of study interventions.<sup>213-217</sup> Secondly, process evaluations provide important information to explain study results.<sup>205,218,219</sup> In the context of negative or neutral studies, this enables researchers to distinguish between inherently flawed interventions and poorly implemented interventions, sometimes termed a type III statistical error.<sup>205,218,219</sup>

Studies frequently incorporate process evaluations in the piloting / feasibility and evaluation stages of the MRC framework.<sup>205,209,220-223</sup> In contrast to previous studies, the format of this study allowed process evaluation data to be used in the development of debriefing interventions. A key challenge in undertaking process evaluations is a lack of consensus regarding terminology, methodology, and reporting.<sup>205,219,224</sup> This has led to the development of frameworks to improve both intervention reporting and assessment of intervention delivery.<sup>207,224-227</sup> For this research, the TIDieR checklist (template for intervention description and replication) is used to describe the intervention and its context and the framework developed by Carroll et al is used to evaluate intervention delivery.<sup>226,227</sup> The 12 item TIDieR checklist facilitates the reporting of the intervention, the context in which it was delivered, and how well it was delivered.<sup>227</sup> The checklist provides a useful framework for describing the intervention and the context of delivery, but provides little guidance on the complexities of evaluating intervention delivery. In contrast, the model developed by Carroll et al provides a cohesive framework to describe both what was delivered (termed

“adherence”) and factors that may have affected the impact of the intervention (termed “potential moderators”).<sup>226</sup> These tools were chosen as, in combination, they cover all the components of a process evaluation and can be used with all study designs.

Data were collected using an intervention delivery data set and two questionnaires. Questionnaires enabled the efficient collection of data from a large number of participants. This process evaluation was not defined *a priori* as part of the CPR Quality Improvement Initiative, but was developed as work for this research.<sup>180</sup> However, some data are included in the CPR Quality Improvement Initiative study paper.

### **3.6.1 Data collection**

A core data set was collected at each debriefing meeting. The data set included the name and clinical role of the facilitator and attendees, as well as details of the cardiac arrest cases discussed.

Two questionnaires were developed. The first questionnaire collected data about participant’s immediate reaction to the debriefing process (Kirkpatrick Level I- reaction). This was completed by every attendee at each meeting as it was considered that the attendee’s reaction may vary week by week. The second questionnaire collected data about the self-reported effect of debriefing on knowledge and professional practice (Kirkpatrick level II/ III). This was completed by attendees on a single occasion as it was felt that the impact on these factors would be stable over time.

In developing questionnaires, previous studies which had examined clinicians’ views of cardiac arrest debriefing were reviewed in an attempt to identify a reliable and valid questionnaire that could be used for this study. Edelson et al surveyed clinicians on the effect of debriefing on guideline knowledge, leadership skills, and usefulness.<sup>152</sup>

Subsequently, an internet survey study by Zebuhr et al assessed the effect of particular debriefing components on knowledge and practice.<sup>112</sup> However, in both studies, the breadth of collected data was limited and neither study published their questionnaire nor described how it was developed. Therefore, there was a need to develop a new questionnaire.

A key consideration in the questionnaire development process was the need to maximise response rate in order to minimise non-response bias.<sup>228</sup> To facilitate this, we chose to develop a brief, anonymised paper-based questionnaires that could be completed by attendees at the end of debriefing meetings. However, it was acknowledged that there was little evidence to support this approach. For example, whilst questionnaire format seems to have little effect on response rate, research typically compares postal questionnaires and internet surveys.<sup>229,230</sup> In contrast, there is little research on the approach that we used, namely a written self-completed questionnaire that is completed immediately. The effect of anonymity on response rate is unclear, but importantly there is no evidence that anonymity is associated with a reduced response rate.<sup>228,231-234</sup> We chose to make questionnaires anonymous as there was no plan to follow-up completed questionnaires and there was a concern that participants might be wary of making negative comments if they knew that they could be identified. There is evidence of improved response rates with shorter questionnaires.<sup>235-237</sup> By limiting the number of questions, it was possible to fit questionnaires on a single page of A5 paper and ensure that questionnaires could be completed quickly at the end of debriefing meetings.

To develop questionnaires, an initial pool of concepts was developed based on the systematic review findings. Concepts were then prioritised based on importance to the research question and specific questions were developed. Questionnaires fitted on a single page of A5 paper and included both closed (multiple-choice and ordinal attitude scales) and open questions to enhance breadth of collected data. They were pilot-

tested by a convenience sample of eight clinicians from a mix of clinical backgrounds (critical care outreach nurses, doctors, ward nurses, and resuscitation officers) to ensure that the question wording was understandable. Minor refinements were made based on feedback.

### **3.6.2 Data analysis**

Data collected from the core data set and demographic data were analysed using descriptive statistics. Attitude scales are reported as median and IQR and number (percentage) of responses in each category.

It was intended to qualitatively analyse free-text responses using a thematic analysis.<sup>238</sup> However, a review of questionnaire responses found that they lacked the richness required for qualitative analysis. Content analysis was selected as an alternative approach. Developed as a method for analysing media output in the late 19<sup>th</sup> century, content analysis consists of the development of a coding frame which is then used to categorise data.<sup>239</sup> Data coding was undertaken independently by two people, and inter-rater reliability assessed using Krippendorff's-alpha. Krippendorff's-alpha can be used across all data types and with any number of coders and was specifically developed for use in content analysis.<sup>240,241</sup> It is measured on a scale between zero and one, with a value greater than 0.8 representing good inter-rater reliability.<sup>240,242</sup>

## **3.7 Qualitative work**

The aim of this work was to explore clinicians' perceptions of cardiac arrest debriefing. These data were then used to develop an understanding of the mechanisms by which debriefings may exert an effect on professional practice. The research aim lent itself to a qualitative approach.<sup>243</sup>

There is little research on how clinicians perceive the debriefing process and the mechanisms by which debriefing affects knowledge and practice. One reason for this is the infrequent provision of cardiac arrest debriefing in clinical practice, so there is limited opportunity to engage with clinicians with experience of debriefing.<sup>43,44,157,159</sup> The CPR Quality Improvement Initiative study provided a rare opportunity to engage with healthcare providers with experience of receiving cardiac arrest debriefing.

The MRC identifies a key part of the development phase of complex interventions as the identification and development of theory.<sup>181</sup> The value of qualitative work in developing complex interventions is exemplified in the development of a coronary heart disease secondary prevention programme by Corrigan et al.<sup>244</sup> The authors used semi-structured interviews and focus groups with patients and general practice staff to identify potential barriers to use of the intervention and to optimise the intervention to meet the needs of patients.

In this work package, data were collected through semi-structured interviews and field notes. Semi-structured interviews captured the views of clinicians with experience of debriefing. Field notes recorded debriefing meeting events and informal interactions with clinicians, who may not have attended debriefing meetings. This approach ensured the collection of rich data from divergent viewpoints, including clinicians that actively engaged in the debriefing process and those that chose not to or were unable to attend debriefing meetings. The use of focus groups, rather than semi-structured interviews, was considered as group interaction may have increased data richness, but the challenges associated with co-ordinating focus groups in an acute hospital made this approach impractical.<sup>245</sup>

### **3.7.1 Data collection**

Semi-structured interview participants were recruited using a purposive stratified approach.<sup>246-248</sup> Purposive sampling ensured that participants had experience and knowledge of the cardiac arrest debriefing process, whilst stratification by professional role ensured that the views from key professional groups were included. The planned sample size of 15 participants (three participants per professional group) was based on published literature.<sup>246-248</sup>

Field notes were collected by myself and recorded key events throughout the study period. They were recorded from memory as soon as possible after the event. Events included debriefing meetings and informal interactions with clinicians.

### **3.7.2 Data analysis**

The need for timely data analysis was an important consideration in selecting the most appropriate analytical approach for this study. Several approaches were considered. Framework analysis was of particular interest as it was specifically designed for studies with tight deadlines.<sup>249,250</sup> However, the approach is not well suited to heterogeneous data and is best-suited to studies with only one type of data, thereby limiting its applicability to this study.<sup>249,251</sup> Thematic analysis was identified as the most appropriate analytical approach.

Thematic analysis forms part of many qualitative analytical approaches, but also represents an analytical approach in its own right.<sup>238</sup> Several approaches have been described in the literature, with all describing a process of coding and theme generation to identify patterns in a dataset.<sup>238,252-254</sup> Nevertheless, there are key differences between approaches in relation to, for example, epistemological approach and use of reliability measures for coding.<sup>255</sup>

For this study, Braun and Clarke's approach to thematic analysis was used.<sup>238</sup> This was selected because it offers a flexible approach with no epistemological assumptions and has a clearly described process for data coding and theme development.<sup>238</sup> In contrast to other approaches, it cautions against the use of multiple coders and inter-rater reliability measures due to the reflexive nature of data coding.<sup>238,255</sup> This approach is supported by an empirical study and was particularly relevant to the present study given the absence of a second data coder.<sup>256</sup>

### **3.8 Development of cardiac arrest debriefing interventions**

Phase one culminated with the development of cardiac arrest debriefing strategies, tailored to NHS practice. The MRC framework provides a general overview of the process for the development and evaluation of complex interventions, but provides little guidance on the specific process of developing an intervention.<sup>181,257</sup>

The process used for intervention development drew, as far as possible, on the limited literature available and comprised three stages. Firstly, a list of debriefing strategies described in the literature and potential modifications of these was compiled. Bonell et al identify feasibility, acceptability, and adequate coverage as key components of effective and generalisable interventions.<sup>258</sup> During the second stage of the process, these factors were applied to the list of debriefing strategies to identify and rule-out approaches that there were unlikely to be generalisable across NHS settings. The final stage applied the theoretical domains framework (TDF) to this short-list to ensure that strategies were underpinned by relevant theory. The three stages of this process were informed by the development work described in chapters four to six.

There are many, often conflicting, behaviour change theories described in the literature.<sup>259,260</sup> This can be daunting for researchers, and may explain a tendency to develop interventions through intuition, rather than by using theoretical constructs.<sup>260,261</sup>

However, use of theory in intervention development is recognised as an essential component in creating an effective and generalisable intervention.<sup>259,262</sup> The TDF describes psychological theory relevant to behaviour change and the implementation of evidence-based practice.<sup>260</sup> The current framework consists of 14 domains, comprised of 84 component constructs.<sup>263</sup> It can be used by researchers who are not health psychologists and therefore represents a significant step forward in facilitating the use of key theory in developing interventions. The TDF has been successfully applied in several studies examining the use of evidence-based practice.<sup>257,264-266</sup> In particular, French et al used the TDF to develop a complex intervention designed to improve back pain management in primary care.<sup>257</sup>

In this thesis, the availability of three hospital sites provided the opportunity to test the feasibility of delivering three approaches to cardiac arrest debriefing. Three distinct approaches were chosen as, in practice, each intervention may be tailored by organisations to meet local requirements.

### **3.9 The CardiOpulmonary Resuscitation DEbriefing (CODE) study**

The CODE study represents stage two of the MRC framework (feasibility/ piloting). The aim of the study was to assess the feasibility of and pilot test the developed debriefing interventions, including a preliminary evaluation of their effect on CPR quality and patient outcome. The study was undertaken between September 2013 and July 2014.

#### **3.9.1 Study design**

The most appropriate study design for the CODE study was a before/ after approach, with interventions allocated by hospital site. Other study designs were impractical or methodologically flawed. For example, consideration was given to the feasibility of randomly allocating cardiac arrest team members to interventions, but inability to



control cardiac arrest composition would have resulted in an unacceptably high level of intervention contamination as one team could be composed of individuals from different intervention groups.<sup>267</sup> A crossover design was also considered by removing debriefing from hospital one at the end of the CPR Quality Improvement Initiative, but a potential carryover effect precluded this approach.<sup>268</sup>

This choice of study design also enabled the CODE study to dovetail with the CPR Quality Improvement Initiative study. The second phase of the CPR Quality Improvement Initiative study ran from November 2011 to May 2013, so it was possible to use data from that study as the control period for the CODE study. It also meant that CODE study interventions were implemented in NHS hospitals which already had both Phillips MRX Q CPR defibrillators (Philips Healthcare, Andover, Massachusetts, USA) to record CPR quality and clinician buy-in to the concept of cardiac arrest debriefing.

Before/after designs are commonly used for studies of cardiac arrest debriefing.<sup>111,152,172</sup> However, the design has two key methodological flaws. Firstly, the lack of a concurrent control makes it difficult to rule out secular trends and other system changes as the cause of any observed change.<sup>173,174</sup> Secondly, the design tends to lead to overestimates of treatment effects.<sup>173,269</sup> A drawback of integrating the CODE study with the CPR Quality Improvement Initiative study was inter-hospital intervention differences in the second phase of the CPR Quality Improvement Initiative study (Table 3-3). These inter-hospital differences made it impossible to directly compare the effectiveness of the three CODE study interventions across hospital sites. Furthermore, the HEFT resuscitation sub-committee decided to implement real-time audiovisual feedback across the Trust as part of standard clinical care at the end of the CPR Quality Improvement Initiative study. In usual clinical practice, real-time audiovisual feedback and debriefing are often used together as the technology that provides CPR quality data for debriefing also provides real-time audiovisual feedback. These factors are acknowledged as study limitations. However, it was considered that they would not

prevent the CODE study assessing the feasibility of delivering developed debriefing interventions in the NHS setting and the potential effect of interventions on CPR quality within hospital sites.

**Table 3-3: Interventions delivered during phase two of the CPR Quality Improvement Initiative study**

	<b>Control Period</b>
<b>Hospital one</b>	Real-time audiovisual feedback + Weekly group debriefing
<b>Hospital two</b>	Real-time audiovisual feedback (No debriefing)
<b>Hospital three</b>	Control (No real-time audiovisual feedback; No debriefing)

### **3.9.2 Primary outcome**

A recent systematic review reported significant heterogeneity in the outcomes used in resuscitation trials, and highlighted the need for the development of a cardiac arrest core outcome set.<sup>270</sup> The American Heart Association consensus statement on selecting primary outcome measures for resuscitation studies recommends that primary outcomes be chosen based on the study question, and identified that no single primary outcome was appropriate for all studies.<sup>271</sup> Given the aims of the CODE study, it was considered reasonable to select a CPR quality outcome as the primary outcome. This decision can be supported on both theoretical and pragmatic grounds.

From a theoretical perspective, the direct aim of the interventions was to improve a process, namely CPR quality. Delivery of high-quality CPR increases the likelihood of a good patient outcome, but outcome at a patient level is influenced by a range of patient and system factors.<sup>18,19,52,272</sup> The precise effect of these confounders is often unknown or unmeasurable, such that the use of a patient outcome increases the risk of incorrectly concluding that no effect exists (a type II statistical error).<sup>273</sup>

From a pragmatic perspective, the study duration was limited to one year due to funding limitations and PhD time regulations. The CPR Quality Improvement Initiative study sample calculation required 152 patients per site in each study phase to reliably detect a rather ambitious 16% absolute improvement in return of spontaneous circulation (ROSC), with a power of 80% at a significance level of 0.05.<sup>180</sup> Historical cardiac arrest incidence data (section 3.3.2) show that that this level of recruitment was not feasible in a 12-month period. Furthermore, local ROSC rates compared favourably with national rates (51% v 45%), so large improvements were unlikely to be achievable.<sup>15</sup>

### 3.9.2.1 Selection of the primary outcome

In selecting an appropriate CPR quality metric as the study primary outcome, several factors were considered to be important:

1. An improvement in care quality should be clinically meaningful,
2. The metric should relate to a therapy required by most cardiac arrest patients, so as to maximise potential sample size and increase generalisability, and
3. An improvement in the metric would be achievable.

Chest compression depth was considered to be the only metric that met all three of these criteria.

Ventilation rate and chest compression incomplete release were rejected on point one. Both metrics affect coronary perfusion pressure in animal and human studies, but there is currently no evidence of a relationship between either metric and patient outcome in humans.<sup>81,274-277</sup> Peri-shock pause duration is associated with patient outcome, but as most in-hospital cardiac arrest patients do not require defibrillation the metric was rejected based on point two.<sup>15,17-19,67,73</sup>

Chest compression rate and flow-fraction are associated with survival and are measurable at most cardiac arrest events.<sup>61,68,72,80,278</sup> However, baseline local performance either already adhered to resuscitation guidelines (mean chest compression rate: 116 compressions per minute) or compared favourably with published literature (mean flow-fraction: 85%).<sup>14</sup> Limited potential to observe any improvement led to the rejection of both metrics based on point three. In contrast, chest compression depth is associated with survival, it is measurable at most cardiac arrest events, and baseline data showed scope for improvement.<sup>70,71,79,278</sup>

One limitation to chest compression depth as a primary outcome is its method of measurement. The Phillips MRX QCPR defibrillator (Philips Healthcare, Andover, Massachusetts, USA) is a validated method of measuring chest compression depth, but only records absolute distance of puck movement.<sup>279</sup> This is a particular problem for in-hospital cardiac arrests where CPR is usually delivered on a bed. As the puck cannot account for compression of underlying surfaces, the chest compression depth actually delivered to the patient will be overestimated. This phenomenon has been demonstrated in a series of manikin studies and clinical studies.<sup>62,280-285</sup> Perkins et al, for example, observed that compression of underlying surfaces accounts for up to 40% of delivered total compression depth.<sup>280</sup> Use of backboards may reduce this overestimation but these were not used at study hospitals.<sup>62,280,282,283</sup> A recent prospective study of ten in-hospital cardiac arrest patients resuscitated on a variety of surfaces found that the overestimation ranged from 8-16 mm (mean 13.3mm) with little difference observed between types of mattresses.<sup>285</sup> This measurement error is recognised as a study limitation, although the error will likely be consistent between study phases.

### 3.9.2.2 **Sample size calculation**

Sample size calculations are used to calculate the required sample size based on a clinically important difference in outcome measure, study power, and a significance

level.<sup>286</sup> This balances the risk of wasting resources by undertaking underpowered studies with the need to avoid exposing study participants to unnecessary risk through harmful or ineffective interventions.<sup>286</sup> The CODE study adopted a slightly different approach in that the sample size calculation was used to determine a minimum sample size. This approach was chosen for two reasons. Firstly, given the results of previous studies, the intervention was considered very unlikely to be harmful to either patients or staff and, in contrast to a randomised controlled trial, all patients were receiving an intervention. Secondly, the nature of the interventions meant that they could be associated with a learning effect, so any improvement might not be observed in the early part of the intervention period. The research ethics committee and study sponsor agreed with this approach, and authorised the study to recruit for a fixed period of 11-months.

The clinical significance of an increase in chest compression depth has been described in several observational studies.<sup>70,76,79</sup> Edelson et al analysed the association between chest compression depth and defibrillation success in 60 hospitalised patients in ventricular fibrillation.<sup>76</sup> In a regression model, the authors found that each 5mm increase in chest compression depth in the 30-seconds preceding defibrillation significantly increased the likelihood of successful defibrillation (odds ratio 1.99, 95% confidence interval 1.08—3.66,  $p= 0.028$ ). Three large out-of-hospital cardiac arrest observational studies have found a positive association between patient outcome and chest compression depth.<sup>70,71,79</sup> In the first of these papers, on which the sample size calculation was based, multivariate analysis showed a strong trend towards improved hospital survival with each 5mm increase in chest compression depth, so a 10mm improvement was considered to be a clinically important outcome.<sup>70</sup> Subsequently, the same group published a larger observational study ( $n=9136$ ) which identified a statistically significant association between each 5mm increase in chest compression depth and survival to hospital discharge.<sup>71</sup>

Mean baseline chest compression depth was 51.4 mm, such that a 10-mm increase would exceed the current maximum depth recommended by the European and UK Resuscitation Councils.<sup>14,58</sup> A chest compression depth greater than 60mm is also associated with increased risk of CPR-related injury.<sup>287</sup> However, as noted above, this mean baseline chest compression depth is an overestimate of the depth actually delivered to the patient.<sup>285</sup> A 10mm improvement in chest compression depth represented an achievable, safe and clinically important study outcome.

The original sample size calculation was undertaken in 2011 using data from 92 cardiac arrests from November 2009 to December 2010. Based on these data (mean chest compression depth 48.2mm, standard deviation 13.7), it was calculated that 40 patients were required in each study period at each hospital to detect a 10mm change in chest compression depth with 90% power at a significance level of 0.05.<sup>288</sup> The target to recruit at least 60 patients per study phase at each hospital, allowed for drop-outs and patients for whom primary outcome data were not available. The sample size calculation was reviewed in March 2014 once the results of the CPR Quality Improvement Initiative study were finalised. Due to a reduction in standard deviation (standard deviation of 10.4), the study power to detect a 10mm change in chest compression depth is higher than the target 90% power.<sup>288</sup>

### **3.9.3 Ethical review process**

The CODE study required approval from an NHS Research Ethics Committee (REC) as access to NHS premises, staff and patients was required. The original application was submitted to the Coventry and Warwickshire REC in April 2013. The application was modelled on the CPR Quality Improvement Initiative study application, with the exception that a retrospective consent process was included for patient participants.

Following a meeting of the REC on 29<sup>th</sup> May 2013, the application was formally rejected. The committee cited three reasons for rejecting the application:

- There was a need for greater clarity regarding study aims and objectives and assessment of intervention effectiveness.
- There was a need to obtain consent from staff participants.
- Minor amendments to the patient information sheet were required.

The committee further advised that if patient data could be collected by a member of the clinical team and anonymised, then the study could be categorised as a service evaluation.

The committee's decision was discussed at a meeting on 7<sup>th</sup> June 2013, attended by Professor Gavin Perkins, Liz Adey (Head of Research, HEFT), Teresa Melody (Manager, Academic Department of Anaesthesia, Critical Care, Pain and Resuscitation, HEFT), and myself.

The initial discussion considered whether the study could be categorised as service evaluation. Using Health Research Authority tools we determined that the study was research.<sup>289,290</sup> The reasons for this decision were:

- The intent of the study was to generate new generalisable information.
- The proposed treatments / services had a limited evidence base and were not in routine use at the Trust.
- Intervention allocation was decided according to a research protocol, rather than through a joint decision between patient and clinician.

Secondly, the need for NHS ethical review was considered. Under current NHS REC standard operating procedures, REC approval is not required for research studies that only recruit NHS staff members on account of their NHS employment status.<sup>291</sup> We

concluded that whilst NHS staff were research participants, patients were also research participants because they were receiving an intervention (CPR guided by real-time audiovisual feedback and delivered by teams who had received debriefing) and patient data formed a key part of the analysis.

On this basis, we continued with the original approach of submitting a full application to an ethics committee flagged for research involving adults who lack mental capacity. The application was revised to address the concerns raised by the Coventry and Warwickshire REC. The revised application was submitted to a different REC (Oxford C) as no suitable appointments were available with the original REC. The revised application was reviewed by the Oxford C REC on 26<sup>th</sup> July 2013, who required minor changes to the consenting process to comply with sections 30-34 of the Mental Capacity Act 2005.<sup>292</sup> Following the required changes, approval from the ethics committee was received on 13<sup>th</sup> August 2013.

### **3.9.4 Data collection procedure**

#### **3.9.4.1 Definition of terms**

For each cardiac arrest event a core dataset was collected, which consisted of patient demographic and arrest characteristic data based on Utstein definitions.<sup>182</sup>

Patient outcomes included return of spontaneous circulation, survival to hospital discharge, and discharge neurological status. Return of spontaneous circulation was defined as the return of a spontaneous palpable pulse for at least twenty minutes. Survival to hospital discharge was defined as the patient's status when they were discharged from the hospital where the cardiac arrest occurred. Discharge neurological status was described using the cerebral performance category (CPC) score and measured at the point of discharge from the hospital where the cardiac arrest occurred. The CPC score records neurological status on a five-point scale, ranging from one (good cerebral performance) to five (brain death) (Table 3-4). As is the standard in



resuscitation research, a CPC score of one or two was categorised as a good neurological outcome.

**Table 3-4: The cerebral performance category score**

	<b>Category</b>	<b>Description</b>
1	Good cerebral performance (normal life)	Conscious, alert, able to work and lead a normal life. May have minor psychological or neurologic deficits (mild dysphasia, non-incapacitating hemiparesis, or minor cranial nerve abnormalities).
2	Moderate cerebral disability (disabled but independent)	Conscious. Sufficient cerebral function for part-time work in sheltered environment or independent activities of daily life (dress, travel by public transportation, food preparation). May have hemiplegia, seizures, ataxia, dysarthria, dysphasia, or permanent memory or mental changes.
3	Severe cerebral disability (conscious but disabled and dependent)	Conscious; dependent on others for daily support (in an institution or at home with exceptional family effort). Has at least limited cognition. This category includes a wide range of cerebral abnormalities, from patients who are ambulatory but have severe memory disturbances or dementia precluding independent existence to those who are paralysed and can communicate only with their eyes, as in the locked-in syndrome
4	Coma/vegetative state (unconscious)	Unconscious, unaware of surroundings, no cognition. No verbal or psychological interaction with environment.
5	Brain death (certified brain dead or dead by traditional criteria)	Certified brain dead or dead by traditional criteria.

From Nolan et al (2014)<sup>15</sup>

The concept of CPR quality is based on the effective delivery of key quality metrics. To improve reporting and facilitate comparisons between studies, a panel developed standardised measures and definitions for these metrics in 2007 (Table 3-5).<sup>293</sup> These standardised definitions were used in the study.

**Table 3-5: CPR quality metrics definitions**

Parameter	Definition	Suggested methods of reporting
Chest compression depth	Maximum posterior deflection of sternum prior to chest recoil	Episode mean $\pm$ SD Fraction of minutes with chest compression depth < 50 mm
Compression incomplete release	Failure to completely remove chest force between compression	Percentage of compressions
Chest compression rate	Frequency of chest compression delivery	Episode mean $\pm$ SD Fraction of minutes with chest compression rate < 100 or >120 min <sup>-1</sup>
No flow-time	Time without chest compressions from commencement of therapy to end of event	Mean no-flow time (in seconds) $\pm$ SD Mean no-flow fraction $\pm$ SD
Pre-shock pause	Time between last compression and delivery of defibrillatory shock	Median pre-shock pause
Post-shock pause	Time between delivery of defibrillatory shock and restarting chest compressions	Median post-shock pause
Ventilation rate	Frequency of positive-pressure ventilation delivery	Episode mean $\pm$ SD

SD- Standard deviation. Table based on Kramer-Johansen et al 2007<sup>293</sup>  
 Compression depth and rate reporting has been updated to reflect 2010 Resuscitation guidelines<sup>12</sup>

### 3.9.4.2 CPR quality metrics

Study defibrillators create a data record when the device is switched on. The internal memory records up to 12 hours of data. Data are downloaded from the defibrillator and uploaded to a computer. Three data sources may be available: accelerometer; transthoracic impedance (TTI); and electrocardiogram (ECG). The use of all three data sources has been used in the resuscitation literature, but they differ in relation to the CPR quality metrics that can be ascertained (Table 3-6), the complexity of data analysis, and time required to analyse data.

**Table 3-6: Availability of CPR quality data from different data sources**

	Data source		
	Accelerometer	TTI	ECG
Chest compression depth	•		
Chest compression rate	•	•	•
Flow-fraction	•	•	•
Incomplete recoil	•		
Pre-shock pause	○	•	•
Post-shock pause	○	•	•
Ventilation rate	○	•	
• - data type available; ○ - data available when used with defibrillator pads TTI- transthoracic impedance; ECG- Electrocardiogram			

For each CPR quality metric, the first five minutes of available data from each cardiac arrest event was included in the study analysis. This approach has been adopted in previous studies, on the basis that the first five minutes represent the best efforts of the resuscitation team.<sup>60,152</sup> The approach is also pragmatic given the time-consuming nature of manual analysis of transthoracic impedance data.

**3.9.4.2.1 Accelerometer data**

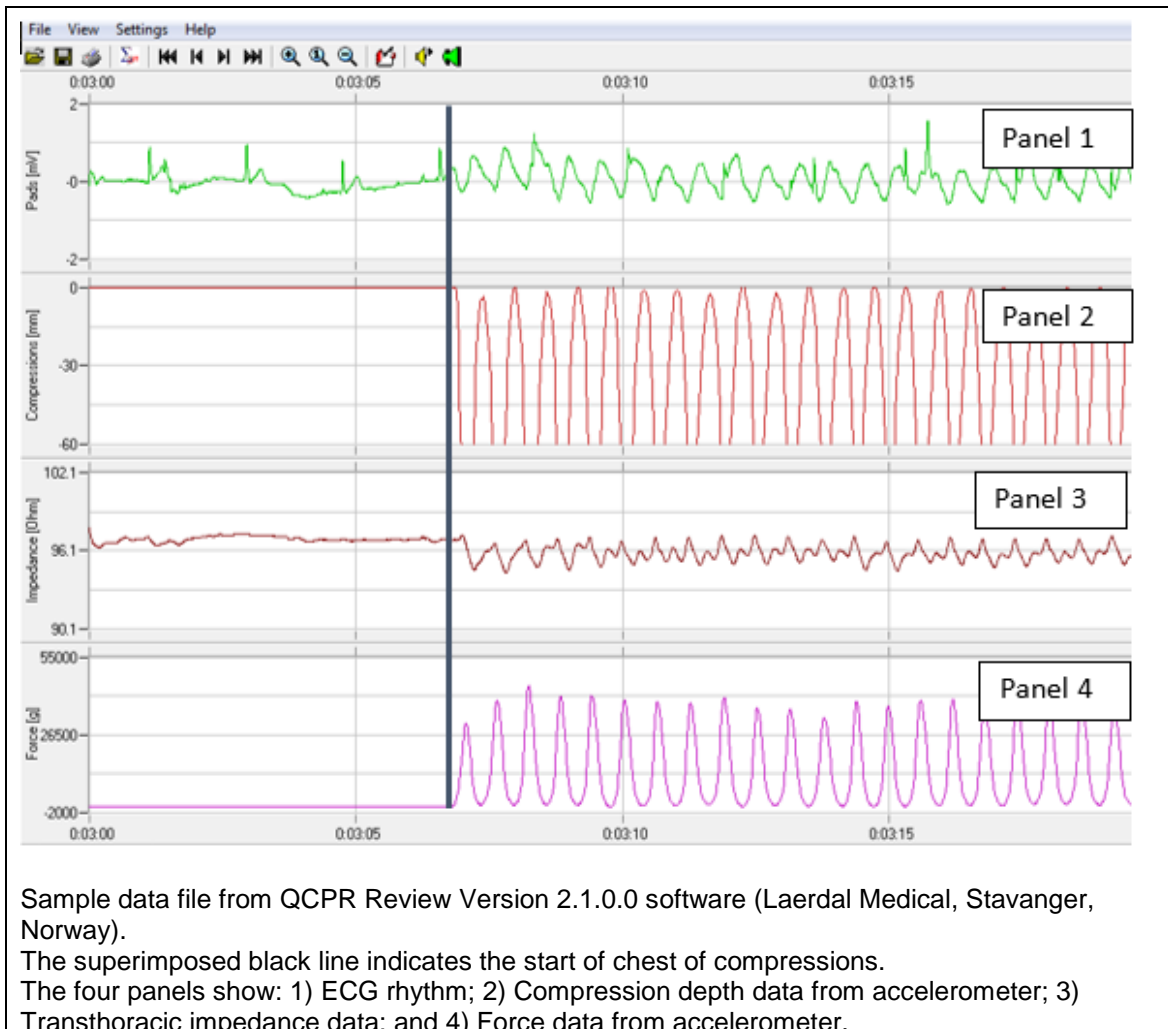
Accelerometer data are collected when the puck and defibrillator pads are used. The defibrillator puck records acceleration and applied force. Data are analysed by manufacturer software (Phillips Heartstart Event Review Pro 4.2 (Phillips Healthcare, Andover, Massachusetts, USA), and presented as an overall event summary, or broken down by 30-second/ one-minute epochs.

**3.9.4.2.2 Transthoracic impedance data**

Transthoracic impedance (TTI), measured in ohms, describes the resistance across the thorax to an alternating current generated through the defibrillator pads.<sup>294</sup> CPR delivery causes changes in TTI allowing CPR metrics to be reliably determined from the TTI waveform, as described in previous studies.<sup>295-302</sup> This is illustrated in Figure 3-4, which shows a computer download of TTI, ECG and accelerometer data. The

superimposed vertical black line in the figure indicates the start of compression delivery, whereupon the TTI waveform pattern clearly changes (panel three).

**Figure 3-4: Comparison of accelerometer, TTI and ECG data: example one**



Most modern defibrillators can record TTI without the need for additional equipment, making it an attractive data source for recording CPR quality.<sup>160,294,303</sup> It does, however, have two limitations. Firstly, it provides no information about chest compression depth or incomplete release. Whilst there is an association between chest compression depth and TTI amplitude, significant inter-patient TTI variability prevents this finding being used in clinical practice.<sup>294,304,305</sup> Secondly, TTI requires manual data extraction. This takes three minutes per minute of data. Manufacturer software (Q CPR Review Version

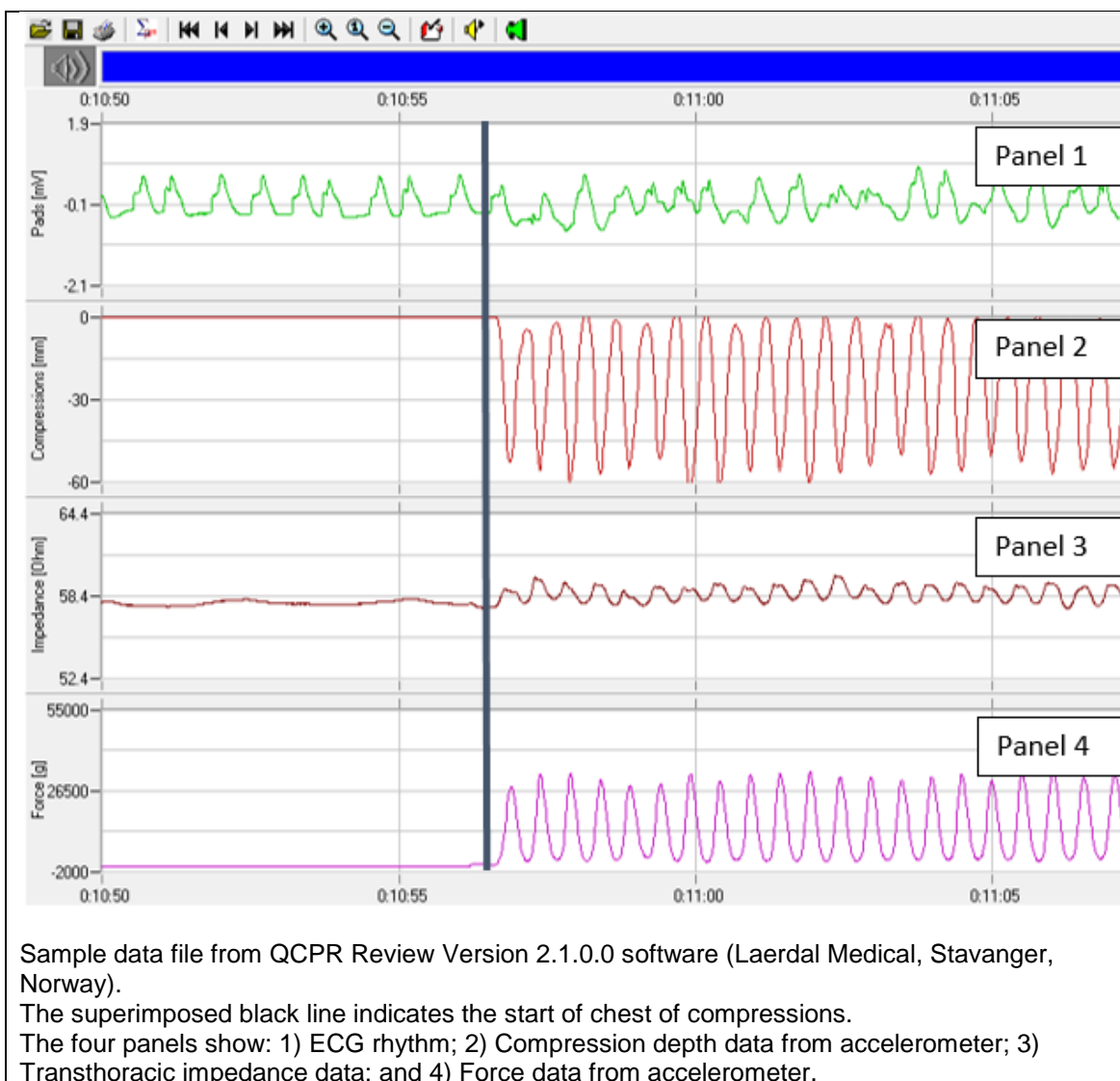
2.1.0.0, Laerdal Medical, Stavanger, Norway) is used to display the waveform to facilitate manual data extraction.

#### **3.9.4.2.3 Electrocardiogram (ECG) data**

ECG data are available when the ECG is monitored through the three-lead ECG during cardiac arrest, or when a defibrillator is used that does not record TTI. During CPR, chest movement causes disturbances in the interface between the ECG electrodes and the skin.<sup>306</sup> As a result, chest compressions appear as 'noise' on the ECG trace. This is illustrated in figure 3-4, where following the start of chest compression delivery (black superimposed vertical line) there is a visible change in the ECG waveform.

This approach to analysing CPR quality metrics has been used in previous studies, but manual data extraction is a time-consuming manual process that is prone to error.<sup>72,307-310</sup> Figure 3-5 provides an example where the underlying ECG rhythm morphology makes it impossible to reliably identify chest compressions on the ECG waveform. This is reflected in a paper by Whitfield et al, where only about half of ECG traces were found to be suitable for analysis.<sup>309</sup> The use of Phillips MRX QCPR defibrillators in all high-risk areas within HEFT meant there were likely to be few cases where neither transthoracic impedance nor accelerometer data were available. On this basis, it was decided to exclude from the study analysis any CPR quality data derived from ECG traces.

Figure 3-5: Comparison of accelerometer, TTI and ECG data: example two



#### 3.9.4.2.4 Comparison of accelerometer and TTI data

Accelerometer data are automatically extracted by computer software, whilst TTI data are manually extracted. To assess the reliability of these two approaches, flow-fraction and chest compression count for the first five minutes of ten randomly selected cardiac arrest events were extracted using both approaches. Results were compared by calculating correlation coefficients and using Bland-Altman plots.<sup>311</sup> Despite use of a relatively small sample size, Pearson's correlation coefficient showed a strong positive correlation between the two approaches (flow-fraction  $r = 0.979$ ,  $p < 0.001$ ; chest compression count  $r = 0.998$ ,  $p < 0.001$ ). Similarly, Bland-Altman plots showed a high

level of agreement, with the 95% confidence intervals having narrow limits and all values falling within these limits (figures 3-6 and 3-7).

### **3.9.5 Data analysis**

#### **3.9.5.1 Analysis of CPR quality (process-based) outcomes**

For process-focussed outcomes, analyses compared CPR quality metrics between study periods at each hospital site and across all hospital sites. Whilst there is some evidence to support the tailoring of CPR delivery to physiological endpoints current resuscitation guidelines continue to recommend the same CPR process for all patients.<sup>14,58,312,313</sup> Therefore, analyses of CPR quality outcomes did not adjust for any patient characteristic.

#### **3.9.5.2 Analysis of patient outcomes**

For patient outcomes, analyses compared data between study periods at each hospital site and across all hospital sites. Analyses adjusted for baseline patient characteristics and were based on an intention-to-treat principle.<sup>314</sup>

For patient outcome analyses, out-of-hospital cardiac arrest events and non-index cardiac arrest events were excluded to prevent skewing of survival data. Out-of-hospital cardiac arrest patients transferred to hospital in cardiac arrest tend to have a poor outcome, and the quality of care delivered by the in-hospital team is unlikely to have a measurable effect on outcome.<sup>315,316</sup> In contrast, patients who survive multiple cardiac arrest events are often those with an easily treatable cause of arrest, such as recurrent episodes of pulseless ventricular tachycardia.

Figure 3-6: Bland-Altman plot for flow-fraction (%)

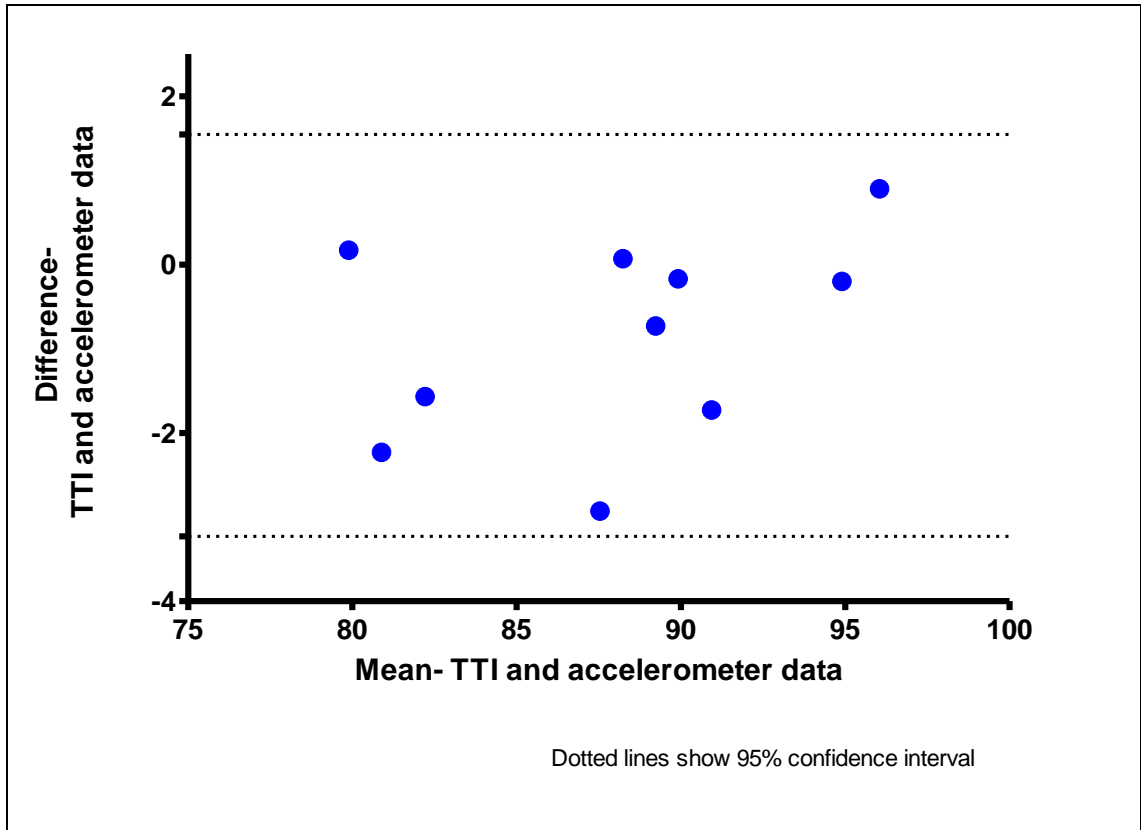
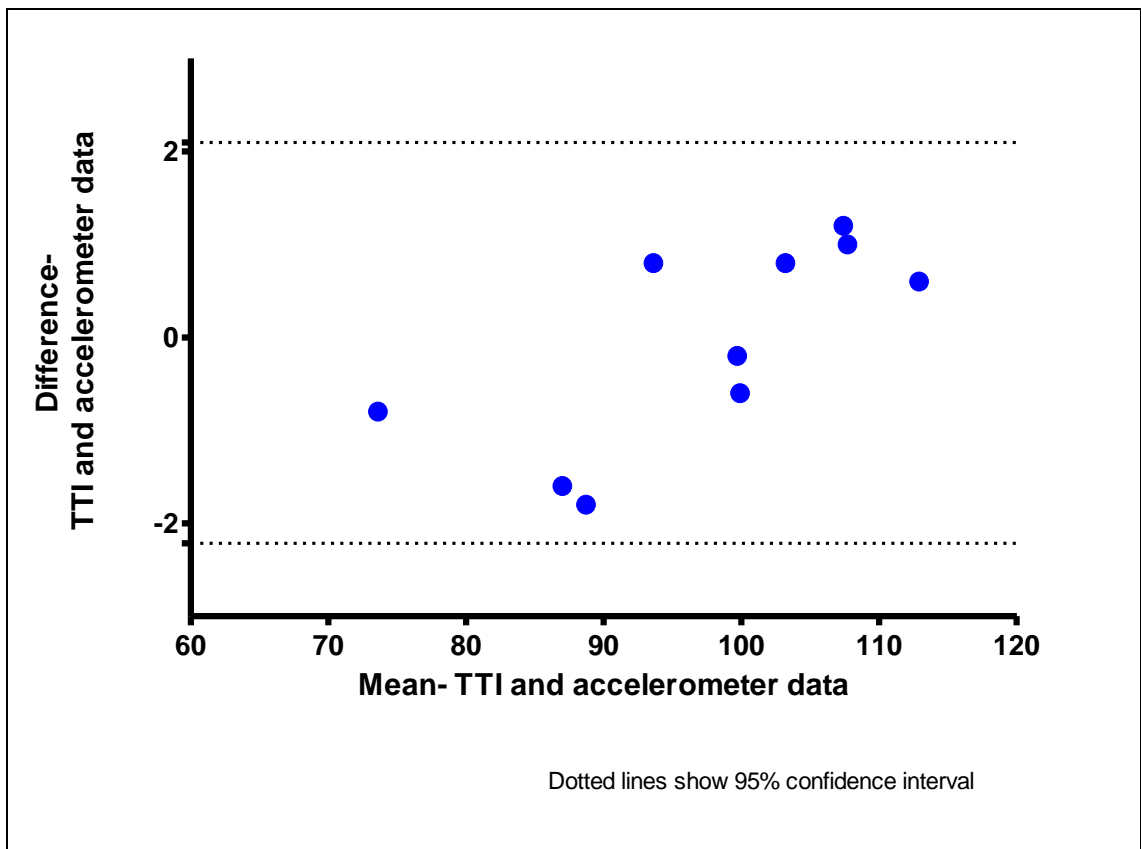


Figure 3-7: Bland-Altman plot of chest compression count per minute





### **3.9.6 Process evaluation**

Alongside patient data collection, data were collected to assess the feasibility of delivering interventions.<sup>207</sup> The MRC highlights the importance of undertaking this work during the piloting/ feasibility phase to help assess intervention uptake and recruitment barriers.<sup>181</sup> The approach adopted was broadly similar to that used for the process evaluation of the weekly group debriefing intervention that formed part of the CPR Quality Improvement Initiative study.

Intervention delivery data collected for each intervention included: the name and clinical role of debriefing recipients, time and date of intervention delivery, and reasons for not delivering the intervention.

The approach to questionnaire administration was modified from the previous study to enable a standardised approach to be used across all hospitals, thereby allowing direct comparisons of debriefing approaches to be made. To allow direct comparisons between interventions, a single questionnaire was developed that incorporated elements from the two previous questionnaires. The questionnaires contained a variety of closed questions (multiple-choice and ordinal attitude scale). Open questions were removed due to the limited data generated in the previous study. Question wording was slightly different between sites to reflect differences in intervention delivery. The questionnaire was distributed by means of an internet survey, and sent out every four months to coincide with junior doctor rotations. The use of an internet survey was supported by the good response rate (68%) to the internet survey undertaken by Zebuhr et al, which compares favourably to many other clinician surveys.<sup>112,317</sup>

Attitude scale data from questionnaires were analysed as ordinal data. Papers often analyse these data as continuous data to enable the use of parametric tests that

theoretically increase statistical power.<sup>318-320</sup> However, the approach contravenes statistical principles and statistical modelling suggests that, in any case, parametric and non-parametric tests have similar power to detect differences when analysing this type of data.<sup>321</sup>

## **Chapter 4: A systematic review and meta-analysis of the effect of debriefing on clinician performance following clinical emergencies**

**An abridged version of this chapter was published as:**

**Couper K, Salman B, Soar J, Finn J, Perkins GD.** Debriefing to improve outcomes from critical illness: a systematic review and meta-analysis. *Intensive Care Med.* 2013;39(9):1513-23.

## 4.1 Abstract

**Introduction:** Debriefing has been identified as a strategy that may improve care delivery at clinical emergencies. Whilst its use is recommended by international guidelines, the effectiveness of the intervention is currently unclear. The aim of this review was to examine the effectiveness of debriefing as a strategy for improving clinician performance at clinical emergencies.

**Methods:** Studies were identified using searches of electronic databases, trial registries, forward and backward citation tracking, interrogation of ILCOR (International Liaison Committee on Resuscitation) worksheet bibliographies and through contact with a subject specialist. Search terms included: feedback, debrief\*, emergency, and resuscitation. All studies that evaluated the independent effect of debriefing on clinician performance at clinical emergencies were included. There was no restriction on study design. Data were extracted using a pre-defined data abstraction form.

**Results:** 27 studies (19 clinical, 8 manikin), covering a broad range of clinical emergencies, were included in a narrative analysis. The narrative analysis found that debriefing improves clinician performance, although studies were often associated with a high risk of bias. A meta-analysis of cardiac arrest studies demonstrated that debriefing is associated with improved chest compression flow-fraction (mean difference 6.80, 95% confidence interval (CI) 4.19-9.40,  $p < 0.001$ ) and return of spontaneous circulation (odds ratio 1.46, 95% CI 1.01-2.13,  $p = 0.05$ ) but had no effect on survival to hospital discharge (odds ratio 0.80, 95% CI 0.38-1.67,  $p = 0.55$ ).

**Conclusion:** The available evidence supports a low grade recommendation for the use of debriefing following clinical emergencies. The review found no evidence that any debriefing approach is superior to any other. Further research is needed to identify the optimal approach. This research should include a full description of the intervention to facilitate comparison between studies and support implementation in the clinical setting.

## 4.2 Introduction

Clinical emergencies, such as cardiac arrest, septic shock and major trauma, require the effective delivery of time critical interventions in order to preserve life. In practice, however, emergency care often fails to adhere to evidence-based guidelines. In cardiac arrest, for example, despite strong evidence to support high-quality cardiopulmonary resuscitation (CPR) and early defibrillation, data suggest that delivery of best care is infrequently achieved.<sup>21,60,63,67,70,76</sup> Despite research often focussing on the development of new therapies, an increased focus on improving the delivery of current interventions may be a more effective way to improve patient outcome.<sup>89</sup>

As a psychological intervention, debriefing was proposed by Mitchell in 1983 as a strategy to enhance mental wellbeing in survivors of major trauma.<sup>135</sup> However formal evaluation of its effectiveness in this context found no evidence of benefit which led to its use declining.<sup>137</sup> The use of debriefing as an educational tool has developed from military and aviation practice.<sup>129,133</sup> In its purist form, debriefing consists of a facilitated discussion where participants critically review their performance and identify ways to improve practice, and is considered a core element of simulation training.<sup>102,116,129</sup> However, the term can be used more broadly to describe all methods of providing performance feedback.<sup>117</sup>

In the clinical setting, the use of debriefing following clinical emergencies is supported by clinical guidelines and is considered valuable by clinicians, but rarely takes place in practice.<sup>117,126,127,154,157-159,322</sup> This may be attributed to clinician uncertainty regarding the evidence-base supporting the use of debriefing. Therefore, the objective of this review was to evaluate the effect of debriefing on clinician performance following clinical emergencies.

## **4.3 Methods**

### **4.3.1 Protocol and registration**

The review was undertaken in accordance with a protocol that was registered with the PROSPERO database on 14<sup>th</sup> May 2012 (registration number: CRD42012002156).<sup>200</sup>

The protocol outlined eligibility criteria, search strategy, outcome measures, and planned analyses. The report is based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.<sup>193</sup>

### **4.3.2 Eligibility criteria**

#### **4.3.2.1 Types of studies**

All types of study that evaluated the independent effect of debriefing provision on clinician performance at clinical emergencies were included. Searches were limited to studies in the English language. No restriction on publication date was imposed.

#### **4.3.2.2 Types of participants**

Studies were included where participants were either qualified or student clinicians that provided care, either independently or as a team member, at clinical emergencies. This included doctors, nurses, paramedics and other health professionals. Clinical emergencies, such as cardiac arrest, traumatic injury, and severe sepsis, were characterised by the need to deliver timely and effective care to save the life of the patient.

#### **4.3.2.3 Types of intervention**

Studies which examined the effect of debriefing provision on clinician performance at clinical emergencies in the clinical or simulation setting were included. Due to the heterogeneous way in which debriefing interventions may be described, studies were included where the intervention met Van de Ridder and colleague's broad definition of feedback, namely: "Specific information about the comparison between a trainee's observed performance and a standard, given with the intent to improve the trainee's

performance.”<sup>118</sup> It was anticipated that there was likely to be marked variability between studies in relation to the nature of the debriefing intervention in terms of, for example, provider, format, and timing.

Studies were included if there was a control comparator. This included comparisons within and between participants, as well as retrospective controls and case series approaches. Studies where the debriefing intervention was combined with any intervention other than purely theoretical education, such that it was not possible to identify an independent debriefing effect, were excluded. Studies were also excluded if debriefing was not given directly to care providers.

#### 4.3.2.4 **Types of outcome measure**

Studies that quantitatively evaluated the effect of the debriefing intervention were included. Following study identification, Kirkpatrick's four-level evaluation model was used to categorise outcome measures to facilitate study and outcome comparison across a range of clinical conditions.<sup>201</sup> Level three outcomes were sub-categorised as technical, non-technical (human factors), or combined outcomes. Combined level three outcomes described scoring systems that incorporated both technical and non-technical components.

A diagram, based on the GRADE (Grading of Recommendations Assessment, Development and Evaluation) framework, showing the relative importance of different Kirkpatrick outcome levels is included as Table 4-1.<sup>323</sup> Critical outcomes for decision making were designated as level four (results) outcomes and level three (behaviour) technical outcomes. Technical behaviour outcomes were categorised as critical as such outcomes may be directly associated with patient outcome. Debriefing, as an educational intervention, is designed to directly affect this outcome. Level three (behaviour) non-technical and combined outcomes were considered important, but not critical for decision-making, as the association between improvements in non-technical

elements of care and patient outcome are less clearly defined. Both level one outcomes (reaction) and level two outcomes (learning) were considered to be of low importance for decision-making due to limited evidence supporting a relationship between these outcome and care delivery or patient outcome.<sup>324,325</sup>

**Table 4-1: GRADE hierarchy: outcome importance for decision-making**

<b>Critical</b>	9	Kirkpatrick level 3: technical outcomes; Kirkpatrick level 4 outcomes
	8	
	7	
<b>Important, but not critical</b>	6	Kirkpatrick level 3: non-technical and combined outcomes
	5	
	4	
<b>Low importance</b>	3	Kirkpatrick level 2 outcomes
	2	
	1	

Subjective assessments of intervention effects, such as asking participants if their practice has improved, were considered equal to objective assessments in Kirkpatrick and Kirkpatrick’s original manuscript.<sup>201</sup> In this review, such subjective outcomes were categorised as level one outcomes, so as not to skew data at other levels.

### 4.3.3 Information Sources

The Cochrane Central Register of Controlled Trials (Issue 3, 2012), Ovid MEDLINE (1946- 2012), Ovid EMBASE (1947-2012), CINAHL (1981-2012), the Education Resources Information Centre, and PsycINFO electronic databases were searched to identify studies. Further studies were identified through consultation with a subject expert (Dr Jasmeet Soar), and interrogation of trial registries and worksheets on debriefing produced as part of the ILCOR (International Liaison Committee on Resuscitation) evidence evaluation process in 2010.<sup>326-329</sup> Forward and backward citation searching of studies was also undertaken.



#### **4.3.4 Search strategy**

Electronic databases were searched using keywords and MeSH terms, including: feedback, debrief\*, resuscitation, shock, and emergency. Full search strategies for each database are included in the appendix (Section 12.1.1).

#### **4.3.5 Study selection**

Following electronic searches and identification of citations through other sources, duplicate citations were identified and removed. Citation titles were screened independently by two authors (Keith Couper (KC), Dr Bilal Salman (BS)) and obviously irrelevant results removed. The full-text of potentially eligible studies was then obtained and assessed independently by the same two authors in an unblinded manner against pre-determined eligibility criteria using a proforma. Where differences of opinion could not be reconciled, a third author (Prof. Gavin Perkins (GDP)) acted as adjudicator.

#### **4.3.6 Data collection process**

To facilitate data abstraction, a tool was developed based on that produced by the Cochrane Effective Practice and Organisation of Care group.<sup>330</sup> The tool was refined following pilot-testing. Data were abstracted by KC and checked for accuracy by a research assistant.

#### **4.3.7 Data items**

From each study, extracted information included: study setting, type of healthcare provider, type of emergency, nature of the intervention, and type of outcome measures.

#### **4.3.8 Risk of bias in individual studies**

The risk of bias in individual studies was evaluated using the process developed by ILCOR for the 2010 resuscitation guidelines.<sup>195</sup> Studies were first allocated a level of evidence (LOE) category between one and five based on study design (Table 4-2) and

then study quality was categorised as ‘good,’ ‘fair’ or ‘poor’ using a predefined list of quality criteria.<sup>195</sup>

**Table 4-2: ILCOR Level of Evidence (LOE) categories**

LOE 1	Randomised controlled trials (or meta-analyses of randomised controlled trials)
LOE 2	Studies using concurrent controls without true randomisation (‘pseudo’-randomised)
LOE 3	Studies using retrospective controls
LOE 4	Studies without a control group (e.g. case series)
LOE 5	Studies not directly related to specific patient/ population
Key: LOE- level of evidence	
From Morley et al 2010 <sup>195</sup>	

Following this assessment, studies were identified as either being supportive of the intervention, neutral to the intervention, or opposing the use of the intervention. It was anticipated that studies would utilise multiple outcomes to assess the effect of the debriefing intervention, which could produce mixed results within each Kirkpatrick level. To be considered supporting or opposing, studies were required to have at least one statistically significant result ( $p \leq 0.05$ ). For studies that met this requirement, the number of significant, compared to non-significant, results and clinical importance of outcomes was evaluated by two authors independently (KC/BS) to allocate studies. A third author (GDP) acted as adjudicator in case of disagreement.

#### **4.3.9 Summary measures and synthesis of results**

The review protocol acknowledged a high likelihood of study heterogeneity, in relation to the debriefing intervention, study design, and outcome measures, which would likely preclude the appropriate use of a meta-analysis. Following study identification, it was decided that a narrative analysis would be the most appropriate method of analysis to describe the impact of debriefing.

For a sub-group of studies that adopted a broadly similar methodological design with interventions targeted at improving CPR delivery in the clinical setting, a meta-analysis was considered appropriate. Differences in intervention delivery (written feedback and group debriefing) facilitated the inclusion of a comparison of these methods of debriefing. The meta-analysis was performed using Revman computer software (Review Manager (RevMan) [Computer program]. Version 5.1. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2011) using a random-effects model. A random-effects model was chosen due to heterogeneity in relation to differences in intervention delivery and study populations.<sup>203</sup> The  $I^2$  statistic was used to measure consistency of results between studies.<sup>204</sup>

For binary outcomes, event frequency was calculated from the reported percentage and total number of patients where it was not directly reported in the index study. When event frequency was not reported and could not be directly ascertained from the percentage and total events, due to percentage rounding, the lowest and 'worst case' frequency value was used. Odds ratios and 95% confidence intervals are reported for binary outcomes.

Continuous outcomes are reported as mean difference and 95% confidence interval. Where the standard deviation was not reported in the index study, it was obtained from the 95% confidence interval based on an assumption that the confidence interval was calculated from a t-distribution.<sup>191</sup> Where necessary, no flow-fraction was transformed to flow-fraction for the meta-analysis.

To analyse different approaches to debriefing approaches, it was planned to compare purist debriefing with other approaches. For this analysis, debriefing was defined as "facilitated or guided reflection in the cycle of experiential learning."<sup>102</sup>

### **4.3.10 Risk of bias across studies**

The GRADE system and associated software (GRADEpro. [Computer program]. Version 3.2. Brozek, Oxman, Schünemann, 2008) was used to record evidence quality for each Kirkpatrick level outcome and each outcome reported in meta-analyses of cardiac arrest studies.<sup>198</sup> The approach assigns a quality of evidence level to each outcome, ranging from very low to high. The first step of the process is to assess evidence quality, based on study design. The second step is then to consider whether to upgrade or downgrade this quality, based on a number of pre-defined criteria, including study limitations, inconsistency and indirectness of evidence.<sup>331</sup> This enables evidence quality for each outcome to be assessed in a consistent and transparent manner.

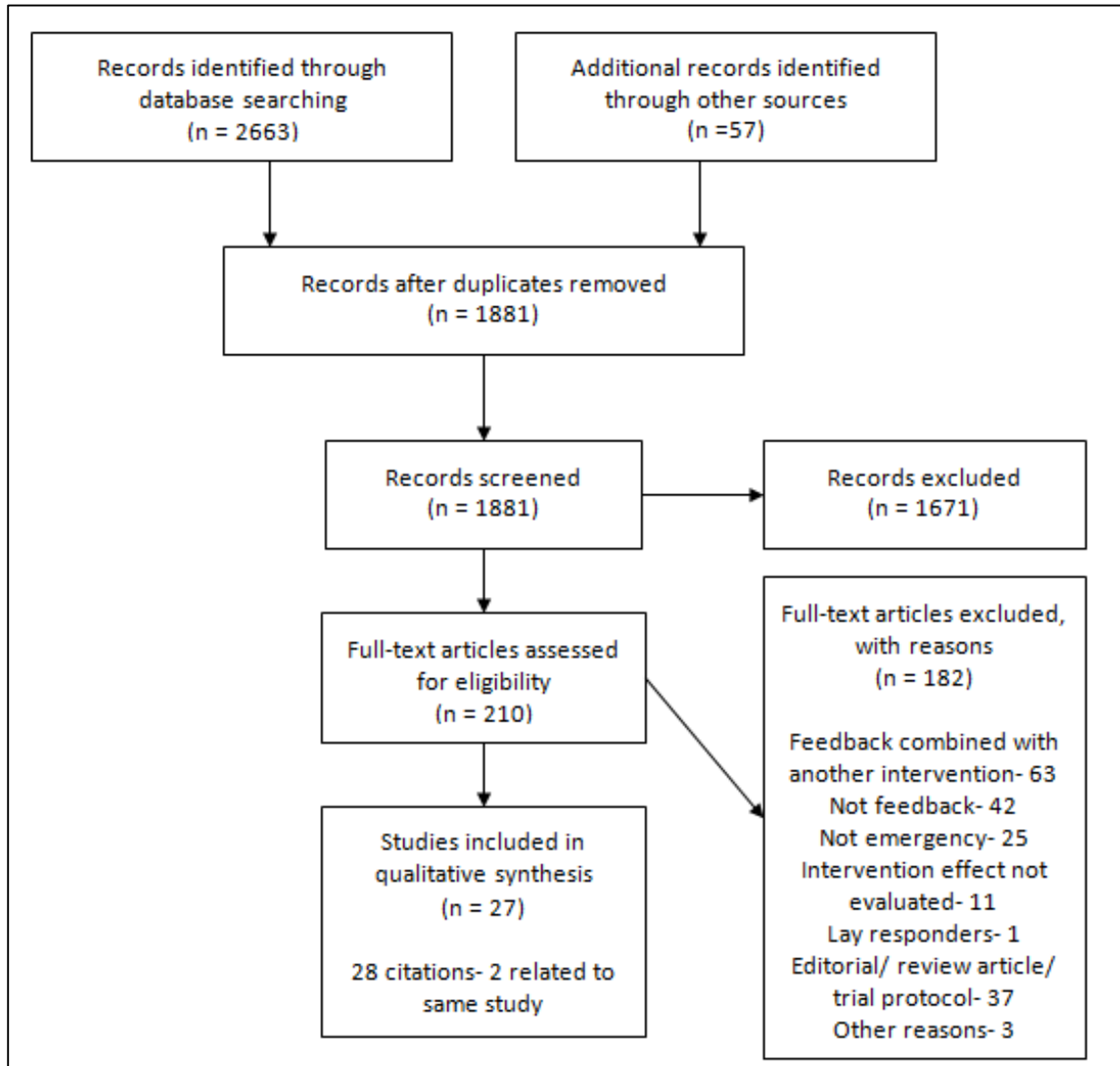
## **4.4 Results**

### **4.4.1 Study selection**

Searches of electronic databases identified 2,663 citations, with a further 57 citations identified through other sources. Removal of duplicate and obviously irrelevant citations led to the exclusion of 2,510 citations. Review of full-text papers led to the further exclusion of 182 citations. The main reasons for exclusion were: delivery of debriefing alongside another intervention, such that it was not possible to assess the independent effect of the debriefing intervention (n=63); interventions that did not meet the pre-specified definition of feedback (n=43); and clinical conditions that were not clinical emergencies (n=25).

In total, 28 citations were identified which met the study inclusion criteria.<sup>107,109,110,112,150,152,169,170,172,178,332-348</sup> Of these, two citations related to the same study, leaving 27 studies included in the final analysis. A list of included studies is included in the appendix (Section 12.1.2). A flow diagram of the study identification process is included as figure 4-1.

**Figure 4-1: Study identification flow diagram**



#### **4.4.2 Study characteristics**

An overview of included studies is included as tables 4-3 and 4-4. Most included studies were undertaken in the clinical setting (n=19), and the remainder were manikin studies (n=8).

**Table 4-3: Study summary table: clinical studies**

	<b>Design</b>	<b>Setting</b>	<b>Emergency</b>	<b>Care provider</b>	<b>N</b>	<b>Intervention/ Comparator</b>	<b>Outcomes (Kirkpatrick level)</b>
<b>Hoyt 1988</b>	NRCT LOE 2- Fair	USA	Trauma	Trauma team	240	Review conference non-attendance Vs. Review conference attendance	Resuscitation duration/ care quality (3T); Knowledge/ practice (1)
<b>Townsend 1993</b>	BA LOE3- Poor	USA	Trauma	Trauma team	883	Control (Pre-I) Vs. Open & closed review (Post-I)	Mortality (4); Resuscitation duration (3T)
<b>O'Connor 1994</b>	BA LOE3-Fair	USA	Trauma/ Cardiac arrest	Ambulance crew	779	Control (Pre-I) Vs. Quality assurance summary (Post-I)	Pre-hosp. ROSC (4); Trauma scene time/ intubation success (3T)
<b>Santora 1996</b>	CS LOE4-Poor	USA	Trauma	Trauma team	66	Case series: review & trauma conference	ATLS guideline adherence (3T); Leadership (3N)
<b>Rawles 1998</b>	ITS LOE3- Fair	Scotland	Myocardial Infarction	General practitioner	414	Control (Pre-I) Vs. Audit report (Post-I)	Thrombolysis administration (3T)
<b>Carbine 2000</b>	CS LOE4-Fair	USA	Neonatal resuscitation	Resuscitation team	50	Case series: feedback review meetings	Neonatal resuscitation guideline adherence (3T)
<b>Scherer 2003</b>	NRCT LOE3-Fair	USA	Trauma	Trauma team	126	Case series: feedback (Pre-I) Vs. Case series: videotape feedback (Post-I)	Trauma care quality (3T)
<b>Bradley 2006</b>	Cohort LOE2- Good	USA	Myocardial Infarction	Ambulance, ED, Cath. Lab.	365 (H)	No feedback Vs. Data feedback	Door to balloon time (3T):
<b>Edelson 2008</b>	BA LOE3-Fair	USA	Adult: cardiac arrest	Resuscitation team	224	Control (Pre-I) Vs. Performance debriefing (Post-I)	ROSC/ hosp. mortality (4); CPR Quality (3T); knowledge (2); usefulness (1)
<b>Scholz 2008</b>	ITS LOE3- Good	Germany	Myocardial Infarction	Ambulance, ED, ICU, Cath. Lab.	114	Control (Pre-I) Vs. Feedback session (Post-I)	30-day/ 6-month mortality (4); Door to balloon time (3T)
<b>Lai 2009</b>	BA LOE3- Good	Thailand	Myocardial Infarction	ED, Cardiology	180	Control (Pre-I) Vs. Feedback (Post-I)	Hosp./ long-term mortality & Hospital LOS (4); Door to balloon time (3T)
<b>Van Wijngarrden 2009</b>	Cohort LOE2- Fair	Holland	Adult: stroke	-	5515	No feedback Vs. Feedback	Thrombolysis rate (3T)
<b>Jiang 2010</b>	CS LOE4- Fair	China	Adult: cardiac arrest	Resuscitation team	45	Case series: video feedback	ROSC/ hosp. mortality (4); CPR Quality (3T)
<b>Percarpio 2010</b>	CS LOE4-Poor	USA	Cardiac arrest	Resuscitation team	30	Case series: code debriefing	Response time/ intubation success (3T); Provider satisfaction (1)
<b>Lin 2011</b>	BA LOE3- Good	Thailand	Myocardial Infarction	ED, Cath. Lab. staff	116	Control (Pre-I) Vs. Data feedback (Post-I)	Door to balloon time (3T)
<b>Nadler 2011</b>	CS LOE4-Poor	Australia	Neonatal resuscitation	Resuscitation team	38	Case series: Debriefing	Guideline adherence (3T); Teamwork/ Procedure control (3N)

	<b>Design</b>	<b>Setting</b>	<b>Emergency</b>	<b>Care provider</b>	<b>N</b>	<b>Intervention/ Comparator</b>	<b>Outcomes (Kirkpatrick level)</b>
<b>Schramm 2011</b>	BA LOE3-Fair	USA	Adult: sepsis	ED, ICU	552	Control (Pre-I) Vs. Feedback (Post-I)	Hosp. mortality/ ICU LOS (4); Sepsis bundle delivery (3T)
<b>Lyon 2012</b>	BA LOE3-Fair	Scotland	Adult: cardiac arrest	Ambulance crew	111	Control (Pre-I) Vs. Written feedback (Post-I)	Pre-hosp. ROSC/ hosp. mortality (4); CPR Quality (3T)
<b>Zebuhr 2012</b>	Survey LOE4-Fair	USA	Paediatric: cardiac arrest	Resuscitation team	34 (C)	Survey: quantitative debriefing	Usefulness (1)
<p>Key:  Study design- BA: Before/After study; CS: Case series; ITS: Interrupted time series; LOE: Level of evidence; NRCT: Non-randomised controlled trial; RCT: Randomised controlled trial.  Care provider- Cath. Lab: Cardiac catheter laboratory; ED: Emergency Department; ICU: Intensive Care Unit.  Intervention/ Comparator: Pre-I: Pre-intervention; Post-I: Post-intervention.  N: data refers to number of patients, except H: Hospitals and C: Clinicians  Outcomes- ATLS: Advanced Trauma Life Support; CPR: cardiopulmonary resuscitation; ROSC: Return of spontaneous circulation</p>							

**Table 4-4: Study summary table: manikin studies**

	<b>Design</b>	<b>Setting</b>	<b>Emergency</b>	<b>Care provider</b>	<b>N</b>	<b>Intervention/ Comparator</b>	<b>Outcomes (Kirkpatrick level)</b>
<b>Anderson 2006</b>	BA LOE4- Good	USA	Neonatal: ECMO	ECMO nurse	9	Control (Pre-I) Vs. Debriefing (Post-I)	Technical skills (3T); behavioural skills (3N)
<b>Savoldelli 2006</b>	RCT LOE1- Good	Canada	Adult: theatre emergency	Anaesthesia doctor	42	Control Vs Oral debriefing Vs. Videotape oral debriefing	ANTS (3N)
<b>Dine 2008</b>	RCT LOE1- Fair	USA	Adult: cardiac arrest	Hospital nurse	65	Debriefing Vs. Debriefing & real-time feedback	CPR quality (3T)
<b>Goffman 2008</b>	BA LOE4- Fair	USA	Shoulder dystocia	Obstetric doctor	71	Control (Pre-I) Vs. Training/ debriefing (Post-I)	Communication (3N); Use of manoeuvres (3T); Performance (3C)
<b>Mikrogiankis 2008</b>	BA LOE4- Fair	USA	Paediatric: trauma	Paediatric doctor	37	Control (Pre-I) Vs. Debriefing session (Post-I)	Team performance (3C)
<b>Morgan 2009/2011</b>	RCT LOE1- Good	Canada	Adult: theatre emergency	Anaesthesia doctor	58	Control or home study Vs. Simulation debriefing	ANTS (3N); DSC (3T); GRS (3C)
<b>Welke 2009</b>	RCT LOE1- Good	Canada	Adult: theatre emergency	Anaesthesia doctor	30	Multimedia presentation Vs. Video- assisted oral debriefing	ANTS (3N)
<b>Boet 2011</b>	RCT LOE1- Good	Canada	Adult: theatre emergency	Anaesthesia doctor	50	Self-debriefing Vs. Instructor debriefing	ANTS (3N)

Key:  
Study design- BA: Before/After study; LOE: Level of evidence; RCT: Randomised controlled trial.  
Care provider- ECMO- extracorporeal membrane oxygenation  
Intervention/ Compator: Pre-I: Pre-intervention; Post-I: Post-intervention.  
N: data refers to number of clinicians  
Outcomes- ANTS- Anaesthetists' non-technical skills;; DSC- Dichotomous score checklist; GRS- Global rating score.



### **4.4.3 Study methods**

#### **4.4.3.1 Clinical studies**

Overall, three studies were categorised as LOE two, ten were LOE three, and six were LOE four.

The three studies categorised as LOE two, included two cohort studies<sup>341,346</sup> and a non-randomised controlled trial.<sup>109</sup> The ten studies that were LOE three comprised seven non-controlled before/ after studies,<sup>150,152,172,342,343,347,349</sup> two time series studies,<sup>344,345</sup> and a non-randomised controlled trial, where there was a temporal distinction between the control and intervention group.<sup>339</sup>

Five case series studies (LOE four) measured performance immediately following intervention implementation and then re-evaluated performance again in the future, based on the assumption that the intervention had no impact at the point of the initial evaluation, but maximal effect at the second evaluation point.<sup>110,169,170,338,348</sup> This arbitrary distinction meant that consecutive events could fall in to different evaluation periods. The sixth LOE four study was a survey study.<sup>112</sup>

#### **4.4.3.2 Manikin studies**

Five manikin studies were randomised controlled trials (LOE one)<sup>107,178,332-334</sup> and three were non-controlled before/after studies (LOE four).<sup>336,337,340</sup>

### **4.4.4 Study participants**

Studies evaluated the effect of debriefing on participant's performance in a range of clinical emergencies, including cardiac arrest (seven studies), trauma resuscitation (five studies), myocardial infarction (five studies), operating theatre emergencies (four studies), neonatal resuscitation (two studies), sepsis (one study), shoulder dystocia

(one study), extracorporeal membrane oxygenation (one study), and stroke (one study). Three clinical studies were pre-hospital studies.

Over half of the included studies were undertaken in America (fifteen studies), with the remaining studies undertaken in Europe (four studies), Canada (four studies), Asia (three studies), and Australia (one study). The four Canadian studies were manikin studies undertaken by the group at the University of Toronto.

#### 4.4.4.1 Clinical studies

In clinical studies, care was delivered by multidisciplinary teams (15 studies), ambulance personnel (two studies), and individual general practitioners (one study). In one study, it was unclear who delivered care and received debriefing, although given the nature of the emergency (percutaneous coronary intervention following ST-elevation myocardial infarction), care was likely delivered by a multidisciplinary team. The number of care providers was detailed in only two studies, although one of these seemed to only include data for medical resuscitation team members.

In 17 clinical studies, care events were the unit of analysis. Some studies explicitly stated that only the first event per patient was included, although at least one study analysed multiple events per patient. Across these 17 studies, the number of included care events ranged from 30 to 5515 (mean 558), although the mean and range are highly influenced by a large (n=5515) cohort study (excluding outlier: mean 248, range 30-883). In the other two studies, Bradley et al analysed data from 365 hospitals,<sup>341</sup> and Zebuhr et al surveyed 34 clinicians.<sup>112</sup>

#### 4.4.4.2 Manikin studies

In all manikin studies, the performance of individual healthcare providers was measured. The mean number of providers enrolled was 44 (range 9 to 71). Study

participants were: anaesthetists (four studies), paediatricians (one study), obstetricians (one study), paediatric ECMO nurses (one study) and hospital nurses (one study).

#### **4.4.5 Study interventions**

In the 27 included studies, there were a total of 35 debriefing interventions (26 from clinical studies, 9 from manikin studies). Interventions are summarised in tables 4-5 and 4-6. Two or more debriefing interventions were provided concurrently in six studies. Intervention format was classified as either oral (26 interventions from 21 studies) or written (4 interventions from 4 studies). For four interventions in four studies, the intervention format was not stated. Interventions were frequently poorly described, with key elements, such as provider, content and frequency, often not detailed in study methods. Even where all key information was recorded, studies often lacked sufficient detail about the intervention to enable replication.

**Table 4-5: Summary of debriefing interventions: clinical studies**

Description (as used in paper)	Format		Facilitator					Receiver				Content					Frequency	
	Oral	Written	Care team	Doctor	Nurse	Paramedic	Sim. instructor	Care team	Open to all	Individual	Senior doctors	Presentation	Video review	QCPR	Discussion	Education		Performance summary
Hoyt 1988	•			•				•				•	•		•	•		Weekly
Townsend 1993	•		•					•				•			•			Every case
O'Connor 1994	•	•						•			•				•		•	-
Santora 1996	•			•	•					•		•			•			Monthly
Rawles 1998	•			•						•					•			Weekly
Carbine 2000	•			•	•			•	•			•			•		•	Fortnightly
Scherer 2003	•			•				•					○					Weekly
Bradley 2006		•		•					•								•	Weekly
Edelson 2008	•			•				•				•		•	•			Weekly
Scholz 2008									•			•					•	Quarterly
Lai 2009								•									•	Monthly
Wijngarden 2009																		-
Jiang 2010	•								•				•		•			Weekly
Percarpio 2010	•				•			•							•			Every case
Lin 2011		•			•			•									•	Every case
Nadler 2011	•				•			•	•			•		•				Weekly
Schramm 2011								•									•	Weekly
Lyon 2012	•	•						•		•							•	Every case
Zebuhr 2012	•			•		•		•	•			•		•	•	•		Monthly
	•			•					•			•		•	•	•		Every case

**Table 4-6: Summary of debriefing interventions: manikin studies**

• As described in paper	Description (as used in paper)	Format		Facilitator				Receiver			Content					Frequency		
		Oral	Written	Care team	Doctor	Nurse	Paramedic	Sim. instructor	Care team	Open to all	Individual	Senior doctors	Presentation	Video review	QCPR		Discussion	Education
	Anderson 2006	•						•		•		•			•			One-off
	Savoldelli 2006	•			•					•					•			One-off
		•			•					•					•			One-off
	Dine 2008	•								•							•	One-off
	Goffman 2008	•								•					•	•		One-off
	Mikrogiankis 2008	•			•					•					•	•		One-off
	Morgan 2009	•						•		•		•			•	•		One-off
	Welke 2009	•								•					•			One-off
	Boet 2011	•						•		•					•			One-off

#### 4.4.5.1 Clinical studies

Of the 26 interventions delivered in the 19 clinical studies, most (n=17) were oral. Four interventions were written, and the format of five interventions was not stated. The debriefing intervention format delivered in studies was: single oral intervention (seven studies), single written intervention (two studies), two oral interventions delivered concurrently (three studies), and a combination of oral and written interventions delivered concurrently (two studies). The five studies that did not describe the intervention format all seemed to deliver a single debriefing intervention.

In the seven studies that delivered a single oral intervention, this typically consisted of a weekly group meeting (five studies). In Percarpio et al a cardiac arrest team debriefing occurred immediately following each event<sup>169</sup> and in Rawles et al two meetings were held with each care provider (general practitioner) over a two year period.<sup>345</sup> Of the three studies that delivered two concurrent oral interventions, two provided frequent event review meetings with care providers that were supplemented by less-frequent general performance reviews. In Townsend et al the trauma team reviewed each of their own cases, with additional meetings held for team leaders and senior doctors to discuss specific cases where issues arose.<sup>349</sup> The two studies that provided only written feedback provided either a monthly performance summary that was forwarded to all care providers<sup>150</sup> or a detailed case-specific summary after each event.<sup>343</sup>

Scherer et al and Lyon et al provided a combination of written and oral debriefing interventions.<sup>172,339</sup> Lyon et al sent a performance summary to ambulance personnel after every event and also offered clinicians the opportunity to discuss their performance with senior clinicians at monthly resuscitation classes. Scherer et al delivered three interventions (weekly verbal feedback, weekly resuscitation conference, monthly written performance summary) in the first three-month period.<sup>339</sup> In the second

three-month period the resuscitation conference incorporated video recordings of events, although it is unclear whether the verbal feedback and written summary continued in this second period.

The debriefing facilitator was often a doctor (seven interventions), although this detail was frequently omitted (eleven interventions). The debriefing receiver was typically the care team, rather than an individual, although in three interventions where care was delivered by a team, the debriefing intervention was only provided to an individual, typically the team leader. Five interventions were described as open to all providers, even if they had not been present at the care event which was the focus of the debriefing. It is likely that in other studies the intervention was also open to all interested parties as Hoyt et al, for example, discuss the potential benefits of learning from other's mistakes suggesting that all individuals were able to attend.<sup>109</sup>

The content of debriefing interventions was often poorly described. Nine interventions incorporated videotape review, and three studies utilised cardiac arrest data downloaded from a defibrillator. Although 12 interventions were identified as incorporating an element of discussion, key details such as duration and nature of discussion was frequently missing. Four interventions were identified as meeting the purist definition of debriefing (Section 4.3.9). However, given the lack of detail about the discussion element of interventions, it was not possible to accurately identify whether other clinical debriefing interventions met this definition.

The intensity of intervention delivery varied considerably, ranging from interventions that were delivered weekly or following every event to an intervention that was delivered twice in a two-year period. The mean duration of intervention delivery was 11.3 months (range three months to two years).

#### 4.4.5.2 Manikin studies

All manikin study interventions consisted of oral debriefing, which met the purist definition of debriefing outlined above (Section 4.3.9). Six interventions were supplemented by a video recording of the performance. In Salvodelli et al, participants were randomised to either oral debriefing, video-assisted oral debriefing or a non-intervention control group.<sup>332</sup> In the three subsequent randomised controlled studies by the same group, video-assisted oral debriefing was considered the gold standard, which was compared with standardised computer debriefing, self-debriefing, and home study/ no intervention. These comparators did not constitute debriefing interventions based on the review inclusion criteria. Video-assisted debriefing was also used in two other manikin studies.

When described, the debriefing facilitator was either a doctor (2 studies) or a simulation instructor (3 studies), although it is likely that the terms were not mutually exclusive. The intervention was delivered immediately after the initial performance evaluation in all studies.

#### 4.4.6 Study outcomes

There was marked variability in included outcomes across studies. Hospital mortality was the most frequently reported outcome (five studies), followed by cardiac arrest chest compression flow-fraction (four studies), door-to-balloon time following myocardial infarction (four studies), and anaesthetists' non-technical skills score (four studies). Edelson et al was the only study which reported outcomes at all four Kirkpatrick levels.<sup>152</sup> Manikin studies only evaluated level three outcomes.

In clinical studies, performance evaluation was typically undertaken at consecutive events for which data were available throughout the study. In manikin studies, performance was typically re-evaluated immediately post-intervention, although re-



evaluation was delayed for six to nine months in Morgan et al, and for seven to 183 days in Goffman et al.<sup>334,336</sup> Welke et al evaluated performance immediately post-intervention and five weeks later.<sup>333</sup>

#### **4.4.6.1 Kirkpatrick level one- reaction**

Level one outcomes were evaluated in the four studies which measured outcomes using a survey. Percarpio et al included a question about provider satisfaction in the debriefing, and measured how this changed over time.<sup>169</sup> Zebuhr et al used an internet questionnaire to evaluate the usefulness and effect of specific debriefing elements (e.g. discussions about chest compression quality and communication) on provider knowledge, confidence, and performance, to identify which elements were reported to be of most benefit.<sup>112</sup> Edelson et al surveyed cardiac arrest team doctors regarding the overall curricular value of the debriefing intervention, together with its perceived effect on guideline knowledge and cardiac arrest leadership.<sup>152</sup> Hoyt et al surveyed all clinicians involved in trauma care regarding the effect of the debriefing intervention on knowledge and care delivery.<sup>109</sup>

#### **4.4.6.2 Kirkpatrick level two- learning**

A single study objectively evaluated the effect of debriefing on provider knowledge by comparing survey responses from clinicians prior to and following participation at debriefing meetings to evaluate the effect of the intervention on clinician's knowledge of the resuscitation guidelines.<sup>152</sup>

#### **4.4.6.3 Kirkpatrick level three- technical performance**

Kirkpatrick level three technical performance outcomes represented the most common outcome measure and were reported in 22 studies (18 clinical, four manikin). Outcome measures used reflected the clinical condition examined in the study. For example, cardiac arrest studies focussed on CPR quality parameters such as chest compression

rate and chest compression flow-fraction, whilst myocardial infarction studies examined thrombolysis delivery and door-to-balloon time.

Most outcomes were objective and well-defined performance measures, such as chest compression depth. In three studies, however, technical performance was given a score by experts in three studies. In Nadler et al performance was evaluated by three experts who graded guideline adherence by scoring five elements, such as providing warmth.<sup>110</sup> Neither tool validity nor the actual scoring system is described, although it appears that each element was scored out of five. Reliability was poor with substantial disagreement between experts reported in relation to three outcomes. Carbine et al developed a local scoring system based on the neonatal resuscitation guidelines to evaluate performance.<sup>348</sup> Scoring was by consensus, hence no reliability data is available. Morgan et al used a scenario-specific scoring system, which had been developed for a previous study, that demonstrated high inter-rater reliability ( $r=0.91$ ).<sup>334</sup>

It is of note that some studies measured elements of care delivery that would now be considered out-dated. For example Townsend et al analysed the routine use of diagnostic peritoneal lavage following trauma, a technique which has now been largely superseded by the use of ultrasound and computerised tomography.<sup>349-351</sup> As the focus of such studies was, as in other studies, the improvement of care delivery in the context of clinical emergencies according to best practice at the time of publication, it was appropriate to include them.

#### **4.4.6.4 Kirkpatrick level three- non-technical performance**

Non-technical performance was evaluated in eight studies (6 manikin, 2 clinical).

Performance was predominantly evaluated by blinded experts using videotape recordings (6 studies), although in Goffman et al experts directly observed the simulation scenario.<sup>336</sup> In four studies, non-technical performance was measured using

the anaesthetist's non-technical skills score (ANTS). The ANTS is a valid and reliable tool for measuring anaesthetist's non-technical skills; that comprises four categories (task management, team working, situation awareness, decision making) which are individually each graded on a four-point scale (poor to good).<sup>352</sup> In the four included studies, reported inter-reliability ranged from 0.44 to 0.76.

Anderson et al used a locally developed tool that incorporated ten elements that were each graded by four instructors on a five point scale and summed.<sup>340</sup> The tool was developed locally by experts, and reported inter-rater reliability was high. In Goffman et al, six elements were assessed as either done or not done to give an overall score out of six.<sup>336</sup> Tool validity is not addressed within the paper and performance was evaluated by expert consensus, so no reliability data are available. In Nadler et al teamwork and procedure were evaluated using 11 outcome measures, using the approach described above (Section 4.4.6.3), which had poor reliability with substantial disagreement between experts in relation to seven outcome measures.<sup>110</sup>

#### **4.4.6.5 Kirkpatrick level three- technical and non-technical performance**

Three manikin studies evaluated provider performance using a scoring system that incorporated elements of both technical and non-technical performance. Both Goffman et al and Morgan et al evaluated overall performance using a single 5-point ordinal scale.<sup>334,336</sup> Mikrogianakis et al assessed performance using a 26-element validated scoring system.<sup>337</sup> Morgan et al and Mikrogianakis et al reported the same inter-rater reliability ( $r=0.71$ ) in relation to their respective tools.<sup>334,337</sup> In Goffman et al, scoring was done by consensus, so inter-rater reliability is not reported.<sup>336</sup>

#### **4.4.6.6 Kirkpatrick level four- results**

All eight studies that included level four outcomes evaluated patient mortality, with two of these studies also examining length of stay. Five studies evaluated mortality at two

time-points. Mortality endpoints included: hospital mortality (five studies); return of spontaneous circulation following cardiac arrest (four studies); 30-day mortality (one study); 6-month mortality (one study); and long-term mortality up to 300 days (one study). Townsend et al compared observed and predicted mortality in the control and intervention groups using the z-statistic, although the mortality time-point is not stated.<sup>349</sup> Length of stay endpoints included intensive care unit length of stay (one study) and hospital length of stay (one study).

#### **4.4.7 Risk of bias within studies**

Clinical studies were associated with a moderate to high risk bias, with most categorised as being of fair quality. Except for two cohort studies and a non-randomised controlled trial, all studies lacked a concurrent control group such that it was not possible to exclude an underlying secular trend.

Most studies either blinded outcome assessors or used clearly-defined objective endpoints, so this was not considered to be an important source of bias. Case selection, however, represented a potential source of bias as studies often relied upon the use of a video recorder to both provide data for intervention delivery and assess performance for outcome evaluation. For example, Santora et al and Scherer et al reported that only 35% and 54% of events respectively were recorded.<sup>338,339</sup> Similarly in Lyon et al, data collection relied on ambulance personnel voluntarily uploading data such that just 39% of events were captured.<sup>172</sup> Such data, however, was frequently omitted in study reports. This risk of bias was intensified in studies by Nadler et al and Carbine et al where only a sub-set of available data was used to evaluate effectiveness of the intervention.<sup>110,348</sup>

In before/after studies there was frequently a comparison of pre- and post-intervention patient characteristics, but only Edelson et al compared provider characteristics.<sup>152</sup>

Both Hoyt et al and Scherer et al compared baseline performance and although similar in Hoyt et al study, there were significant baseline differences in the paper by Scherer et al.<sup>109,339</sup> There was also a risk of intervention contamination in both these studies, as both studies analysed performance based on team leader allocation, without accounting for exposure of other team members to the debriefing intervention. There was no contamination risk in other clinical studies as they either only collected data following intervention implementation (case series) or no intervention was delivered prior to debriefing implementation (before/after studies).

The risk of bias in manikin studies was generally lower than in clinical studies. A key issue in relation to manikin studies was the potential existence of a learning effect, whereby providers gain experience in the simulation environment such that their performance improved irrespective of the provision of any intervention. The randomisation method was not detailed in two randomised controlled studies, creating a potential risk of allocation bias.<sup>107,332</sup> In Dine et al there were key differences in group characteristics (recent CPR training and ICU experience) and performance at baseline, that may have influenced study results.<sup>178</sup> In the other four randomised controlled studies, both group characteristics and baseline performance were measured and were similar.

Six studies used performance video recordings to facilitate blinded outcome assessment. In Dine et al, defibrillator data were used to provide objective performance evaluation.<sup>178</sup> However, in Goffman et al performance evaluation was undertaken live and unblinded as it was not logistically possible to get adequate video images of obstetric manoeuvres to facilitate the use of video recordings for evaluation.<sup>336</sup> Furthermore, as assessors had personal knowledge of the participants, this likely increased the risk of bias. In relation to the three studies that did not reassess performance immediately post-intervention, there was a potential contamination risk as participants allocated to different interventions may have discussed the study.

#### **4.4.8 Results of individual studies**

Overall, study results suggest that debriefing is associated with improvements in clinician performance at clinical emergencies. Using the ILCOR framework, 20 of the 27 included studies, reported a benefit associated with debriefing at one or more outcome levels (Table 4-7).

##### **4.4.8.1 Kirkpatrick level one: effect of debriefing on reaction**

Three out of four studies identified benefits associated with debriefing in relation to level one outcomes.<sup>109,112,152</sup> The other study by Percarpio et al examined provider satisfaction with the cardiac arrest process following the implementation of debriefing.<sup>169</sup> Whilst this increased gradually throughout their case series, high baseline satisfaction and a lack of any formal statistical analysis of the change meant that the effect is difficult to quantify. In both Edelson et al and Zebuhr et al, clinicians reported that they found debriefing to be useful.<sup>112,152</sup> In addition, Edelson et al found that clinicians reported improved knowledge (83%) and leadership skills (70%). In Hoyt et al, most participants reported a beneficial effect on resuscitation and trauma knowledge (93.4%) and care delivery (90.5%).<sup>109</sup>

##### **4.4.8.2 Kirkpatrick level two: effect of debriefing on learning**

Edelson et al was the only study to objectively evaluate the effect of debriefing on learning.<sup>152</sup> Following the implementation of debriefing, clinicians demonstrated improved knowledge of resuscitation in relation to the defibrillation algorithm (38% v 93%,  $p<0.001$ ), correct ventilation rate (35% v 58%,  $p=0.04$ ), and there was a trend to improved knowledge in relation to the correct chest compression rate (75% v 90%,  $p=0.07$ ).

**Table 4-7: ILCOR evidence table**

		<b>Level of evidence</b>				
		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Evidence supporting clinical question</b>	<b>Good</b>	Savoldelli 2006 <sup>3N</sup> Morgan 2009/ 2011 <sup>3T</sup>	Bradley 2006 <sup>3T</sup>	Scholz 2008 <sup>3T</sup> Lai 2009 <sup>3T</sup> Lin 2011 <sup>3T</sup>	Anderson 2006 <sup>3N</sup>	
	<b>Fair</b>	Dine 2008 <sup>3T</sup>	Hoyt 1998 <sup>3T, 1B</sup> van Wijngaarden 2009 <sup>3T</sup>	O'Connor 1994 <sup>3T</sup> Scherer 2003 <sup>3T</sup> Edelson 2008 <sup>4A, 3T, 2, 1A</sup> Schramm 2011 <sup>3T</sup> Lyon 2012 <sup>3T</sup>	Goffman 2008 <sup>3T, 3C, 3N</sup> Jiang 2010 <sup>3T</sup> Zebuhr 2012 <sup>1A</sup>	
	<b>Poor</b>			Townsend 1993 <sup>3T, 4B</sup>	Santora 1996 <sup>3N</sup>	
<b>Evidence neutral to clinical question</b>	<b>Good</b>	Morgan 2009/ 2011 <sup>3C, 3N</sup> Welke 2009 <sup>3N</sup> Boet 2011 <sup>3N</sup>		Scholz 2008 <sup>4B</sup> Lai 2009 <sup>4B, 4C</sup>	Anderson 2006 <sup>3T</sup>	
	<b>Fair</b>			O'Connor 1994 <sup>4A</sup> Rawles 1998 <sup>3T</sup> Edelson 2008 <sup>4B</sup> Schramm 2011 <sup>4B, 4C</sup> Lyon 2012 <sup>4A, 4B</sup>	Carbine 2000 <sup>3T</sup> Jiang 2010 <sup>4A, 4B</sup> Mikrogianakis 2008 <sup>3C</sup>	
	<b>Poor</b>				Santora 1996 <sup>3T</sup> Percarpio 2010 <sup>3T, 1A</sup> Nadler 2011 <sup>3N</sup>	
<b>Evidence opposing clinical question</b>	<b>Good</b>					
	<b>Fair</b>					
	<b>Poor</b>				Nadler 2011 <sup>3T</sup>	

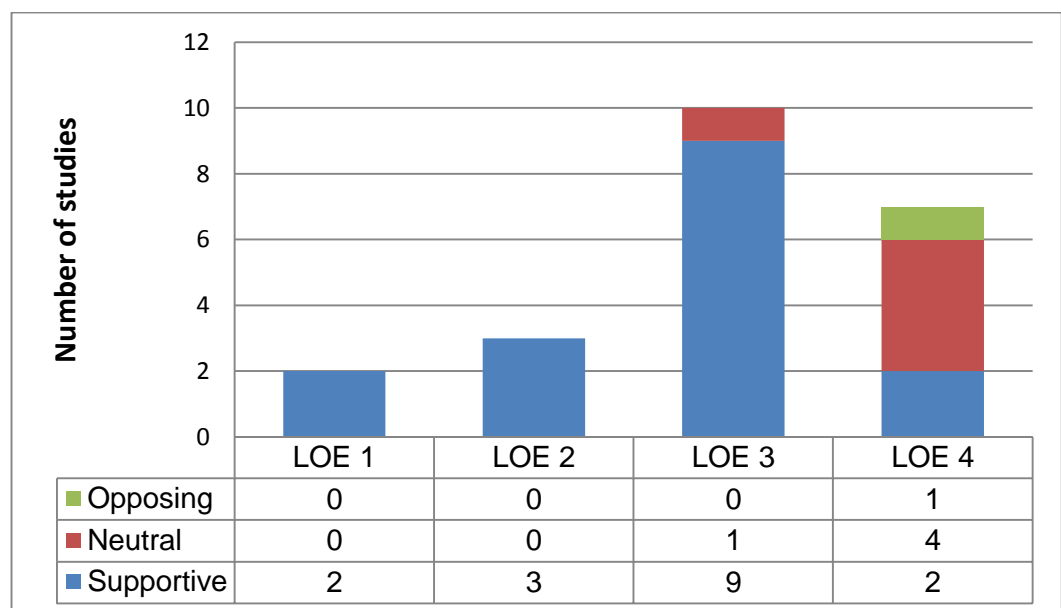
Outcome codes (number relates to Kirkpatrick Level)- 4A: Return of spontaneous circulation; 4B: Mortality; 4C: Length of stay; 3T: Technical performance; 3C: Combined technical and non-technical performance; 3N: Non-technical performance; 2: Knowledge; 1A: Usefulness of debriefing; 1B: Subjective effect on care delivery/ knowledge

#### 4.4.8.3 Kirkpatrick level three: effect of debriefing on behaviour (technical performance)

Of the 22 studies that evaluated the effect of debriefing on technical performance outcomes, 16 studies (13 clinical, three manikin) supported the use of debriefing.

Studies that were neutral or opposed the use of debriefing at this outcome level tended to be subject to an increased risk of bias. In the group of 15 studies whose evidence was categorised as level one to three, 14 studies supported the use of debriefing. In contrast, six of the seven studies categorised as level of evidence four were either neutral to or opposed the use of debriefing (Figure 4-2).

**Figure 4-2: Number of studies supporting, opposing or neutral to study question in relation to level of evidence for Kirkpatrick level three (technical) outcome**



Four cardiac arrest studies demonstrated a positive association between debriefing and improved technical performance. In the manikin study by Dine et al manikin, the number of participants who delivered adequate CPR improved with both debriefing (24% v 35%,  $p=0.29$ ) and real-time feedback (16% v 29%,  $p=0.220$ ), but this effect became clinically and statistically significant when debriefing was combined with real-time feedback (29% v 65%,  $p=0.005$ ).<sup>178</sup> In Edelson et al, the addition of group debriefing to real-time feedback significantly improved the delivery of CPR, with notable



improvements in mean chest compression depth ( $44\text{mm} \pm 10$  v  $50\text{mm} \pm 10$ ,  $p < 0.001$ ), ventilation rate per minute ( $18 \pm 8$  v  $13 \pm 7$ ,  $p < 0.001$ ), and chest compression no-flow fraction ( $0.20 \pm 0.13$  v  $0.13 \pm 0.10$ ,  $p < 0.001$ ).<sup>152</sup> However, other clinical studies found debriefing to be associated with improved performance even in the absence of real-time feedback.<sup>170,172</sup> In Lyon et al, debriefing was associated with a marked improvement in flow-fraction (73.0%, 95% confidence interval (CI) 68.6-77.3 v 79.3%, 95% CI 76.9-81.8,  $p = 0.007$ ) and a reduction in time to first defibrillation (20.25 seconds (interquartile range (IQR) 15.5–25.5) v 13.5 seconds (IQR 2.2–22.0),  $p = 0.006$ ).<sup>296</sup> Equally, in Jiang et al, there was a significant reduction in median no-flow time per minute (11 seconds (IQR 3–28) v 7 seconds (IQR 2–19),  $p < 0.01$ ) and time delay to first chest compression (11 seconds (IQR 5-50) v 0 seconds (IQR 0-12),  $p = 0.01$ ).<sup>170</sup> The randomised controlled manikin study by Morgan et al that examined anaesthetist's management of intraoperative emergencies that resulted in cardiac arrest found performance improved significantly following a debriefing intervention, when compared with participants who did not receive debriefing.<sup>334</sup>

Four clinical studies demonstrated an association between the provision of debriefing and reduction in door-to-balloon time following myocardial infarction.<sup>341-344</sup> Of particular note is the cohort study by Bradley et al which incorporated data from 365 American hospitals in a multivariate model to show that debriefing reduced door-to-balloon time by 8.6 minutes (95% CI -13.6 to -3.6,  $p = 0.001$ ). In the three single-centre studies, results were more impressive with reported reduction in door-to-balloon ranging from 23 minutes in Lai et al to 53 minutes in Scholz et al.<sup>342,344</sup> A similar approach to Bradley et al was used by van Wijngaarden et al who reported that debriefing was associated with increased likelihood of thrombolysis administration (odds ratio (OR) 1.19, 95% CI 1.04 to 1.36) to acute stroke patients in The Netherlands.<sup>346</sup>

In trauma studies, providing debriefing was associated with a reduction in the time that patients spent in the emergency department prior to receiving definitive care,

particularly in the most critically injured patient group,<sup>109,349</sup> as well as improvements in the delivery of specific key trauma resuscitation interventions.<sup>109,339</sup> In Scherer et al, the initial debriefing intervention had no impact on care delivery, but when this was supplemented by videotape footage the performance of key interventions, such as airway assessment and recording of blood pressure, improved significantly.<sup>339</sup> O'Connor and Megargel focussed on trauma care in the pre-hospital setting and found that the implementation of a written feedback performance summary significantly reduced the incidence of prolonged trauma scene time from 24.8% to 1.4% ( $p < 0.001$ ) of cases.<sup>150</sup> Schramm et al and Goffman et al both also reported improvements in performance following the implementation of debriefing interventions in relation to sepsis bundle delivery in the clinical setting and correct use of shoulder dystocia manoeuvres in the simulation laboratory respectively.<sup>336,347</sup>

Six studies (1 clinical LOE3, 4 clinical LOE4, 1 manikin LOE4) found no association between debriefing and improved technical performance. In Nadler et al, debriefing was associated with a statistically significant deterioration in the mean score for neonatal resuscitation intubation performance between the first and second performance evaluation periods ( $3.20 \pm 1.05$  v  $2.48 \pm 0.91$ ,  $p = 0.01$ ).<sup>110</sup> However, there was no difference in performance in other areas of technical performance, such as providing warmth and maintaining airway patency. In the other five studies, debriefing was not associated with any effect on technical performance.

#### **4.4.8.4 Kirkpatrick level three: effect of debriefing on behaviour (non-technical performance)**

Of the eight studies (two clinical, six manikin) that evaluated the effect of debriefing on non-technical behaviour performance outcomes, four studies reported a positive effect with the remaining four reporting a neutral effect. In a clinical trauma study by Santora et al compliance with the leadership standard increased from 70% of cases in the early part of the case series to 90% in the latter part ( $p < 0.05$ ).<sup>338</sup> In the other clinical study by

Nadler et al, only one of the eleven outcomes ('was information sought?') improved significantly with two further outcomes showing a trend towards improvement, but there was no difference in relation to the remaining eight outcome measures.<sup>110</sup>

In the four randomised controlled manikin studies (LOE 1) that evaluated non-technical skill performance using the anaesthetists non-technical skills score, only Salvodelli et al found that debriefing provision, compared to a non-debriefing control group, improved non-technical performance.<sup>332</sup> In the other three studies, the debriefing intervention was associated with a statistically significant improvement of between 5% and 25%, but similar improvements were observed in the non-debriefing arms.<sup>107,333,334</sup> In both Goffman et al and Anderson et al, debriefing interventions were associated with significant improvements in communication and behavioural skills respectively.<sup>336,340</sup>

#### **4.4.8.5 Kirkpatrick level three: effect of debriefing on behaviour (combined technical and non-technical performance)**

Three manikin studies used a scoring system that incorporated both technical and non-technical performance components to evaluate performance. Of these studies, only the study by Goffman et al reported an improvement in performance.<sup>336</sup>

#### **4.4.8.6 Kirkpatrick level four: effect of debriefing on results**

Of the eight studies that included mortality as an endpoint, debriefing was associated with a reduction in mortality in two studies. In Edelson et al debriefing was associated with a statistically significant improvement in return of spontaneous circulation (ROSC) following in-hospital cardiac arrest (45% v 59%,  $p=0.03$ ), although this did not translate to an improvement in survival to hospital discharge.<sup>152</sup> In Townsend et al, where observed and expected mortalities in both the pre-debriefing and post-debriefing were compared, the debriefing intervention was associated with a statistically significant improvement in survival.<sup>349</sup> In the remaining six studies, no change in mortality or length of stay was observed following the introduction of debriefing.

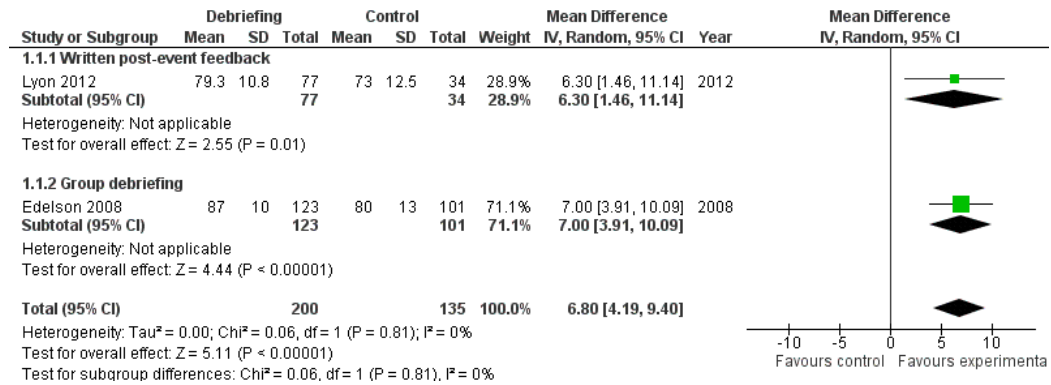
#### 4.4.9 Synthesis of results

A random effects meta-analysis of four clinical cardiac arrest studies was performed. Two of these studies delivered an oral debriefing intervention, and two provided written feedback. Chest compression flow-fraction data from two studies (335 events),<sup>152,172</sup> ROSC data from four studies (789 events),<sup>150,152,170,172</sup> and survival to hospital discharge data from three studies (365 events)<sup>152,170,172</sup> were analysed. Data from Jiang et al could not be included in the chest compression flow-fraction analysis as the study only reported results data as median and interquartile range.<sup>170</sup>

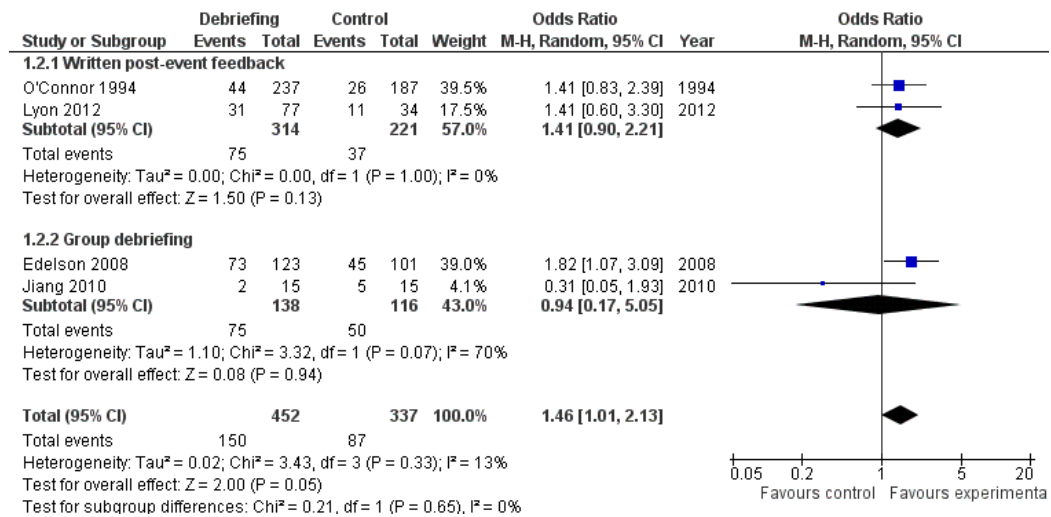
Debriefing was found to be associated with a statistically significant improvement in chest compression flow-fraction (mean difference 6.80, 95% CI 4.19 to 9.40,  $p < 0.001$ ) (Figure 4-3). A positive effect was also found in relation to return of spontaneous circulation (OR 1.46, 95% CI 1.01 to 2.13,  $p = 0.05$ ), but this did not translate in to an improvement in survival to hospital discharge (OR 0.80, 95% CI 0.38 to 1.67,  $p = 0.55$ ) (Figures 4-4 and 4-5).

Forest plots (Figures 4-3 to 4-5) incorporate a sub-group analysis comparing written feedback with oral debriefing. This analysis found no difference between the effect sizes for these different debriefing approaches, in relation to chest compression flow-fraction (written: mean difference 6.30, 95% CI 1.46-11.14 v oral: mean difference 7.00, 95% CI 3.91-10.09,  $p = 0.81$ ), ROSC (written: OR 1.41, 95% CI 0.90-2.21 v oral: OR 0.94, 95% CI 0.17-5.05,  $p = 0.65$ ) or survival to hospital discharge (written: OR 0.99, 95% CI 0.28-3.48 v oral: OR 0.71, 95% CI 0.28-1.77,  $p = 0.67$ ).

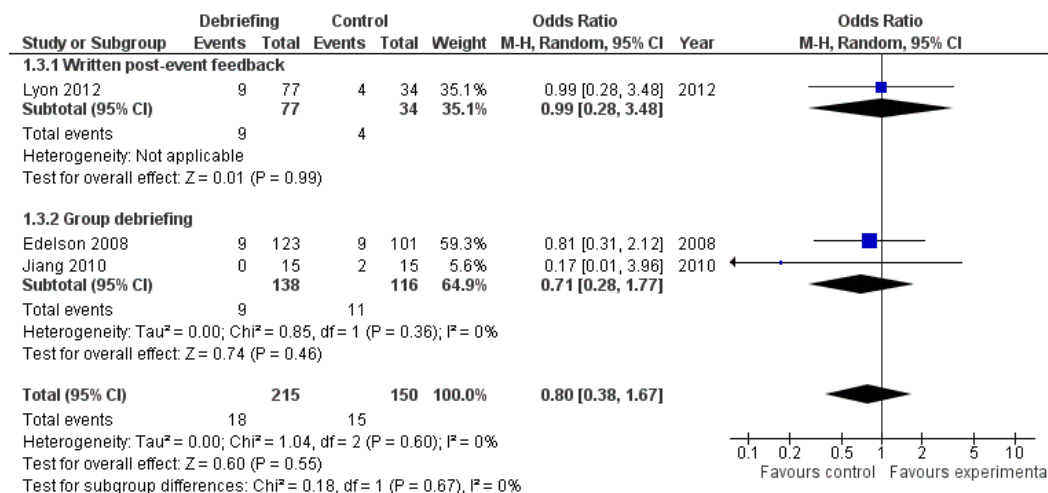
**Figure 4-3: Forest plot: debriefing v control (Cardiac arrest clinical studies), outcome: flow-fraction (%)**



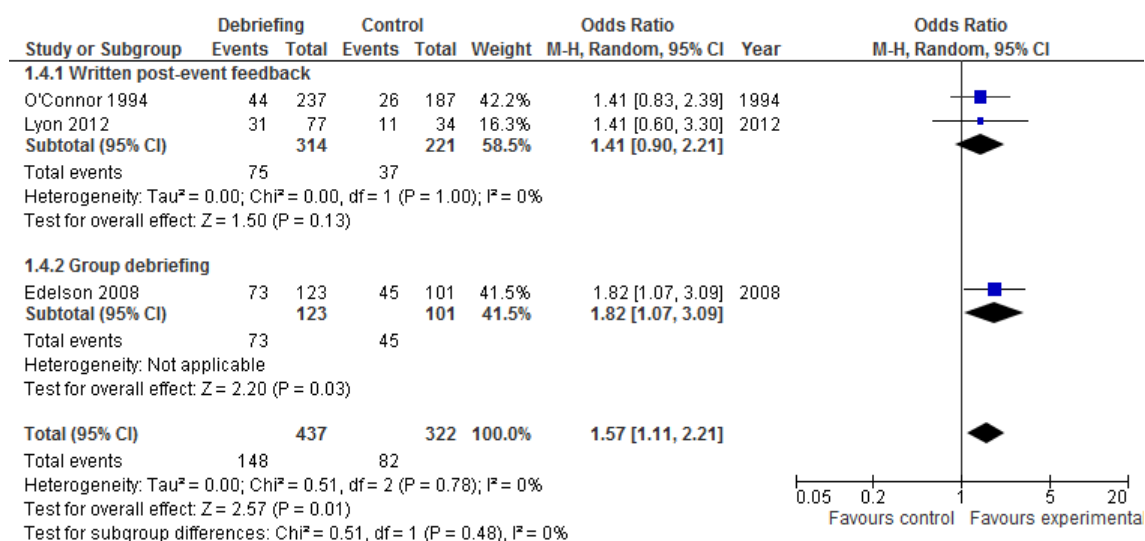
**Figure 4-4: Forest plot: debriefing v control (Cardiac arrest clinical studies), outcome: return of spontaneous circulation**



**Figure 4-5: Forest plot: debriefing v control (Cardiac arrest clinical studies), outcome: survival to discharge**



**Figure 4-6: Forest plot: debriefing v control (Cardiac arrest clinical studies), outcome: return of spontaneous circulation (excludes study by Jiang et al)**



#### **4.4.10 Risk of bias across studies**

For each outcome, except for Kirkpatrick Level III non-technical skills, initial evidence quality based on the GRADE system was categorised as low, due to the high number of non-randomised studies included in the review.

Three of these outcomes (Kirkpatrick Level I, Kirkpatrick Level III- combined technical and non-technical skills, and survival to discharge in cardiac arrest studies) were downgraded to the very low category. The Kirkpatrick Level I outcome was downgraded due to risk of bias. The Kirkpatrick level III combined technical and non-technical skills outcome was downgraded for indirectness. Survival to discharge in cardiac arrest studies was downgraded for imprecision. The remaining five outcomes (Kirkpatrick Level II, Kirkpatrick Level III technical performance, Kirkpatrick Level IV, chest compression flow-fraction in cardiac arrest studies, ROSC in cardiac arrest studies) were neither downgraded nor upgraded so remained as low quality evidence.

The Kirkpatrick Level III non-technical skills outcome was initially described as high quality evidence, but was downgraded to low quality evidence due to the risk of bias and indirectness.

GRADE tables for all outcomes are included in the appendix (Section 12.1.3).

#### **4.4.11 Additional analyses**

Amongst cardiac arrest studies included in meta-analyses, overall study heterogeneity was low. In the return of spontaneous circulation meta-analysis, there was substantial heterogeneity in the group debriefing sub-group ( $I^2=70\%$ ), although overall heterogeneity was low ( $I^2=8\%$ ). As a case series, Jiang et al was categorised as a level of evidence four study and therefore subject to a higher risk of bias compared with other studies in the meta-analysis.<sup>170</sup> Furthermore, its small sample size ( $n=45$ ) led to

wide confidence intervals. Excluding Jiang et al from the meta-analysis increased the effect size of debriefing in relation to ROSC (OR 1.57, 95% CI 1.11 to 2.21,  $p=0.01$ ) (Figure 4-6). A similar approach was not considered for the survival to discharge meta-analysis as reported heterogeneity was 0% for both within group differences and across all studies.

Further sub-group analyses were not undertaken. Poor methodological descriptions in studies meant that it was not possible to accurately categorise debriefing interventions in most studies, which precluded comparisons of different approaches to debriefing.

## **4.5 Discussion**

This review identified 27 studies addressing debriefing after a clinical emergency spanning a variety of settings. The overall quality of evidence of index studies was generally low. Of the 27 studies, 20 studies demonstrated benefit associated with debriefing at one or more outcome levels. This comprised evidence of a positive reaction to debriefing (three of four studies), improved learning (one of one studies), enhanced non-technical performance (four of eight studies), enhanced technical performance (16 of 22 studies), and improvement in patient-focussed outcomes (two of eight studies). Heterogeneity of clinical settings and styles of debriefing precluded formal meta-analysis for the majority of studies. Four studies examining CPR quality and patient outcomes were eligible for meta-analysis. This found evidence of improved CPR quality (chest compression flow-fraction mean difference 6.80, 95% CI: 4.19 to 9.40,  $p<0.001$ ) and short-term patient outcome (ROSC OR 1.46, 95% CI 1.01 to 2.13,  $p=0.05$ ), but no difference in long-term patient outcome (survival to discharge OR 0.80, 95% CI 0.38 to 1.67,  $p=0.55$ ).



The findings of this review are supported by other related studies. A Cochrane systematic review by Ivers and colleagues examined the effect of audit and feedback on professional practice in 140 clinical studies.<sup>119</sup> Due to inclusion criteria relating to study design, no clinical emergency studies were included. The review found that debriefing interventions were associated with small to moderate improvements in healthcare provider performance, and there was some evidence that this translated in to improved patient outcomes. Tannenbaum and Cerasoli examined the effect of debriefing on performance in 31 studies from a broad range of disciplines including healthcare emergencies, organisational development, and the military.<sup>103</sup> The authors concluded that debriefing improved performance by 20-25%, but methodological limitations around study identification methods and the pooling of data from diverse areas limits the generalisability of this result.

Although markedly different in its approach, inclusion criteria and data management, the work by Ivers et al provide some interesting insight in to the results of this review.<sup>119</sup> Through a meta-regression, Ivers et al identified several factors as being associated with increased feedback effectiveness, namely: poor baseline performance; feedback delivery in both written and oral formats; delivery on more than one occasion; delivery by a supervisor or colleague; and the inclusion of clear targets. In this review, the results of four of the six studies where debriefing was found to have no effect on technical performance, may be explained by these findings.

Specifically, good baseline performance was evident in studies Carbine et al, Santora et al, and Percarpio et al such that statistically significant improvements would have been difficult to achieve.<sup>169,338,348</sup> In Rawles et al, a low-intensity debriefing intervention was delivered where debriefing was provided twice over a two-year period by a member of the research team.<sup>345</sup> In the remaining two studies, other factors may explain study findings. In Anderson et al, the debriefing intervention was associated with a marked improvement in technical performance, but the small sample size (n=9)

meant that the study was likely underpowered to reliably detect statistically significant improvements.<sup>340</sup> In Nadler et al, important methodological limitations in relation to how data were collected and how care delivery was assessed makes it challenging to drawing meaningful conclusions from the study findings.<sup>110</sup>

In total, 35 debriefing interventions were described by studies included in this review. Despite marked differences in approach, each debriefing approach sought to improve care delivery by modifying clinician behaviour using an experiential learning approach. Kolb's cycle of experiential learning describes a process where event reflection and critical review are used to identify strategies to improve future performance.<sup>105</sup> In oral debriefing approaches the experiential learning process is guided by a facilitator, so it is fully integrated in the intervention. At the other extreme, clinicians independently complete this experiential learning process in written feedback approaches. In meta-analyses, sub-group analysis showed no difference between the effectiveness of these approaches. As such, a particular debriefing approach cannot be recommended and further research is required to identify the optimal debriefing method.

In our meta-analysis, favourable improvements in CPR quality and short-term patient outcomes did not translate to improved long-term outcomes. This may be due to CPR being a complex treatment comprising several separate but inter-related processes such that improvements in some outcomes may not impact upon long-term survival. Although the meta-analysis for survival to hospital discharge included information from 365 participants, it is likely that a much larger sample would be required to reliably demonstrate any change in long-term outcomes. Finally, debriefing interventions often focus on care delivery during the emergency, and may therefore neglect pre-emergency and post-emergency factors, that are also important determinants of patient outcome.<sup>18,19,52</sup>

## 4.6 Limitations

This review has several limitations. Firstly, the quality of index studies was generally low. This is reflected in evidence quality for each outcome being ranked, using the GRADE system, as low or very low. For clinical studies, study designs were typically subject to medium or high risk of bias. Five manikin randomised studies were included in the review. Such studies are useful for testing the potential efficacy of an intervention, but findings still need to be tested in clinical studies. This indirectness led to the downgrading of GRADE system evidence quality for two outcomes in this review.<sup>353</sup> There is a need for future clinical studies to adopt more robust methodological designs.

Secondly, significant study heterogeneity, due to the broad scope of this review, meant that it was not possible to pool data from the majority of studies. A wide variety of outcome measures were used, even within studies of the same clinical condition. Recent focus on developing outcome sets for clinical studies may address this issue.<sup>354</sup> However, a core outcome set covering the full spectrum of clinical emergencies will be difficult to produce. As the optimal debriefing method remains unclear, we had planned a comparison of debriefing methods. Although meta-analyses of clinical cardiac arrest studies compared oral debriefing with written feedback, lack of study detail prevented accurate classification of debriefing interventions in the majority of studies. This issue has been identified in the simulation literature, where a framework has been developed to standardise reporting of debriefing interventions.<sup>116</sup> This approach may, however, be usurped by the recent development of the TIDieR (template for intervention description and replication) framework, which provides a similar solution that can be applied to interventions in both clinical and manikin studies.<sup>227</sup> Where journal word limits restricts the inclusion of a full description of the intervention, the use of supplementary online materials provides an attractive solution.

Finally, this review may not reflect true clinical practice as studies were included only when the independent effect of the debriefing intervention could be identified. This was the main reason for the exclusion of 63 studies. At the Children's Hospital of Philadelphia, for example, debriefing is delivered alongside several other interventions to optimise CPR quality.<sup>42,112,355,356</sup> The desire to improve care delivery is understandable, particularly in the context of emergency care where improved performance is associated with patient survival. However, this approach fails to subject quality improvement interventions to the same rigorous evaluation demanded of other healthcare interventions.<sup>179</sup> Whilst this review has subjected debriefing to rigorous evaluation by attempting to identify the independent effect of the intervention, delivering debriefing alongside other quality improvement interventions in practice may enhance or reduce the effect size of the debriefing intervention. It is recommended that institutions that implement debriefing do so as part of a quality improvement programme where the intervention effect is monitored.

## **4.7 Conclusion**

This review supports the use of debriefing in clinical practice as a strategy to improve technical performance (Kirkpatrick Level III) at clinical emergencies. However, it is considered prudent to advocate that debriefing interventions be implemented as part of a quality improvement initiative where the effect of the intervention is monitored. The effect of debriefing on non-technical skills (Kirkpatrick Level III) and patient outcomes (Kirkpatrick Level IV) remains unclear. There remains a need for further high-quality research which seeks to identify the effect of debriefing on these outcomes, and which identifies the optimal method for debriefing delivery. Future research should consider the use of standardised outcome sets and contain a detailed description of any debriefing intervention to facilitate comparison with other studies and allow replication in other institutions.

## **4.8 Acknowledgements**

This systematic review is KC's own work. KC developed the review protocol, undertook database searches, assessed studies for eligibility, extracted study data, assessed studies for risk of bias, analysed data, wrote this chapter, and prepared the review for publication. However, the following individuals are acknowledged as making contributions to aspects of the review. Professor Judith Finn contributed to developing the data analysis plan and the preparation of the published manuscript. Dr Jasmeet Soar contributed to the design of the review protocol, the data analysis plan, and the preparation of the published manuscript. Dr Bilal Salman independently assessed the eligibility of studies for inclusion and the risk of bias, and contributed to the preparation of the published manuscript. Dr Chris Bridle contributed to the design of the review protocol. Ms Chharitha Veerapaneni acted as a second checker for data extraction.

## **Chapter 5: A process evaluation of weekly group cardiac arrest debriefing**

## 5.1 Abstract

**Introduction:** Cardiac arrest debriefing is associated with improvements in cardiopulmonary resuscitation (CPR) quality and return of spontaneous circulation. However, cardiac arrest debriefing studies often omit key details about the debriefing intervention in the study report, thereby limiting its uptake in practice. This process evaluation describes a weekly group debriefing cardiac arrest intervention, the context in which it was delivered and an evaluation of its delivery.

**Methods:** During the study period, weekly group cardiac arrest debriefing was delivered as part of the CPR Quality Improvement Initiative study at a large NHS teaching hospital. This process evaluation uses data from a core intervention delivery data set and two questionnaires. Questionnaires evaluated debriefing meeting attendee's immediate response to meetings and the effect of the intervention on self-reported knowledge, confidence, and clinical practice.

**Results:** Between November 2011 and May 2013, 74 debriefing meetings were held. These were attended by 323 clinicians on a total of 932 occasions. The mean attendance per meeting was  $13 \pm 5$ , with a median meeting attendance per clinician of one (interquartile range (IQR) 1-2). A median of two (IQR 1-2) cardiac arrests were reviewed at each meeting. There were nine debriefing meetings where no cardiac arrest suitable for discussion had taken place in the preceding week. Over the study period, 106 cardiac arrest events were reviewed at debriefing meetings. Of these, no member of the direct care team was present for 29 (35%) event reviews. Questionnaire respondents considered the meetings to be clinically relevant and reported that attendance had a positive effect on resuscitation knowledge and practice.

**Conclusion:** This process evaluation found that the debriefing intervention was deliverable in a large teaching hospital. Clinicians reported that the intervention was of educational value. We observed practical challenges such that intervention delivery may not be feasible in smaller NHS hospitals. There is a need to develop models of cardiac arrest debriefing that are better suited to the NHS setting.

## 5.2 Introduction

Each year, 85% of the \$100 billion worldwide healthcare research spend is wasted.<sup>211</sup>

A major contributor to this wastage is study reports that do not adequately describe interventions and their delivery, thereby preventing successful interventions being implemented in other organisations.<sup>210-217</sup> For example, an analysis of 133 trial reports published in six leading medical journals found that only 39% of interventions were adequately described.<sup>214</sup> Similarly, an analysis of National Institute of Health Research Health Technology Assessment studies found that less than a third of studies contained a complete description of the intervention.<sup>216</sup>

Cardiac arrest debriefing is a case in point. Despite evidence and international recommendations to support its use, surveys of American and Finnish hospitals suggest that the intervention is rarely used in practice.<sup>43,44,97,99,117</sup> Studies of cardiac arrest debriefing tend to be outcome-focussed, such that a full description of the intervention is rarely included in study reports. One study report of a weekly group cardiac arrest debriefing intervention summarised the intervention in just 71 words, such that key information on who delivered the intervention and the number of staff that received the intervention was omitted.<sup>170</sup>

Process evaluation is a technique to describe an intervention, the context in which it was delivered and how well it was delivered.<sup>205,206</sup> The aim of this process evaluation was to fulfil these goals in relation to the delivery of a weekly group cardiac arrest debriefing intervention. It was anticipated that these data would also provide pertinent information about the deliverability of this debriefing intervention in other hospitals and inform the development of alternative approaches to cardiac arrest debriefing.



## 5.3 Methods

This process evaluation uses data from questionnaires and a debriefing meeting core data set to evaluate the delivery of a weekly group cardiac arrest debriefing intervention in an NHS hospital. The weekly group debriefing intervention was delivered as part of the Cardiopulmonary Resuscitation (CPR) Quality Improvement Initiative study.<sup>180</sup>

The CPR Quality Improvement Initiative study was granted ethical approval by Coventry Research Ethics Committee on 26<sup>th</sup> June 2009 (REC reference: 09/H1210/65). Approval to undertake this ancillary work was granted by Heart of England NHS Foundation Trust Research and Development department on 25<sup>th</sup> April 2012. As a study involving only NHS staff, this study did not require further ethical review under current NHS research governance requirements.<sup>291</sup>

### 5.3.1 The CPR Quality Improvement Initiative study

The CPR Quality Improvement Initiative study was a prospective cohort study conducted across the three hospitals, which make up Heart of England NHS Foundation Trust.<sup>180</sup> The study consisted of two phases. During phase one (November 2009- November 2011), CPR quality and patient outcome data were collected at the three hospitals. In phase two (November 2011-May 2013), real-time audiovisual feedback was implemented at hospital two, whilst real-time audiovisual feedback supplemented by weekly group debriefing was implemented at hospital one. Hospital three remained as a control site throughout phase two of the study to allow for the estimation of any secular change in CPR quality or patient outcome. The primary study outcome was return of spontaneous circulation. The study did not incorporate a pre-planned process evaluation of the debriefing intervention.

The primary analysis used regression modelling to estimate the effect of each intervention on CPR quality and patient outcome. This analysis compared intervention

patients with control group patients (all phase one patients plus hospital three patients during phase two). Neither real-time audiovisual feedback nor real-time audiovisual feedback supplemented by cardiac arrest debriefing were found to be associated with any improvement in patient outcome or CPR quality. However, the magnitude of the improvements observed at hospital three during phase two of the study were such that they could not be attributed to an underlying secular trend. A secondary analysis, which was not defined *a priori*, examined differences across all hospitals between phases one and two of the study. This analysis identified evidence of statistically and clinically significant improvements in return of spontaneous circulation (adjusted odds ratio 1.87, 95% confidence interval (CI) 1.06-3.30,  $p=0.03$ ) and CPR quality (for example, chest compression flow-fraction, mean difference 5.91, 95% CI 3.17-8.64,  $p<0.001$ ). There was no effect on survival to hospital discharge or good neurological outcome. This finding was attributed to intervention contamination between intervention and control sites, leading to the improvements at hospital three during phase two of the study. In retrospect, this contamination was almost inevitable given that the hospital sites formed part of a single NHS Trust with rotation of clinical staff, such as the critical care outreach team, between sites.<sup>267</sup>

### **5.3.2 Intervention overview**

The weekly group debriefing intervention that was delivered was modelled on the Resuscitation with Actual Performance Integrated Debriefing (RAPID) intervention developed in Chicago.<sup>152</sup> A full description of the planned intervention, based on the TIDieR (template for intervention description and replication) framework, is provided in table 5-1.<sup>227</sup> In brief, a 45-minute meeting was held every Tuesday lunchtime on the acute medical unit at a large teaching hospital. Meetings incorporated a brief review of research surrounding a cardiac arrest topic followed by a review of two cardiac arrest cases that had taken place in the preceding week. Case reviews focussed on CPR quality. All interested clinical staff were eligible to attend. Personalised email invitations were sent to clinicians known to have attended the cardiac arrest events planned for

**Table 5-1: Overview of weekly group debriefing intervention**

Why	<p>Previous studies have found that cardiac arrest debriefing is associated with improvements in CPR quality and patient outcome.</p> <p>The aim of the intervention was to improve CPR quality through sharing of good practice and learning lessons from clinical events.</p>
What	<p><b>Materials</b></p> <p>Posters advertising debriefing meetings were placed in staff areas throughout the hospital. Members of the research team regularly attended medical handover meetings to remind attendees about meetings. Members of the direct care team known to have attended a cardiac arrest event scheduled for discussion were sent an email 1-4 days prior to the meeting inviting them to attend.</p> <p>The debriefing meeting included a discussion about cardiac arrest management. This was supplemented by a slide presentation (Microsoft PowerPoint 2007, Microsoft, Redmond, Washington) to show relevant data and potential discussion points. Example presentation slides are shown in the appendix (Section 12.2.1).</p> <p><b>Procedures</b></p> <p>Debriefing meetings consisted of four sections:</p> <ol style="list-style-type: none"> <li>1. Introduction- this section summarised the rationale for the research study and set ground rules (confidentiality/ no-blame environment).</li> <li>2. Review of relevant research- this section was included in most meetings. Key resuscitation literature was reviewed and discussed.</li> <li>3. Case review and discussion- recent cardiac arrest events were reviewed. Summaries included background to the arrest and patient characteristics, review of the arrest event and CPR quality data, and information on patient outcome. Patient details were anonymised. Clinicians who had been present at the cardiac arrest were invited to share their insight in to events. Other attendees participated in discussions to share their experiences. Cases were selected based on points of interest.</li> <li>4. Summary of key learning points- the final section consisted of a review of key learning points and provided a further opportunity to ask questions.</li> </ol>
Who provided	<p>Meetings were facilitated by nurses or doctors with a specialist interest in cardiac arrest management. They were either Advanced Life Support providers or instructors. Preparatory work for debriefings was undertaken by a resuscitation research nurse.</p>
How	<p>Group debriefing meetings were held on a weekly basis. Meetings lasted 45-minutes.</p>
Where	<p>The intervention was delivered at a large teaching hospital, with 703 beds. In 2013, there were 271 cardiac arrests which were attended by the hospital emergency team.</p> <p>Debriefing meetings were held in a seminar room located on the hospital acute medical unit. This was a central location on the hospital site. The room accommodated approximately 30 people and was equipped with a computer and audiovisual facilities to show presentation slides. The table and chairs were arranged in a horseshoe shape. Lunch was provided at each meeting.</p>
When and how much	<p>Meetings were open to all clinicians, including doctors, nurses, allied health professionals, and medical and nursing students. Meetings were held every Tuesday lunchtime.</p>
Tailoring	<p>Meetings were tailored on a weekly basis, depending on the cases being reviewed and the amount of discussion generated. This was a dynamic process, which sought to adapt to attendees' learning needs.</p>
Modifications	<p>During the first three-months of the study, an iterative approach was used to tailor intervention delivery, based on reactions from attendees. This tailoring principally focused on the way in which case reviews were presented.</p>
How well	<p><b>Planned:</b> A core data set was collected at each debriefing meeting.</p> <p><b>Actual:</b> See data in chapter.</p>

discussion. The aim of the intervention was to improve CPR quality through the sharing of good practice and learning of lessons from clinical events.

### **5.3.3 Debriefing meeting process data**

A core data set was collected for each weekly meeting. The data set recorded details of reviewed cardiac arrests events, meeting attendees, members of the direct care team present for the case review, key meeting themes, and facilitator details. We also estimated the time required to deliver the intervention based on our experiences during the study period.

### **5.3.4 Questionnaires**

Two paper-based questionnaires were developed. Questionnaire one evaluated meeting attendee's immediate response to debriefing meetings (Kirkpatrick level I), whilst questionnaire two examined the effect of attending meetings on self-reported knowledge, confidence and practice (Kirkpatrick level II/ III).<sup>201</sup> Copies of questionnaires are included in the appendix (Sections 12.2.2 and 12.2.3).

#### **5.3.4.1 Questionnaire content**

Draft questionnaires were developed based on systematic review findings and then pilot-tested by a convenience sample of clinicians from a variety of professional backgrounds. Questionnaires were duplex printed on A5 paper. Both questionnaires contained open, closed and attitude scale questions. Permitted responses to attitude scale questions ranged from 1 (strongly disagree) to 5 (strongly agree).

#### **5.3.4.2 Sampling and recruitment**

The questionnaires and their purpose were briefly introduced at the start of each debriefing meeting. Questionnaires were then distributed and meeting attendees were asked to complete questionnaires at the end of the meeting. Completed questionnaires

were left in the centre of the meeting room table to facilitate collection and to ensure that respondents could not be identified based on where they were seated.

Questionnaire one was distributed at each meeting to all attendees. Individuals were asked to complete a questionnaire for each meeting that they attended because the questionnaire examined the clinician's immediate response to the debriefing meeting which might vary each week depending on the facilitator and nature of discussion. Questionnaire two was completed by meeting attendees on one occasion only as it examined less fluid outcomes. The questionnaire was distributed at meetings in the final month of each junior doctor four-month rotation.

### **5.3.5 Data analysis**

Data were analysed using SPSS software (SPSS v22.0, IBM, New York, USA).

Nominal data are reported as frequency and percentage, and compared using the  $\chi^2$  test. Continuous data were assessed for normality. Normally distributed data are reported as mean and standard deviation and compared using the T-test. Data that are not normally distributed data are reported as median and interquartile range (IQR) and compared using the Mann-Whitney U test.

Questionnaire free-text responses were categorised using a coding frame. Responses were split in to individual statements, and each statement allocated a code. They were then coded independently by myself and a research assistant. Inter-rater reliability was calculated using the Krippendorff-alpha statistic, using a macro developed for SPSS computer software by Hayes and Krippendorff.<sup>241</sup> A Krippendorff-alpha level above 0.8 was deemed to represent an acceptable level of reliability.<sup>240,242</sup>

## **5.4 Results**

### **5.4.1 Overview of collected data**

#### **5.4.1.1 Process data**

Over the 80-week period between November 2011 and May 2013, 74 cardiac arrest debriefing meetings were held. Six meetings were cancelled due to: bank holidays (n=4), a hospital infection outbreak (n=1), and the August doctor changeover (n=1). Process data were collected for all meetings, except for some data on members of the direct care team present for the case review which was only routinely collected from May 2012.

#### **5.4.1.2 Questionnaires**

Between May 2012 and May 2013, questionnaire one was completed 375 times by debriefing meeting attendees. The response rate, calculated based on attendance at meetings where questionnaires were distributed, was 66%. Questionnaire two was distributed at three time points (July 2012, November 2012, and March 2013) and was completed by 49 clinicians. The response rate was 64%.

### **5.4.2 Debrief meeting process data**

#### **5.4.2.1 Debriefing meeting facilitator**

Eleven individuals facilitated the 74 debriefing meetings. Most meetings were facilitated by a resuscitation research nurse (n=56, 76%) with the remainder facilitated by three resuscitation officers (n=10, 14%), a registrar (n=1, 1%), five junior doctors (n=6, 8%) and a research assistant (n=1, 1%).

#### **5.4.2.2 Debriefing meeting attendees**

A total of 323 individuals, excluding meeting organisers, attended debriefing meetings making up 932 total attendances. The mean attendance per meeting was 13 (standard deviation= 5, range 3-24). Most clinicians attended a single debriefing meeting (n=208, 64%). Attendees were mainly junior doctors (n=113, 35%), healthcare students (n=61,

19%), and nurses (n=50, 15%) (Table 5-2). The median meeting attendance per person was 1 (IQR 1-2), but breakdown by professional group shows marked differences between groups. The group with the highest median number of attendances was, perhaps unsurprisingly, resuscitation officers (11 (IQR 1-36)), followed by critical care practitioners and critical care outreach nurses (2 (IQR 1-6)), and junior doctors (2 (IQR 1-4)).

**Table 5-2: Debriefing meeting attendance data by clinical group**

	Number of attendees- n(%)	Total number of attendances- n(%)	Attendances per person- median (IQR)
Consultant	17 (5%)	74 (8%)	1 (1-4)
Registrar	35 (11%)	68 (7%)	1 (1-2)
Junior doctor	113 (35%)	412 (44%)	2 (1-4)
Nurse	50 (15 %)	56 (6%)	1 (1-1)
CCP/ CCO Nurse	20 (6%)	85 (9%)	2 (1-6)
RO	7 (2%)	119 (13%)	11 (1-36)
Healthcare student	61 (19%)	66 (7%)	1 (1-1)
Other/ not stated	20 (6%)	52 (6%)	1 (1-4)
<b>Total</b>	<b>323 (100%)</b>	<b>932 (100%)</b>	<b>1 (1-2)</b>
CCP- Critical Care Practitioner; CCO- Critical Care Outreach; RO- Resuscitation Officer; IQR- interquartile range			

#### 5.4.2.3 Meeting topic

The meeting research topic focussed mainly on technical aspects of CPR delivery (n=34, 46%), such as chest compression depth (Table 5-3). Human factors (n=12, 16%) and underpinning knowledge (n=12, 16 %) also featured frequently. During September 2012, meeting topics were based around a Trust patient safety initiative, called “Safety September.”

**Table 5-3: Debriefing meeting themes**

<b>Theme</b>	<b>No. of meetings- n (%) N=74</b>
<b>Technical skills</b>	<b>34 (46%)</b>
Chest compression depth	8 (11%)
Chest compression rate	5 (7%)
Flow-fraction	5 (7%)
Perishock pause/ defibrillation	4 (5%)
Ventilation rate	4 (5%)
Tachy-/Brady-arrhythmias	4 (5%)
Chest compression leaning	3 (4%)
Airway management	1 (1%)
<b>Human factors</b>	<b>12 (16%)</b>
Cardiac arrest decision-making	5 (7%)
Team leadership	4 (5%)
Team dynamics/ composition	2 (3%)
Pre-briefing	1 (1%)
<b>Underpinning knowledge</b>	<b>12 (16%)</b>
Overview/ introduction to CPR quality	4 (5%)
Post-resuscitation care	4 (5%)
Reversible causes	2 (3%)
Cardiac arrest research	1 (1%)
Deviating from guidelines	1 (1%)
<b>Safety September meetings</b>	<b>4 (5%)</b>
Medication	1 (1%)
Surgery	1 (1%)
Sepsis	1 (1%)
Staff safety	1 (1%)
<b>No specific theme</b>	<b>12 (16%)</b>

#### 5.4.2.4 Cardiac arrest discussions

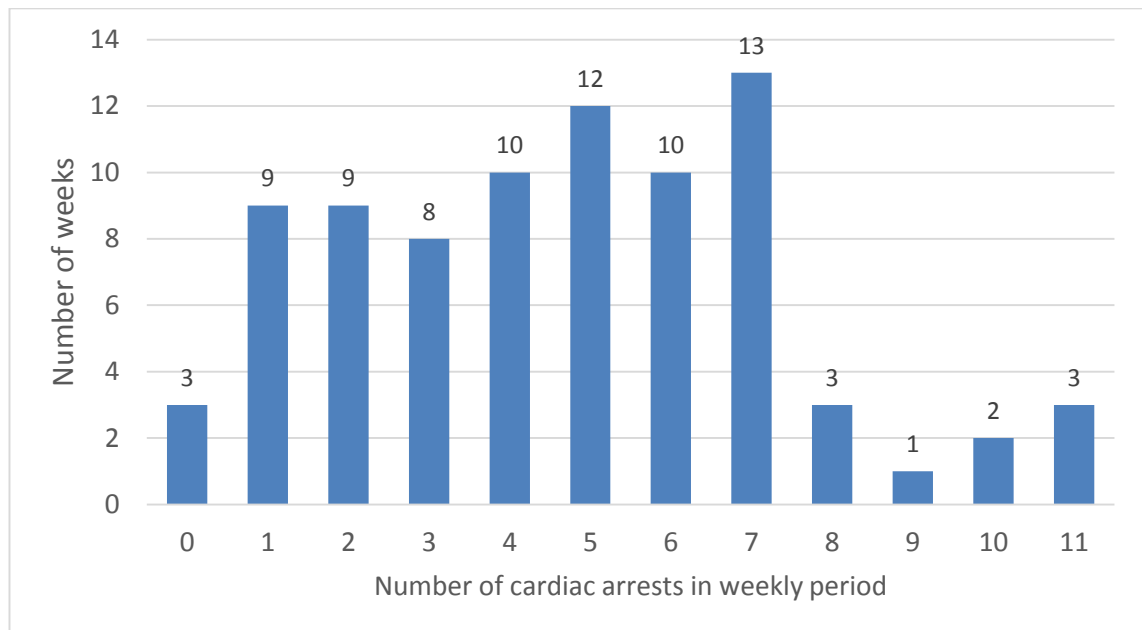
Debriefing meetings incorporated the review of cardiac arrest events attended by the hospital emergency team. Between November 2011 and May 2013, 388 cardiac arrest events occurred of which 106 (27%) were reviewed at debriefing meetings. The median number of arrests discussed per meeting was 2 (IQR 1-2, range 0-3).

During the study period, the mean number of cardiac arrests per week was 4.7 (standard deviation= 0.3). Figure 5-1 shows that during the study period there were 12 weeks when the weekly cardiac arrest incidence was less than two events. These data include brief cardiac arrests that were generally unsuitable for discussion. Overall, there were nine debriefing meetings where no cardiac arrest event suitable for discussion had taken place. At these meetings, discussion focussed on general



principles of cardiac arrest management. At a further 24 meetings a single cardiac arrest case was discussed.

**Figure 5-1: Bar chart for number of cardiac arrests per week**



We analysed the differences between the 106 cardiac arrest events that were reviewed and the 282 cases that were not reviewed (Table 5-4). Reviewed cardiac arrests lasted longer, and were less likely to be monitored or present with a shockable rhythm. CPR quality was similar between groups, but a greater proportion of discussed cardiac arrests resulted in death and poor neurological outcome.

#### 5.4.2.5 Cardiac arrest event attendees

Of the 106 cardiac arrests reviewed at debriefing meetings, data on whether the direct care team was present were available for 84 cases. A median of one (IQR 0-3, range 0-7) direct care team member was present for each arrest review, but no team member was present for 29 (35%) case reviews. Direct care team members who attended debriefing meetings were usually junior doctors (n=62, 46%), nurses (n=21, 16%), critical care practitioners or critical care outreach nurses (n=18, 13%), and resuscitation officers (n=16, 12%).

**Table 5-4: Comparison of discussed and non-discussed cardiac arrest events**

	<b>Arrest discussed (n=106)</b>	<b>Arrest not discussed (n=282)</b>	<b>P-value*</b>
<b>Patient demographics</b>			
Age- median (IQR)	77 (62-84)	74 (63-83)	0.40†
Male gender- n (%)	61 (57.5%)	176 (62.4%)	0.38
<b>Arrest characteristics</b>			
Out-of-hospital cardiac arrests	1 (0.9%)	6 (2.1%)	0.44
Cardiac arrest rhythm- n (%)			
VF	10 (9.4%)	37 (13.1%)	
VT	4 (3.8%)	22 (7.8%)	
PEA	61 (57.5%)	125 (44.3%)	
Asystole	31 (29.2%)	62 (22.0%)	
Unknown	0 (0%)	36 (12.8%)	<0.001
Arrest monitored- n (%)	39 (36.8%)	145 (51.4%)	0.01
Arrest witnessed- n (%)	67 (63.2%)	195 (69.1%)	0.27
Duration (mins)- median (IQR)	15 (9-24)	6 (2-19)	<0.001†
<b>CPR Quality (First five minutes)</b>			
CC Rate (/min)- mean ± SD	115.4 ± 10.4	115.4 ± 11.3	0.96‡
CC Depth (mm)- mean ± SD	53.9 ± 10.8	52.2 ± 9.8	0.34‡
Flow-fraction (%)- mean ± SD	84.9 ± 7.4	84.5 ± 6.3	0.69‡
Chest recoil (%)- median (IQR)	13.4 (4.3-21.7)	8.2 (3.7-18.2)	0.08†
<b>Patient outcomes</b>			
ROSC- n (%)	47 (46.1%)	152 (59.4%)	0.02
Survival to discharge- n (%)	11 (10.8%)	62 (24.2%)	0.004
Good neurological outcome (CPC 1/ 2)- n(%)	9 (8.8%)	58 (22.7%)	0.002
<p>*by chi-squared test unless stated; † by Mann-whitney U test; ‡ by independent sample T-test                      IQR- interquartile range; VF- ventricular fibrillation; VT- ventricular tachycardia; PEA- Pulseless electrical activity;                      CC- chest compression; SD- standard deviation; ROSC- return of spontaneous circulation; CPC- cerebral performance                      category</p> <p>Arrest duration data from 96 patients in discussed group and 244 patients from not discussed group                      CPR quality data from 84/83/84/77 patients in discussed group and 83/61/83/58 patients in non-discussed group for rate/                      depth/ flow-fraction/ recoil respectively                      Patient outcome data excludes out-of-hospital cardiac arrest patients and repeat events- 102 patients in discussed                      group and 256 in non-discussed group</p>			

### 5.4.3 Time demand

We estimated that it took approximately 36.5 hours per month to deliver the intervention, based on our experiences during the study period. This excludes the time used by clinicians to attend debriefing meetings. A break-down of time required for

individual processes is shown in table 5-5. These timings are standardised to a cardiac arrest incidence of ten events per month and presentation of two cases per week to facilitate comparison with approaches described in the Cardiopulmonary Resuscitation Debriefing study (chapter eight).

**Table 5-5: Estimate for time taken per month to deliver weekly group debriefing**

Process	Components	Hours per months*
Case identification	Review of cardiac arrest cases, downloading of defibrillator data, and initial review of data	4
Medical note review	Identify location of medical notes and review medical notes for relevant information	8
Case analysis	In-depth case analysis based on medical notes and defibrillator data	8
Review of research	Review of literature for relevant up-to-date information relevant to cardiac arrest	2
Creation of debrief information	Create presentation to show case information	10
Informing of clinicians	Advertise debriefing at medical handover; Identify and email clinicians that attended case identified for discussion inviting them to attend	3
Delivery of debriefing	Deliver intervention	1.5
<b>Total hours per month</b>		<b>36.5</b>

## 5.4.4 Questionnaire data

### 5.4.4.1 Questionnaire one

Of the 375 completed questionnaires, most were completed by junior doctors (n=178, 47%), resuscitation officers (n=44, 12%), and registrars (n=23, 6%) (Table 5-6). Less than a quarter of respondents (n=85, 23%) reported that they had attended one of the cardiac arrest events being discussed that week.

**Table 5-6: Questionnaire one: demographic details of questionnaire respondents**

Respondent professional group- n(%)	
Consultant	14 (4%)
Registrar	23 (6%)
Junior doctor	178 (47%)
Nurse	21 (6%)
CCP/ CCO Nurse	40 (11%)
RO	44 (12%)
Student (medical/ nursing)	30 (8%)
Other/ not stated	25 (7%)
Attended cardiac arrest- n (%)	85 (23%)

CCP- Critical Care Practitioner; CCO- Critical Care Outreach; RO- Resuscitation Officer; CA- Cardiac Arrest

Attitude scale questions were answered in 373 questionnaires (Table 5-7). Most respondents agreed or strongly agreed that debriefing meetings were relevant to clinical practice (n=364, 98%), that they felt comfortable contributing to discussions (n=337, 90%), and that they would recommend meetings to others (n=368, 99%).

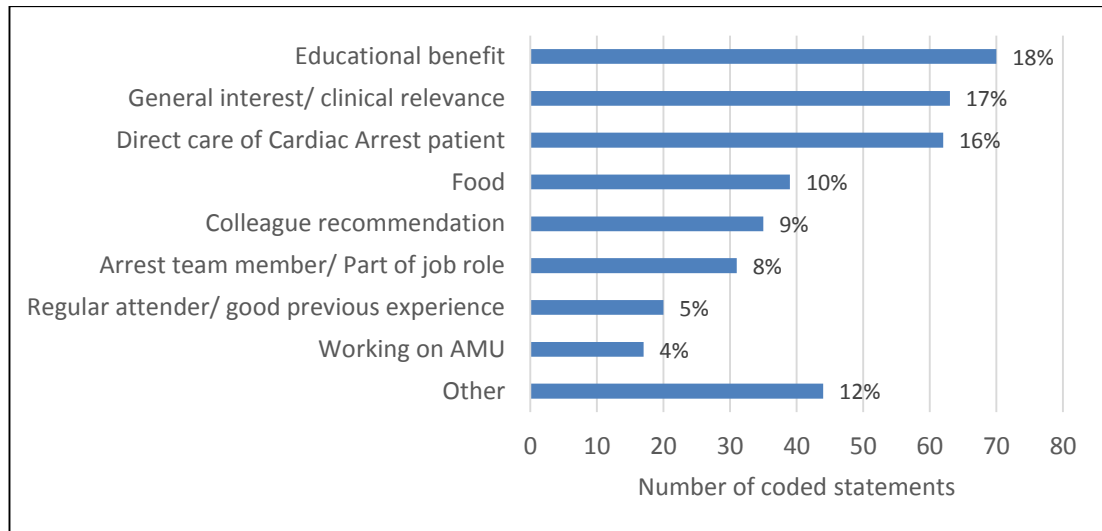
**Table 5-7: Questionnaire one: ordinal attitude scale responses**

	Response frequency- n(%)					MD (IQR)
	1	2	3	4	5	
The meeting was relevant to my practice	1 (0%)	4 (1%)	4 (1%)	122 (33%)	242 (65%)	5 (4-5)
I felt comfortable contributing to discussions	1 (0%)	4 (1%)	31 (8%)	112 (30%)	225 (60%)	5 (4-5)
I would recommend these meetings to others	1 (0%)	0 (0%)	4 (1%)	107 (29%)	261 (70%)	5 (4-5)

Key: 1- Strongly disagree; 2- disagree; 3- neutral; 4- agree; 5- strongly agree; MD- Median; IQR- Interquartile range

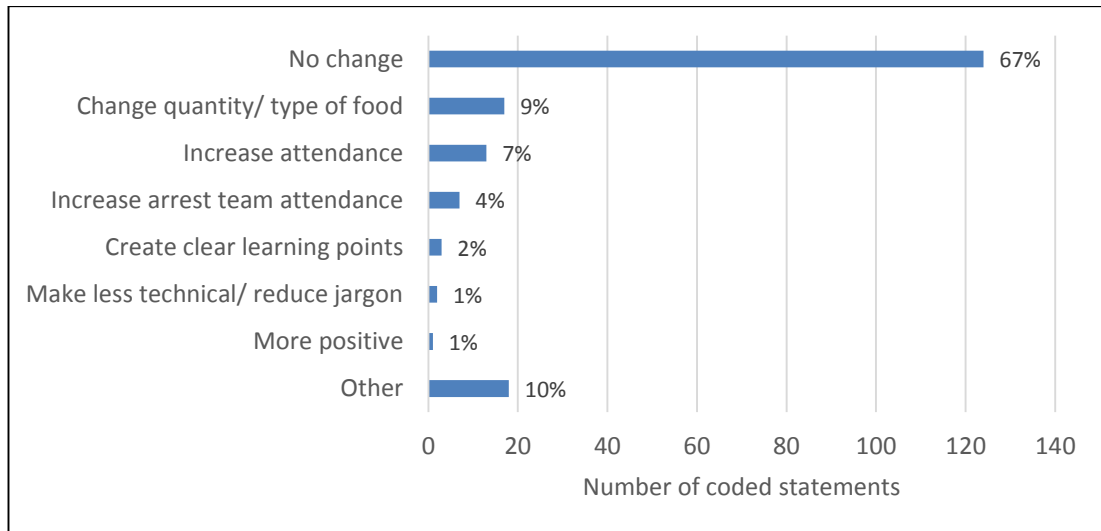
Respondents provided their reason for attending debriefing meetings in 315 questionnaires which generated 381 codes (Figure 5-2). The coding frame (appendix: section 12.2.4) showed a high level of inter-rater reliability (Krippendorff-alpha 0.93). The most commonly cited reasons for attending debriefing meetings were educational benefit (n=70, 18%), general interest (n=63, 17%), clinical relevance (n=63, 17%), and involvement at the cardiac arrest scheduled for discussion (n=62, 16%). The provision of food was also regularly mentioned (n=39, 10%).

**Figure 5-2: Questionnaire one: reason for attendance (381 statements coded from 315 questionnaires)**



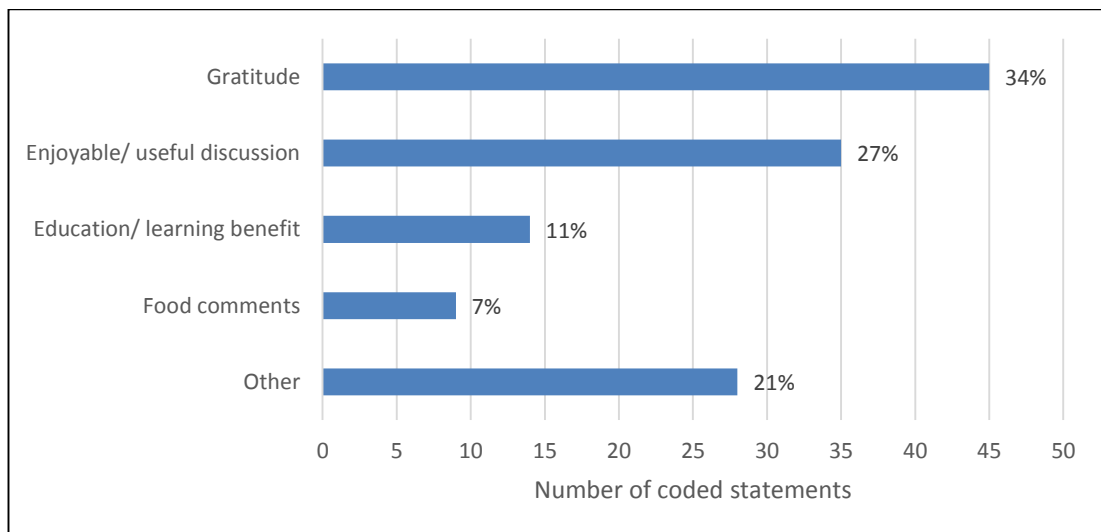
In 178 questionnaires respondents answered the question, 'is there anything you would change about these meetings,' leading to the generation of 185 coded statements (Figure 5-3). The coding frame (appendix: section 12.2.4) showed a high level of inter-rater reliability (Krippendorff-alpha 0.97). Most respondents (n=124, 67%) stated that nothing needed to be changed. Other responses mentioned changing the quantity or type of food (n=17, 9%) and increasing attendance, both generally (n= 13, 4%) and specifically from the direct care team (n=7, 4%). A small number of responses suggested making changes to meeting content, including the need to identify key learning points (n=3, 2%), to reduce the use of technical terms (n=2, 1%), and to reduce negativity (n=1, 1%).

**Figure 5-3: Questionnaire one: anything you would change (185 statements coded from 178 questionnaires)**



Respondents recorded other comments in 90 questionnaires, generating 131 coded statements (Figure 5-4). The coding frame (appendix: section 12.2.4) demonstrated a high level of inter-rater reliability (Krippendorff-alpha 0.86). Responses typically reflected gratitude (n=45, 34%) or an enjoyable or useful discussion (n=35, 27%). A small number of responses referred to the provision of food (n=9, 7%).

**Figure 5-4: Questionnaire one: other comments (131 statements coded from 90 questionnaires)**



#### 5.4.4.2 Questionnaire two

Of the 49 responses to questionnaire two, most were completed by junior doctors (n=29, 59%), and critical care practitioners or critical care outreach nurses (n=8, 16%) (Table 5-8). No questionnaires were completed by either nurses or those in the other/ not stated group. Respondents reported that they had attended a median of two (IQR 0-3) cardiac arrests and four (IQR 2-6) debriefing meetings in the month and four-months preceding questionnaire completion respectively.

**Table 5-8: Questionnaire two: demographic details of questionnaire respondents**

Respondent professional group- n(%)	
Consultant	2 (4%)
Registrar	4 (8%)
Junior doctor	29 (59%)
CCP/ CCO Nurse	8 (16%)
RO	3 (6%)
Student (medical/ nursing)	3 (6%)
CA attended in last month- median (IQR)	2 (0-3)
Debrief meetings attended in last 4-months- median (IQR)	4 (2-6)
CCP- Critical Care Practitioner; CCO- Critical Care Outreach; RO- Resuscitation Officer; CA- Cardiac Arrest; IQR- interquartile range	

All respondents answered ordinal attitude scale questions, although one respondent marked the question relating to team leadership as not applicable (Table 5-9). Most respondents agreed or strongly agreed that their attendance at debriefing meetings had led to an improvement in their cardiac arrest guideline knowledge (n=43, 88%), underpinning knowledge (n=42, 86%), confidence as a member of a cardiac arrest team (n=36, 73%), confidence as a team leader (n=32, 67%), and clinical practice (n=38, 78%).

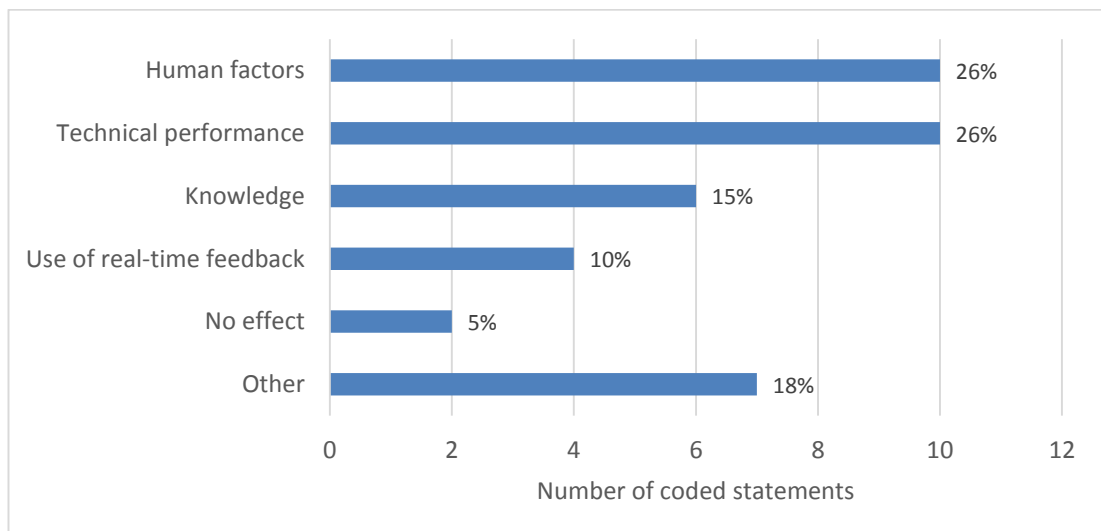
**Table 5-9: Questionnaire two: ordinal attitude scale responses**

	Response frequency- n(%)					MD (IQR)
	1	2	3	4	5	
My knowledge of resuscitation guidelines has improved	0 (0%)	0 (0%)	6 (12%)	25 (51%)	18 (37%)	4 (4-5)
My underpinning knowledge in relation to CA management has improved	0 (0%)	1 (2%)	6 (12%)	19 (39%)	23 (47%)	4 (4-5)
I am more confident in participating in CA	0 (0%)	0 (0%)	13 (27%)	17 (35%)	19 (39%)	4 (3-5)
I am more confident in leading CA*	0 (0%)	1 (2%)	15 (31%)	19 (39%)	13 (27%)	4 (3-5)
My clinical practice in relation to CA has improved	0 (0%)	0 (0%)	11 (22%)	22 (45%)	16 (33%)	4 (4-5)

Key: CA- Cardiac arrest; 1- Strongly disagree; 2- disagree; 3- neutral; 4- agree; 5- strongly agree; MD- Median; IQR- Interquartile range  
 \*- 48 responses (1 answer marked not applicable)

Twenty-four respondents entered free-text answers in relation to the effect of debriefing on practice which generated 39 codes (Figure 5-5). The coding frame (appendix: section 12.2.5) demonstrated a high level of inter-rater reliability (Krippendorff-alpha 0.94). Respondents described how the meetings improved their technical skills (n=10, 26%), human factors (n=10, 26%), knowledge (n=6, 15%) and use of the real-time audiovisual feedback technology (n=4, 10%). Two respondents stated the meetings had no effect on their practice (n=2, 5%).

**Figure 5-5: Questionnaire two: effect on performance (39 statements coded from 24 questionnaires)**





## 5.5 Discussion

This process evaluation describes a weekly group cardiac arrest debriefing intervention, the context in which it was delivered, and has evaluated how well it was delivered. Carroll et al model provides a framework for evaluating the delivery of an intervention.<sup>226</sup> The two main components of the model are adherence and potential moderators. Adherence assesses the 'dose' of the intervention that was actually delivered. Potential moderators are factors that may impact on the effectiveness of the intervention.

In relation to adherence, process data show that between November 2011 and May 2013, 74 debriefing meetings were delivered, which were attended by 323 clinicians who made up a total of 932 attendances. Questionnaire responses showed that clinicians viewed the intervention positively. However, intervention delivery was resource-intensive, such that we estimated that delivery of meetings required approximately 36.5 hours per month. Whilst the intervention was delivered broadly as planned, we faced two key challenges. Firstly, variability in cardiac arrest incidence meant that almost half the time there were less than two suitable cardiac arrest events available for discussion at meetings. Secondly, members of the cardiac arrest direct care team were often unable to attend the debriefing meeting where that cardiac arrest was discussed.

The review of cardiac arrest events was considered a key component of the intervention. It provided an opportunity to use actual events to identify challenges which impeded the delivery of high-quality CPR and, through discussion, identify possible solutions to these challenges. This is similar to the concept of case-based learning which is used frequently in health education.<sup>357</sup> The intervention was delivered in a large teaching hospital with over 250 cardiac arrests per year. Despite this, there were

33 (44.6%) meetings where there were less than two cardiac arrest events suitable for discussion. Of these, there were nine weeks where no cardiac arrest events were suitable for discussion. Data from the National Confidential Enquiry into Patient Outcome and Death report on in-hospital cardiac arrest shows that the incidence at the study hospital is in the top 15% of UK hospitals, such that this issue will present an even greater challenge in many other NHS organisations.<sup>32</sup>

Attendance at debriefing meetings by the direct care team was considered important as it provided the team with direct feedback on their performance and allowed others to hear their personal story of the cardiac arrest. However, despite debriefing meetings being well attended overall, there was often no member of the direct care team present. Using the case history and CPR quality data it was still possible to discuss the case, but insight in to the event was often limited. Attending debriefing meetings may have been challenging for many clinicians due to NHS shift patterns and clinical workload.<sup>358</sup> Indeed, the professional group with the highest median debriefing attendance was resuscitation officers (median attendance 11 meetings, IQR 1-36). Aside from a specialist interest in cardiac arrest, this likely reflects, in contrast to other groups, an office hours working pattern and the absence of fixed clinical commitments. To tackle this issue, Nadler et al held debriefing meetings several times per day.<sup>110</sup> However, this does not offer a pragmatic solution as it considerably increases facilitator workload and likely reduces the number of clinicians at each meeting, thereby limiting discussion.

The key potential moderators relevant to this study were quality of delivery and participant responsiveness. Quality of delivery describes how well the intervention was delivered. Tools for assessing debriefing facilitation have been developed in the simulation setting, but these are not generalisable to the clinical setting, so there is currently no direct objective way to measure the quality of clinical debriefing facilitation.<sup>359,360</sup> Informal feedback was regularly provided to facilitators by colleagues

and this was used to tailor the intervention over the first few months. Questionnaire data suggest that most respondents were satisfied with delivery. When asked in questionnaires if they would change anything about the meetings, a small number suggested a need for change in relation to food provision or attendance, and a single person stated that meetings were too negative in tone. Overall, most respondents did not feel that there was a need for any change to debriefing meetings.

Participant responsiveness describes how participants regard the intervention. Overall this was extremely positive with most questionnaire respondents reporting that the meetings were clinically relevant and that they would recommend them to colleagues. Indeed, colleague recommendation was often cited as a reason for attending the meetings. Meetings focussed on CPR quality and the process of care delivery as this is a direct result of team performance.<sup>162</sup> Nevertheless, the significant difference in patient outcome between cardiac arrest events selected for discussion and those not selected was a cause for concern. It was recognised that this could give clinicians an inaccurate impression of outcome following in-hospital cardiac arrest events, given that in previous studies clinicians have reported concerns regarding the perceived futility of some in-hospital cardiac arrest events.<sup>154,361</sup> However, this likely reflects the process used to select cardiac arrest events, which prioritised cardiac arrest events with points of interest for discussion. Furthermore, clinicians did not express any concern in questionnaire responses.

As the first formal process evaluation of a cardiac arrest debriefing intervention, comparison with other studies is challenging. Intervention delivery data have been reported in previous studies, but key details are often omitted. For example, Edelson et al report that 6-10 medical trainees attended debriefing meetings each week and conducted a questionnaire where respondents described the intervention as useful and reported improvements in knowledge and skill.<sup>152</sup> However, the study report does not detail how many different trainees actually attended or how many debriefing meetings

were actually held. Zebuhr et al provide a more detailed overview of their cardiac arrest debriefing intervention.<sup>112</sup> They include details on the number of meetings held (six over a 12-month period), the total number of clinicians that attended (n=50), the number of meetings attended per individual (median two), and provide questionnaire data on the relative importance of different components of the intervention. Nevertheless, important data are not reported, such as the number of direct care team members present at debriefing meetings or the average number of attendees at each meeting. This second item was particularly relevant given that the paper reports that one debrief meeting attendee expressed concern that the large number of attendees stifled discussion. Interestingly, the information (mean 25 attendees per meeting) was shared in a subsequent publication by the group.<sup>111</sup> In future studies, there is a need for studies to provide a full description of the debriefing intervention and include details of its delivery in practice.

## **5.6 Limitations**

This process evaluation has two main limitations. Firstly, the process evaluation was not defined in advance such that data were not systematically collected from the start of the study. This problem has been described previously in relation to published process evaluations.<sup>205,224</sup> In this study, all data items were only collected systematically once the intervention had been ongoing for six months. Whilst some data could be collected retrospectively, other data, such as questionnaires, were not available for the period November 2011 to May 2012. During this six-month period, the intervention was developed iteratively. This did not lead to substantial changes, but it is unknown whether survey responses in this early period would have differed significantly from those collected after May 2012.

Secondly, response rates for questionnaires one and two were 66% and 64% respectively. A high response rate is necessary to minimise the risk of non-response

bias.<sup>228</sup> A response rate between 60% and 70% has been described as acceptable, although clinician surveys frequently do not achieve this target.<sup>317,362-364</sup> Maximising response rate was a key consideration throughout the questionnaire design process, leading to the decision to use a short paper-based survey that could be completed quickly by respondents at the meeting.<sup>228</sup> Our questionnaire response rate was similar to that reported by Zebuhr et al (68%) in their cardiac arrest debriefing internet survey study.<sup>112</sup> The denominator used for reported response rates is the number of clinicians present at meetings where questionnaires were distributed.<sup>228</sup> Use of an alternative denominator, such as the total number of attendees at all meetings, would substantially reduce the quoted response rates.

## **5.7 Conclusion**

This process evaluation of weekly group cardiac arrest debriefing found that it was possible to deliver weekly group cardiac arrest debriefing in a large teaching hospital, and clinicians reported that the intervention was relevant and of educational value. However, there were important practical challenges associated with the delivery of the intervention, principally variability in cardiac arrest incidence meaning that in some weeks no cardiac arrests were available for review and clinician working patterns that meant the direct care team was often unable to attend debriefing meetings. Despite these challenges, the CPR Quality Improvement Initiative found that the intervention contributed to a system-wide improvement in CPR quality and return of spontaneous circulation. These data suggest that implementation of the intervention is unlikely to be feasible in other NHS hospitals, particularly smaller hospitals with a lower incidence of cardiac arrest. There is a need to develop models of cardiac arrest debriefing that are better suited to the NHS setting.

## **5.8 Acknowledgements**

KC undertook this study. Mehboob Chilwan is acknowledged as acting as the second coder for free-text questionnaire responses.

## **Chapter 6: “Getting resus at the forefront”: a qualitative study of the mechanisms of cardiac arrest debriefing**

## 6.1 Abstract

**Introduction:** Debriefing has been proposed as a strategy to improve the delivery of cardiac arrest care, but previous studies have predominantly focussed on clinical outcomes. Clinician perceptions of debriefing and the mechanisms by which debriefing affects practice have not previously been described. The aim of this study was to develop an understanding of how clinicians perceive debriefing and the mechanisms by which debriefing affects practice.

**Methods:** Tape-recorded semi-structured interviews were undertaken with a purposive sample of clinicians, stratified for professional role, who had experience of cardiac arrest debriefing. Field notes of debriefing meetings and other events during the study period were also collected.

**Results:** Thirteen semi-structured interviews and 41 sets of field notes were thematically analysed. Four themes emerged from the data, namely: 'the impracticality of debriefing,' 'the individual and feedback- managing the 'ego',' 'finding solutions through discussion,' and 'a change in culture: the effect of cardiac arrest debriefing.' These themes were used to develop a model that describes six mechanisms through which debriefing may have an effect on practice. These mechanisms work through two modalities, discussion with colleagues with similar experiences and feedback on performance to cardiac arrest attendees. These modalities should be underpinned by a no-blame culture

**Conclusion:** Cardiac arrest debriefing is a complex intervention that affects cardiac arrest performance through six distinct mechanisms via two key modalities. Different debriefing approaches may affect modalities to varying extents. This may alter the effectiveness of different debriefing approaches. Further research is needed to compare the effectiveness of different debriefing approaches.



## 6.2 Introduction

The purpose of debriefing in both the simulation and clinical setting is to review team and individual care delivery, with a view to improving care delivery at future events.<sup>162</sup> However, there are key differences between debriefing in the clinical and simulation setting, which likely impact on how debriefing affects practice. In the simulation laboratory, participants usually take part in a scenario that is immediately followed by a group debrief, which is supplemented by video footage and facilitator observations. In this context, the mechanism by which debriefing affects practice is theoretically grounded in notions of learning from reflection and experience.<sup>105,106</sup>

In contrast, debriefing in the clinical setting may be delivered in a number of ways.<sup>164</sup> Key differences between debriefing approaches include: proximity of the debrief to the event, use of external facilitation and objective data, and the inclusion of clinicians not present at the event. The use of these different approaches in published studies is seemingly driven by local context and resources, rather than a clear theoretical underpinning.<sup>115,164</sup> In part, this is a symptom of ongoing uncertainty regarding the optimal debriefing approach.

The heterogeneity of clinical debriefing approaches makes it impossible to generalise debriefing mechanisms from the simulation to the clinical setting. For example, in debriefing approaches where all interested clinicians are invited to attend, the concept of learning from reflection may apply to clinicians that attended the event being discussed, but cannot be readily extended to clinicians that did not attend.<sup>112,152</sup> As a result, cardiac arrest debriefing in the clinical setting may be considered a complex intervention, that likely affects practice through several distinct mechanisms.<sup>181</sup>

This concept of cardiac arrest debriefing as a complex intervention is supported by a recent qualitative study that examined the effect of performance measurement and feedback on practice in American hospitals.<sup>365</sup> The study found that performance

measurement and feedback was associated with unexpected ancillary benefits, such as organisational pride in high-performing organisations and improved staff education. Equally, however, debriefing may have negative consequences. A large systematic review found that feedback may sometimes be associated with a deterioration in performance.<sup>120</sup>

Realist theory describes how the effectiveness ('the outcome') of a complex intervention, such as cardiac arrest debriefing, is determined by both where it is undertaken ('the context') and the way in which it works ('the mechanism').<sup>366</sup> Understanding these factors is key to developing effective interventions. To date, however, the ways in which cardiac arrest debriefing leads to improved care delivery and how debriefing is perceived by clinicians have not been researched. The aim of this study was to elicit clinicians' experiences of the weekly cardiac arrest group debriefing intervention that was delivered as part of the Cardiopulmonary Resuscitation (CPR) Quality Improvement Initiative study and to develop an understanding of the mechanisms by which debriefing may affect practice.

## **6.3 Methods**

### **6.3.1 Management and governance**

The study was carried out at Heartlands Hospital, a large teaching hospital in Birmingham that forms part of Heart of England NHS Foundation Trust. It was undertaken as part of a PhD in Health Sciences that is examining the use of debriefing following cardiac arrest.

The CPR Quality Improvement Initiative study was a prospective cohort study, evaluating the effect of real-time audiovisual feedback technology and group cardiac arrest debriefing on CPR quality at an NHS Trust.<sup>180</sup> During the second phase of the study, weekly cardiac arrest debriefing meetings, based on the approach developed by Edelson et al, were held at Birmingham Heartlands Hospital.<sup>152</sup> In total, 74 meetings

were held between November 2011 and May 2013. All interested clinicians were invited to attend with a specific email invitation being sent to clinical staff that had had direct clinical input in to the cardiac arrest event scheduled for discussion. I facilitated most meetings with support from hospital resuscitation officers and doctors during periods of absence. A description and process evaluation of the intervention is included as chapter five of this thesis.

This study was a sub-study of the CPR Quality Improvement Initiative, which was approved by the Coventry Research Ethics Committee on 26<sup>th</sup> June 2009 (REC reference: 09/H1210/65). It is reported in accordance with the consolidated criteria for reporting qualitative research (COREQ) framework.<sup>367</sup>

### **6.3.2 Study design**

This study generated data from two sources: semi-structured interviews and field notes.

#### **6.3.2.1 Semi-structured interviews**

The study recruited clinicians that participated in a debriefing meeting following their attendance at a cardiac arrest and who were willing to be interviewed within three months of the meeting.<sup>368</sup> The sample was stratified by professional role, namely: doctor, resuscitation officer, critical care outreach nurse, critical care practitioner, and ward nurse. This approach was selected to ensure representation from the five professional groups that normally deliver care at in-hospital cardiac arrests and to ensure that participants had knowledge and experience of the phenomena being studied.<sup>246-248</sup>

Potential participants were approached based on their engagement with the debriefing process. This was judged based on how often they attended meetings and willingness to participate in discussions. They were approached following debriefing meetings and

offered a brief explanation of the study and a study information sheet. After obtaining written informed consent, a tape-recorded interview was undertaken by myself in a private room in the hospital at a mutually convenient time.

An interview schedule (appendix: section 12.3) was developed that sought to explore: participant's exposure to cardiac arrest debriefing and their perceptions of debriefing; its perceived effect on performance; elements of the debriefing process that were considered most important; and attitudes to other debriefing approaches. The interview schedule was adapted during the interviewing process using an iterative process. The semi-structured approach facilitated comparison of question responses. During the interview, non-scripted follow-up questions were used to seek clarification on answers and elicit further information about points raised by the interviewee.

The first minute of each interview consisted of an introduction that reiterated the study purpose, estimated interview duration, interview confidentiality, and use of quotes in outputs. It was stated that I was undertaking the interview as a researcher and the interviewee was encouraged to ignore my personal association with the cardiac arrest debriefing meetings when responding to questions.

Interviews were tape-recorded and then transcribed verbatim by a transcriber. As agreed with participants, transcriptions referred to participants by their professional role and study identification number to preserve anonymity. Transcriptions were standardised, based on the approach described by McLellan et al, such that the naturalness of the participant's language was preserved.<sup>369</sup> Transcriptions were checked by myself against the audio recordings and any transcription errors corrected. It was planned to continue interviews until data saturation was achieved, which was predicted to require approximately 15 interviews, with the aim of recruiting three participants per professional group.<sup>246,247</sup>

### 6.3.2.2 Field notes

I made field notes of key events during the study period. These were anonymised at the point of transcription by referring to clinicians only by their professional role in the text. Two types of field note were collected. Firstly, I collected field notes of weekly cardiac arrest debriefing meetings between November 2011 and February 2013. These included details of the setting-up of the meeting, the topics discussed, and reflections on the debriefing meeting process. A research assistant attended eight debriefing meetings and made a contemporaneous note of discussions, which were used as an aide memoir in creating a field note for those meetings. Secondly, I recorded notes of naturally occurring informal conversations with clinicians about the debriefing process, particularly those clinicians that did not attend debriefing meetings.

All field notes were produced as soon as possible after the event.

### 6.3.3 Data analysis

Audio-recording of interviews and interview and field note transcriptions were inputted in to NVivo computer software (NVivo Version 10, QSR International, Victoria, Australia). The use of computer software improved coding consistency and increased speed of analysis through the use of search facilities and other software tools.<sup>370,371</sup> Data were thematically analysed. Thematic analysis is a flexible analytical approach that aims to draw out the implicit and explicit patterns in data.<sup>238,252</sup>

The analysis was an exploratory data-driven process that followed the six-stage approach described by Braun and Clarke, as summarised in Table 6-1.<sup>238,252</sup>

Throughout the analytical process, regular meetings were held with supervisors to discuss data coding and theme generation.

**Table 6-1: Thematic analysis process**

Stage one	Familiarizing yourself with your data
Stage two	Generating initial codes
Stage three	Searching for themes
Stage four	Reviewing themes
Stage five	Defining and naming themes
Stage six	Producing the report

From Braun and Clarke<sup>238</sup>

During the first stage of the process, data immersion was achieved through a process of repeated listening to audio recordings and reading of transcribed data. Initial coding of semi-structured interviews was undertaken during phase two. This process is described by Charmaz as, “naming segments of data with a label that simultaneously categorises, summarises, and accounts for each piece of data.”<sup>372</sup> This initial coding represented a shift to beginning the process of interpreting data.<sup>372</sup> The initial coding frame was developed through the coding of semi-structured interview transcripts, and then explored and tested by applying it to field note data through a process of constant comparison.<sup>373</sup>

The third stage involved identifying patterns by grouping codes under common headings to develop initial themes. Conceptual thematic maps were used to help visualise these patterns.<sup>238</sup> This led to the development of initial theme categories, which were reviewed during stage four of the process by re-examining coded data and testing themes through a further process of constant comparison.<sup>373</sup> For stage five, themes were defined and named by identifying the importance of each theme to the research question. For three of the four themes, it was felt appropriate to incorporate several sub-themes to break-down overarching complex themes. Whilst the process is described here in a linear fashion, the actual process of analysis was iterative and involved moving between stages on a regular basis to refine and review the analysis. An example of the analytical process using two interview extracts is shown in table 6-2.

**Table 6-2: Example of thematic analysis process**

Interview extract	Stage two Initial code	Stage three Searching for themes	Stage four Reviewing themes	Stage five Defining and naming themes
<p>“I do think there are lots of doctors who for various reasons don’t attend. I think that could be due to you know lots of people don’t like to take criticism... you know... and there is that fear factor that being challenged or admitting that you didn’t do as well as you could do.”[Doctor]</p>	<p>Personality and feedback</p>	<p>Initially described as: Theme- “Attitudes of individuals to feedback”</p>	<p>Theme reviewed and was broadened to include both how an individual may respond to feedback and the different ways in which feedback may be used by the individual.</p>	<p>Final theme: The Individual and feedback- managing the ‘ego’</p> <p>The theme describes the individual’s response to and use of feedback, which is provided as part of the debriefing process. A quote was used in the theme title to reflect how the clinician’s personality may impact their response to feedback.</p>
<p>“I am very aware of the puck these days... I am looking for the puck. I always want that on simply because I actually like the feedback it gives me because rather than having to watch someone do compressions I can hear those compressions if you like from the feedback the puck gives.” [Critical care practitioner]</p>	<p>Use of real-time feedback</p>	<p>Initially described as: Theme- “The cultural effect of cardiac arrest debriefing.”</p> <p>Sub-theme “Changing the use of real-time feedback”</p>	<p>The overarching theme was renamed to emphasise the change in culture observed by interview participants.</p> <p>The sub-theme was reviewed and broadened to reflect how the same concept was likely to apply to other technologies associated with cardiac arrest care.</p>	<p>Final theme: “A change in culture: the effect of cardiac arrest debriefing.” The overarching theme is about how debriefing may have a cultural effect, impacting both practice and how clinicians perceive cardiac arrest care.</p> <p>The sub-theme is about how debriefing affects the use of assistive technologies by clinicians.</p>

An additional step was incorporated following stage five. Published research and theory related to each of the themes were identified. These data were synthesised to generate theory about the ways in which debriefing may affect clinical practice, enabling the development of a model to describe this process. This final report describes the themes and the development of this model.

Quotes are included throughout this report to represent the data upon which each theme is based. The male personal pronoun is used throughout to maintain participant anonymity.

## 6.4 Results

### 6.4.1 Semi-structured interviews

Between October 2012 and January 2013, 13 individual semi-structured interviews were undertaken. Fourteen clinicians were initially approached to participate in the study. One critical care outreach nurse agreed to participate but it was not possible to schedule an interview within the three month window due to the nurse's shift pattern. Characteristics of the thirteen interviewees are shown in table 6-3.

**Table 6-3: Characteristics of interview participants**

	Participants (n=13)
Clinical role- n	
Doctor	4
Resuscitation Officer	3
Critical Care Outreach Nurse	2
Critical Care Practitioner	2
Nurse	2
Male sex- n	8
Highest level of CPR training- n	
Advanced Life Support- instructor	4
Advanced Life Support- provider	7
Immediate Life Support	0
Basic Life Support	2
Clinical experience: Years since qualification- median (IQR)	12 (3-18)
Debriefing attendance: Weekly meetings attended- median (IQR)	11 (9-17)
IQR- interquartile range	



The average interview duration was 17 minutes (range 12 to 26 minutes). Due to technical failure, a single interview was not tape-recorded. This was identified immediately following the interview, allowing a written interview note to be immediately made. After the 13<sup>th</sup> interview data saturation was observed, so no further interviews were conducted.

### **6.4.2 Field notes**

Between November 2011 and May 2013, 41 sets of field notes were collated. This comprised 36 notes of debriefing meetings and five notes of informal conversations.

### **6.4.3 Thematic analysis**

Four major themes were identified through thematic analysis, namely: 'the impracticality of debriefing,' 'the individual and feedback- managing the 'ego',' 'finding solutions through discussion,' and 'a change in culture: the effect of cardiac arrest debriefing.'

#### **6.4.3.1 Theme I: The impracticality of debriefing**

This theme is about the practical challenges of debriefing delivery. These challenges were commonly cited as influencing the likely impact of debriefing in the clinical setting, with each debriefing model having its own practical challenges. Interviewees talked about a number of challenges that were categorised under the following sub-themes: reassembling the cardiac arrest team; the timing of cardiac arrest debriefing; and facilitation of debriefing.

##### **6.4.3.1.1 The challenge of reassembling the team**

Six interviewees said that attendance at debriefing meetings was poor by members of team involved in the case being discussed. Interviewees described their frustration at this. They described how it reduced the impact of the debriefing session as it was

perceived that the cardiac arrest attendees did not receive performance feedback and other meeting attendees did not benefit from hearing the 'story' of the cardiac arrest. Similarly, it was recorded in field notes that members of the direct care team involved in the case were commonly absent and these also noted similar impacts on the debriefing process. These factors are discussed further in themes two and three.

Non-attendance was attributed by interviewees to conflicting demands on time, which were considered to be either unavoidable or due to personal factors. Some clinicians described why they did not attend debriefing meetings during informal conversations, which were recorded as field notes. These reasons included attending emergency calls at the same time as the meeting and absence from work on the day of the meeting. However, some clinicians did attend meetings on their day-off or they came to work early to attend. Interviewees described how personal factors could act as a barrier to clinicians attending debriefing meetings. Interviewees suggested that these personal factors might include concern about what the meeting entailed, concern about the risk of criticism and a perception that attendance might not be beneficial.

*"I do think there are lots of doctors who for various reasons don't attend. I think that could be due to you know lots of people don't like to take criticism you know and there is that fear factor that being challenged or admitting that you didn't do as well as you could do."* [Interview- Doctor]

A registrar, when invited to a debriefing meeting during an informal conversation, responded "Why? Was it controversial?" indicating surprise at the invitation. Field notes record two different occasions where, prior to a meeting, a junior doctor stated that they were unable to attend as they needed to perform an urgent clinical task. However, on both occasions a consultant that was head of the junior doctor's team overheard the conversation and informed the junior doctor that these tasks were not urgent and stated that the junior doctor should attend the debriefing meeting. It is unclear from the data whether the junior doctor believed the task was actually urgent or was using the task as an excuse for non-attendance. When asked how it would be possible to improve attendance by the direct care team, one interviewee suggested mandating

attendance. This idea was considered by another interviewee, but he said that keeping attendance voluntary was important to ensure that attendees were willing to contribute to discussions and receive feedback.

Hot debriefing is a debriefing approach that occurs immediately after the cardiac arrest. This may enable all team members to attend and participate as work factors associated with non-attendance will seemingly be obviated. Despite expressing reservations about the practicality of hot debriefing, eight interviewees described occasionally participating in hot debriefings, even if this was just limited to an experienced clinician providing brief feedback to a team leader or for perceived psychological support for students and junior staff. When asked about their thoughts on hot debriefing, ten interviewees reported that it did not reflect the realities of clinical life as, irrespective of patient outcome, key tasks need to be completed.

*“I think one of the problems is most of the arrests are out of hours... as soon as it is done, particularly if it is a prolonged arrest, the work's piled up in the meantime and everybody just wants to finish the documentation and go. There isn't that protected time to say, right lets huddle together, what did we do well? What did we do badly? It's a great idea but on call, out of hours, when things are busy it's just not feasible.” [Interview- Doctor]*

*“I don't think doing it immediately post arrest is viable when you have got relatives and, you know, the relatives came quite quickly afterwards and you have got a body there.” [Interview- Nurse]*

In contrast, one doctor described how a hot debriefing was achieved during a night shift, despite a heavy workload:

*“One night... we had three medical alerts slash cardiac arrests in a row, where we literally ran from one to the other to the other, but nevertheless we still actually did find some time to talk about at least one of them.” [Interview- Doctor]*

#### **6.4.3.1.2 Timing the debrief**

The interview questions about at what time point a debrief should take place elicited a range of opinions. Aside from the practical issues of hot debriefing, six interviewees who expressed reservations also talked about the lack of objective data as a barrier

(see theme three). Four interviewees were concerned that hot debriefing may not focus on key points.

*“Post arrest I’m not sure is possibly the best time to start discussing who did what right and who did what not so right. I think it is a more useful forum to do it with hindsight rather than in the heat of the moment... immediately post arrest... if somebody wants to give you feedback they may not necessarily focus on the most important things from that arrest. I think looking at the data and analysing it a little bit better gives you a chance to see it from afar if you like and focus on the most important things.”* [Interview- Critical Care practitioner]

Two interviewees expressed concern about how ready they or the team generally were for debriefing immediately after the event, due to the stressful nature of cardiac arrest. In particular, one nurse disliked the idea of hot debriefing as he felt that he would not have been ready for an immediate debrief. He reported using the period between the cardiac arrest and the debriefing meeting that he attended as an opportunity to reflect on events.

*“I don’t think you are going to process that information as well as you would maybe a couple of days later... I was really glad of that time actually even though I didn’t sleep very well but when I came back I could collect my thoughts and I could add to that discussion.”* [Interview- Nurse]

Nevertheless, seven interviewees considered it important to review the event immediately as this would be the time of best recollection. In so doing, they acknowledged the key practical challenges in delivering hot debriefing.

#### **6.4.3.1.3 Facilitating the debrief**

Interviewees described facilitation as an important part of the debriefing process. They cited challenges associated with facilitation, particularly the management of sensitive issues such as poor performance and personal conflicts in a quasi-public forum. When asked about their views on different debriefing models, four interviewees expressed a dislike of debriefing approaches that did not include external facilitation. These interviewees expressed concern that facilitation by the team leader may be ineffective as the team leader might lack the knowledge or skills to effectively undertake the role or lack insight in to how care could have been improved.

*“[if it] isn’t facilitated then you haven’t got someone to manage control and you don’t necessarily have an expert in the room who can provide clarity on points so you’ve got potentially the blind leading the blind if you’ve got a bunch of people who don’t know what they are doing.” [Interview- Resuscitation Officer]*

*“They [the team leader] might not be trained in feedback or might not have any experience of feedback and I don’t think the leader is always the best person to feed that back.” [Interview- Critical Care practitioner]*

One interviewee attached particular importance to the facilitator as someone who could resolve conflict. He described how he felt that he may have been criticised at a debriefing meeting that he could not attend and hypothesised what would have happened had he been present. He concluded that the facilitator would have managed any disagreement.

*“I know the criticism of one of my arrests... when I wasn’t there. That would have probably got my back up severely.... I am not quite sure how I would deal with that but maybe that is up to the chair to deal with.” [Interview- Critical care outreach nurse]*

Field notes record several examples of challenging situations encountered by debriefing meeting facilitators. These challenges included: the death of a young patient; treatment errors; and failure to adhere best practice. Field notes also record several meetings, where stimulating discussion was difficult and describe these meetings as “quasi-didactic lectures.” Equally, however, field notes record examples of meetings that required minimal facilitation and which overran due to the amount of discussion generated.

This theme has explored the challenges associated with delivering debriefing in clinical practice. Practical challenges affect all debriefing models and these may reduce the effectiveness of the debriefing process. These challenges were summed up by a resuscitation officer, who remarked on the infrequency that debriefing is delivered in clinical practice:

*“Lots of people talk a good game and say ‘Yes you know we really believe in giving feedback and we really believe in debriefing and think it is a really good idea’ and then you challenge people and they go yes we don’t actually do it because it is really difficult.” [Interview- Resuscitation Officer]*

#### 6.4.3.2 Theme II: the Individual and feedback- managing the 'ego'

This theme is about the provision of feedback information to clinicians and the role of feedback in the overall debriefing process. All interviewees described feedback on performance as an important component of the debriefing process.

*“Constructive feedback is always useful because at the end of the day that is going to improve our practise and improve patient care.”* [Interview- Resuscitation officer]

*“If it’s going to improve outcomes and if it is going to make us adhere to the guidelines in a more rigorous way, it has got to be a good thing.”* [Interview- Critical care outreach nurse]

*“It comes back to patient outcome. I don’t really care if somebody criticises me as long as I get a better outcome for my patients and they go on to live longer healthier lives.”* [Interview- Doctor]

In describing the process by which feedback affected practice, two interviewees made implicit reference to theories of reflection and experiential learning.

*“The meetings we are having right now, I think they are really good and I have learnt a lot... you’re learning from experience.”* [Interview- Doctor]

*“If you don’t reflect and then go through how events happened, how they unfolded... I don’t think you improve. And the actual debrief... is a completion of a learning cycle. If you don’t get a debrief then nobody really knows: how anyone else felt; how you actually performed, yourself; how you performed as a team; how you communicated as a team. So your performance potentially, unless it’s perfect which is unlikely to be, then you’re never going to find areas where actually you think I could have improved and try and put that into your day to day practice.”* [Interview- Doctor]

When discussing feedback, four interviewees commented on the attitudes of other clinicians to receiving feedback, including describing groups who chose not to attend debriefing meetings because they were adverse to receiving feedback. One doctor described these colleagues as having “egos,” whilst another doctor attributed such an attitude to a personality flaw.

*“A lot of people get very defensive about feedback ....I don’t see feedback as a criticism but then I have sort of almost been taught that feedback isn’t necessarily a criticism. It’s actually about improving you so if you’re not doing something right it is better to know about it and it sort-of affects a change in attitude. It’s important, you should actually embrace the fact that you have been told something that you can improve on ... If nobody offers you feedback then*

*you're likely to find that either... you're absolutely perfect (laughs) or people just don't feel that they can ever talk to you about how things are going and you are going to worry about your own personality."* [Interview- Doctor]

Field notes record how clinicians had a wide variety of responses to receiving feedback at debriefing meetings. At one meeting, for example, it is recorded that two junior doctors who had attended the same cardiac arrest had very different responses to the receipt of feedback. One junior doctor is noted to have been extremely reflective about the event and keen to share their experience, whilst another junior doctor felt that the resuscitation attempt was inappropriate and was dismissive of the idea that any lessons could be learned from the experience. As such, this second doctor was one of a small number of clinicians that attended meetings, but chose not to enter in to the spirit of the process.

Field notes record that the effective facilitation of the debriefing meeting was particularly challenging in the context of poor performance. Nevertheless, nine interviewees attached particular importance to discussing cardiac arrest events where their care delivery was suboptimal for their own personal benefit. When responding to a question about whether he would mind an arrest that he attended being discussed in his absence, one doctor responded:

*"I would probably prefer it if I was there mainly for my own learning but as for someone ripping to shreds my arrest in my absence, I don't really mind because there are always going to be mistakes and stuff to learn from so from that point of view I don't mind. I just prefer to be there because I'd probably learn from it myself if I was there and you were discussing a very bad arrest."* [Interview- Doctor]

Whilst no interviewee reported a personal adverse response to feedback, one interviewee did suggest that this may have happened had he been present at a meeting where, based on a third hand report, he felt his performance was criticised. In addition, a critical care practitioner referred to a colleague who felt that the debriefing process had been negative, but stated that this did not reflect his personal experience.

Two interviewees described how feedback 'egos' could be modified by the timing and format of feedback. For example, an interviewee suggested that delaying feedback might provide individuals with the opportunity to individually reflect on events, so that they felt more prepared to discuss events in an open forum. Equally, it was suggested that receiving feedback in a less public forum such as in a small-group or as written feedback may be more acceptable to some clinicians. The benefit of written feedback was described as:

*"From a beneficial kind-of way, those with maybe egos they can privately assimilate the information and maybe if the thing that stops them from coming to the public meetings is that it is public then maybe they can learn from their own situations from the written feedback which they can keep private."*  
[Interview- Doctor]

Defibrillator downloads of CPR quality metrics were used in debriefing meetings to provide objective performance feedback and provide an overview of events. Eleven participants reported that such data formed a key part of the debriefing process and field notes record how these data gave structure to the debriefing meeting and stimulated discussion.

*"The cardiac arrest data... drives home the points of the speed and the depths of the cardiac compressions... the fact that the compressions are the most important thing. Another positive thing is showing the read outs from the defibs which shows the pre- and post-shock pauses which helps to highlight that... when you're actually in a cardiac arrest it keeps it in the forefront of your mind that... you want to keep the pauses as short as possible and I think that really helps."* [Interview- Critical care practitioner]

During one meeting, field notes record how a doctor stated that he had been disappointed the previous week when no data had been presented and commented that he considered the data to be the most interesting part of the debriefing meeting. Two interviewees did comment initially that data were not helpful, but as they discussed the issue further it became clear that these participants only viewed specific parts of the data as being of limited value.

*"The data is kind of interesting. It's almost the same every week... that is normally not that useful... because I have never seen any results that are ridiculously bad or ridiculously good, but what has been useful is kind-of looking at the rhythms when you put them up and people deciding what it was or what it*



*wasn't and then just hearing basically the story of the cardiac arrest.*" [Interview-Doctor]

When discussing hot debriefing, interviewees often considered the absence of objective data to be a drawback due to the risk of subjectivity.

*"[Hot debriefing]... no objective data on performance. I think then it becomes... it possibly becomes just a subjective discussion and could not necessarily be very constructive if not done in the right way."* [Interview-Critical care practitioner]

This theme has discussed the importance of feedback, including its use as a stimulus for reflection and practice change. Interviewees were positive about feedback, but described how providing feedback in a quasi-public forum may not be acceptable to all clinicians. Interviewees stated that feedback should be based on objective measures of performance, which may reduce the acceptability of some approaches to debriefing.

#### **6.4.3.3 Theme III: finding solutions through discussion**

This third theme is about how discussions during debriefing meetings facilitate finding solutions to the challenges of managing cardiac arrest patients. Underpinning this theme is the description by ten interviewees of cardiac arrest care as a complex process that requires the delivery of time-critical interventions.

*"Cardiac arrest to me is a high stress situation where you need to get things very precise and get your decision making very very clear."* [Interview- Doctor]

*"You have just got to act quickly and your reaction time is basically counted against you. You have got to be quick with everything."* [Interview- Nurse]

Field notes provide specific examples of this complexity, such as the co-ordination of a large team and the assimilation of clinical information to facilitate decision-making whilst managing the delivering of high-quality CPR. The theme incorporates three sub-themes: vicarious learning and solution finding; the importance of a no-blame culture; and the psychological benefits of discussion.

#### **6.4.3.3.1 Vicarious learning and solution finding**

All interviewees described how debriefing allowed them to learn from the experiences of others through a process of discussion and identifying solutions to specific problems.

*“What has been useful is... the story of the cardiac arrest... If somebody was maybe having difficulty with the airway and how did they get round it or maybe there might be some other slightly not so common features of cardiac arrest, like the use of ultrasound... That has been useful, just to kind-of hear people’s experiences of it and that normally generates quite a lot of discussion which I learn a lot from.” [Interview- Doctor]*

Nine interviewees also described how learning opportunities were available even when the cardiac arrest team did not attend the debrief, although a particular benefit was attached to debriefing meetings attended by the team as this enhanced the learning experience for all attendees.

*“When there were people who attended the arrest, saw the runnings of the arrest and the events as they unfolded they gave a sort-of more real life sort of picture of the sequence of events so that was if they were then it made the whole debrief and learning cycle that much better. When people weren’t there then unfortunately it was very much being treated as a situation with regards the puck feedback. Now that in itself was quite useful because from a CPR point of view, sort-of maintaining a current knowledge of the recommended protocols and measurement and things is very important... From my point of view there were benefits from both systems but I preferred it when there were team members to actually go through the sequence of events.” [Interview- Doctor]*

Field note data provides examples of discussions generating rich learning opportunities, such as airway management, treatment of hyperkalaemia in the context of profound acidaemia, and managing cardiac arrest patients in the cardiac catheter laboratory. Interviewees expressed concern about the use of debriefing approaches that were confined to the immediate care team, as such learning opportunities would then not be available to the wider team.

#### **6.4.3.3.2 The importance of a no-blame culture**

As recorded in field notes, the concept of a non-punitive environment was reiterated at the start of every meeting. During interviews, eight participants described how this culture during debriefing meetings was important, in terms of stimulating discussion.

*“You know the format of the meetings are such that nobody, as far as I could tell, feel particularly criticised for anything they have done because it is about finding solutions... As soon as people feel they are going to be criticised for what they have done then you are going to get a significant negative feeling about the meetings and... that’s going to impact on people as to whether they go to the meetings or not.” [Interview- Resuscitation Officer]*

*“I think the culture you create is very important that you have made it a non-blame thing. It is just about discussing the pros and cons of what was or wasn’t done... I think that culture helps elicit a lot of good conversational points.” [Interview- Critical care practitioner]*

Nevertheless, field note data and interviews did identify some difficulties with such a culture. Whilst supportive of the concept, one interviewee was concerned that a non-blame culture might absolve clinicians of accountability where there was evidence of poor performance. Another interviewee cited an example of a cardiac arrest event where an inexperienced junior doctor had made a significant error. He stated that he was pleased the case was not selected for discussion as the nature of the error meant that it would have been difficult to discuss in a constructive manner.

*“[They] didn’t know how to do very, very basic things...If that had come up in the debrief I am not sure how I would have... made that criticism without it being unconstructive or personal ... [if] something like that had come up I don’t know what I would have done in the forum.” [Interview- Critical Care Outreach Nurse]*

Field notes record examples of decisions that were made by the meeting facilitator to preserve this culture. For example, a decision was made not to use one cardiac arrest event as a case study where there was evidence of latent treatment errors. This was due to concerns that discussion might be professionally embarrassing for the clinicians concerned. There was also one discussed case where the defibrillator record directly contradicted the account of the clinician, but field notes record that the facilitator decided not to challenge the clinician as it was felt that doing so might make others wary of participating in discussions.

#### 6.4.3.3.3 Psychological benefits of discussion

Four interviewees described feeling stressed following cardiac arrest events. Field notes provide examples of particularly challenging cardiac arrests, such as the prolonged resuscitation of a thrombolysed patient, and a young haematology patient that had a cardiac arrest secondary to a cerebral haemorrhage. This second case was remarked on by one participant:

*“I think probably the only one where we had a significant number of nurses from the ward was the haematology arrest. I think because they knew the patient well and found it quite distressing so they came.”* [Interview- Critical care outreach nurse]

One interviewee described having difficulty sleeping following a challenging cardiac arrest and reported that they derived a psychological benefit from discussing the event at a debriefing meeting.

*“I came [to the debriefing meeting] because... I thought it was a traumatic event and the debrief was a perfect opportunity really for me to kind-of place everything away in its box and make sure we did everything we possibly could have.”* [Interview- Nurse]

Four interviewees reported the occasional use of hot debriefing strategies to help themselves and other arrest team members offload acute concerns and provide reassurance following cardiac arrest events in order to prevent the events from affecting their work.

*“[Hot debriefing] is something I sort-of often use in practice but it is very emotive. It’s very much about issues that are very pertinent to people at the time... it is often people who have often been either particularly upset by an arrest .... so it has its time and place because there are people who need to talk at the time and understand what happened.”* [Interview- Resuscitation Officer]

*“A lot of the arrests I have been to, I have tried to involve students on the ward to participate... quite often afterwards they can become very emotional... I think if it is something that is done immediately it gives them a chance to sort of chat to somebody and almost debrief about the situation and they can be given feedback.”* [Interview- Critical Care Outreach nurse]

This theme has discussed the potential value of discussing cardiac arrest events. At an individual level, one interviewee reported a psychological benefit following the discussion of a cardiac arrest event that they described as emotionally distressing. At a

broader level, discussion facilitated the opportunity to learn from other clinicians' experiences and identify solutions that clinicians could implement in their own practice. However, to be effective, there was a general consensus that debriefing must be underpinned by a culture that avoids blame.

#### **6.4.3.4 Theme IV: A change in culture: the effect of cardiac arrest debriefing**

Theme four is about the broader effect of debriefing on practice at a team and organisational level within the clinical setting. It encompasses three sub-themes: opening up the feedback process and changing attitudes; harnessing the benefits of assistive technology; and the effect of debriefing on practice.

##### **6.4.3.4.1 Opening up the feedback process and changing attitudes**

Five interviewees described how information from debriefing meetings was often shared beyond those that actually attended the meeting. This process increased interest in cardiac arrest within the hospital and affected a shift in the way that clinical staff perceived cardiac arrest.

*"What's good to see is over those last couple of rotations to see the development and the change in people's perceptions about how cardiac arrests are and can be managed... it appears purely from observations that the principles that we discuss are adopted by those trainees as they progress through that four month period so it looks like it is having an impact certainly on the way in which people talk about what they do and should be doing."*  
[Interview- Resuscitation officer]

*"I have not seen any meetings like that in any other hospitals I have worked in and I think that shows in arrests I have been to... it's getting resus at the forefront and making it important so that people are discussing it."* [Interview- Resuscitation officer]

Interviewees described how, prior to the implementation of weekly group debriefing meetings, they rarely received any form of debrief after cardiac arrest events. When debriefing did occur, it tended to be ad hoc and superficial. For example, one junior doctor's only recollection of receiving any form of receiving cardiac arrest debriefing related to the successful insertion of a large intravenous cannula.

*“The sort-of things I have experienced before are that the cardiac arrest happens- it is either successful or it is not. Then everyone kind of disperses and then it’s never spoken about again.” [Interview- CCOT]*

*“Certainly as an RO I don’t ever remember formerly receiving feedback even as part of the development other than “that’s fine.” You know, nothing specific ... Certainly from memory I don’t think I have ever had feedback in terms of my technical performance at all.” [Interview- Resuscitation officer]*

The implementation of weekly group debriefing enabled attendees to share what they had learnt with others and also promoted multidisciplinary discussions outside of meetings. Five interviewees provided specific examples of these processes.

*“I brought that [the debrief] back to the unit and I gave a little mini debrief on the unit.” [Interview- Nurse]*

*“It’s unfortunate that a lot of arrests occur at night or in non-clinical hours which means limited staff can attend the discussions. I have personally have fed back to people if they couldn’t attend the discussion and they have wanted more information.” [Interview- Resuscitation Officer]*

*“we go into that room but the conversations are taking place before you get there and they are carrying on after so although we have got that hour/ forty five minutes... that is not how long the debrief is... The debrief doesn’t end because it is half past one and that has probably helped a lot with the working relationships between the medics and the nurses.” [Critical Care Outreach Nurse]*

The same critical care outreach nurse went on to describe how the implementation of the debriefing programme had changed practice within his team, such that discussions about cardiac arrest were now more likely to take place in an open forum, rather than these discussions being limited to a small number of individuals.

*“So, it might be a difficult situation or a particular scenario that I had a problem with and I’m going, how could I have done that better? Or was that the right thing? I probably would have gone to speak to [a resuscitation officer] about it. But now I wouldn’t do that, I would do it within the resuscitation forum... I think that is a better way to do it because more people hear it.” [Interview- Critical Care Outreach Nurse]*

#### **6.4.3.4.2 Harnessing the benefits of assistive technologies**

Field notes record how a brief overview of real-time audiovisual feedback technology was given at each meeting, with additional information given in response to questions.

For example, at one meeting an attendee asked whether the puck design itself might impair CPR quality. This enabled the facilitator to describe how this was not the case through reference to published research. Six interviewees described how debriefing increased their awareness of real-time audiovisual feedback technology, its value in providing real-time information about performance, and as a source of objective data for the debriefing process.

*“I saw the puck wasn’t there so I quickly slid it under the guys hand while he was doing his compressions because I know it is important to gather this data and also... that little voice saying regards to either the depth or the rate saying either that the person doing the compressions or the team leader can then relay that to the compressionist.” [Interview- Doctor]*

*“I am very aware of the puck these days. That’s kind of been drilled in to us now... the first thing I look for is the airway but then I am looking for the puck. I always want that on simply because I actually like the feedback it gives me because rather than having to watch someone do compressions I can hear those compressions... from the feedback the puck gives.” [Interview- Critical care practitioner]*

Field notes record that a common problem experienced during cardiac arrests was that the real-time feedback verbal prompts were often difficult to hear. Notes record how meeting attendees identified potential solutions, such as limiting the number of people present at cardiac arrests (‘crowd control’) and nominating a person to relay feedback to the person delivering compressions.

#### **6.4.3.4.3 The effect of debriefing on practice**

When asked about how debriefing had affected their personal practice, eleven interviewees described effects on either technical care or non-technical care delivery.

*“Definitely hands on chest... That’s a lot more kind-of focussed in my mind now and I’m conscious of seeing... as a team leader it is easier to spot it.” [Interview- Junior doctor]*

*“Experience in the weekly meetings, it makes you appreciate the team dynamics a lot more... When you start getting in to the team dynamics it was nice to sort of learn the structure like: this is your leader, this is how it is going to happen. It became far calmer really going into a cardiac arrest situation and I can now read situations a lot better and get less flustered by them.” [Interview- Junior doctor]*

Some clinicians with more cardiac arrest experience found it difficult to identify specific examples of the effect that attendance at debriefing had had on their practice. These clinicians tended to describe how debriefing had affected thought processes.

*"I think I am experienced enough... I am pretty proficient in cardiac arrests without blowing my own trumpet too much... so I don't think... I mean there are certain issues it has probably informed so maybe I am not being very accurate"* [Interview- Critical Care Outreach Nurse]

*"I am and ought to be a proponent of exemplar practice at resuscitation attempts... if I am... not an exemplar of ideal practise then there is something wrong with the system. Sometimes, it [the debrief] clarifies, you know, a minor point or perhaps where there is a more contentious issue it widens the thinking a little bit but not significantly, no."* [Interview- Resuscitation officer]

Two interviewees expressed concern that the potential effect of debriefing may not be fully realised due to the infrequent exposure of some clinicians to cardiac arrest.

*"We often don't have nurses from the ward... whether they would benefit or not because of the frequency of the arrests they deal with might be very very low but I can't imagine it wouldn't be helpful to us. The next time I go to an arrest on [an elderly care ward] that those nurses have been to the debrief and understand what the emphases are. The same as we are working with the SHOs more effectively, maybe they would work with us more effectively as well."* [Interview- Critical care outreach nurse]

*"I think there is a risk that where there is relatively limited exposure to cardiac arrests that will limit the impact of the debriefing... if we have a couple of cardiac arrests in a month and we debrief one of them, very few people who debriefed at the first one are going to be able to apply and consolidate at the next one.. you have got limited impact purely because of the lack of arrests."* [Interview- Resuscitation officer]

In addition to its impact on individual practice, debriefing, as illustrated in the above quote, was reported to improve working relationships between members of the multidisciplinary team involved in cardiac arrest care.

This theme discussed the broader impact of debriefing. These effects including a shift in the way that clinicians perceive cardiac arrest, creating more open cardiac arrest debriefing processes and improving the way that clinicians use assistive technologies.



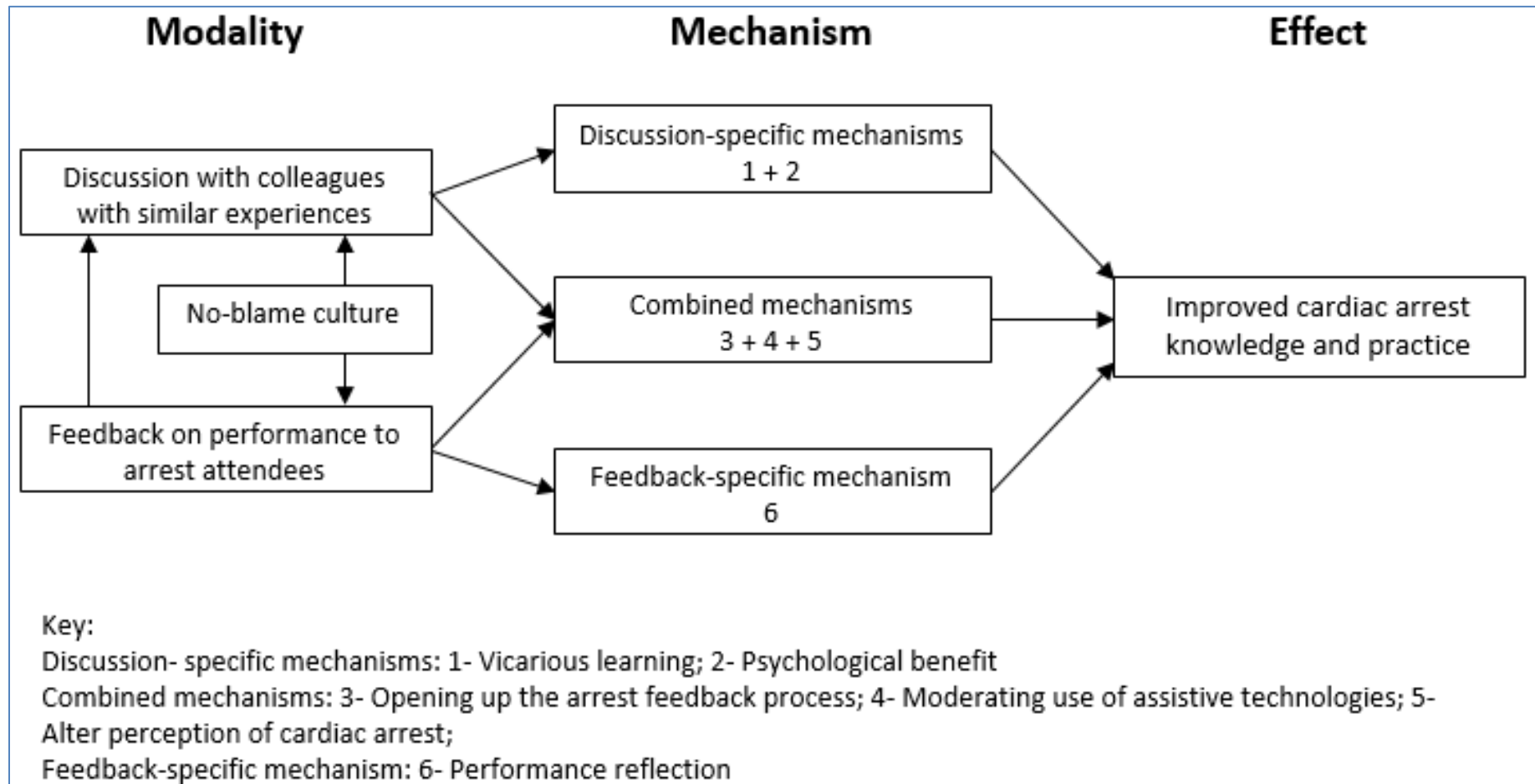
## 6.5 Discussion

In this study, thematic analysis of field notes and semi-structured interviews with clinicians generated four themes: 'the impracticality of debriefing,' 'the individual and feedback- managing the 'ego',' 'finding solutions through discussion,' and 'a change in culture: the effect of cardiac arrest debriefing.' Identification of these themes facilitated the development of a model that sought to show the mechanisms by which cardiac arrest debriefing may affect practice.

The developed model incorporates two key modalities (discussion with colleagues with similar experiences and feedback on performance) through which six mechanisms exert an effect on cardiac arrest practice (Figure 6-1). The six mechanisms can be categorised by their driving modality, namely: feedback-specific mechanisms (performance reflection); discussion-specific mechanisms (vicarious learning; psychological benefit); and mechanisms driven by both modalities (opening up the arrest feedback process; moderating the use of assistive technologies; alter perception of cardiac arrest). The effectiveness of both modalities is seemingly dependent on the adoption of a no-blame approach. Furthermore, there is evidence of interplay between the discussion with colleagues and feedback on performance modalities, with the effect of the former seemingly enhanced by the latter.

An important theme in this study was the consideration of the practicalities of delivering debriefing in the clinical setting. The model may be used to conceptualise the strengths and weakness of debriefing approaches by taking in to consideration practical delivery issues (Table 6-4). For example, hot debriefing allows the whole direct care team to discuss the event and receive performance feedback, but this is limited by the lack of objective data, the short time period available, and absence of an external facilitator and the wider care team.

Figure 6-1: Model of debriefing mechanisms



**Table 6-4: Effect of debriefing techniques on debriefing modalities**

	Modality	
	Feedback	Discussion
Hot debriefing	+	+
Individual oral debriefing	++	+
Cold group debriefing	+	++
Written feedback	++	-
++ Strong effect; + Weak effect; - No effect		

In contrast, written feedback provides feedback to the whole direct care that incorporates objective data, but provides no forum for discussion (Table 6-4). Whilst this process provides a useful schema to compare debriefing approaches, the relative importance of these two modalities in practice remains unclear.

Previous studies of cardiac arrest debriefing have focussed on the clinical outcomes of the intervention. This is the first study to attempt to develop an understanding of how clinicians view the debriefing process and generate theory about how the process may exert an effect on cardiac arrest knowledge and practice. In so doing, it seeks to address some of the knowledge gaps identified in the 2010 International Liaison Committee on Resuscitation evidence evaluation process.<sup>117</sup> The remainder of this discussion examines each of the six mechanisms in detail.

### **6.5.1 No blame**

In this study, clinicians valued the creation of a no-blame culture at debriefing meetings, as it was considered that this made clinicians feel more comfortable discussing cardiac arrest events, particularly in relation to poor performance or errors. Nevertheless, there was some evidence of a conflict as focus on this goal meant that key learning points may have been glossed over or neglected to preserve this culture.

In 1991, a survey of American junior doctors found that only 54% of errors were discussed with senior clinicians and that these doctors felt unable to discuss the error in 27% of cases due to hospital culture.<sup>374</sup> Such data has driven the perceived need in healthcare to create no-blame cultures. For example, the 2000 Department of Health publication 'An organisation with a memory' outlined a strategy to ensure that the NHS was able to learn from healthcare errors.<sup>375</sup> A similar strategy was outlined in an American Institute of Medicine report published in the same year.<sup>376</sup> Subsequent government publications have reiterated the need to develop 'no-blame cultures' if high-quality and safe healthcare is to be effectively delivered.<sup>377-379</sup> However, the recently published Berwick report found that this laudable aim had not yet been fully achieved.<sup>380</sup> In view of this, the apparent creation of a no-blame culture at debriefing meetings represents a notable achievement.

The concept of 'no-blame' has been challenged by some commentators as there is a concern that it may be abused to absolve individual clinicians of responsibility for latent errors, such as failure to undertake hand washing.<sup>381-383</sup> This concept of accountability becomes more complex where, as in the case of cardiac arrest, care delivery is undertaken by teams.<sup>384</sup> A similar concern was highlighted by a clinician in this study. In the case of latent errors, a more formal review of the cardiac arrest event may be necessary. This is both for reasons of organisational governance and to prevent clinician embarrassment if such errors are exposed in an open forum. However, where cardiac arrest debriefing is confined to the direct care team, it may be more appropriate and acceptable to review such cases.

### **6.5.2 Vicarious learning**

Participants in this study considered the opportunity to hear about colleagues' experiences and reflections on a cardiac arrest event to be a valuable learning experience. This mechanism has been described previously, but has received relatively

little attention in recent studies of debriefing.<sup>385</sup> In their 1988 study of debriefing following trauma resuscitation, Hoyt et al described how “individuals uninvolved in the resuscitation can benefit by seeing other’s mistakes and triumphs” through the debriefing process and review of videotapes.<sup>109</sup> This concept has been described as ‘vicarious learning.’<sup>109</sup> It has parallels with Bandura’s social cognitive theory, which describes how individuals learn by observing the behaviour of others.<sup>386</sup>

Data from manikin studies support the concept that observing a scenario and participating in a debrief may be as beneficial, or even more so, than actual participation in the clinical scenario.<sup>387,388</sup> In this study meeting attendees did not observe the cardiac arrest event, but instead relied on colleagues’ descriptions of the event supplemented by defibrillator downloads. A similar process has been described in a study of nursing students where the students applied learning from case studies presented by clinical nurse specialists to their own practice.<sup>389</sup>

By its nature, vicarious learning requires the presence of a group of people willing to share experiences. For this type of learning, there is a need for effective group dynamics, but problems are commonly reported in the medical education literature.<sup>390,391</sup> In particular, effective facilitation and small group size are often cited as important strategies in optimising group discussion and learning.<sup>392-396</sup> For the debriefing in this study, the facilitator was external to the cardiac arrest team and interviewees acknowledged the importance of this. The room size restricted attendance to 25 clinicians, which exceeds the optimum group size identified in some studies.<sup>393</sup> Nevertheless, some interview participants felt that a higher attendance would actually further enhance their learning.

### **6.5.3 Psychological benefit**

Cardiac arrest is as a complex care event that can induce stress in clinicians.<sup>154-156,397-</sup>

<sup>399</sup> In this study, debriefing was implemented to improve care delivery, rather than for

anticipated psychological benefit. Nevertheless at least one clinician reported deriving an ancillary psychological benefit through the discussion of a cardiac arrest event. Our debriefing approach was based on the 3D model of debriefing (defusing, discovering, deepening) developed by Zigmont and colleagues.<sup>400</sup> This provides participants with the opportunity to discuss emotions during the first ('defusing') stage

Our primarily educational approach differed from some previous studies of cardiac arrest debriefing, where the target of the intervention has been psychological support.<sup>397,398,401,402</sup> A recent study has extended this concept of debriefing for psychological support to lay bystanders following pre-hospital cardiac arrests.<sup>143</sup> Critical incident stress debriefing, as a strategy to prevent or reduce psychological stress in rescuers, was developed by Mitchell in the 1980s.<sup>135</sup> Whilst the technique is still used in settings such as the paediatric emergency department, its effectiveness has been challenged by systematic reviews which found no evidence of benefit.<sup>136,137,141,142,402</sup> Indeed, the National Institute of Clinical Evidence currently recommends against the routine provision of critical incident stress debriefing.<sup>140</sup>

Nevertheless, even when the primary focus of the debriefing process is educational, it seems that the discussion of the event in the context of a debrief may provide a small number of clinicians with psychological comfort.

#### **6.5.4 Opening up the arrest feedback process**

Study participants viewed feedback to the direct care team as an important component of debriefing. The finding that most interviewees had rarely experienced cardiac arrest debriefing previously correlates with the findings in many other studies.<sup>83,154,157,158</sup> Data from systematic reviews shows that overall debriefing improves care delivery, although occasionally it may demotivate clinicians and negatively affect care delivery.<sup>91,92,103,115,119-121</sup>

The failure to routinely provide feedback on performance may, in part, reflect the challenge of collecting objective cardiac arrest performance data.<sup>160</sup> In manikin studies, the benefit of supplementing verbal feedback with objective data, such as videotape recordings, is unclear.<sup>403</sup> Nevertheless, clinical debriefing approaches tend to include objective data, such as videotape recordings or defibrillator downloads, when they are available.<sup>109,152,170</sup> This reflects evidence that clinicians often have difficulty in reliably self-assessing their performance and have a poor recollection of cardiac arrest events.<sup>166,167</sup> In this study, interviewees considered the inclusion of objective performance data to be an important component of the intervention.

The focus of cardiac arrest debriefing is inevitably the quality of CPR. Debriefing clinicians about suboptimal care delivery may create a negative response through a complex conflict between the clinician's desire to reflect on the feedback to improve practice and a perceived threat to their competence.<sup>404-406</sup> Delivery of debriefing in an open forum might increase this negative response. In the simulation setting, fear of peer judgement and fear of inaccurate portrayal of ability have been identified as barriers to participation.<sup>407</sup> Similarly, in the clinical setting these issues have been identified as impeding learning at morbidity and mortality meetings.<sup>408,409</sup> This study identified isolated reports of clinicians responding negatively to feedback. Interestingly, such clinicians were criticised by some interview participants, who considered this to represent a personality flaw. Whilst interview participants regarded feedback positively, the delivery of debriefing in a less open forum may be more acceptable to some clinicians.

This study provided evidence that the debriefing programme established other new feedback pathways in to clinical practice. In recent years, commentators have advocated a need for a culture shift in medical training programmes to enhance learning including the embedding of debriefing in daily practice.<sup>410-412</sup> A Health Foundation report on NHS reliability and safety identified inadequate individual and

system feedback mechanisms as contributing to poor healthcare reliability.<sup>125</sup> Whilst there is little empirical data about the effect of establishing a culture of debriefing, one study found an association between organisational performance and effective feedback to clinicians.<sup>123</sup> The implementation of a cardiac arrest debriefing programme may be a useful way to attain this goal.

### **6.5.5 Moderating the use of assistive technologies**

Study participants described how debriefing affected the way that they used CPR assistive technologies, particularly real-time audiovisual feedback. Evidence of suboptimal CPR delivery in practice has increased interest in the use of assistive technologies designed to improve the CPR quality.<sup>60,63</sup> However, the introduction of technology in to healthcare is a complex process.

The complexity of this process is reflected in the mixed results seen in previous studies of real-time audiovisual feedback.<sup>84,85</sup> Hostler et al undertook a large cluster randomised controlled trial which found that real-time audiovisual feedback introduced with only basic provider training led to only modest improvements in CPR quality and had no effect on patient outcome.<sup>177</sup> In contrast, a study, albeit with a higher risk of bias, which implemented real-time audiovisual feedback alongside intensive scenario-based training that highlighted good practice regarding the use of the technology reported significant improvements in both CPR quality and patient outcome.<sup>98</sup>

Normalisation process theory describes how embedding and integrating interventions in practice is affected by four elements (coherence, cognitive participation, collective action, reflexive monitoring).<sup>413</sup> This study provides evidence that debriefing affected these elements through discussions that focussed on the benefits of using real-time audiovisual feedback to guide CPR delivery (coherence, reflexive monitoring) and discussions on strategies to improve the cardiac arrest team's use of the technology (collective action). Through this process, real-time audiovisual feedback became



'normalised' in practice, thereby increasing the potential impact of the technology on cardiac arrest practice.

### **6.5.6 Alter perception of cardiac arrest**

In this study, interviewees described how debriefing affected their perception of cardiac arrest and the importance of CPR quality. Cardiac arrest care may be perceived by some clinicians to be a futile endeavour. In a survey of junior doctors, almost all (97%) respondents reported involvement in a resuscitation attempt that they considered inappropriate.<sup>154</sup> Equally, a study in which elderly care registrars were asked to describe a memorable experiences of cardiac arrest frequently led to recollections of cardiac arrests that were considered to be futile and inappropriate.<sup>361</sup> This correlates with evidence that in-hospital cardiac arrest victims are often elderly with multiple co-morbidities and who require assistance with activities of daily living.<sup>18,32</sup>

Medical futility can be conceptualised as having quantitative and qualitative elements.<sup>414</sup> Quantitative futility describes conditions where treatment has been unsuccessful for 100 consecutive cases, whilst qualitative futility refers to treatments that will lead to complete medical dependency. Perceived delivery of futile care may expose rescuers to a risk of burnout and other negative psychological responses.<sup>415-419</sup> Whilst survival following in-hospital cardiac arrest is poor, it does not meet the threshold of quantitative futility.<sup>15</sup> Furthermore, survivors often have good long-term outcomes.<sup>22,23</sup> However, as the cardiac arrest team has limited opportunity to follow-up cardiac arrest patients, their last contact with a patient will usually involve a transfer to the mortuary or intensive care unit.

The primary focus in debriefing meetings was CPR quality. This approach is advocated by Salas et al as whilst the cardiac arrest team can affect processes of care, the outcome will be partly determined by patient and arrest characteristics that are outside the control of the cardiac arrest team.<sup>18,19,162</sup> Nevertheless, through the use of case

studies, it was possible to demonstrate the real impact that high-quality CPR can have on patient outcome.

### **6.5.7 Performance reflection**

Several interviewees referred to the importance of reflection in affecting a change in their practice. By its nature, the benefits of reflection will be predominantly limited to those who were present at the cardiac arrest, although discussion points may trigger other participants to reflect on their own experiences. The practical challenges associated with members of the direct care team being able to attend the debrief were frequently described by interview participants.

Empirical evidence to support the value of reflection is lacking, but reflection is nevertheless often considered to be an important mechanism by which debriefing affects practice.<sup>420,421</sup> Indeed, debriefing definitions often place reflection at the centre of the debriefing process.<sup>102,422</sup> For example, Fanning and Gaba define debriefing as “facilitated or guided reflection in the cycle of experiential learning.”<sup>102</sup> Kolb and Schon have both described theories that place reflection as an essential component of learning.<sup>105,106</sup>

The ability to reflect on practice has been identified as a core skill for the excellent and competent clinician.<sup>423,424</sup> Nevertheless, clinicians may find the reflective process challenging. During debriefing, some groups may require minimal facilitator input during the debriefing process, whilst others require considerable facilitator input to ensure salient learning points are discussed.<sup>102,114</sup> This finding was observed in this study. As such, the effectiveness of a debriefing approach may be dependent on appropriate facilitation to help clinicians fully reflect on and learn from the event.

## 6.6 Limitations

The study has several limitations, which are predominantly related to my role in the research.

In this study, I led the majority of the debriefing meetings, undertook the interviews, recorded field notes, and analysed the data. These multiple roles may have created a role conflict that affected both interview data collection and my analysis of these data. Furthermore, a previous study found that being interviewed by a fellow health care professional may in itself affect interviewee responses as the interviewee perceives the interview to be an assessment of their professional competence.<sup>425</sup> Manipulation of professional title has been used in previous studies to reduce this effect, but was not possible in this study as I was known to all participants.<sup>426</sup> Nevertheless, this did enable us to share a professional language in interviews.<sup>427</sup> To reduce the effect of these role conflicts, the interview preamble encouraged interviewees to view me purely as a researcher (appendix: section 12.3). In addition, an attempt was made to identify a colleague to validate data coding, although this did not prove possible. Whilst the overall impact of these role conflicts on study findings is unknown, resource limitations meant that the approach undertaken was the only practical way to complete this research. Nevertheless, the effect was mitigated through regular meetings with supervisors to discuss data coding and the development of the thematic framework.

A second limitation related to the choice of interview participants. Participants were selected based on their attendance and participation at debriefing meetings so that they had experience of the phenomena of interest. Inevitably, therefore, they were likely to be clinicians who supported the concept of cardiac arrest debriefing and considered it to be beneficial. This is not to say, however, that participants were universally positive about all aspects of debriefing. An insight in to the views of less-engaged clinicians was achieved through several informal discussions that were captured as field notes.

Thirdly, recording field notes of debriefing meetings was challenging as it was not possible to make contemporaneous notes as I was, in most cases, facilitating the meeting. On a few occasions, supplementary contemporaneous notes were recorded by a research assistant. Field notes were made as soon as possible after the meeting, but the generation of accurate and rich field notes was found to be difficult. Consideration was given to the use of a recording device to enhance data richness, but covert recording was considered unethical and it was considered that overt recording might hinder open discussion.

Finally, this was a single-centre study that recruited participants who had experience of a single approach to cardiac arrest debriefing. The study findings and the developed model may not be generalisable to other organisations. Further, this study should be viewed as an attempt to generate theory about the mechanisms by which debriefing may affect practice and does not represent any attempt to empirically assess the effectiveness of these mechanisms.

## **6.7 Conclusion**

Through analysis of field notes and semi-structured interviews, this study identified four major themes ('the impracticality of debriefing,' 'the individual and feedback- managing the 'ego',' 'finding solutions through discussion,' and 'a change in culture: the effect of cardiac arrest debriefing') and a number of sub-themes. The analysis facilitated the development of a model that describes six potential mechanisms by which cardiac arrest debriefing may affect cardiac arrest knowledge and practice. These target a number of behaviours and processes and provide evidence that cardiac arrest debriefing is a complex intervention.<sup>181</sup>

Only one (performance reflection) of the six identified mechanisms requires attendance at the cardiac arrest under discussion. Whilst the effectiveness of the remaining mechanisms may be enhanced through the involvement of members of the direct care team, it does not seem that this is essential in order for them to have an effect on practice. Different debriefing approaches may exert an effect on the six mechanisms in different ways and to different extents, such that empirical studies are needed to characterise the effectiveness of different debriefing approaches. In so doing, the validity of the model and the relative importance of different mechanisms may be tested.

## **6.8 Acknowledgements**

KC undertook this study. Dawn Hill is acknowledged for her contribution in transcribing interview audio recordings.

## **Chapter 7: Development of cardiac arrest debriefing interventions**

## 7.1 Abstract

**Introduction:** Complex interventions are often developed based on researcher intuition. The failure to consider intervention generalisability or underpinning theory in this process may reduce the effectiveness of an intervention and contribute to differences in results between studies. The aim of this work package was to develop three cardiac arrest debriefing interventions using a process that prioritised both the generalisability of the intervention to other NHS organisations and the support of relevant theory.

**Methods:** This work package developed and used a three-stage approach that drew upon findings from our preparatory work (systematic review, process evaluation, qualitative study). Firstly, a list of approaches to cardiac arrest debriefing based on findings from the literature was devised. Secondly, the generalisability of these interventions was assessed to develop a shortlist of approaches. Finally, behaviour change theory was applied to this shortlist through the use of the theoretical domains framework.

**Results:** The initial literature scoping identified 18 cardiac arrest debriefing approaches. Of these, we excluded 11 approaches as they were considered to not be generalisable across NHS hospitals. The shortlist of seven approaches was split in to three groups based on broad intervention characteristics. Following application of the theoretical domains framework, the approach in each group with the strongest theoretical underpinning was identified. These three approaches were individual debriefing for direct care team members following each cardiac arrest, written feedback to the direct care team following each cardiac arrest event, and monthly group debriefing.

**Conclusion:** Detailed preparatory work combined with an assessment of feasibility and behavioural change theory facilitated the development of three approaches to cardiac arrest debriefing that are generalisable across NHS hospitals. The feasibility of delivering these interventions in NHS hospitals needs to be empirically tested.



## 7.2 Introduction

The development of a complex intervention is, in itself, complex. The best approach to developing an intervention is likely to be one that both draws upon relevant theory and which considers the generalisability of the intervention.<sup>258,263</sup> In practice, however, a researcher will often develop an intervention based on intuition.<sup>263</sup> This may explain why complex interventions often have limited generalisability and produce variable results.<sup>258,263</sup>

The intuitive development of complex interventions is a practice that pervades the cardiac arrest debriefing literature. There are likely to be two key reasons for studies adopting this approach. Firstly, the literature provides little guidance on how to actually develop a complex intervention.<sup>257</sup> For example, the Medical Research Council framework provides detailed advice on what preparatory work should be undertaken, but offers no explicit guidance on how to use these data to develop the intervention.<sup>181,257</sup> Secondly, the application of relevant theory is challenging for researchers without expertise in health psychology, given the number and nature of theories described in the literature.<sup>261,385,428,429</sup>

This chapter describes the development of three cardiac arrest debriefing interventions. In the absence of clear guidance on how to develop a complex intervention, we developed a novel process that drew on relevant theory and which prioritised the importance of developing interventions that were generalisable to other NHS hospitals.

## 7.3 Methods

We used a three-step approach to develop cardiac arrest debriefing interventions. These stages were: identification of strategies, assessment of generalisability, and application of theory using the theoretical domains framework (TDF).

Following development, we planned to empirically test interventions at the three hospitals, which comprise Heart of England NHS Foundation Trust. This provided the opportunity to test the feasibility of delivering three interventions. In selecting cardiac arrest debriefing approaches, we recognised the need to select three distinct approaches as, in practice, organisations will make minor modifications to an intervention to meet local requirements.

### **7.3.1 Stage one: identification of cardiac arrest debriefing approaches**

A list of approaches to cardiac arrest debriefing was developed using findings from our systematic review, other debriefing literature, and our own experience of delivering cardiac arrest debriefing. Potential modifications of these approaches were included. Each intervention was categorised based on six variables (format, frequency, facilitator, recipient, duration, and the type of data used for the debrief).

### **7.3.2 Stage two: assessment of generalisability**

Stage two provided the opportunity to assess whether each intervention would be deliverable in other NHS hospitals. Bonell et al identify three characteristics of a generalisable intervention, namely feasibility, adequate coverage, and acceptability.<sup>258</sup> Feasibility describes whether it is practically possible to deliver an intervention. Adequate coverage refers to whether an intervention reaches its target population. Acceptability describes whether the intervention will be acceptable to its intended recipients.

During this stage, we assessed whether each intervention identified during stage one possessed these three characteristics. This assessment drew on our qualitative and process evaluation work, and enabled us to identify and rule out debriefing approaches that were considered unlikely to be generalisable. There was some overlap between stages one and two of this process. Our approach to categorisation of debriefing

approaches meant that our initial list could potentially include 720 debriefing approaches. We therefore adopted a pragmatic approach to the listing of approaches such that we elected not to list each variation if a similar approach had already been identified as not being generalisable.

### **7.3.3 Stage three: application of theory**

The theoretical domains framework synthesises 33 behaviour change theories.<sup>260</sup> First developed in 2005, it is designed to be accessible to researchers without specialist expertise in health psychology. The TDF was refined in 2012, such that it currently consists of 14 domains, which include a total of 84 constructs (Table 7-1).<sup>263</sup> Through these constructs, the TDF covers the key factors that influence clinician behaviour and overcomes the problems associated with the use of a small number of narrow theories.<sup>263,428</sup> Since its development, it has been cited over 130 times and has previously been used in the development of complex interventions.<sup>257,266,430</sup>

During stage three of the process, we applied these TDF domains to our shortlist of debriefing approaches to identify which approaches were best supported by theory. We included all constructs in this analysis as previous work in a similar field suggests that all domains may be relevant to the operability of such interventions.<sup>265</sup>

**Table 7-1: Theoretical domains framework: domains and constructs**

<b>Domain/ Definition</b>	<b>Constructs</b>
<p>1. Knowledge</p> <p>An awareness of the existence of something</p>	<p>Knowledge (including knowledge of condition /scientific rationale)</p> <p>Procedural knowledge</p> <p>Knowledge of task environment</p>
<p>2. Skills</p> <p>An ability or proficiency acquired through practice</p>	<p>Skills</p> <p>Skills development</p> <p>Competence</p> <p>Ability</p> <p>Interpersonal skills</p> <p>Practice</p> <p>Skill assessment</p>
<p>3. Social/ Professional Role and Identity</p> <p>A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting</p>	<p>Professional identity</p> <p>Professional role</p> <p>Social identity</p> <p>Identity</p> <p>Professional boundaries</p> <p>Professional confidence</p> <p>Group identity</p> <p>Leadership</p> <p>Organisational commitment</p>
<p>4. Beliefs about Capabilities</p> <p>Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use</p>	<p>Self-confidence</p> <p>Perceived competence</p> <p>Self-efficacy</p> <p>Perceived behavioural control</p> <p>Beliefs</p> <p>Self-esteem</p> <p>Empowerment</p> <p>Professional confidence</p>
<p>5. Optimism</p> <p>The confidence that things will happen for the best or that desired goals will be attained</p>	<p>Optimism</p> <p>Pessimism</p> <p>Unrealistic optimism</p> <p>Identity</p>
<p>6. Beliefs about Consequences</p> <p>Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation</p>	<p>Beliefs</p> <p>Outcome expectancies</p> <p>Characteristics of outcome expectancies</p> <p>Anticipated regret</p> <p>Consequents</p>
<p>7. Reinforcement</p> <p>Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus</p>	<p>Rewards (proximal / distal, valued / not valued, probable / improbable)</p> <p>Incentives</p> <p>Punishment</p> <p>Consequents</p> <p>Reinforcement</p> <p>Contingencies</p> <p>Sanctions</p>
<p>8. Intentions</p> <p>A conscious decision to perform a behaviour or a resolve to act in a certain way</p>	<p>Stability of intentions</p> <p>Stages of change model</p> <p>Transtheoretical model and stages of change</p>

Domain/ Definition	Constructs
<p>9. Goals</p> <p>Mental representations of outcomes or end states that an individual wants to achieve</p>	<p>Goals (distal / proximal)            Goal priority            Goal / target setting            Goals (autonomous / controlled)            Action planning            Implementation intention</p>
<p>10. Memory, Attention and Decision Processes</p> <p>The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives</p>	<p>Memory            Attention            Attention control            Decision making            Cognitive overload / tiredness</p>
<p>11. Environmental Context and Resources</p> <p>Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour</p>	<p>Environmental stressors            Resources / material resources            Organisational culture /climate            Salient events / critical incidents            Person x environment interaction            Barriers and facilitators</p>
<p>12. Social influences</p> <p>Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours</p>	<p>Social pressure            Social norms            Group conformity            Social comparisons            Group norms            Social support            Power            Intergroup conflict            Alienation            Group identity            Modelling</p>
<p>13. Emotion</p> <p>A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event</p>	<p>Fear            Anxiety            Affect            Stress            Depression            Positive / negative affect            Burn-out</p>
<p>14. Behavioural Regulation</p> <p>Anything aimed at managing or changing objectively observed or measured actions</p>	<p>Self-monitoring            Breaking habit            Action planning</p>

Adapted from Cane et al 2012<sup>263</sup>

## 7.4 Results

Based on our review of the literature we developed a list of 18 cardiac arrest debriefing approaches (Table 7-2). This comprised three hot debriefing approaches and 15 cold debriefing approaches. During stage two, eleven approaches were excluded as they were assessed as not being generalisable (Table 7-2). The most common reasons for exclusion were unfeasibility (nine approaches) and unacceptability (six approaches). Our shortlist comprised seven approaches (approach 8, 12, 13, 14, 16, 17, 18).

These seven shortlisted approaches could be broadly categorised in three groups. The first group included only approach eight (individual oral debriefing for members of the direct care team). The second group consisted of cold group debriefing delivered at different frequencies, namely approach 12 (a dedicated monthly group debriefing meeting), approach 13 (a dedicated quarterly group debriefing meeting), and approach 14 (monthly group debriefing delivered as a brief section (10-minutes) in another meeting). The final group included written feedback approaches which were delivered to different audiences, namely approach 16 (written feedback to the direct care team after each arrest), approach 17 (written feedback to all hospital staff after each cardiac arrest), and approach 18 (a monthly written summary sent to all hospital staff).

The application of the TDF domains to shortlisted approaches is shown in table 7-3. The identification of three broad groupings and the availability of three hospital sites where interventions could be tested enabled us to select the approach in each group that was considered best supported by underpinning theory. For group one, this was, by default, approach number eight (individual oral debriefing for members of the direct care team), although this was very reasonable given the findings from our application of the TDF.

**Table 7-2: List of cardiac arrest debriefing approaches**

Approach	Format	Frequency	Facilitator	Recipient	Duration (up to)	Data	Feasible	Adequate Coverage	Acceptable
1 (Hot)	Oral	After every arrest	External facilitator	Team leader	10 minutes	Clinician recall	x	x	x
2 (Hot)	Oral	After every arrest	Team leader	Direct care team (as group)	10 minutes	Clinician recall	x	✓	x
3 (Hot)	Oral	After every arrest	External facilitator	Direct care team (as group)	10 minutes	Clinician recall	x	✓	x
4 (Cold)	Oral	After every arrest	External facilitator	Team leader	10 minutes	Clinician recall CPR quality data	✓	x	x
5 (Cold)	Oral	After every arrest	External facilitator	Direct care team (as group)	10 minutes	Clinician recall CPR quality data	x	✓	x
6 (Cold)	Oral	After every arrest	External facilitator	Direct care team (as group)	30 minutes	Clinician recall	x	✓	x
7 (Cold)	Oral	After every arrest	External facilitator	Direct care team (as group)	30 minutes	Clinician recall CPR quality data	x	✓	✓
8 (Cold)	Oral	After every arrest	External facilitator	Direct care team (individually)	10 minutes	Clinician recall CPR quality data	✓	✓	✓
9 (Cold)	Oral	After every arrest	External facilitator	Hospital clinical staff	45 minutes	Clinician recall CPR quality data	x	✓	✓
10 (Cold)	Oral	Weekly	External facilitator	Hospital clinical staff	45 minutes	Clinician recall CPR quality data	x	✓	✓
11 (Cold)	Oral	Fortnightly	External facilitator	Hospital clinical staff	45 minutes	Clinician recall CPR quality data	x	✓	✓

<b>Approach</b>	<b>Format</b>	<b>Frequency</b>	<b>Facilitator</b>	<b>Recipient</b>	<b>Duration (up to)</b>	<b>Data</b>	<b>Feasible</b>	<b>Adequate Coverage</b>	<b>Acceptable</b>
12 (Cold)	Oral	Monthly	External facilitator	Hospital clinical staff	45 minutes	Clinician recall CPR quality data	✓	✓	✓
13 (Cold)	Oral	Quarterly	External facilitator	Hospital clinical staff	45 minutes	Clinician recall CPR quality data	✓	✓	✓
14 (Cold)	Oral	Monthly summary*	External facilitator	Hospital clinical staff	10 minutes	CPR quality data	✓	✓	✓
15 (Cold)	Written	After every arrest	-	Team leader	-	CPR quality data	✓	✘	✓
16 (Cold)	Written	After every arrest	-	Direct care team	-	CPR quality data	✓	✓	✓
17 (Cold)	Written	After every arrest		Hospital clinical staff		CPR quality data	✓	✓	✓
18 (Cold)	Written	Monthly summary	-	Hospital clinical staff	-	CPR quality data	✓	✓	✓

\* Incorporated as part of another meeting- e.g. quality assurance, mortality and morbidity



**Table 7-3: Application of theoretical domains framework to shortlist of cardiac arrest debriefing approaches**

TDF construct	Effect of approaches on construct
1. Knowledge	All interventions provide the opportunity to provide knowledge. There will be greater opportunity with approaches that provide the opportunity for discussion (approach 8, 12, 13, 14) in contrast to approaches where there is no opportunity for discussion (approach 14, 16, 17, 18).
2. Skills	Debriefing interventions provide no opportunity to practice technical skills, but may provide some opportunity to develop interpersonal skills and competence through discussions about human factors and alternative methods of skill delivery (approach 8, 12, 13). Specific brief advice may be included in written feedback (approach 16, 17, 18). Approach 14 provides limited opportunity for discussion, which may limit its usefulness in this area.
3. Social/ Professional Role and Identity	Clinicians view their commitment to delivering best care as a core component of their professional role and identity. Most view the discussion of events in an open forum (approach 12, 13, 14) or the receipt of objective information on their performance (approach 8, 16) as part of this role. There is a potential threat to this professional role if care delivery is suboptimal, particularly when data are shared beyond the direct care team (approach 12, 13, 14, 17, 18).
4. Beliefs about Capabilities	It is difficult to assess quality of CPR without the availability of objective data. Our qualitative work found that clinicians valued these data. Data were described as an important component of debriefing, in that it stimulated reflection on events, thereby affecting performance. Such data may also promote reflection by challenging misplaced self-confidence/ competence. This process may be more effective with data showing personal/ team performance (approach 8, 12, 13, 16, 17), rather than summary data from several cardiac arrest events (approach 14, 18).
5. Optimism	There is often unjustified pessimism about survival following in-hospital cardiac arrest patients. Our qualitative work showed that debriefing can shift clinicians' perception of in-hospital cardiac arrest so that they become more optimistic about the potential reversibility of the condition. This may be affected by both discussion (approach 8, 12, 13, 14) and feedback on own performance (all approaches).
6. Beliefs about Consequences	Debriefing provides the opportunity to review evidence that demonstrates the effect of suboptimal CPR delivery on patient outcome. This overlaps with construct five (optimism) as often the perception that CPR quality is unimportant is driven by pessimism about outcome following in-hospital cardiac arrest. Debriefing approaches that incorporate a discussion element may be more effective in impacting beliefs about the consequences of not delivering high-quality CPR (approach 12, 13). Other approaches enable key information to be shared, but these will inevitably be more limited in their scope (approach 8, 14, 16, 17, 18).

TDF construct	Effect of approaches on construct
7. Reinforcement	Reinforcement in debriefing interventions results from regular exposure to debriefing interventions. This enables an improvement in performance to be identified. Approaches that are infrequent or generic, such as those that (i.e. information is sent to the wider team) are less likely to result in such positive reinforcement (approach 13, 14, 17, 18).
8. Intentions	As clinicians do not intend to deliver suboptimal care at cardiac arrest events, the effect of debriefing on other constructs (e.g. knowledge, beliefs about consequences) may increase clinicians' resolve to deliver high-quality CPR.
9. Goals	All debriefing approaches provide the opportunity to set specific goals for CPR quality by comparing the team's performance with national guidelines. <sup>14</sup> This triggers reflection on performance if an individual was a direct care team member at the cardiac arrest event being debriefed (approach 8, 12, 13, 16).
10. Memory, Attention and Decision Processes	The concept of debriefing "getting resus at the forefront" was a key finding in our qualitative study. This increases organisational focus on CPR quality. This is an important process as cardiac arrest is a complex medical emergency that may lead to cognitive overload. Debriefing approaches that are delivered more frequently will have a greater impact on this construct through regular exposure of clinicians to this key message (approach 8, 12, 14, 16, 17, 18).
11. Environmental Context and Resources	Debriefing interventions are unlikely to have any measurable effect on environment, context or resources.
12. Social influences	Our qualitative study found evidence that multidisciplinary discussions about cardiac arrest events in an open forum promoted group identify and improved working relationships between members of the multidisciplinary cardiac arrest team. This established a social norm that the team is expected to deliver high-quality CPR. This was demonstrated despite many clinicians attending debriefing meetings on a single occasion. These effects are likely to realised only through group debriefing approaches (approach 12, 13, 14).
13. Emotion	Cardiac arrests are complex events that can induce stress and anxiety. Discussion at debriefing meetings may sometimes reduce this anxiety (approach 8, 12, 13). However, clinicians may also not feel able to discuss stressful events in an open forum, such that written feedback may be more beneficial (approach 16, 17, 18). Approach 14 provides minimal opportunity for discussion, so offers little scope for emotional benefit whilst placing the participant in an open forum in which they may feel vulnerable.
14. Behavioural Regulation	This construct overlaps significantly with construct six (beliefs about capabilities) and construct nine (goals).

For group two, approach 12 (monthly group debriefing meeting) was selected. The quarterly delivery of approach 13 was considered too infrequent to promote and maintain clinician focus on the importance of CPR quality (construct ten: memory, attention and decision processes). Approach 14 was rejected as, in contrast to approaches 12 and 13, it provides limited opportunity for discussion which may reduce its effect on knowledge and skills (construct one: knowledge; construct two: skills). Furthermore, in contrast to feedback on a specific event, the use of a data summary was considered less likely to encourage reflection and reinforce the importance of CPR quality (construct four: beliefs about capabilities; construct seven: reinforcement).

In group three, approach 16 (written feedback to the direct care team after each arrest) was selected. Approaches 17 and 18 were primarily rejected as the benefit in sharing information with the wider clinical team was outweighed by the potential threat to the clinicians' social and professional role if information were shared widely and the feedback recorded suboptimal care delivery (construct three: social/ professional role and identity).

## **7.5 Discussion**

In this work package, we have described a three-step process for developing cardiac arrest debriefing approaches. Three interventions were developed, namely monthly group debriefing, written feedback to the direct care team after each cardiac arrest, and individual oral debriefing to the direct care team after each cardiac arrest. The approach used has, as far as possible, ensured that each intervention is both generalisable across the NHS and grounded in behaviour change theory.

Variations of each intervention have been described previously, but are not currently in widespread use. Carbine et al described a monthly debriefing intervention in which neonatal resuscitations were reviewed during a quality assurance meeting, but do not

detail what proportion of the meeting was allocated to these reviews.<sup>348</sup> Lyon et al provided written feedback to the direct care team following pre-hospital cardiac arrests.<sup>172</sup> Individual oral debriefing has been described in a trauma study, but the intervention was only offered to the trauma team leader.<sup>338</sup>

This is the first study to develop cardiac arrest debriefing approaches using an approach based on the importance of intervention generalisability and the application of behaviour change theory. Previous cardiac arrest debriefing have seemingly been developed using only researcher intuition as to what is likely to be effective. The concept of generalisability describes the need for an intervention to be both deliverable and effective outside of the organisation in which it was developed. The criteria for intervention generalisability described by Bonell et al were developed in response to evidence that sexual health trials rarely considered intervention delivery in other settings.<sup>258</sup> Cardiac arrest debriefing studies tend to be undertaken in a single centre, such that the intervention is often developed to specifically address a local need to improve CPR quality. Whilst this approach is reasonable, it has led to the use of interventions, such as weekly group debriefing intervention, which are challenging to deliver in many other organisations.

Cardiac arrest debriefing studies make infrequent reference to theory. In Wolfe et al, a reference is made to adult learning theory but this is in the context of a passing reference in a post-hoc explanation of how the intervention affected practice.<sup>111</sup> This infrequent use of theory is in keeping with the findings of systematic reviews of the use of theory in studies of knowledge translation interventions, such as debriefing.<sup>261,385</sup> Davies et al reviewed the use of theory in 235 studies that were included in a Health Technology Assessment review of guideline dissemination and implementation strategies.<sup>261</sup> Of the included studies, 53 (23%) studies were judged to have incorporated a behaviour change theory, but only ten (4%) studies made explicit reference to theory. Similarly, Colquhoun et al found that only 20 (14%) of the 140

studies included in the Cochrane review on the use of audit and feedback explicitly referred to theory.<sup>385</sup> A recent literature scope identified 82 separate behaviour change theories described in the literature.<sup>429</sup> As such, the common omission of reference to theory in the development of a complex intervention is perhaps unsurprising.

Eccles et al draw a parallel between failure to use theory in intervention development with undertaking a randomised controlled trial of a drug without first understanding its pharmacology.<sup>262</sup> Michie et al describe three reasons for incorporating theory in the development of an intervention.<sup>431</sup> Firstly, an intervention is more likely to be effective if it is informed by theory. Secondly, a theoretically-informed intervention enables the theory itself to be evaluated. Finally, at a broader level, it enables researchers to identify what works and why, thereby facilitating the development of theory across contexts and populations. This is not to suggest that a theoretically informed intervention will be universally effective, particularly if the theory used is either not applicable to the study setting or is poorly applied.<sup>259</sup>

The development of the TDF has enabled researchers without expertise in health psychology to incorporate behaviour change theory in complex intervention development.<sup>260</sup> Its use in the development of complex interventions has been described previously.<sup>257,430</sup> For example, French et al used the framework in the development of a primary care lower back pain intervention.<sup>257</sup>

Cardiac arrest debriefing studies have typically found an association between implementation of debriefing and an improvement in CPR quality, although this finding is not universal.<sup>115</sup> One explanation for this may be that, to date, these interventions have lacked a clear theoretical basis and may not be generalisable to other organisations. The key strength in our approach is that we prioritised both intervention generalisability and the incorporation of underpinning theory in developing each intervention.

## **7.6 Limitations**

Our process for developing three cardiac arrest debriefing interventions has two key limitations. Firstly, whilst the use of the TDF in developing complex intervention has been described previously, our overall approach was novel.<sup>257,430</sup> This new approach to complex intervention development was driven by a lack of guidance in the literature.<sup>257</sup> Our approach was considered reasonable, but its effectiveness remains unclear.

Secondly, intervention development was undertaken without the assistance of a health psychologist. Francis et al caution that there is the risk of superficial use of the TDF if it is applied without the guidance of a health psychologist.<sup>266</sup> However, the TDF was explicitly developed for researchers without health psychology expertise.<sup>260</sup> We felt our application of the TDF was rigorous, such that it is unclear whether guidance from a health psychologist would have made a measurable difference to the development of each intervention.

## **7.7 Conclusion**

In this study, a rigorous approach was used to develop three cardiac arrest debriefing approaches that are both based on theory and generalisable across the majority of NHS settings. The cardiac arrest debriefing approaches identified were monthly group debriefing, written feedback to the direct care team after each cardiac arrest, and individual debriefing for members of the direct care team following each cardiac arrest. There is now a need to test the feasibility of delivering these interventions in the NHS setting and to assess their effect on CPR quality and patient outcome.

## **Chapter 8: The CardiOpulmonary resuscitation DEbriefing (CODE) study**

## 8.1 Abstract

**Introduction:** The use of cardiac arrest debriefing is associated with improvements in cardiopulmonary resuscitation (CPR) quality and return of spontaneous circulation. In response to evidence that some cardiac arrest debriefing approaches are challenging to deliver in NHS hospitals, we developed three cardiac arrest debriefing approaches that are tailored to NHS working practice. The aim of this study was to evaluate the deliverability and effectiveness of these debriefing approaches.

**Methods:** We undertook a before/ after study at three hospital sites, which comprise one NHS trust. During the second phase of the study, three cardiac arrest debriefing models were implemented at study hospitals (one model per hospital). To evaluate the effectiveness of the interventions, CPR quality and patient outcome data were collected from consecutive adult cardiac arrest events attended by the hospital cardiac arrest team. The primary outcome was chest compression depth.

**Results:** Between November 2011 and July 2014, 1198 cardiac arrest events were eligible for study inclusion (782 phase one; 416 phase two). During phase two of the study, cardiac arrest debriefing interventions were delivered to 191 clinicians on 344 occasions. Debriefing interventions were not associated with a clinically important improvement in CPR quality. The interventions had no effect on patient outcome.

**Conclusion:** The delivery of these cardiac arrest debriefing strategies was feasible, but did not have a clinically important effect on CPR quality. We attribute this finding to the high-quality of CPR being delivered in study hospitals at baseline.

Trial registration: ISRCTN39758339



## 8.2 Introduction

The use of cardiac arrest debriefing is recommended in international resuscitation guidelines.<sup>97,100,101</sup> A variety of debriefing approaches are described in the literature, but the most effective approach remains unclear.<sup>97,117,164</sup> One of the more popular approaches consists of a weekly group meeting at which clinical staff review recent cardiac arrest events.<sup>110,152,170</sup> In an American hospital, the implementation of this debriefing approach was associated with a significant improvement in cardiopulmonary resuscitation (CPR) quality and return of spontaneous circulation (ROSC).<sup>152</sup>

The deliverability and effectiveness of complex interventions, such as cardiac arrest debriefing, may be affected by the context in which they are implemented.<sup>206,219,432-434</sup> Differences between international health systems precludes the widespread adoption of weekly group debriefing in the United Kingdom. There was therefore a need to develop debriefing approaches that are tailored to NHS working practices. We developed three such approaches using a rigorous process, based on the Medical Research Council framework for the development and evaluation of complex interventions.<sup>181</sup> The aim of this study was to test the feasibility of delivering these approaches in the NHS setting and to assess their effect on CPR quality and patient outcomes.

## 8.3 Methods

We implemented three cardiac arrest debriefing interventions (monthly group debriefing, individual debriefing, written feedback) at three hospitals which comprise Heart of England NHS Foundation Trust. One cardiac arrest debriefing strategy was implemented at each hospital. Using a before/ after analysis, the CODE (cardiopulmonary resuscitation debriefing) study evaluated the deliverability of each intervention and its effect on CPR quality and patient outcome.

The study was approved by the Oxford C Research Ethics Committee (REC number: 13/SC/0363, 13<sup>th</sup> August 2013) who waived the requirement to obtain informed consent from study participants prior to study enrolment.

The study was registered with Current Controlled Trials Registry (ISRCTN39758339).

### **8.3.1 Study participants**

The study recruited two groups of participants: patients and staff.

#### **8.3.1.1 Patient inclusion/ exclusion criteria**

Adult patients (aged  $\geq 18$  years) were included if they had a cardiac arrest at one of the study hospitals which was attended by the hospital emergency team. Patients were excluded if they had a valid do not attempt cardiopulmonary resuscitation (DNACPR) order at the time of the cardiac arrest event.

#### **8.3.1.2 Staff inclusion/ exclusion criteria**

Staff at hospital one were eligible to receive cardiac arrest debriefing if they were involved, or potentially involved, in the care of cardiac arrest patients. Staff at hospitals two and three were eligible to receive cardiac arrest debriefing if they attended a cardiac arrest where accelerometer data were collected and where the cardiac arrest lasted at least five minutes.

### **8.3.2 Study design and interventions**

Phase one of the study (November 2011- May 2013) comprised the intervention period of the CPR Quality Improvement Initiative study. During phase two of the study (September 2013-July 2014), a tailored cardiac arrest debriefing intervention was delivered at each study hospital. The study design is summarised in Table 8-1. This dovetailing of the CODE study with the CPR Quality Improvement Initiative enabled CPR Quality Improvement Initiative study to act as control period data for the CODE

study and meant that Phillips MRX QCPR defibrillators (Philips Healthcare, Andover, Massachusetts) were already in place at study hospitals

**Table 8-1: CODE study design**

	<b>Phase one (Nov 2011 -May 2013)</b>	<b>Phase two (Sept 2013-July 2014)</b>
<b>Hospital one</b>	Weekly group debriefing*	Monthly group debriefing*
<b>Hospital two</b>	No debriefing*	Oral personal debriefing*
<b>Hospital three</b>	No debriefing	Written Feedback*

Key: \* Real-time audiovisual feedback provided

The aim of each intervention implemented during phase two was to improve CPR delivery at cardiac arrest events. At hospital one, clinicians received monthly group debriefing. This enabled us to measure the effect of reducing the frequency (weekly to monthly) of the group debriefing intervention that hospital one staff received during phase one of the study. At hospital two, staff received individual debriefing. This was a verbal debriefing intervention that lasted approximately five minutes, that was intended to be delivered to cardiac arrest attendees within four days of the cardiac arrest. At hospital three, written feedback sheets were emailed to cardiac arrest attendees as soon as possible after the cardiac arrest event.

Interventions were allocated to hospitals, based on the character of the hospital and where it was thought they would work most effectively. Full details of each intervention, based on the TIDieR (template for intervention description and replication) framework, are included in Tables 8-2 to 8-4.<sup>227</sup> All interventions were delivered by myself, who worked full-time on the study across the three hospital sites.

**Table 8-2: Overview of monthly group debriefing intervention: hospital one**

Why	<p>Whilst early data supports the use of cardiac arrest debriefing, some models may not be deliverable in the NHS setting.</p> <p>This intervention is intended to be deliverable in the NHS. Its aim is to improve delivery of CPR.</p>
What	<p><b>Materials</b></p> <p>Posters advertising the meetings were placed in staff areas throughout the hospital. Members of the research team regularly attended medical handover meetings to remind clinicians about the meetings. Clinicians that were known to have attended the cardiac arrest events planned for discussion were sent an email 1-4 days prior to the meeting specifically inviting them to attend.</p> <p>The debriefing meeting consisted of a discussion about cardiac arrest management. This was supplemented by a slide presentation (Microsoft PowerPoint 2007, Microsoft, Redmond, Washington) to show relevant data and potential discussion points. Example presentation slides are shown in the appendix (Section 12.2.1).</p> <p><b>Procedures</b></p> <p>Debriefing meetings consisted of four sections:</p> <ol style="list-style-type: none"> <li>1. Introduction- this section summarised the rationale for the research study and set ground rules for the meeting, including emphasis of the need for a confidential and no-blame environment with a focus on improving practice.</li> <li>2. Review of relevant research- this section was included in most meetings, and provided an opportunity to review and discuss key literature in the field of cardiac arrest, such as the importance of CPR quality.</li> <li>3. Case review and discussion- 1-3 recent cardiac arrest events were reviewed. Summaries included background to the arrest and patient characteristics, review of the arrest event and CPR quality data, and patient outcome. Patient details were anonymised. Clinicians who had been present at the cardiac arrest were invited to share their insight in to events. Other debriefing attendees participated in discussions to share any similar experiences.</li> <li>4. Summary of key learning points- the final section consisted of a review of key learning points and provided a further opportunity to ask questions.</li> </ol>
Who provided	Debriefings were facilitated by myself (a resuscitation research nurse), who also undertook all meeting preparatory work.
How	Group face-to-face debriefing meetings lasting approximately 45-minutes were held every month.
Where	The intervention was delivered at a large teaching hospital with 703 beds. In 2013, there were 271 cardiac arrests which were attended by the hospital emergency team. Debriefing meetings were held in a seminar room located on the hospital acute medical unit, which was a central location on the hospital site. The room was large enough to accommodate up to approximately 30 people and was equipped with a computer and audiovisual facilities to show presentation slides. The table and chairs were arranged in a horseshoe shape. Lunch was provided at each meeting.
When and how much	All meetings were open to all clinicians. This encompassed doctors, nurses, and allied health professionals, as well as medical and nursing students. Meetings were held on the second Tuesday of each month for eleven months.
Tailoring	Meetings were tailored each month, based on the cases being discussed and amount of discussion generated. This was a dynamic process, which sought to adapt to attendees' needs.
Modifications	No modifications were made during the study period. The meeting format had been developed during a previous study.
How well	<p><b>Planned:</b> A data set was collected at each debriefing meeting, including a register of attendees.</p> <p><b>Actual:</b> See data in chapter.</p>

**Table 8-3: Overview of individual oral debriefing intervention: hospital two**

Why	<p>Whilst early data supports the use of cardiac arrest debriefing, some models may not be deliverable in the NHS setting.</p> <p>The intervention is intended to be deliverable in the NHS. Its aim is to improve delivery of CPR.</p>
What	<p><b>Materials</b></p> <p>Posters advertising cardiac arrest debriefing were placed in staff areas throughout the hospital.</p> <p>The debriefing consisted of a brief (approximately 5-minutes) discussion about the cardiac arrest. This was supplemented by a brief slide presentation (Microsoft PowerPoint 2007, Microsoft, Redmond, Washington) to show relevant data and key learning points. Example presentation slides are shown in the appendix (Section 12.4.1).</p> <p><b>Procedures</b></p> <p>Following an eligible cardiac arrest, a list of attendees was identified through case notes and rotas. These clinicians were emailed and offered the chance to participate in an individual debrief.</p> <p>Debriefings consisted of a review of cardiac arrest event. This included a summary of the event and patient characteristics, review of electrocardiogram rhythms, and CPR quality. The participant was encouraged to reflect on events and ask questions. Patient details were anonymised.</p>
Who provided	Debriefings were facilitated by myself (a resuscitation research nurse).
How	An individual oral debrief that lasted approximately 5-minutes was held following eligible cardiac arrests with event attendees individually.
Where	The intervention was delivered at a district general hospital with 480 beds. In 2013, there were 134 cardiac arrests which were attended by the hospital emergency team. Debriefs were held at the hospital at a location convenient to the recipient. Locations used included ward areas and private offices. A laptop computer was used to show presentation slides.
When and how much	All clinicians that attended the cardiac arrest were eligible to receive a debrief. Debriefs were held as soon as possible after the cardiac arrest, ideally 3-4 days after the cardiac arrest.
Tailoring	Meetings were tailored to the needs of each participant. The length of the debrief was determined by the case being discussed, the participant's reflective process, and amount of discussion generated.
Modifications	No modifications were made during the study period.
How well	<p><b>Planned:</b> A data set was collected for each cardiac arrest event and each debrief.</p> <p><b>Actual:</b> See data in chapter.</p>

**Table 8-4: Overview of written feedback intervention: hospital three**

Why	<p>Whilst early data supports the use of cardiac arrest debriefing, some models may not be deliverable in the NHS setting.</p> <p>The intervention is intended to be deliverable in the NHS. Its aim is to improve delivery of CPR.</p>
What	<p><b>Materials</b></p> <p>Posters advertising the intervention were placed in staff areas throughout the hospital.</p> <p>A feedback sheet was created using Microsoft Word (Microsoft Word 2007, Microsoft, Redmond, Washington) to show relevant CPR quality data, a summary of the cardiac arrest event, and key learning points. The length of the sheet was a single side of A4. An example feedback sheet is shown in the appendix (Section 12.4.2).</p> <p><b>Procedures</b></p> <p>Following each cardiac arrest, a list of attendees was identified through case notes and rotas.</p> <p>Defibrillator data were downloaded. In conjunction with information from the case notes, a feedback sheet was created.</p> <p>The feedback sheet was emailed to cardiac arrest attendees. The covering email requested that recipients reply to confirm that they had attended the cardiac arrest and reviewed the feedback sheet. Patient details were anonymised.</p>
Who provided	Feedback sheets were compiled by myself (a resuscitation research nurse).
How	Feedback sheets were emailed to cardiac arrest attendees as soon as possible after each eligible cardiac arrest.
Where	The intervention was delivered at a small district hospital with 248 beds. In 2013, there were 102 cardiac arrests which were attended by the hospital emergency team. Clinicians could review feedback sheets at any location where they could access their email account.
When and how much	Cardiac arrest feedback sheets were sent via email to all clinical staff who attended cardiac arrest. The sheet was sent as soon as possible after an eligible cardiac arrest.
Tailoring	The format of feedback sheets were standardised. Free-text varied based on key learning points identified from the CPR data.
Modifications	No modifications were made during the study period.
How well	<p><b>Planned:</b> A data set was collected for each cardiac arrest event and each debrief.</p> <p><b>Actual:</b> See data in chapter.</p>

### 8.3.3 Study data collection

The following data were collected for each cardiac arrest event:

- Demographic data: gender, age, reason for admission.
- Cardiac arrest data: time of cardiac arrest, location of cardiac arrest, initial rhythm, whether the arrest was monitored or witnessed, or was an out-of-hospital cardiac arrest.
- CPR quality outcomes: chest compression depth, chest compression rate, chest compression flow-fraction, incidence of incomplete release, peri-shock pause.
- Patient outcomes: Return of spontaneous circulation (ROSC), survival to hospital discharge, discharge cerebral performance category score.

Definitions of data items were based on Utstein definitions and other standardised definitions.<sup>182,293</sup> ROSC was defined as the return of a spontaneous palpable pulse for at least twenty minutes.

#### **8.3.3.1 Demographic, cardiac arrest, and patient outcome data**

Demographic and cardiac arrest characteristic data were contemporaneously collected and recorded on a local database by the critical care outreach team member that attended the cardiac arrest event. Patient outcome data were collected by the resuscitation service, based on clinical records and discharge summaries.

Demographic, cardiac arrest characteristic, and patient outcome data were primarily collected for local participation in the National Cardiac Arrest Audit and to comply with Department of Health requirements for monitoring of in-hospital cardiac arrest events.<sup>15,186</sup> Staff that collected data had received training in the collection of these data and the definitions of individual data items.

A log of phone calls that requested emergency team attendance was maintained by the hospital switchboard. The log recorded the call date and time, emergency location, and patient details. Every weekday throughout the study period, resuscitation service staff reconciled data recorded by the switchboard with those recorded by the critical care outreach team to ensure that no cardiac arrest event was missed.

Any apparent data discrepancies were investigated through a process of questioning staff and reviewing clinical records.

#### **8.3.3.2 CPR quality data**

Study defibrillators automatically recorded CPR quality data when used at cardiac arrests. The main defibrillator in use at the trust during the study period was the Phillips MRX QCPR defibrillator (Philips Healthcare, Andover, Massachusetts). When used

with the puck placed on the patient's chest during cardiac arrest, the device collects key CPR quality metric data, namely: chest compression depth, chest compression rate, chest compression flow-fraction, chest compression incomplete release, and peri-shock pause. These accelerometer data were automatically extracted by manufacturer software (Phillips Heartstart Event Review Pro 4.2 software, Phillips Healthcare, Andover, Massachusetts, USA).

When the team forgot to use the CPR puck, transthoracic impedance data were extracted from the defibrillator record. Transthoracic impedance data require manual extraction to derive chest compression rate, chest compression flow-fraction, and peri-shock pause. Chest compression depth and chest compression incomplete release data are not available. Chest compression rate and flow-flow-fraction data derived from manual analyses are highly correlated with data derived from automatic analyses of accelerometer data (flow-fraction  $r = 0.979$ ,  $p < 0.001$ ; chest compression count  $r = 0.998$ ,  $p < 0.001$ ). Manufacturer software (QCPR Review V2.1 software, Laerdal Medical, Stavanger, Norway) was used to display these data to facilitate data extraction.

Both approaches to data extraction have been used in previous studies and shown to be validated approaches.<sup>60,152,279,295-302</sup> The standard definition for each outcome, as defined in the resuscitation literature, was used to ensure consistency and facilitate comparison with other studies.<sup>182,293</sup>

A cardiac arrest event was only included in the analysis of CPR quality outcomes if it contained at least five minutes of CPR quality data. For eligible cases, the first five minutes of available data for each variable were extracted. This approach has been used in previous studies, and provides a consistent measure of the emergency team's best CPR performance.<sup>60,152</sup>



### **8.3.4 Primary outcome and statistical analysis**

The primary study outcome was chest compression depth. Chest compression depth is associated with defibrillation success in in-hospital cardiac arrest and survival in out-of-hospital cardiac arrest.<sup>70,71,76,79</sup> The results of these studies show that a 10mm centimetre improvement in chest compression depth is a clinically important outcome.

Based on a standard deviation of 13.67, a sample size of 40 participants per hospital site in each study phase was required to detect a 10mm difference in chest compression depth at 90% power and significance level of 0.05.<sup>288</sup> The required sample size was increased to 60 participants per hospital in each phase to allow for participants for whom primary outcome data would not be available. Given cardiac arrest incidence at the two smaller hospitals, this recruitment rate was considered feasible within the allocated intervention period of 11-months.

### **8.3.5 Protection against bias**

It was not possible to blind either the researcher or the emergency teams at each hospital site to the study intervention. Most data items were objective data and so not subject to outcome bias.

The cerebral performance category (CPC) score may be subject to outcome bias, with some variability between recorders reported in the literature.<sup>435</sup> To minimise this potential bias, we ensured that CPC data were collected only by a small number of hospital resuscitation service staff, who worked across all three hospital sites. These staff have received training in the use of clinical records and discharge summaries to assess the CPC score. In addition, the primary purpose for collecting these data was for participation in local and national audits, rather than for this research study.<sup>15,186</sup>

### **8.3.6 Process evaluation**

To assess feasibility of intervention delivery within the NHS, a process evaluation data set was collected for each debriefing method. This incorporated the number of cardiac arrest events for which debriefing was offered, the number of attendees offered debriefing, the number and grade of clinicians that received debriefing, and the time at which it was delivered. We also sought to estimate the delivery time for each intervention.

In addition, debriefing recipients at each hospital were invited to complete an internet survey to gauge their reaction to cardiac arrest debriefing (Kirkpatrick Level I), the impact of debriefing on knowledge (Kirkpatrick Level II), and the self-reported effect of debriefing on practice (Kirkpatrick Level III). Questionnaires included a combination of closed questions and ordinal attitude scale questions. A similar questionnaire was used at each hospital site to enable responses to be compared between sites (appendix: section 12.4.3). Small differences in question wording reflected intervention differences between hospital site.

Invitations to complete the questionnaire were sent via email in December 2013, April 2014, and July 2014. At each time point, clinicians who had received a debriefing intervention in the preceding four months were invited to complete the questionnaire. Clinicians were invited to complete the questionnaire at one time point only, even if they then received the debriefing intervention again. The questionnaire was sent to the person's known email account, usually a hospital email account. An invite could not be sent if the clinician's email address could not be found. A reminder email was sent out after two weeks. These time points coincided with the rotation of junior doctors. The questionnaire was hosted on the internet site, [surveymonkey.com](http://surveymonkey.com) (SurveyMonkey Inc, Palo Alto, California, USA). No identifiable information was collected and responses were not tracked to individuals.

### 8.3.7 Data analysis

Data were analysed using SPSS statistical software (SPSS Version 22.0, IBM, Chicago, Illinois, USA). Categorical data are summarised using frequencies and percentages, and compared using the  $\chi^2$  test. Continuous variables were assessed for normality. Normally distributed data are reported as mean and standard deviation (SD) and compared using a t-test. Non-normally distributed data are reported as median and interquartile range (IQR) and compared using either the Mann Whitney U test or Kruskal Wallis test. In addition, the mean and standard deviation are reported for these outcome variables to facilitate comparison with other studies.

Outcome analyses for both CPR quality and patient outcome data compare phases one and two, both within each hospital and across all three hospitals. For normally distributed continuous outcomes, differences are reported as mean difference and 95% confidence interval (CI). Dichotomous outcomes include delivery of guideline-adherent care, ROSC, and discharge cerebral performance category. The cerebral performance category (CPC) at discharge was dichotomised as good neurological recovery (CPC 1/2) and poor neurological recovery (CPC 3/4/5). Dichotomous outcomes are presented as odds ratio and 95% CI and calculated using logistic regression. Patient outcome analyses (ROSC, survival to discharge, and neurological status at discharge) exclude out-of-hospital cardiac arrest patient and patients that had previously participated in the study and are adjusted for baseline patient characteristics.

For the process evaluation dataset, questionnaire responses were compared between hospital sites. Categorical data are summarised using frequencies and percentages and compared using either fishers-exact test or the  $\chi^2$  test. Continuous data and ordinal attitude scale data are reported as median and interquartile range, and compared using the Kruskal Wallis test. In addition, frequencies and percentages for each category are reported for ordinal attitude scale data.

For all analyses, a p-value  $\leq 0.05$  is considered statistically significant.

### **8.3.8 Ethical considerations**

Anonymised data collected as part of the CPR Quality Improvement Initiative study were used as phase one data for this study. The CPR Quality Improvement Initiative study was approved by Coventry Research Ethics Committee (REC number: 09/H1210/65, 26<sup>th</sup> September 2009). The committee waived the requirement to obtain any consent from patients.

Approval for the CODE study was granted by the Oxford C Research Ethics Committee (REC number: 13/SC/0363, 13<sup>th</sup> August 2013). Consent arrangements for the CODE study differed from those of the CPR Quality Improvement Initiative study. Patients were initially enrolled under a Mental Capacity Act consent waiver.<sup>292</sup> Where the patient survived the cardiac arrest, we sought consent from the patient or their representative for use of data.

For clinician participants, written consent was obtained from participants at hospitals one and two prior to intervention delivery. At hospital three, email feedback was sent to the clinician's email account, with a request that they reply to confirm that they had attended the cardiac arrest, reviewed the feedback sheet, and consented to study participation. For questionnaires, completion of the internet survey was interpreted as consent to study participation.

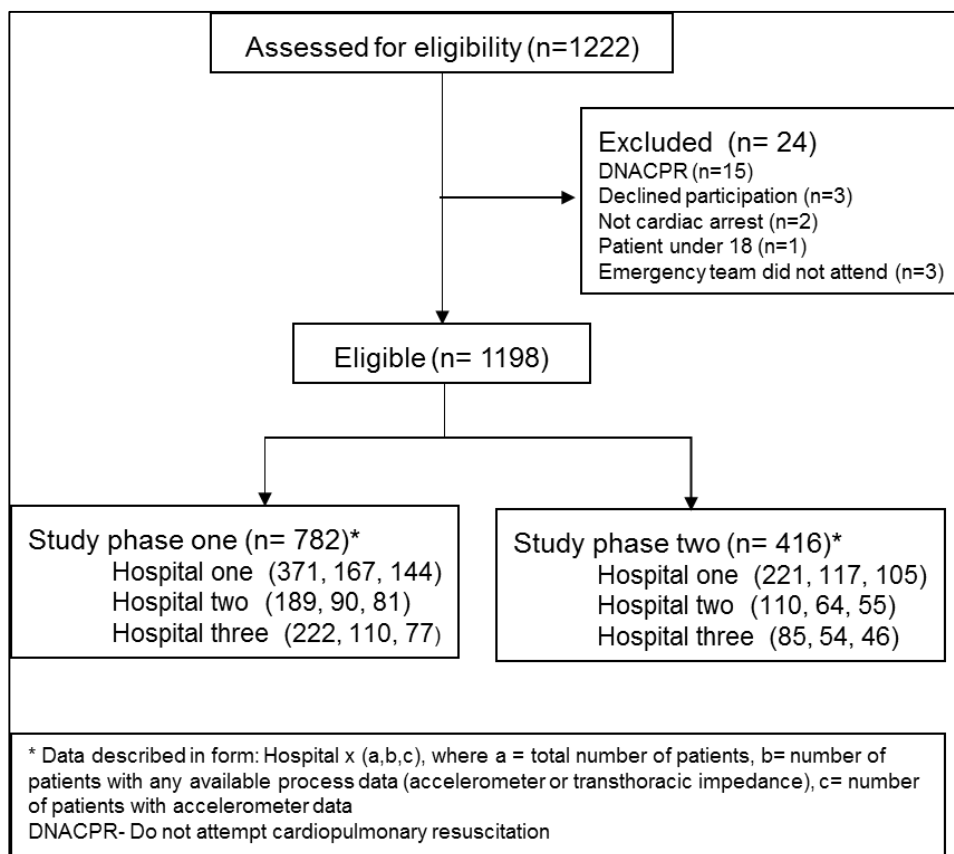
## **8.4 Results**

### **8.4.1 Overview of study events**

In the two study phases (phase one: November 2011-May 2013; phase two Sept 2013-July 2014), 1218 events were screened for eligibility. Of these, 1198 (782 phase one; 416 phase two) cardiac arrest events were eligible for study inclusion. Reasons for

exclusion were the presence of a DNACPR order (n=15), participant refusal (n=3), and other reasons (n=6). CPR quality data were available for 602 episodes (367 phase one; 235 phase two), of which 508 episodes (302 phase one; 206 phase two) included accelerometer data. A study consort diagram is included as figure 8-1. The required sample size was achieved at all hospital sites in both study phases.

**Figure 8-1: Study consort diagram**



During the study period, there were a total of 154 out-of-hospital cardiac arrests (113 phase one; 41 phase two). The majority (n=133, 86%) of these occurred at hospital three. Of the included events, 58 events (36 phase one; 22 phase two) related to patients who had previously participated in the study

During phase two, 191 clinicians received debriefing interventions on a total of 344 occasions. A breakdown of debriefing intervention recipients by professional grade and hospital site is included in table 8-5. At all three hospitals, junior doctors were the most

frequent recipients of debriefing interventions. Ten clinicians received interventions at more than one hospital site, comprising seven critical care outreach nurses, two resuscitation officers, and one junior doctor. The greatest interaction was between hospitals two and three (six clinicians), followed by hospitals one and two (two clinicians), and hospitals one and three (two clinicians).

**Table 8-5: CODE study intervention staff recipients**

	Hospital One		Hospital Two		Hospital Three	
	Attendees- n (%)	Attendances per person- median (IQR)	Attendees- n (%)	Attendances per person- median (IQR)	Attendees- n (%)	Attendances per person- median (IQR)
Consultant	10 (12%)	1 (1-2)	1 (2%)	1 (1-1)	1 (2%)	1
Registrar	11 (13%)	1 (1-2)	6 (10%)	3 (1-4)	12 (22%)	3 (1-4)
Junior doctor	25 (29%)	1 (1-2)	26 (42%)	1 (1-2)	16 (30%)	2 (1-3)
Nurse	7 (8%)	1 (1-2)	19 (31%)	1 (1-2)	11 (20%)	1 (1-1)
CCP/ CCO	6 (7%)	1 (1-3)	7 (11%)	1 (1-2)	12 (22%)	2 (1-3)
RO	4 (5%)	3 (1-5)	2 (3%)	2	1 (2%)	3
Healthcare student	17 (20%)	1 (1-1)	1 (2%)	1	1 (2%)	1
Other	5 (6%)	1 (1-2)	0	-	0	-
<b>Total</b>	<b>85 (100%)</b>	<b>1 (1-2)</b>	<b>62 (100%)</b>	<b>1 (1-2)</b>	<b>54 (100%)</b>	<b>2 (1-3)</b>

CCP- Critical Care Practitioner; CCO- Critical Care Outreach nurse; RO- Resuscitation Officer

### 8.4.2 Hospital one: monthly group debriefing

At hospital one, 11 monthly group debriefing meetings were held during the study period. At these meetings, there were a total of 140 attendances by 85 clinicians. The mean number of attendees per meeting was 13 (SD=5), with a median number attendances per person of one meeting (IQR 1-2, range 1-9). Most attendees were junior doctors (n=25, 29%) and healthcare students (n=17, 20%). Breakdown of attendees by professional group is shown in table 8-5.

During the study period, there were a total of 224 cardiac arrest events, of which 19 (8.5%) events were discussed at the eleven group debriefing meetings. A median of two cases (IQR 1-2, range 1-3) were discussed per meeting. Of the nineteen cases

discussed, someone present at the cardiac arrest event was present for the discussion for 9 (47%) cases, although this was typically only one (four cases) or two (three cases) clinicians.

There were a total of 371 eligible cardiac arrest events during phase one and 221 events during phase two at hospital one. Patient demographics were similar between study phases, except in relation to whether the cardiac arrest was witnessed and the patient category (Table 8-6). Table 8-7 provides an overview of CPR quality data at all hospital sites, whilst tables 8-8 and 8-9 give the differences between phases one and two for continuous and dichotomous outcomes respectively. The intervention was associated with an improvement in chest compression depth ( $53.2 \pm 10.4$  v  $57.2 \pm 12.4$ , mean difference 4.07, 95% CI 1.22 – 6.92,  $p=0.005$ ) and the proportion of episodes with a mean chest compression depth more than 50mm (odds ratio 1.98, 95% CI 1.13-3.47,  $p=0.02$ ) (Tables 8-7 to 8-9). The intervention was not associated with any change in relation to any other CPR quality outcome (Tables 8-7 to 8-9). The intervention had no effect on any patient outcome (Table 8-10).

**Table 8-6: Demographic details and arrest characteristics by hospital site**

	All hospitals			Hospital one			Hospital two			Hospital three		
	Phase one (n=782)	P-value*	Phase two (n=416)	Phase one (n=371)	P-value*	Phase two (n=221)	Phase one (n=189)	P-value*	Phase two (n=110)	Phase one (n=222)	P-value*	Phase two (n=85)
<b>Age- median (IQR)†</b>	76 (66-84)	0.933	76 (66-84)	75 (63-83)	0.30	75 (65-83)	77 (71-85)	0.741	80 (67-85)	78 (68-84)	0.287	75 (64-84)
<b>Male sex- n (%)</b>	465 (59.5%)	0.769	251 (60.3%)	225 (60.6%)	0.742	131 (59.3%)	106 (56.1%)	0.963	62 (56.4%)	134 (60.4%)	0.202	58 (68.2%)
<b>Patient category- n(%)</b>												
Medical	686 (87.7%)		373 (89.7%)	318 (85.7%)		189 (85.5%)	151 (79.9%)		101 (91.8%)	217 (97.7%)		83 (97.6%)
Surgical	94 (12.0%)		34 (8.2%)	53 (14.3%)		25 (11.3%)	36 (19.0%)		7 (6.4%)	5 (2.3%)		2 (2.4%)
Trauma	2 (0.3%)		9 (2.2%)	0		7 (3.2%)	2 (1.1%)		2 (1.8%)	0		0
Obstetric	0	0.001	0	0	0.002	0	0	0.01	0	0	0.958	0
<b>Initial rhythm- n (%)</b>												
VF	92 (11.8%)		64 (15.4%)	47 (12.7%)		31 (14.0%)	12 (6.3%)		14 (12.7%)	33 (14.9%)		19 (22.4%)
VT	45 (5.8%)		14 (3.4%)	25 (6.7%)		7 (3.2%)	11 (5.8%)		4 (3.6%)	9 (4.1%)		3 (3.5%)
PEA	377 (48.2%)		209 (50.2%)	181 (48.8%)		112 (50.7%)	98 (51.9%)		57 (51.8%)	98 (44.1%)		40 (47.1%)
Asystole	204 (26.1%)		100 (24.0%)	86 (23.2%)		55 (24.9%)	50 (26.5%)		26 (23.6%)	68 (30.6%)		19 (22.4%)
Unknown	64 (8.2%)	0.132	29 (7.0%)	32 (8.6%)	0.398	16 (7.2%)	18 (9.5%)	0.371	9 (8.2%)	14 (6.3%)	0.413	4 (4.7%)
<b>Witnessed- n(%)</b>	504 (64.5%)	0.001	307 (73.8%)	253 (68.2%)	0.012	172 (77.8%)	117 (61.9%)	0.649	71 (64.5%)	134 (60.4%)	0.014	64 (75.3%)
<b>Monitored- n(%)</b>	322 (41.2%)	0.138	153 (36.8%)	178 (48.0%)	0.164	93 (42.1%)	64 (33.9%)	0.491	33 (30%)	80 (36%)	0.482	27 (31.8%)
<b>OOHCA- n(%)</b>	113 (14.5%)	0.02	41 (9.9%)	7 (1.9%)	0.144	1 (0.5%)	11 (5.8%)	0.102	2 (1.8%)	95 (42.8%)	0.762	38 (44.7%)

\* P-value by chi-squared test unless stated. † By Mann-Whitney U test

IQR- interquartile range; VF- ventricular fibrillation, VT- ventricular tachycardia, PEA- pulseless electrical activity, OOHCA- out-of-hospital cardiac arrest



**Table 8-7: Overview of CPR quality outcomes**

	<b>Phase one</b>	<b>Phase two</b>	<b>P-Value*</b>
<b>Monthly group debrief (hospital one)</b>			
CC depth (mm)- mean (SD)	53.2 (10.4)	57.2 (12.4)	0.005
CC rate (/min)- mean (SD)	115.4 (10.8)	113.9 (8.9)	0.21
CC flow-fraction (%)- mean (SD)	84.7 (6.8)	83.8 (7.9)	0.31
CC incomplete recoil (%)			
Mean (SD)	15.3 (16.3)	15.8 (17)	
Median (IQR)	10.3 (4.2-20.4)	8.2 (4.3-23.1)	0.90†
Pre-shock pause (secs)			
Mean (SD)	6.3 (7.5)	5.6 (6.8)	
Median (IQR)	2.7 (1.6-9.7)	2.9 (1.5-6.3)	0.92†
Post-shock pause (secs)			
Mean (SD)	2.4 (1.0)	2.4 (1.1)	
Median (IQR)	2.1 (1.8-2.8)	2.3 (1.7-2.7)	0.91†
<b>Individual debrief (hospital two)</b>			
CC depth (mm)- mean (SD)	49.0 (10.0)	51.1 (10.0)	0.24
CC rate (/min)- mean (SD)	116.5 (10.4)	117.5 (9.7)	0.55
CC flow-fraction (%)- mean (SD)	82.9 (6.8)	84.5 (6.1)	0.15
CC incomplete recoil (%)			
Mean (SD)	16.0 (13.8)	13.3 (15.2)	
Median (IQR)	12.0 (4.7-24.5)	8.7 (2.6-18.0)	0.12†
Pre-shock pause (secs)			
Mean (SD)	9.4 (9.1)	5.2 (5.4)	
Median (IQR)	6.4 (3.0-11.8)	3.3 (1.8-4.6)	0.12†
Post-shock pause (secs)			
Mean (SD)	3.5 (3.0)	2.5 (1.2)	
Median (IQR)	3.0 (1.8-3.7)	2.1 (1.9-2.6)	0.28†
<b>Written feedback (hospital three)</b>			
CC depth (mm)- mean (SD)	50.5 (10.2)	51.5 (11.9)	0.63
CC rate (/min)- mean (SD)	117.4 (12.1)	113.7 (9.8)	0.04
CC flow-fraction (%)- mean (SD)	87.1 (7.1)	88.2 (6.3)	0.33
CC incomplete recoil (%)			
Mean (SD)	20.7 (22.5)	15.9 (18.9)	
Median (IQR)	10.4 (2.9-36.4)	7.7 (3.1-24.3)	0.39†
Pre-shock pause (secs)			
Mean (SD)	9.0 (8.6)	5.6 (4.8)	
Median (IQR)	5.3 (3.3-12.5)	2.40 (2.1-10.3)	0.11†
Post-shock pause (secs)			
Mean (SD)	2.7 (1.2)	2.6 (1.4)	
Median (IQR)	2.3 (1.8-3.4)	2.3 (1.9-2.6)	0.78†
<b>All hospitals</b>			
CC depth (mm)- mean (SD)	51.4 (10.4)	54.3 (12.0)	0.004
CC rate (/min)- mean (SD)	116.3 (11.1)	114.8 (9.5)	0.09
CC flow-fraction (%)- mean (SD)	85.0 (7.05)	85.0 (7.26)	0.98
CC incomplete recoil (%)			
Mean (SD)	16.9 (17.7)	15.1 (16.9)	
Median (IQR)	10.9 (3.7-23.6)	8.3 (3.7-21.0)	0.18†
Pre-shock pause (secs)			
Mean (SD)	8 (8.3)	5.5 (5.9)	
Median (IQR)	4.2 (2.3-11.0)	3.0 (2.0-5.9)	0.05†
Post-shock pause (secs)			
Mean (SD)	2.7 (1.7)	2.5 (1.2)	
Median (IQR)	2.30 (1.8-3.3)	2.30 (1.8-2.6)	0.50†

CC- Chest compression. \*All p-values calculated using T-test, unless stated. †- By Mann-Whitney U test

**Table 8-8: CPR quality outcomes: continuous outcomes**

	<b>Mean difference (95% CI)</b>	<b>P-value</b>
<b>Chest compression depth (mm)</b>		
Monthly group debrief (hospital one)	4.07 (1.22 – 6.92)	0.005
Individual debrief (hospital two)	2.06 (-1.39 – 5.52)	0.24
Written feedback (hospital three)	0.99 (-3.00 – 4.98)	0.63
Study phase two (all hospitals)	2.94 (0.92 - 4.95)	0.004
<b>Chest compression rate (compressions per minute)</b>		
Monthly group debrief (hospital one)	-1.52 (-3.91 – 0.86)	0.21
Individual debrief (hospital two)	1.00 (-2.27 – 4.28)	0.55
Written feedback (hospital three)	-3.73 (-7.22 - -0.24)	0.04
Study phase two (all hospitals)	-1.45 (-3.11 – 0.21)	0.09
<b>Chest compression flow fraction</b>		
Monthly group debrief (hospital one)	-0.90 (-2.62 – 0.83)	0.31
Individual debrief (hospital two)	1.55 (-0.55 – 3.64)	0.15
Written feedback (hospital three)	1.12 (-1.13 – 3.38)	0.33
Study phase two (all hospitals)	0.02 (-1.15 – 1.19)	0.98

**Table 8-9: CPR quality outcomes: dichotomous outcomes**

	<b>Odds ratio (95% CI)</b>	<b>P-value</b>
<b>Chest compression depth <math>\geq</math> 50mm</b>		
Monthly group debrief (hospital one)	1.98 (1.13 - 3.47)	0.02
Individual debrief (hospital two)	1.43 (0.72 - 2.8)	0.31
Written feedback (hospital three)	0.99 (0.48 – 2.07)	0.98
Study phase two (all hospitals)	1.52 (1.05 - 2.20)	0.03
<b>Chest compression rate- 100-120 compressions per minute</b>		
Monthly group debrief (hospital one)	1.52 (0.89 – 2.59)	0.13
Individual debrief (hospital two)	0.65 (0.34 – 1.27)	0.21
Written feedback (hospital three)	2.01 (1.00 – 4.07)	0.05
Study phase two (all hospitals)	1.31 (0.92 - 1.86)	0.13

**Table 8-10: Patient outcomes**

	Phase one N (%)	Phase two N (%)	Effect of interventions			
			Unadjusted odds ratio (95% CI)	P-Value	Adjusted odds ratio (95% CI)*	P-Value
<b>Hospital one- Monthly group debrief</b>						
(342 phase one; 206 phase two)						
ROSC	191 (55.8%)	117 (56.8%)	1.04 (0.73 – 1.47)	0.83	1.04 (0.71 – 1.53)	0.83
STD	70 (20.5%)	48 (23.3%)	1.18 (0.78 – 1.79)	0.44	1.35 (0.79 – 2.30)	0.28
Neurologically intact survival (CPC 1/2)	65 (19.0%)	46 (22.3%)	1.23 (0.80 – 1.87)	0.35	1.38 (0.80 – 2.39)	0.25
<b>Hospital two- Individual debrief</b>						
(170 phase one; 103 phase two)						
ROSC	71 (41.8%)	47 (45.6%)	1.17 (0.72 – 1.92)	0.53	1.04 (0.59 – 1.85)	0.89
STD	22 (12.9%)	20 (19.4%)	1.62 (0.84 – 3.14)	0.15	1.48 (0.62 – 3.53)	0.38
Neurologically intact survival (CPC 1/2)	19 (11.2%)	12 (11.7%)	1.05 (0.49 – 2.26)	0.91	0.79 (0.27 – 2.32)	0.66
<b>Hospital three- Written feedback</b>						
(121 phase one; 44 phase two)						
ROSC	61 (50.4%)	19 (43.2%)	0.75 (0.37 – 1.50)	0.41	0.66 (0.29 – 1.51)	0.33
STD	22 (18.2%)	10 (22.7%)	1.32 (0.57 – 3.08)	0.52	1.40 (0.45 – 4.33)	0.56
Neurologically intact survival (CPC 1/2)	18 (14.9%)	7 (15.9%)	1.08 (0.42 – 2.80)	0.87	1.04 (0.28 – 3.78)	0.96
<b>All hospitals</b>						
(633 phase one; 353 phase two)						
ROSC	323 (51.0%)	183 (51.8%)	1.03 (0.80 - 1.34)	0.81	0.99 (0.74 – 1.32)	0.94
STD	114 (18.0%)	78 (22.1%)	1.29 (0.94 - 1.78)	0.12	1.36 (0.90 – 2.06)	0.14
Neurologically intact survival (CPC 1/2)	102 (16.1%)	65 (18.4%)	1.18 (0.83 – 1.66)	0.36	1.20 (0.77 – 1.87)	0.42
ROSC- Return of spontaneous circulation; STD- survival to discharge; CPC- cerebral performance category. *- excludes patients with unknown initial rhythm						

### 8.4.3 Hospital two: individual oral debriefing

At hospital two, there were 108 arrests during the study period of which 43 (39.81%) were eligible for clinicians to receive debriefing. The reasons for arrests not being eligible for debriefing were a duration less than five minutes (n=17, 15.7%), absence of accelerometer data (n=15, 13.9%) or a combination of both reasons (n=29, 26.9%). Two arrests (1.9%) were subject to a clinical review outside of the research process, and two arrests (1.9%) occurred just prior to the study end so there was no opportunity to offer debriefing.

In total, 211 cardiac arrest attendances (126 unique clinicians) were identified as having probably attended a cardiac arrest eligible for debrief. Debriefing was provided on 94 (44.55%) occasions to 62 (49.2%) clinicians. Junior doctors (n=26, 42%) and nurses (n=19, 31%) were the most common professional groups to receive debriefing (Table 8-5). Reasons for non-delivery included difficulty contacting the clinician (n=104, 89%), clinicians stating that they did not attend the cardiac arrest (n=9, 8%), clinician refusal (n=2, 2%), and inability to schedule (n=2, 2%). The median number of clinicians offered debriefing following each eligible cardiac arrest event was five (IQR: 4-6, range 1-9). The median number of clinicians to receive debriefing per eligible cardiac arrest event was two (IQR 1-3, range 0-5).

The median duration between the cardiac arrest event and intervention delivery was 6.7 days (IQR 4.5-12.0 days, range 1.9 hours to 28.6 days). Comparison of daytime and nighttime arrests showed a trend towards more clinicians being offered debriefing following daytime arrests, (Day: 5 (IQR 4-7) v Night: 5 (IQR 3-5), p=0.06), although the number of clinicians who received debriefing was similar (Day: 2 (IQR 1-4) v Night: 2 (IQR 1-3), p=0.34). However, the median number of days between the cardiac arrest event and debriefing delivery was significantly less for daytime cardiac arrests (Day: 5 (IQR 1-9) v Night: 12 (IQR: 8-16), p<0.001).

There were a total of 189 eligible cardiac arrest events during phase one and 110 events during phase two at hospital two. Patient demographics were similar between study phases, except in relation to patient category (Table 8-6). In relation, to the primary outcome, the intervention was not associated with any change in chest compression depth ( $49.0 \pm 10.0$  v  $51.1 \pm 10.0$ , mean difference 2.06, 95% CI -1.39 – 5.52,  $p=0.24$ ) (Table 8-3). Similarly, the intervention was not associated with a change in relation to any other CPR quality outcome (Tables 8-7 to 8-9). The intervention was not associated with any improvement in patient outcome (Table 8-10).

#### **8.4.4 Hospital three: written feedback**

At hospital three, 86 cardiac arrests occurred during the study period. Of these 41 (47.67%) events were eligible for debriefing. Reasons for arrests not being eligible for debriefing included a duration less than five minutes ( $n=16$ , 19%), absence of accelerometer data ( $n=10$ , 12%) or a combination of both reasons ( $n=16$ , 19%). Two (2%) cardiac arrest events were subject to review outside of the research process, and one (1%) cardiac arrest event occurred just before the end of the study period so there was no opportunity to send a feedback sheet to cardiac arrest attendees.

In total, 129 clinicians were identified as being responsible for 252 attendances at eligible cardiac arrest events and were sent a feedback sheet by email. Of these, 54 clinicians replied a total of 110 (44%) times (median 2 (IQR 1-3) occasions per clinician) to confirm their attendance at the cardiac arrest event, that they had reviewed the feedback sheet, and consented to study participation. A further 21 replies were received, but these stated that the clinician did not attend the cardiac arrest ( $n=11$ , 4%), that they did not recall the cardiac arrest ( $n=9$ , 4%), or that they refused study participation ( $n=1$ , 0.4%). Despite follow-up emails, there was no reply from the remaining 121 (48%) cardiac arrest attendees.

Most feedback recipients were junior doctors (n=16, 30%), registrars (n=12, 22%), and critical care practitioners/ critical care outreach nurses (n=12, 20%) (Table 8-5). The mean duration between the cardiac arrest event and the feedback sheet being sent by email was 7.1 days (SD=2.8, range 4 hours- 17.7 days)

There were a total of 222 eligible cardiac arrest events during phase one and 85 events during phase two at hospital three. Patient demographics were similar between study phases, except there was a greater proportion of witnessed cardiac arrests during phase two compared with phase one (Table 8-6). For the primary outcome, the intervention was not associated with any change in chest compression depth ( $50.5 \pm 10.2$  v  $51.5 \pm 11.9$ , mean difference 0.99, 95% CI -3.00 – 4.98, p=0.63) (Table 8-7). However, there was a statistically significant difference in chest compression rate ( $117.4 \pm 12.1$  v  $113.7 \pm 9.8$ , mean difference -3.73, 95% CI -7.22 - -0.24, p=0.04), which was associated with an improvement in the delivery of guideline-adherent care (chest compression rate 100-120 compressions per minute: odds ratio 2.01, 95% CI 1.00-4.07, p=0.05) (Tables 8-7 to 8-9). The intervention was not associated with any change in relation to any other CPR quality outcome. (Tables 8-7 to 8-9). The intervention was not associated with any improvement in patient outcome (Table 8-10).

#### **8.4.5 All hospitals**

To examine for a system-wide effect, we compared differences between phases one and two across all hospitals. Overall, there were 782 eligible cardiac arrest events during phase one and 416 during phase two. Demographic data between study phases were similar, except in relation to patient category, an increased proportion of witnessed cardiac arrests during phase two, and a reduced proportion of out-of-hospital cardiac arrests in phase two. For the primary outcome, there was a statistically significant improvement in chest compression depth between study periods ( $51.4 \pm 10.4$  v  $54.3 \pm 12.0$ , mean difference 2.94, 95% CI 0.92 – 4.95, p=0.004), and an increased proportion of patients who received a mean chest compression depth of 50

mm or more (odds ratio 1.52, 95% CI 1.05-2.20, p=0.03) (Tables 8-7 to 8-9). There was also evidence of a reduction in median pre-shock pause duration (4.2 seconds (IQR 2.3-11.0) v 3.0 (IQR 2.0-5.9), p=0.05) (Table 8-7). There was no evidence of a difference between study periods in relation to any other CPR quality outcome (Tables 8-7 to 8-9). There was no evidence of any change in patient outcome (Table 8-10).

#### **8.4.6 Clinician questionnaires**

Questionnaires invites were sent to 173 clinicians (62 hospital one, 59 hospital two, 52 hospital three) and were completed by 66 clinicians, representing a response rate of 38%. Response rates for individual hospitals were 31%, 42%, and 42% for hospitals one, two and three respectively (Table 8-11).

Questionnaires could not be sent to 30 clinicians (26 at hospital one, three at hospital two, one at hospital three) as their email address was not known. At hospital one, this consisted of three locum doctors, 19 medical and nursing students, and four persons categorised as other. At hospital two, no email was available for two nurses and one nursing student. At hospital three, a current email address could not be located for one student nurse.

Demographic data were similar between hospital sites (Table 8-11). Most respondents agreed or strongly agreed that the debriefing intervention that they received was interesting (n=62, 95%) and that they would recommend it to others (n=61, 94%) (Table 8-12). Debriefing recipients at hospital one all agreed that they felt comfortable contributing to discussion (n=19, 100%). Furthermore, most staff at hospitals two and three agreed or strongly agreed that the debriefing had prompted them to reflect on the cardiac arrest event (n=40, 87%). In relation to these Kirkpatrick level I outcomes, responses were similar between the models of debriefing at the different hospital sites.

**Table 8-11: Demographic characteristics of questionnaire respondents**

	Hospital one (n=19)	Hospital two (n=25)	Hospital three (n=22)	P-value*
<b>Response rate (%)</b>	31%	42%	42%	0.32†
<b>Clinical role- n (%)</b>				
Consultant	3 (16%)	1 (4%)	1 (5%)	
Registrar	2 (11%)	4 (16%)	7 (32%)	
Junior doctor	4 (21%)	9 (36%)	3 (14%)	
Critical Care Outreach/ CCP	2 (11%)	6 (24%)	4 (18%)	
Resuscitation officer	3 (16%)	2 (8%)	1 (5%)	
Nurse	3 (16%)	3 (12%)	5 (23%)	
Other	2 (11%)	0 (0%)	1 (5%)	0.38
<b>Years in current role- median (IQR)</b>	1 (0.5-4.5)	1 (0.7-3.5)	1.5 (0.6-5.3)	0.59‡
<b>Highest level of resuscitation training- n(%)</b>				
ALS- instructor	6 (32%)	3 (12%)	2 (9%)	
ALS- provider	10 (53%)	18 (72%)	13 (59%)	
ILS	2 (11%)	1 (4%)	6 (27%)	
BLS	1 (5%)	3 (12%)	1 (5%)	0.15
<b>Number of cardiac arrests attended in the last four months- n (%)</b>				
1-3	5 (26%)	7 (28%)	8 (36%)	
4-6	6 (32%)	7 (28%)	6 (27%)	
7-9	0 (0%)	2 (8%)	1 (5%)	
10 or more	7 (37%)	7 (28%)	3 (14%)	
Not stated/ other	1 (5%)	2 (8%)	4 (18%)	0.70
<b>Number of times cardiac arrest feedback received/ attended debriefing meetings in last four months- n (%)</b>				
1	8 (42%)	9 (36%)	9 (41%)	
2	5 (26%)	9 (36%)	3 (14%)	
3 or more	6 (32%)	6 (24%)	5 (23%)	
Not stated/ other	0 (0%)	1 (4%)	5 (23%)	0.21

\*All p-values calculated using fisher-exact test unless stated  
†Calculated by chi-square test. ‡ Calculated by Kruskal-Wallis test.  
CCP- Critical Care Practitioner; ALS- advanced life support. ILS- Immediate Life Support. BLS- Basic Life Support.



**Table 8-12: Questionnaire responses to ordinal attitude scale questions**

	Hospital One (n=19)						Hospital Two (n=25)						Hospital Three (n=22)						P-value*
	Response frequency- n (%)					MD (IQR)	Response frequency- n (%)					MD (IQR)	Response frequency- n (%)					MD (IQR)	
	1	2	3	4	5			1	2	3	4		5		1	2	3		4
The meeting/ feedback was interesting†	0 (0%)	0 (0%)	0 (0%)	10 (53%)	9 (47%)	4 (4-5)	0 (0%)	0 (0%)	0 (0%)	15 (60%)	10 (40%)	4 (4-5)	0 (0%)	1 (5%)	2 (10%)	10 (48%)	8 (38%)	4 (4-5)	0.56
Would recommend feedback/ meetings to others‡	0 (0%)	0 (0%)	0 (0%)	8 (42%)	11 (58%)	5 (4-5)	0 (0%)	0 (0%)	0 (0%)	12 (48%)	13 (52%)	5 (4-5)	0 (0%)	1 (5%)	3 (14%)	9 (43%)	8 (38%)	4 (4-5)	0.18
Felt comfortable contributing to discussions‡	0 (0%)	0 (0%)	0 (0%)	11 (58%)	8 (42%)	4 (4-5)	Not asked					Not asked					N/A		
Feedback prompted reflection on cardiac arrest‡	Not asked						0 (0%)	0 (0%)	1 (4%)	10 (40%)	14 (56%)	5 (4-5)	0 (0%)	2 (10%)	3 (14%)	7 (33%)	9 (43%)	4 (4-5)	0.17
Has led to improved resuscitation guideline knowledge‡	0 (0%)	1 (5%)	2 (11%)	13 (68%)	3 (16%)	4 (4-4)	0 (0%)	2 (8%)	5 (21%)	14 (58%)	3 (13%)	4 (3-4)	0 (0%)	3 (14%)	10 (48%)	5 (24%)	3 (14%)	3 (3-4)	0.06
Has led to improved confidence in cardiac arrest participation‡	0 (0%)	1 (5%)	5 (26%)	10 (53%)	3 (16%)	4 (3-4)	0 (0%)	1 (4%)	8 (32%)	10 (40%)	6 (24%)	4 (3-5)	0 (0%)	4 (19%)	9 (43%)	5 (24%)	3 (14%)	3 (3-4)	0.12
Has led to improvements in cardiac arrest clinical practice‡	0 (0%)	0 (0%)	2 (11%)	14 (74%)	3 (16%)	4 (4-4)	0 (0%)	0 (0%)	7 (28%)	13 (52%)	5 (20%)	4 (3-4)	0 (0%)	1 (5%)	10 (48%)	7 (33%)	3 (14%)	3 (3-4)	0.08

MD- Median; IQR- Interquartile range; 1- Strongly disagree; 2- disagree; 3- neutral; 4- agree; 5- strongly agree

\*- Samples compared using Kruskal Wallis test. †- No response from one respondent at hospital three.

‡- No response from one respondent at hospital two and one respondent at hospital three

The remaining three survey questions collected Kirkpatrick II and Kirkpatrick level III outcomes and showed evidence of trends towards differences between debriefing approaches (Table 8-12). In response to a question about the effect of the intervention on resuscitation guideline knowledge (Kirkpatrick level II), staff at hospitals one and two tended to describe a greater impact than staff at hospital three (Hospital one: 4 (IQR 4-4) v Hospital two: 4 (IQR 3-4) v Hospital three: 3 (IQR 3-4),  $p=0.06$ ). Equally, staff at hospitals one and two tended to be more likely to describe a positive effect on their clinical practice (Kirkpatrick Level III), when compared with hospital three (Hospital one: 4 (IQR 4-4) v Hospital two: 4 (IQR 3-4) v Hospital three: 3 (IQR 3-4),  $p=0.08$ ). Results in the question on self-reported confidence in relation to cardiac arrest practice were similar between hospital sites (Hospital one: 4 (IQR 3-4) v Hospital two: 4 (IQR 3-5) v Hospital three: 3 (IQR 3-4),  $p=0.12$ ).

#### **8.4.7 Time demand**

Practical experience of the delivery of interventions facilitated the development of an estimate of the time required for the delivery of each intervention. We found written feedback required ten hours per month to deliver, whilst monthly group debriefing and individual oral debriefing required 15.5 and 16.5 hours per month respectively (Table 8-13). Whilst preparation took longer for monthly group debriefing meetings due to the greater amount of detail required, delivery took longest for individual oral debriefing, such that overall the time required to deliver both interventions was similar. All timings were standardised to a cardiac arrest incidence of ten events per month.

**Table 8-13: Estimate for time taken to deliver debriefing interventions per month**

Process	Components	Hours required (per month)		
		Monthly group debriefing*	Individual oral debriefing†	Written feedback‡
Case identification	Review of cardiac arrest cases, downloading of defibrillator data, and initial review of data (MGD/ IOD/ WF)	4	4	4
Medical note review	Identify location of medical notes and review medical notes for relevant information (MGD/ IOD/ WF) IOD/ WF IOD/WF tend to require less data capture from medical notes and may sometimes be deliverable without access to medical notes.	2.5	2	2
Case analysis	In-depth case analysis based on medical notes and defibrillator data (MGD/ IOD/ WF) More detailed analysis required for MGD/ IOD	2.5	2	1.5
Review of research	Review of literature for relevant up-to-date information relevant to cardiac arrest (MGD/ IOD/ WF) More detailed analysis required for MGD	1	0.5	0.5
Creation of debrief information	Create presentation to show case information (MGD/ IOD) Create feedback sheet of case information (WF)	2.5	1.5	1
Informing of clinicians	Advertise debriefing at medical handover; Identify and email clinicians that attended case identified for discussion inviting them to attend (MGD) Identify clinicians that attended case and email/ phone offering them debriefing opportunity; Schedule time and location to meet (IOD) Identify clinicians that attended case and email feedback sheet (WF)	1.5	2.5	1
Delivery of debriefing	Deliver intervention (MGD/ IOD)	1.5	4	-
<b>Total time (in hours) per month</b>		<b>15.5</b>	<b>16.5</b>	<b>10</b>
<p>MGD- Monthly group debriefing; IOD- Individual oral debriefing; WF- Written feedback. * Based on one meeting per month with a cardiac arrest incidence of ten events per month            † Based on ten cardiac arrest events per month, with debriefing delivered for four events and three clinicians receiving debriefing per cardiac arrest            ‡ Based on ten cardiac arrest events per month, with debriefing delivered for four events</p>				

## 8.5 Discussion

This multi-centre before/after study assessed the deliverability of three cardiac arrest debriefing strategies and assessed the effect of these interventions on CPR quality and patient outcomes.

The study first demonstrated that delivery of these interventions was feasible in the NHS setting, with a total of 191 clinicians receiving debriefing interventions on a total of 343 occasions during the 11-month study period. The intervention was delivered least frequently at hospital two where it was delivered on 94 occasions, compared to 140 occasions at hospital one and 110 at hospital three. The time required to deliver interventions varied between 10 and 16.5 hours per month.

The study also examined the effect of interventions on CPR quality. In relation to the primary outcome, there was no evidence of an association between a change in chest compression depth and the implementation of either written feedback (hospital three) or individual oral debriefing (hospital two). At hospital one, where the frequency of the group debriefing meeting was decreased from weekly to monthly, the intervention was associated with a small statistically significant increase in chest compression depth ( $53.2 \pm 10.4$  v  $57.2 \pm 12.4$ ,  $p=0.005$ ). The improvement at hospital one was the primary driver behind the small statistically significant increase in chest compression depth observed across all hospitals ( $51.4 \pm 10.4$  v  $54.3 \pm 12.0$ ,  $p=0.004$ ). The magnitude of these differences was not considered to be clinically important.

In relation to secondary outcomes, there was evidence of general improvement across all hospital sites, but few changes were statistically significant. There was a statistically significant change in chest compression rate between phases one and two at hospital three. Whilst mean chest compression rate in both study periods complied with UK resuscitation guidelines, there was an increase in the greater proportion of patients that

received the recommended chest compression rate (odds ratio 2.01, 95% CI 1.00-4.07,  $p=0.05$ ).<sup>14</sup> Across all hospitals, there was a reduction in pre-shock pause (4.2 seconds (IQR 2.3-11.0) v 3.0 (IQR 2.0-5.9),  $p=0.05$ ).

The study found no evidence that interventions had any effect on patient outcome, but the study was not powered to reliably detect changes in these outcomes. Nevertheless, it is noteworthy that there did appear to be a general, albeit non-statistically significant, improvement across all hospitals. Most staff reported that interventions had a positive effect on knowledge and clinical practice.

The finding that interventions were found to be deliverable in the NHS setting is unsurprising, given that interventions were developed through a robust process that prioritised intervention deliverability. The lack of effect observed on CPR quality outcomes is surprising, given that previous studies have generally shown cardiac arrest debriefing to be associated with a positive effect on CPR quality.<sup>115</sup> There are three possible explanations for this negative result: the interventions are ineffective in all circumstances; the interventions were implemented poorly; or that the interventions were ineffective in this particular context.

The suggestion that the interventions are ineffective in all circumstances is unconvincing given that similar interventions have been associated with improvements in CPR quality in previous studies.<sup>111,112,172</sup> For example, Lyon et al reported that the implementation of written feedback was associated with improvements in flow-fraction and time to first defibrillation.<sup>172</sup> Nevertheless, it is curious that the largest improvement in chest compression depth was observed at hospital one, where the debriefing intervention was, in effect, downgraded from a weekly group meeting to a monthly group meeting. This finding likely represents a secular trend. It is also noteworthy that our qualitative work identified two key pathways (discussion with colleagues with similar experiences and feedback on performance) through which debriefing may affect

professional practice, but the 'discussion with colleagues' pathway was not formally utilised by the interventions at both hospital two (individual debriefing) and hospital three (written feedback). There is a need for further work to address the relative importance of these two pathways.

Similarly, it is unlikely that interventions were ineffective due to poor implementation. Improper implementation, sometimes termed a type III statistical error, is a common reason for implementations to be found to be ineffective.<sup>205,207,219,434</sup> There were practical challenges associated with intervention delivery at all three hospital sites, but it is unlikely that these were the reason for the lack of observed effect on CPR quality. For example, at hospital one (monthly group debriefing), a member of the immediate care team was not present for the review of a cardiac arrest event in 53% of cases. A challenge at hospital two was that the median time to intervention delivery was nearly seven days, in contrast to the 3-4 days planned when developing the intervention. Direct comparisons with other studies is not possible, as these data are not reported in previous studies, but it is likely that they also faced some practical challenges.<sup>111,112,152,170</sup>

Whilst it is difficult to fully exclude poor implementation as contributing to study findings, it is noteworthy that all interventions in this study were delivered by one person working across three hospital sites. Hospital geographical spread meant that each hospital was generally only visited two or three times per week. In contrast, if implemented as part of standard practice, delivery of interventions would likely be delivered by resuscitation officers based predominantly at one hospital which would make delivery more straightforward.<sup>27</sup>

The most likely explanation for study findings is that interventions were ineffective in the context in which they were implemented. This study was carried out in an NHS

Trust, which had hosted the CPR Quality Improvement Initiative study over the preceding four years. This study had led to system-wide improvements in CPR quality.

There are limited published data describing the quality of CPR delivered at in-hospital cardiac arrest. Tables 8-14 and 8-15 compare CODE study CPR quality and patient outcome data with data published by Edelson et al and the National Cardiac Arrest Audit.<sup>15,152</sup> These comparisons highlight the high quality of care being delivered both at baseline and throughout the CODE study. In particular, baseline CODE study CPR quality data compare very favourably with that reported by Edelson et al in their study of cardiac arrest debriefing (Table 8-14).<sup>152</sup> An alternative to this explanation is that debriefing interventions prevented a decline in CPR quality that may otherwise have occurred following the end of the CPR Quality Improvement Initiative study. A cohort study to examine CPR quality after the end of CODE study would be needed to test this hypothesis.

**Table 8-14: Comparison of CPR quality data: Edelson et al 2008 and CODE study**

	Edelson et al <sup>152</sup> Control period (n=101)	Edelson et al <sup>152</sup> Intervention period (n=123)	CODE Study Phase one (n=367)	Code Study Phase two (n=235)
CC Depth (mm)- mean ± SD	44 ± 10	50 ± 10	51.4 ± 10.4	54.3 ± 12.0
CC Rate (/minute)- mean ± SD	100 ± 13	105 ± 10	116.3 ± 11.1	114.8 ± 9.5
CC Flow Fraction (%)- mean ± SD	80 ± 13	87 ± 10	85.0 ± 7.05	85.0 ± 7.26
Pre-shock pause (secs)- median (IQR)	16.0 (8.5-24.1)	7.5 (2.8-13.1)	4.2 (2.3-11.0)	3.0 (2.0-5.9)
Post-shock pause (secs)- median (IQR)	7.1 (2.7-14.8)	2.4 (1.9-3.6)	2.30 (1.8-3.3)	2.30 (1.8-2.6)
CC- chest compression. SD- Standard deviations. IQR- Interquartile range				

**Table 8-15: Comparison of patient outcome data: National Cardiac Arrest Audit and CODE study**

	National Cardiac Arrest Audit (n=23,554) <sup>15</sup>	CODE Study phase one (n=633)	Code Study phase two (n=353)
ROSC- n (%)	10607 (45%)	323 (51.0%)	183 (51.8%)

Survival to discharge- n(%)	4153 (18.4%)	114 (18%)	78 (22.1%)
ROSC- return of spontaneous circulation			

Findings in this study contrast with previous studies, which have typically reported clinical and statistically significant improvement associated with the use of cardiac arrest debriefing.<sup>111,112,152,170,172,175,176</sup> Our systematic review and meta-analysis of cardiac arrest debriefing found that debriefing was associated with a significant improvement in flow-fraction (mean difference 6.80, 95% CI 4.19 to 9.40,  $p < 0.001$ ) and return of spontaneous circulation (odds ratio 1.46, 95% CI 1.01-2.13,  $p = 0.05$ ).<sup>115</sup> However, studies included in the review typically started with a poor baseline quality of CPR. Importantly, the Cochrane systematic review on audit and feedback found that interventions are more likely to be effective if the quality of baseline care delivery is poor.<sup>119</sup> The corollary to this is, as observed in this study, that interventions are less likely to be effective if the quality of baseline care delivery is high.

In the complex intervention literature, the context in which an intervention is implemented is recognised as a key determinant of the success of an intervention.<sup>206,219,432-434</sup> Indeed, the basis of realist theory is that the effectiveness of an intervention will be determined both by how the intervention works and setting in which it is implemented.<sup>366,436</sup> However, context is not always described adequately in study reports.<sup>212-215</sup> The TIDieR framework, as was used in this study, mandates the reporting of information on context, such that its use may lead to improved reporting in future debriefing studies.<sup>227</sup>

Cardiac arrest debriefing remains in its infancy. Whilst it seems that cardiac arrest debriefing can be an effective intervention, there is a clear need to adopt realist theory and start to consider what is likely to work and in what circumstances. This requires a need to recognise that cardiac arrest debriefing is not a single intervention, but



represents a number of approaches that likely vary in their cost, effectiveness and deliverability. Studies should provide both a full description of the debriefing intervention and the context in which it was delivered.

## 8.6 Limitations

This study has several limitations. The key limitation relates to the study methodology. This was a before/after study undertaken in three hospitals which comprise a single NHS trust. This study design increases the risk of a type I statistical error as it is not possible to control for underlying secular trends.<sup>173,174</sup> Undertaking the study in a single NHS trust increased the risk of intervention contamination between study sites.<sup>267</sup> Indeed, ten clinicians actually received study interventions at more than one hospital, although this likely underestimates the true incidence of contamination. However, this methodology was chosen based on practical grounds and was considered reasonable given that the primary aim of the study was to assess the feasibility of delivering debriefing interventions and to provide initial data on the effect of interventions on CPR quality and patient outcomes, rather than to be a definitive effectiveness trial.

The second limitation relates to the decision to integrate this study with the CPR Quality Improvement Initiative study. This created differences in baseline interventions between hospital sites, making it impossible to directly compare the effectiveness of interventions. However, again, this was a practical decision and was judged reasonable given the study's primary aim.

Thirdly, differences between the consent approach used during phases one and two of the study may have skewed data. During both phases of the study, patients initially entered the study under a Mental Capacity Act consent waiver.<sup>292</sup> In phase one of this study, which formed part of the CPR Quality Improvement Initiative study, retrospective consent was not sought. In contrast, during phase two of the study, retrospective

consent was sought from survivors or their proxy decision maker. By definition, patients that refused consent had survived the cardiac arrest event. This change stemmed from different interpretations of the Mental Capacity Act 2005 by research ethics committees.<sup>292</sup> The issue of consent in cardiac arrest research is ethically problematic, as the time-critical nature of the condition requires that patients be enrolled without first obtaining informed consent.<sup>437</sup> However, the conflict in this study arose from whether consent should be sought following the event in the context of research that relates to a past event with no ongoing intervention. Whilst the literature describes a variety of approaches and different national laws, the change in approach during this study is likely to be unusual.<sup>437,438</sup> During phase two, only three patients actually refused consent for the use of their data in study analyses, so this limitation is unlikely to have had a significant effect on study findings.

Finally, the relatively low questionnaire response rate (38.2%) creates a high risk of non-response bias making it difficult to draw meaningful and generalisable conclusions from these data.<sup>228</sup> Various strategies were used to try and optimise response rate, including preservation of anonymity, use of reminders, and the creation of a short survey that could be accessed from any computer with internet access.<sup>237</sup> Low response rates in clinician surveys are common, particularly in internet surveys.<sup>317,362,363</sup> Our response rate was markedly lower than the response rate (68%) reported by Zebuhr et al in their cardiac arrest debriefing internet survey.<sup>112</sup> As such, findings from these questionnaires should be interpreted with caution.

## **8.7 Conclusion**

Delivery of all three cardiac arrest debriefing interventions was feasible in the NHS setting, but overall interventions were not associated with clinically important improvements in CPR quality or patient outcomes. We attribute this finding to high-quality CPR delivery at baseline, such that clinically important improvements in CPR

quality were difficult to achieve. This study shows that provision of cardiac arrest debriefing may provide little additional benefit in high-performing organisations. If implemented, organisations should closely monitor the effectiveness of any cardiac arrest debriefing intervention. There is a need for study reports of cardiac arrest debriefing interventions to provide a full report of the intervention and to describe the context in which it was delivered.

## **8.8 Acknowledgements**

KC undertook this study, but acknowledges the contribution from the following individuals. Dr Richard Field and Mr Mehboob Chilwan collected and extracted some CPR quality data included in this study. Mr Peter Sutton and Mrs Teresa Melody assisted in obtaining informed consent from patient participants or their proxy decision maker.

## **Chapter 9: Conclusion**

In-hospital cardiac arrest is an important health problem that is associated with a significant mortality burden. Cardiac arrest debriefing is an educational strategy that may reduce the burden of this condition by improving the quality of cardiopulmonary resuscitation (CPR) delivered at in-hospital cardiac arrests. The intervention can take a variety of forms, ranging from written feedback to regular group meetings. In clinical studies, the use of cardiac arrest debriefing has been associated with improvements in CPR quality and return of spontaneous circulation, although the impact of debriefing on outcomes such as survival to hospital discharge and quality of life is unclear. However, some debriefing approaches are challenging to deliver in many NHS hospitals.

This thesis has described the development and feasibility assessment of three cardiac arrest debriefing approaches that were tailored to NHS working practices. The structure of this thesis is modelled on the first two stages of the Medical Research Council framework for the development and evaluation of complex interventions. The first section of the thesis comprises three work packages, namely a systematic review, a process evaluation, and a qualitative study. Data from these work packages were synthesised to develop three cardiac arrest debriefing approaches. The second section of the thesis comprises the cardiopulmonary resuscitation debriefing study, which evaluated the deliverability of the three developed interventions and their effect on CPR quality and patient outcome.

## **9.1 Systematic review**

Systematic reviews have previously analysed the effect of debriefing on care delivery, but these reviews were not specific to cardiac arrest or clinical emergencies. Cardiac arrest, like other clinical emergencies, presents unique challenges due to the need to deliver time-critical interventions to save life. As such, the findings from these other systematic reviews are not readily generalisable to the setting of cardiac arrest.

The systematic review presented in this thesis included studies that examined the effect of debriefing interventions on clinician performance at clinical emergencies. Included studies were extremely heterogeneous, covering a range of clinical emergencies, study settings, and intervention designs. Studies were typically subject to a high risk of bias. In a narrative analysis, there was low quality evidence that debriefing is associated with an improvement in technical elements of care delivery, but there was no evidence of an effect on non-technical performance and patient outcome. In a sub-group of four cardiac arrest studies, a meta-analysis found low quality evidence that debriefing is associated with an improvement in flow-fraction (mean difference 6.80, 95% CI 4.19 to 9.40,  $p < 0.001$ ) and return of spontaneous circulation (odds ratio (OR) 1.46, 95% CI 1.01 to 2.13,  $p = 0.05$ ). Very low quality evidence found no evidence of an association between the use of debriefing and survival to hospital discharge (OR 0.80, 95% CI 0.38 to 1.67,  $p = 0.55$ ).

This is the first systematic review to specifically examine the role of debriefing on clinician performance following clinical emergencies. Study heterogeneity precluded the use of meta-analysis in relation to most included studies. The narrative analysis and meta-analysis of cardiac arrest studies support the use of debriefing following cardiac arrest and other clinical emergencies as a strategy to improve care delivery. The review highlights the need for future studies to provide a full description of the debriefing intervention and, where possible, to adopt study designs that are less prone to a high risk of bias.

## **9.2 Process evaluation**

Studies of cardiac arrest debriefing have, to date, generally failed to include key intervention information, such as a full description of the intervention, details of the context in which it was delivered, and an evaluation of how well the intervention was

delivered. The omission of this information may contribute to research waste by preventing the implementation of cardiac arrest debriefing in other organisations.

This process evaluation examined the delivery of a weekly group cardiac arrest debriefing intervention at a large NHS hospital. The intervention was delivered as part of the CPR Quality Improvement Initiative study, and was associated with a system-wide improvement in CPR quality and return of spontaneous circulation. The process evaluation provided a full description of the intervention and the context in which it was delivered. The evaluation of its delivery provided evidence that the intervention was delivered broadly as planned. Questionnaires provided evidence that clinicians viewed cardiac arrest debriefing as useful and that the debriefing intervention was associated with self-reported improvements in knowledge and practice. However, the process evaluation also showed that weekly group debriefing is likely to be undeliverable in many NHS hospitals. In particular, NHS working patterns meant that members of the direct care team were often unable to attend the meeting where their cardiac arrest event was discussed and most NHS hospitals have insufficient cardiac arrests to facilitate delivery of weekly meetings.

This work package provides important information about the challenges associated with delivering weekly group debriefing. These challenges have not been described previously and highlight the need to develop alternative approaches to cardiac arrest debriefing that are better suited to NHS working practice.

### **9.3 Qualitative study**

Clinical studies provide evidence that debriefing is associated with improvements in CPR quality and patient outcome. However, the way in which debriefing is perceived by clinicians and the mechanisms by which these effects are realised have not previously been researched. These data are important in developing cardiac arrest debriefing



interventions by improving our understanding of why debriefing approaches may differ in their effectiveness. We undertook a qualitative study to examine these concepts. Data were collected from 13 semi-structured interviews and 41 sets of field notes.

In a thematic analysis, four major themes were identified, namely: 'the impracticality of debriefing,' 'the individual and feedback- managing the 'ego',' 'finding solutions through discussion,' and 'a change in culture: the effect of cardiac arrest debriefing.' These themes identified cardiac arrest debriefing as a complex intervention which, whilst challenging to deliver, affects various organisational levels, including the individual, the team, and the hospital. These themes were used to develop a model to describe six mechanisms through which debriefing may affect clinical practice. These mechanisms seem to be driven by two modalities (discussion with colleagues with similar experiences and feedback on performance). We argued that different debriefing approaches may affect these modalities to different extents. Further work is needed to identify the relative importance of these two modalities.

This study demonstrated that cardiac arrest debriefing is a complex intervention. We developed new insights in to how clinicians perceive debriefing and developed a model which sought to conceptualise the mechanisms by which debriefing affects clinical knowledge and practice. There is a need to empirically test these findings.

## **9.4 Intervention development**

Based on the findings from the preceding work, we identified the need to develop cardiac arrest debriefing interventions that were tailored to NHS working practices. A key limitation with previous cardiac arrest debriefing interventions is that, as is common with many complex interventions, they were often developed based on researcher intuition. As such, neither generalisability nor underpinning theory were given adequate consideration during the development process.

We created a three-stage process to develop three cardiac arrest strategies that could be delivered across NHS organisations. Both underpinning theory and intervention generalisability were prioritised during this process. The three developed interventions were monthly group debriefing, individual oral debriefing to the direct care team after each cardiac arrest, and written feedback to the direct care team after each cardiac arrest.

The use of a theoretically-driven rigorous process to develop generalisable cardiac arrest debriefing was, in itself, novel. We identified the need to undertake further work to test the deliverability of these three interventions in NHS hospitals.

## **9.5 The CODE study**

The aim of the CODE (cardiopulmonary resuscitation debriefing) study was to evaluate the deliverability of the three cardiac arrest debriefing in the NHS setting and to assess their effect on CPR quality. The study collected data on patient outcome, but was not powered to detect a clinically important difference in relation to these outcomes. In a before/ after study, which dovetailed with the CPR Quality Improvement Initiative study, we demonstrated that, despite some practical challenges, all three interventions were deliverable within the NHS setting. In an internet survey clinicians positively evaluated all three debriefing approaches. However, interventions were not associated with a clinically important effect on CPR quality or patient outcome.

We attribute this finding to the high quality of CPR being delivered at study hospitals at baseline, such that further clinically important differences would have been difficult to achieve. This is, in itself, an important finding as it highlights that cardiac arrest debriefing interventions may not be associated with improvements in CPR quality in all settings.

## **9.6 Thesis summary and future work**

Cardiac arrest debriefing is a relatively new intervention. Most studies to date have focused on outcomes associated with the intervention. Much of the work included in this thesis is novel and represents new knowledge about the role of debriefing following cardiac arrest. This includes work that has systematically reviewed the effect of debriefing on clinical emergency care delivery, development of new theory on how debriefing may affect clinical practice, and an evaluation of the feasibility of delivering three cardiac arrest debriefing interventions in the NHS setting. The work in this thesis supports the concept of cardiac arrest debriefing, but also highlights that debriefing is not effective in all settings.

Future studies should aim to provide more robust evidence to evaluate the effectiveness of debriefing, compare the effectiveness of different cardiac arrest debriefing approaches, and aim to identify those organisations which are most likely to benefit most from the implementation of a cardiac arrest debriefing programme. This work should aim to more precisely define the costs associated with the delivery of different debriefing approaches. All future studies should provide a full description of the cardiac arrest debriefing approach used and include an evaluation of its delivery.

Cardiac arrest debriefing is a complex intervention and undertaking this work will likely present many challenges. It is hoped that the work in this thesis has laid the foundations for these future studies and will thereby contribute, either directly or indirectly, to improving outcomes for victims of in-hospital cardiac arrest.

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# Chapter 11: Publications

## 11.1 Book chapters

Soar J, **Couper K**. Improving Outcomes from Cardiac Arrest– Quality, Education and Implementation. In: Soar J, Perkins GD, Nolan J, eds. ABC of Resuscitation. London: Wiley Press; 2012.

## 11.2 Original papers in peer-reviewed journals

Davies M, **Couper K**, Bradley J, Baker A, Husselbee N, Woolley S, Davies RP, Perkins GD. A simple solution for improving reliability of cardiac arrest equipment provision in hospital. *Resuscitation*. 2014; 85(11):1523-26.

**Couper K**, Salman B, Soar J, Finn J, Perkins GD. Debriefing to improve outcomes from critical illness: a systematic review and meta-analysis. *Intensive Care Med*. 2013; 39(9):1513-23.

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## 11.3 Editorials in peer-reviewed journals

**Couper K**, Yeung J. Hyperoxia following cardiac arrest: How much is too much? *Resuscitation*. 2014; 85(9):1123-4.

**Couper K**, Finn J. Real-time feedback during basic life support training: does it prevent skill decay? *Resuscitation*. 2013; 84(8):1005-6.

**Couper K**, Abella BS. Auditing resuscitation performance: Innovating to improve practice. *Resuscitation*. 2012; 83(10):1179-80.

## 11.4 Poster and oral presentations

**Couper K**, Kimani PK, Chilwan M, Cooke MW, Davies RP, Field RA, Gao F, Quinton S, Stallard N, Perkins GD. The impact of real-time audiovisual feedback and debriefing: The CPR Quality Improvement Initiative. Abstract accepted as oral presentation for European Resuscitation Council Congress 2014, Bilbao. Published as *Resuscitation*. 2014; 85(Suppl 1):S7

**Couper K**, Griffiths F, Perkins GD. "Getting resus at the forefront": a qualitative study of the mechanisms of cardiac arrest debriefing. Abstract accepted as poster presentation for European Resuscitation Council Congress 2014, Bilbao. Published as *Resuscitation*. 2014; 85(Suppl 1):S83-4

**Couper K**, Chilwan M, Baker A, Davies RP, Griffiths F, Perkins GD. Clinician perceptions of the usefulness of cardiac arrest debriefing: a questionnaire study. Abstract accepted as poster presentation for European Resuscitation Council Congress 2014, Bilbao. Published as *Resuscitation*. 2014; 85(Suppl 1):S84

**Couper K**, Whitehead L, Melody T, Perkins GD. Cardiac arrest team role pre-allocation and debriefing: A policy analysis of West Midlands hospitals. Abstract accepted as poster presentation for European Resuscitation Council Symposium 2013, Krakow. Published as *Resuscitation*. 2013; 84(Suppl 1):S68

**Couper K**, Whitehead L, Melody T, Perkins GD. Hospital cardiac arrest team composition variability: A policy analysis of West Midlands hospitals. Abstract accepted as poster presentation for European Resuscitation Council Symposium 2013, Krakow. Published as *Resuscitation*. 2013; 84(Suppl 1):S65

Chilwan M, Kimani P, **Couper K**, Melody T, Davies R, Stallard N, Perkins GD. The effect of the 2010 resuscitation guidelines on CPR quality: An observational study. Abstract accepted as poster presentation for European Resuscitation Council Symposium 2013, Krakow. Published as *Resuscitation*. 2013; 84(Suppl 1):S24

Patel JM, **Couper K**, Melody T, O'Brien R, Parekh D. Prevalence and impact of invasive fungal infections in intensive care. Abstract accepted as poster presentation for 33rd International Symposium on Intensive Care and Emergency Medicine 2013, Brussels. Published as *Critical Care*. 2013; 17(Suppl 2):P88

# Chapter 12: Appendix

## 12.1 Systematic review

### 12.1.1 Systematic review search strategy

#### Ovid MEDLINE

1. exp Feedback/
2. Feedback.mp.
3. Debrief\$.mp.
4. exp Shock/
5. Cardiogenic shock.mp.
6. Hypovolemic shock.mp.
7. Hypovolaemic shock.mp.
8. Septic shock.mp.
9. Anaphylactic shock.mp.
10. exp Emergencies/
11. exp Heart Arrest/
12. exp Cardiopulmonary Resuscitation/
13. exp Resuscitation/
14. Resuscitation.mp.
15. exp Anesthesiology/
16. exp Airway Obstruction/
17. exp Airway Management/
18. exp Respiratory Therapy/
19. exp Angioplasty, Balloon, Coronary/
20. exp Thrombolytic Therapy/
21. 1 or 2 or 3
22. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
23. 21 and 22
24. Limit 23 to English language

#### Ovid EMBASE

1. exp feedback system/
2. Feedback.mp.
3. Debrief\$.mp.
4. exp shock/
5. Cardiogenic shock.mp.
6. Hypovolemic shock.mp.
7. Hypovolaemic shock.mp.
8. Septic shock.mp.
9. Anaphylactic shock.mp.
10. exp emergency/
11. exp heart arrest/
12. exp cardiopulmonary arrest/
13. exp resuscitation/
14. Resuscitation.mp.
15. exp Anesthesiology/
16. exp Airway obstruction/
17. exp Respiration control/
18. exp Percutaneous coronary intervention/
19. exp Fibrinolytic therapy/
20. 1 or 2 or 3



21. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
22. 20 and 21
23. Limit 22 to English language
24. Limit 23 to conference abstract
25. 23 not 24

## CINAHL

1. (MH "Feedback")
2. "Feedback"
3. "Debrief\*"
4. (MH "Shock+")
5. "Cardiogenic shock"
6. "Hypovolemic shock"
7. "Hypovolaemic shock"
8. "Septic shock"
9. "Anaphylactic shock"
10. (MH "Emergencies+")
11. (MH "Heart Arrest+")
12. (MH "Resuscitation, Cardiopulmonary+")
13. (MH "Resuscitation+")
14. "Resuscitation"
15. (MH "Anesthesiology")
16. (MH "Airway Obstruction+")
17. (MH "Airway Management+")
18. (MH "Respiratory Therapy+")
19. (MH "Angioplasty, Transluminal, Percutaneous Coronary")
20. (MH "Thrombolytic Therapy")
21. 1 or 2 or 3
22. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
23. 21 and 22

## COCHRANE CENTRAL

1. MeSH descriptor Feedback explode all trees
2. Feedback
3. Debrief\*
4. MeSH descriptor Shock explode all trees
5. Cardiogenic shock
6. Hypovolemic shock
7. Hypovolaemic shock
8. Septic shock
9. Anaphylactic shock
10. MeSH descriptor Emergencies explode all trees
11. MeSH descriptor Heart Arrest explode all trees
12. MeSH descriptor Cardiopulmonary Resuscitation explode all trees
13. MeSH descriptor Resuscitation explode all trees
14. Resuscitation
15. MeSH descriptor Anesthesiology explode all trees
16. MeSH descriptor Airway Obstruction explode all trees
17. MeSH descriptor Airway Management explode all trees
18. MeSH descriptor Respiratory Therapy explode all trees
19. MeSH descriptor Angioplasty, Balloon, Coronary explode all trees
20. MeSH descriptor Thrombolytic Therapy explode all trees
21. (1 OR 2 OR 3)
22. (4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20)
23. (21 AND 22)

## ERIC via PROQUEST

1. su.EXACT(("Biofeedback" OR "Feedback (Response)"))
2. Feedback
3. Debrief\*
4. su.EXACT("First Aid")
5. Shock
6. Resuscitation
7. Emergenc\*
8. CPR
9. 1 OR 2 OR 3
10. 4 OR 5 OR 6 OR 7
11. 9 AND 10
12. Limit 11 to English language

## PSYCHOINFO (1806 to present)

1. feedback.ti,ab
2. exp FEEDBACK/
3. exp "DEBRIEFING (PSYCHOLOGICAL)"/
4. debrief\$.ti,ab
5. exp SHOCK/
6. (cardiogenic AND shock).ti,ab
7. (anaphylactic AND shock).ti,ab
8. (septic AND shock).ti,ab
9. (hypovolemic AND shock).ti,ab
10. (hypovolaemic AND shock).ti,ab
11. exp CPR/
12. exp ARTIFICIAL RESPIRATION/
13. exp ANESTHESIOLOGY/
14. 1 OR 2 OR 3 OR 4
15. 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13
16. 14 AND 15
17. 14 AND 15 [Limit to: English Language]

## 12.1.2 List of studies included in systematic review

### 12.1.2.1 Clinical studies

Bradley EH, Herrin J, Wang Y, Barton BA, Webster TR, Mattera JA, et al. Strategies for reducing the door-to-balloon time in acute myocardial infarction. *New England Journal of Medicine*. 2006;355(22):2308-20.

Carbine DN, Finer NN, Knodel E, Rich W. Video recording as a means of evaluating neonatal resuscitation performance. *Pediatrics* 2000;106(4):654-8.

Edelson DP, Litzinger B, Arora V, Walsh D, Kim S, Lauderdale DS, et al. Improving in-hospital cardiac arrest process and outcomes with performance debriefing. *Archives of Internal Medicine*. 2008;168(10):1063-9.

Hoyt DB, Shackford SR, Fridland PH, Mackersie RC, Hansbrough JF, Wachtel TL, et al. Video recording trauma resuscitations: an effective teaching technique. *The Journal of Trauma*. 1988;28(4):435-40.

Jiang C, Zhao Y, Chen Z, Chen S, Yang X. Improving cardiopulmonary resuscitation in the emergency department by real-time video recording and regular feedback learning. *Resuscitation*. 2010;81(12):1664-9.

Lai CL, Fan CM, Liao PC, Tsai KC, Yang CY, Chu SH, et al. Impact of an audit program and other factors on door-to-balloon times in acute ST-elevation myocardial infarction patients destined for primary coronary intervention. *Academic Emergency Medicine*. 2009;16(4):333-42.

Lin JF, Hsu SY, Wu S, Liao CS, Chang HC, Liu CJ, et al. Data feedback reduces door-to-balloon time in patients with ST-elevation myocardial infarction undergoing primary percutaneous coronary intervention. *Heart and Vessels*. 2011;26(1):25-30.

Lyon RM, Clarke S, Milligan D, Clegg GR. Resuscitation feedback and targeted education improves quality of pre-hospital resuscitation in Scotland. *Resuscitation*. 2012;83(1):70-5.

Nadler I, Sanderson PM, Van Dyken CR, Davis PG, Liley HG. Presenting video recordings of newborn resuscitations in debriefings for teamwork training. *BMJ Quality and Safety*. 2011;20(2):163-9.

O'Connor RE, Megargel RE. The effect of a quality improvement feedback loop on paramedic skills, charting, and behavior. *Prehospital and Disaster Medicine*. 1994;9(1):35-8.

Percarpio KB, Harris FS, Hatfield BA, Dunlap B, Diekroger WE, Nichols PD, et al. Code debriefing from the Department of Veterans Affairs (VA) Medical Team Training program improves the cardiopulmonary resuscitation code process. *Joint Commission Journal on Quality and Patient Safety*. 2010;36(9):424-9.

Rawles J, Sinclair C, Jennings K, Ritchie L, Waugh N. Audit of prehospital thrombolysis by general practitioners in peripheral practices in Grampian. *Heart*. 1998;80(3):231-4.

Santora TA, Trooskin SZ, Blank CA, Clarke JR, Schinco MA. Video assessment of trauma response: adherence to ATLS protocols. *The American Journal of Emergency Medicine*. 1996;14(6):564-9.

Scherer LA, Chang MC, Meredith JW, Battistella FD. Videotape review leads to rapid and sustained learning. *American Journal of Surgery*. 2003;185(6):516-20.

Scholz KH, Hilgers R, Ahlersmann D, Duwald H, Nitsche R, von Knobelsdorff G, et al. Contact-to-Balloon Time and Door-to-Balloon Time After Initiation of a Formalized Data Feedback in Patients With Acute ST-Elevation Myocardial Infarction. *American Journal of Cardiology*. 2008;101(1):46-52.

Schramm GE, Kashyap R, Mullon JJ, Gajic O, Afessa B. Septic shock: A multidisciplinary response team and weekly feedback to clinicians improve the process of care and mortality. *Critical Care Medicine*. 2011;39(2):252-8.

Townsend RN, Clark R, Ramenofsky ML, Diamond DL. ATLS-based videotape trauma resuscitation review: education and outcome. *The Journal of Trauma*. 1993;34(1):133-8.

van Wijngaarden JD, Dirks M, Huijsman R, Niessen LW, Fabbriotti IN, Dippel DW. Hospital rates of thrombolysis for acute ischemic stroke: the influence of organizational culture. *Stroke*. 2009;40(10):3390-2.

Zebuhr C, Sutton RM, Morrison W, Niles D, Boyle L, Nishisaki A, et al. Evaluation of quantitative debriefing after pediatric cardiac arrest. *Resuscitation*. 2012;83(9):1124-8

#### 12.1.2.2 Manikin studies

Anderson JM, Murphy AA, Boyle KB, Yaeger KA, Halamek LP. Simulating extracorporeal membrane oxygenation emergencies to improve human performance. Part II: assessment of technical and behavioral skills. *Simulation in healthcare*. 2006;1(4):228-32.

Boet S, Bould MD, Bruppacher HR, Desjardins F, Chandra DB, Naik VN. Looking in the mirror: Self-debriefing versus instructor debriefing for simulated crises. *Critical Care Medicine*. 2011;39(6):1377-81.

Dine CJ, Gersh RE, Leary M, Riegel BJ, Bellini LM, Abella BS. Improving cardiopulmonary resuscitation quality and resuscitation training by combining audiovisual feedback and debriefing. *Critical Care Medicine*. 2008;36(10):2817-22.

Goffman D, Heo H, Pardanani S, Merkatz IR, Bernstein PS. Improving shoulder dystocia management among resident and attending physicians using simulations. *American Journal of Obstetrics and Gynecology*. 2008;199(3):294e1-5.

Mikrogianakis A, Osmond MH, Nuth JE, Shephard A, Gaboury I, Jabbour M. Evaluation of a multidisciplinary pediatric mock trauma code educational initiative: a pilot study. *The Journal of Trauma*. 2008;64(3):761-7.

Morgan PJ, Kurrek MM, Bertram S, LeBlanc V, Przybyszewski T. Nontechnical skills assessment after simulation-based continuing medical education. *Simulation in Healthcare*. 2011;6(5):255-9.

Morgan PJ, Tarshis J, LeBlanc V, Cleave-Hogg D, DeSousa S, Haley MF, et al. Efficacy of high-fidelity simulation debriefing on the performance of practicing

anaesthetists in simulated scenarios. *British Journal of Anaesthesia*. 2009;103(4):531-37.

Savoldelli GL, Naik VN, Park J, Joo HS, Chow R, Hamstra SJ. Value of debriefing during simulated crisis management: Oral versus video-assisted oral feedback. *Anesthesiology*. 2006;105(2):279-85.

Welke TM, LeBlanc VR, Savoldelli GL, Joo HS, Chandra DB, Crabtree NA, et al. Personalized oral debriefing versus standardized multimedia instruction after patient crisis simulation. *Anesthesia and analgesia*. 2009;109(1):183-89.

## 12.1.3 GRADE tables

### Effect of debriefing on clinician performance at clinical emergencies

**Population:** Clinicians that manage clinical emergencies. **Settings:** Pre-hospital and in-hospital. Manikin and Clinical. **Intervention:** Debriefing. **Comparison:** Control

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Control	Corresponding risk Debriefing				
<b>Kirkpatrick Level I: Reaction.</b> Subjective intervention effect; usefulness	See comment	See comment	Not estimable	104 (4 studies)	⊕⊖⊖⊖ <b>very low</b> <sup>1</sup>	Three studies support use of debriefing. Unable to pool data due to study heterogeneity. One study did not report number of participants.
<b>Kirkpatrick Level II: Learning</b>	See comment	See comment	Not estimable	88 (1 study)	⊕⊕⊖⊖ <b>low</b>	Single study. Supports use of debriefing.
<b>Kirkpatrick Level III: Technical performance.</b> Multiple outcomes	See comment	See comment	Not estimable	4236 (22 studies)	⊕⊕⊖⊖ <b>low</b>	Sixteen studies support use of debriefing. One study opposed use of debriefing. Unable to pool data due to study heterogeneity. Number of participants excludes two cohort studies (one with 5515 patients; one with 365 hospitals)
<b>Kirkpatrick Level III: Non-technical performance.</b> Multiple outcomes	See comment	See comment	Not estimable	444 (8 studies)	⊕⊕⊖⊖ <b>low</b> <sup>2,3</sup>	Four studies support use of debriefing. Unable to pool data due to study heterogeneity.
<b>Kirkpatrick Level III: Combined technical and non-technical.</b>	See comment	See comment	Not estimable	274 (3 studies)	⊕⊖⊖⊖ <b>very low</b> <sup>4,5</sup>	One study supports use of debriefing. Unable to pool data due to study heterogeneity.
<b>Kirkpatrick Level IV: Patient-focussed outcomes.</b> Mortality, Length of Stay	See comment	See comment	Not estimable	2517 (8 studies)	⊕⊕⊖⊖ <b>low</b>	Two studies support use of debriefing. Unable to pool data due to study heterogeneity.

<sup>1</sup> Data from survey studies with no control group.

<sup>2</sup> Data from randomised controlled studies and observational studies.

<sup>3</sup> Majority of data from manikin studies. Generalisability to clinical setting is unclear.

<sup>4</sup> Data from manikin studies. Generalisability to clinical setting is unclear.

<sup>5</sup> Two studies used non-validated tools to evaluate performance.

## Effect of debriefing on clinician performance at cardiac arrests

**Population:** Clinicians that manage cardiac arrests. **Settings:** Clinical cardiac arrest studies: pre-hospital and in-hospital. **Intervention:** Debriefing. **Comparison:** Control

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Control	Corresponding risk Debriefing				
<b>Chest compression fraction (%)</b>		The mean chest compression fraction (%) in the intervention groups was <b>6.8 higher</b> (4.19 to 9.4 higher)		335 (2 studies)	⊕⊕⊖⊖ <b>low</b>	
<b>Return of spontaneous circulation</b>	<b>258 per 1000</b>	<b>337 per 1000</b> (260 to 426)	<b>OR 1.46</b> (1.01 to 2.13)	789 (4 studies)	⊕⊕⊖⊖ <b>low</b>	
<b>Survival to hospital discharge</b>	<b>100 per 1000</b>	<b>82 per 1000</b> (41 to 157)	<b>OR 0.80</b> (0.38 to 1.67)	365 (3 studies)	⊕⊖⊖⊖ <b>very low</b> <sup>1</sup>	

- The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI). **CI:** Confidence interval; **OR:** Odds ratio;

<sup>1</sup> Downgraded for imprecision- wide confidence intervals.



## 12.2 Process evaluation

### 12.2.1 Example debriefing meeting slides

### Cardiac Arrest Case-Based Discussion Meeting



### Overview

- Background
- Discussion based on recent cardiac arrest
- Opportunity to ask questions/ make comments
- Questionnaires

Ground rules

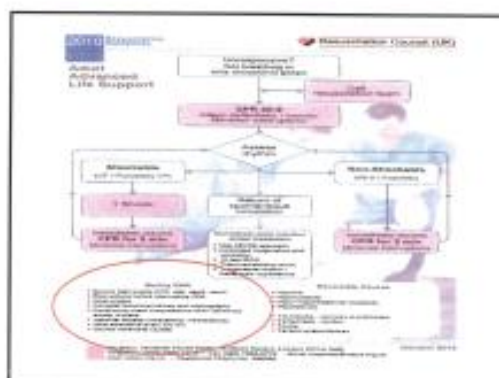
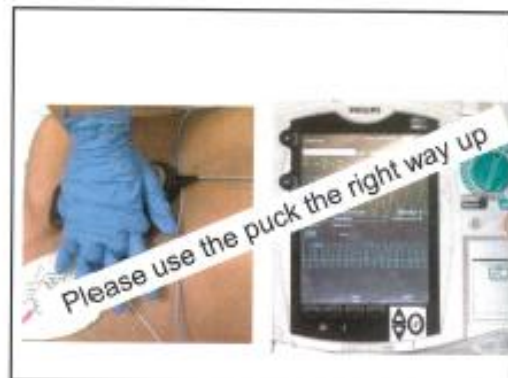
- Confidentiality
- No blame
- Take part in discussion- issues will be generic

### Background- Quality CPR Initiative

Good evidence that quality of in-hospital CPR is sub-standard

Currently looking at methods of improving CPR quality within HEFT

Heartlands- real-time feedback and weekly meetings- held at 12:30 in AMU handover room every Tuesday



### During CPR

- Ensure high-quality CPR: rate, depth, recoil
- Plan actions before interrupting CPR
- Give oxygen
- Consider advanced airway and capnography
- Continuous chest compressions when advanced airway in place
- Vascular access (intravenous, intraosseous)
- Give adrenaline every 3-5 min
- Correct reversible causes

### Last week....

Discussed

- Defibrillation and peri-shock pause
- Reduced peri-shock pause associated with improved outcome
- Change of defibrillation technique introduced in 2010

### This week's focus.....

Flow Time

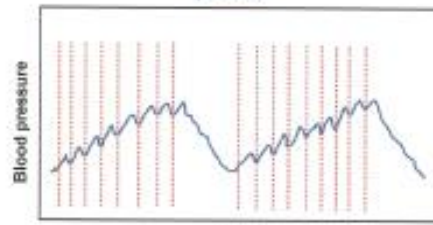
### Flow Time

% of time during a cardiac arrest spent doing chest compressions

Affected by

- Pauses for rhythm checks
- Ventilations (when no advanced airway)
- Defibrillation
- Ineffective team leadership

### Physiological effect of chest compression pauses

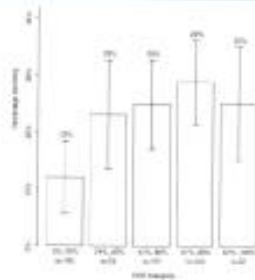


= chest compression

Berg et al, 2007

### Chest Compression Fraction Determines Survival in Patients With Out-of-Hospital Ventricular Fibrillation

Circulation. 2009;120:1241-1247



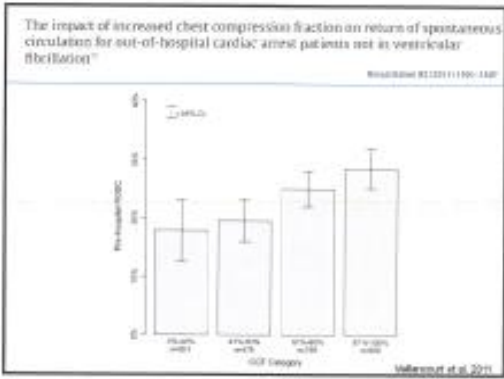
Christensen et al, 2009

### Chest Compression Fraction Determines Survival in Patients With Out-of-Hospital Ventricular Fibrillation

Circulation. 2009;120:1241-1247

Chest Compression Fraction	CCF Groups				
	0-25% (n=10)	25-50% (n=10)	50-75% (n=10)	75-100% (n=10)	100% (n=10)
Median CCF (range)	22.0 (0-30)	33.0 (25-40)	51.0 (40-60)	77.0 (60-90)	100.0 (100-100)
Median ROSA (range)	1.0 (0-1)	1.0 (0-1)	1.0 (0-1)	1.0 (0-1)	1.0 (0-1)
Survival rate (%)	0.0	0.0	0.0	0.0	100.0

Christensen et al, 2009



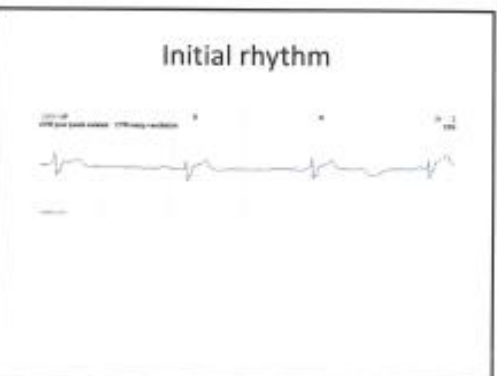
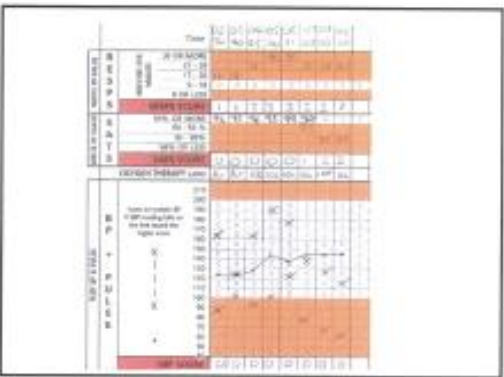
### Cardiac arrest 1

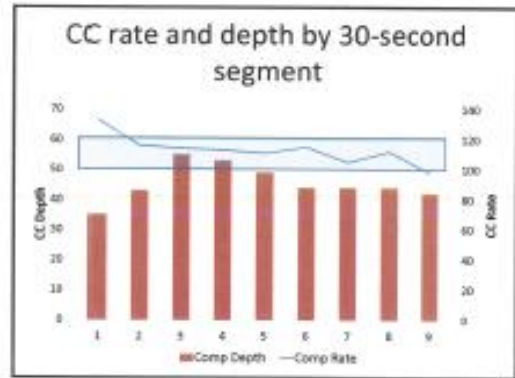
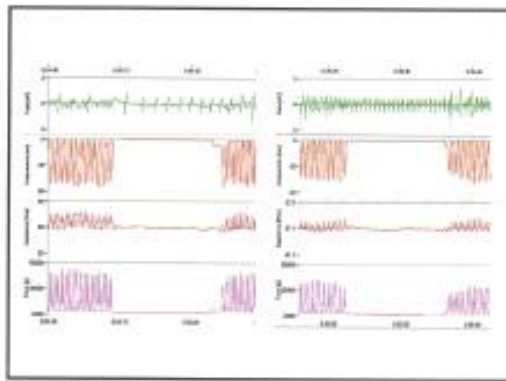
**Situation** Adult emergency- Ward xx- xxx/xx/xx at xxxxx

**Background** 90 year old female  
Admitted xxx/xx/xx  
Abdo pain, coffee ground vomit (no change in stool), SOB  
Lives alone- playing bingo previous night

PMHx: Thrombosis (multiple)  
Imp: LVF ?cause, haematemesis.

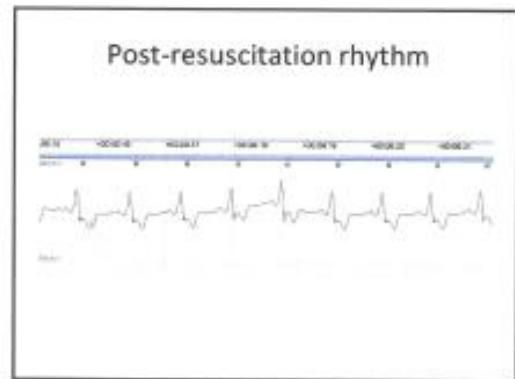
**Assessment** CA





### Blood gases

	Pre-arrest 08:04	Intra-arrest
pH	7.24	6.96
pO <sub>2</sub>	8.20	10.6
pCO <sub>2</sub>	8.94	13.0
Hb	13.9	12.5
HCO <sub>3</sub>	24.7	13.9
BE	1.3	-9.8
Gluc	11.5	-
K <sup>+</sup>	8.1	4.9
Lactate	2.0	8.5



### Summary statistics

Compression rate	113
Compression depth	46
Flow-time	79%
Leaning	3.1%

Outcome:  
ROSC achieved  
Decision to withdraw care

### Cardiac arrest 2

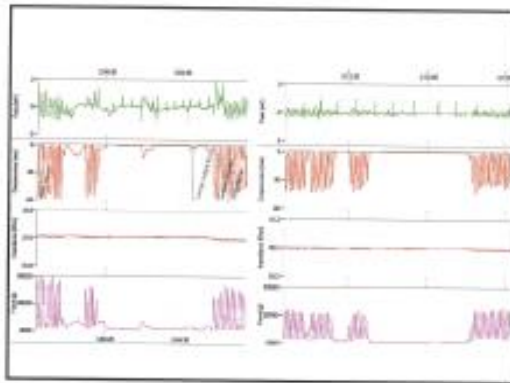
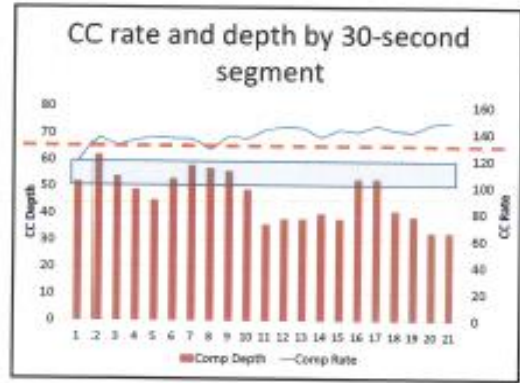
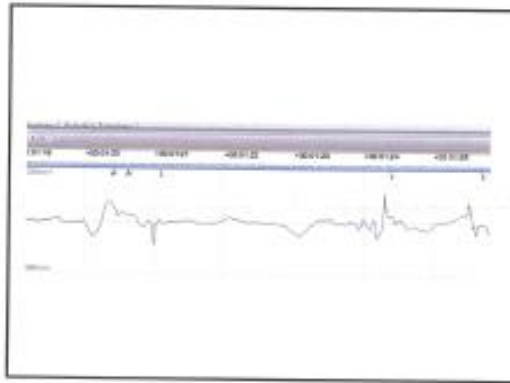
Situation: Adult emergency- Ward xx- xx/xx/xx- xx:xx

Background: 46 year old male  
Admitted xx/xx/xx  
Right pleural effusion- Right VATS + decortication.  
PMHx: ESRF (dialysis), T1DM, Right arm paralysis

Current issues: ongoing consolidation right lung, ↓ albumin, poor glycaemic control, malnourished, ↑CRP (220)

Obs- 11:30, MEWS=2

Assessment: CA





### Summary statistics

Compression rate	130
Compression depth	47
Flow-time	77%
Leaning	40%

Outcome:  
Attempt terminated- no reversible cause

**Thank you**  
**Any questions?**

## 12.2.2 Questionnaire one

<p style="text-align: center;"><b>Cardiac Arrest Case-Based Discussion Evaluation</b> Weekly evaluation</p> <p style="text-align: center;">Date: _____</p> <p>Did you attend any of the cardiac arrests being discussed this week? Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p><b>Please state your role and grade (e.g. ITU SHO; Staff Nurse)</b></p> <p>_____</p> <p><b>Please give your views on this week's cardiac arrest case-based discussion meeting- Please circle the appropriate answer</b></p> <table style="width: 100%; text-align: center; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="writing-mode: vertical-rl; transform: rotate(180deg);">Strongly disagree</th> <th style="writing-mode: vertical-rl; transform: rotate(180deg);">Disagree</th> <th style="writing-mode: vertical-rl; transform: rotate(180deg);">Neutral</th> <th style="writing-mode: vertical-rl; transform: rotate(180deg);">Agree</th> <th style="writing-mode: vertical-rl; transform: rotate(180deg);">Strongly agree</th> </tr> </thead> <tbody> <tr> <td>The meeting was relevant to my practice</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td>I felt comfortable contributing to discussions</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td>I would recommend these meetings to others</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </tbody> </table> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>What prompted you to attend today's meeting?</b></p>    </div> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>Is there anything you would change about these meetings?</b></p>    </div> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>Any other comments?</b></p>    </div> <p style="text-align: right; margin-top: 10px;">Thank you for completing this questionnaire</p>		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	The meeting was relevant to my practice	1	2	3	4	5	I felt comfortable contributing to discussions	1	2	3	4	5	I would recommend these meetings to others	1	2	3	4	5	<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;">  <p>THE UNIVERSITY OF <b>WARWICK</b></p> </div> <div style="text-align: center;"> <p>Thank you for completing this questionnaire</p> </div> <div style="text-align: center;">  <p><b>HEART of ENGLAND</b> NHS Foundation Trust</p> </div> </div> <p style="text-align: center; margin-top: 20px;"><b>Post-Event feedback in clinical emergencies</b></p> <p>The questionnaire overleaf forms part of a research study looking at ways to improve the delivery of post-event debriefing meetings. You are being asked to complete this questionnaire as you have attended today's meeting.</p> <p>Completion of the questionnaire is entirely voluntary. There is no requirement to complete it. You are asked not to write your name on the questionnaire- this is to ensure that it remains anonymous. As the questionnaire is anonymous, it will not be possible for you to withdraw your questionnaire once it has been returned.</p> <p>Completion of the questionnaire will not directly benefit you or present any risk or detriment, but it may help improve these meetings in the future.</p> <p>If you require any further information, please contact Keith Couper (Tel 0121 4242966, <a href="mailto:keith.couper@heartofengland.nhs.uk">keith.couper@heartofengland.nhs.uk</a>) or Prof Gavin Perkins.</p> <p>If you have any complaints about the conduct of this research, please contact Lorain Rawlins, Senior Investigations Manager, Heart of England NHS Foundation Trust, Birmingham, B9 5SS, Tel: 0121 424 0237.</p>
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree																				
The meeting was relevant to my practice	1	2	3	4	5																				
I felt comfortable contributing to discussions	1	2	3	4	5																				
I would recommend these meetings to others	1	2	3	4	5																				
Vers 1.0. 8/4/12      Feedback- Clin. Emerg.	Vers 1.0. 8/4/12      Feedback- Clin. Emerg.																								

## 12.2.3 Questionnaire two

### Cardiac Arrest Case-Based Discussion Evaluation

Date: \_\_\_\_\_

Please state your role and grade (e.g. ITU SHO; Staff Nurse)

\_\_\_\_\_

How many cardiac arrests have you attended in the **last month**?

0     1     2     3     4     5 or more

How many cardiac arrest case-based discussion meetings have you attended since **April-2012**?

1     2     3     4     5     6 or more

Following your attendance at case-based discussion, please identify your agreement with the following statements



Please circle the appropriate answer	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
My knowledge of resuscitation guidelines has improved	1	2	3	4	5
My underpinning knowledge in relation to cardiac arrest management has improved	1	2	3	4	5
I am more confident in participating in cardiac arrests	1	2	3	4	5
I am more confident in leading cardiac arrests	1	2	3	4	5    n/a
My clinical practice in relation to cardiac arrests has improved	1	2	3	4	5

Please provide examples of any change in your knowledge or practice that has resulted from your attendance at case-based discussion meetings

(Please continue overleaf if necessary)

**Thank you for completing this questionnaire**

### Post-Event feedback in clinical emergencies

The questionnaire overleaf forms part of a research study looking at ways to improve the delivery of post-event debriefing meetings. You are being asked to complete this questionnaire as you have attended today's meeting.

Completion of the questionnaire is entirely voluntary. There is no requirement to complete it. You are asked not to write your name on the questionnaire- this is to ensure that it remains anonymous. As the questionnaire is anonymous, it will not be possible for you to withdraw your questionnaire once it has been returned.

Completion of the questionnaire will not directly benefit you or present any risk or detriment, but it may help improve these meetings in the future

If you require any further information, please contact Keith Couper (Tel 0121 4242966, keith.couper@heartofengland.nhs.uk) or Prof Gavin Perkins.

If you have any complaints about the conduct of this research, please contact Lorain Rawlins, Senior Investigations Manager, Heart of England NHS Foundation Trust, Birmingham, B9 5SS, Tel: 0121 424 0237.

Vers 1.1. 23/6/12

Feedback- Clin. Emerg.

Vers 1.1. 23/6/12

Feedback- Clin. Emerg.

## 12.2.4 Content analysis coding frame: questionnaire one

Question	Code	Example of statement
What prompted you to attend today's meeting?	Arrest team member/ Part of job role	"Part of resus team"; "Am on crash team"
	Working on acute medical unit	"I was in the department as RMO"
	Involved in cardiac arrest event scheduled for discussion	"I was at the arrest and wanted feedback on my role"; "I was team leader at one of the cases for discussion"
	Educational benefit	"Recent ALS course- wished to consolidate learning outcomes"; "Learning opportunity"
	General interest/ clinical relevance	"Relevance to practice. Interesting cases"; "interesting discussion"
	Colleague recommendation	"Heard it was interesting"; "Recommended by consultant"
	Regular attender/ previous good experience	"Came once before and find them quite interesting"; "I'm a regular"
	Food	"Pizza!!"; "Lunch break"
	Other	"To work towards perfection"; "Never attended before"
	No response	-
Is there anything you would change about these meetings?	Nothing/ no change	"No"; "Too good to be changed"
	Change in quantity/type of food	"Food- nice but needs a change"; "Not enough pizza today!"
	Increase arrest team attendance	"Need more team members to attend to discuss what went well/ badly"
	Increase attendance generally	"Increase ward staff attendance"; "Protected time so more F1/F2 can attend"
	Make less negative	"Sometimes feels negative and blaming"
	Reduce jargon/ make more understandable	"It went over my head a bit, but still learnt a lot."
	Identify clear learning points	"More specific improvement points"
	Other	"?Review ED arrests also"; "Should continue"
	No response	-
Any other comments?	Gratitude	"Thanks"
	Education/learning benefit	"Excellent learning experience"; "Constructive environment to discuss cases"
	Enjoyable/ useful discussion	"Good MDT approach and discussion generated"; "Good discussion"
	Food (general comments)	"Nice pizza"; "Pizza! Yay"
	Other	"Open atmosphere"; "Continue meetings"; "Good to have new presenters"
	No response	-



## 12.2.5 Content analysis coding frame: questionnaire two

Question	Code	Example of statement
Please provide examples of any change in your knowledge or practice that has resulted from your attendance at case-based discussion meetings	No effect	"No real change in practice/ knowledge"; "Not much"
	Effect on practice: technical skills	"Attaching pads and assess rhythm immediately"; "how to maximise time on chest"
	Effect on practice: non-technical skills	"Human factors and team knowledge improved"; "team leader dynamics"
	Effect on practice: use of puck	"Reminder to use puck"
	Effect on knowledge	"knowledge of factors associated with good survival improved"
	Other	"Avoid mistakes of others"

## 12.3 Qualitative study: Interview schedule

### Preamble

Firstly, thank you very much for agreeing to participate in this interview, which forms part of my PhD. The aim of this interview is to investigate your feelings about the provision of feedback following cardiac arrest, and I have asked you to participate because you have attended one or more of the weekly cardiac arrest feedback meetings. I anticipate that it will take less than 20 minutes.

I recognise that you know me through my role at the weekly meetings. However, I am interviewing you in my role as a researcher. I am genuinely interested in your feelings and attitudes about the feedback process, so please be totally honest in your answers. I appreciate that you have read the information sheet and signed a consent form. I just want to reiterate a couple of things. Firstly, your participation in this process is anonymous. You have consented to allow me to use specific quotes in both my thesis and any publications, but any quotes that I use will only refer to you by role (e.g. junior doctor). Secondly, I will tape record this interview, but the recording will be destroyed as soon as the interview has been transcribed. Are you happy to start?"

### Questions

1. Firstly, can you tell me about your experience of the weekly cardiac arrest feedback meetings that you have attended?
  - Prompt questions
    - I. Anything else?
    - II. What do you think works particularly well?
    - III. What changes would you make to the meetings?
2. Thinking back to the last cardiac arrest that you attended, in what way do you think the weekly meetings had any impact on the way that you performed at that cardiac arrest?
  - Follow-up
    - I. What about other members of the team?
3. Can you tell me about any other experiences you have had (other than the weekly meetings) where you have received feedback following your involvement at a cardiac arrest?
4. I think you have attended (xx) arrests over the last (xx) months, and have attended (xx) meetings. (xx) of these arrests were discussed at meetings but you were unable to come. Is that correct?
  - a. How do you feel about your arrests being discussed when you were unable to be present?

- b. On the flip side of this, how do you feel about discussing other team's arrests, where they are not present?
5. Finally, I would like to discuss with you some other types of feedback that have been used by others. Can you tell what your thoughts are about each one, in terms of how useful you think it would be and how practical it would be in practice:
- a. An immediate post-arrest discussion between people who attended the cardiac arrest without any objective data on performance
  - b. A delayed (1-4 days later) post-arrest discussion between people who attended the cardiac arrest with objective data on performance
  - c. Individual/ small group feedback, where a facilitator will follow-up after every cardiac arrest and arrange to discuss a cardiac arrest with individuals or small groups a few days after the cardiac arrest with objective performance data
  - d. Written feedback, where you are sent a performance summary with some pointers to help you perform better.

Use card to illustrate these.

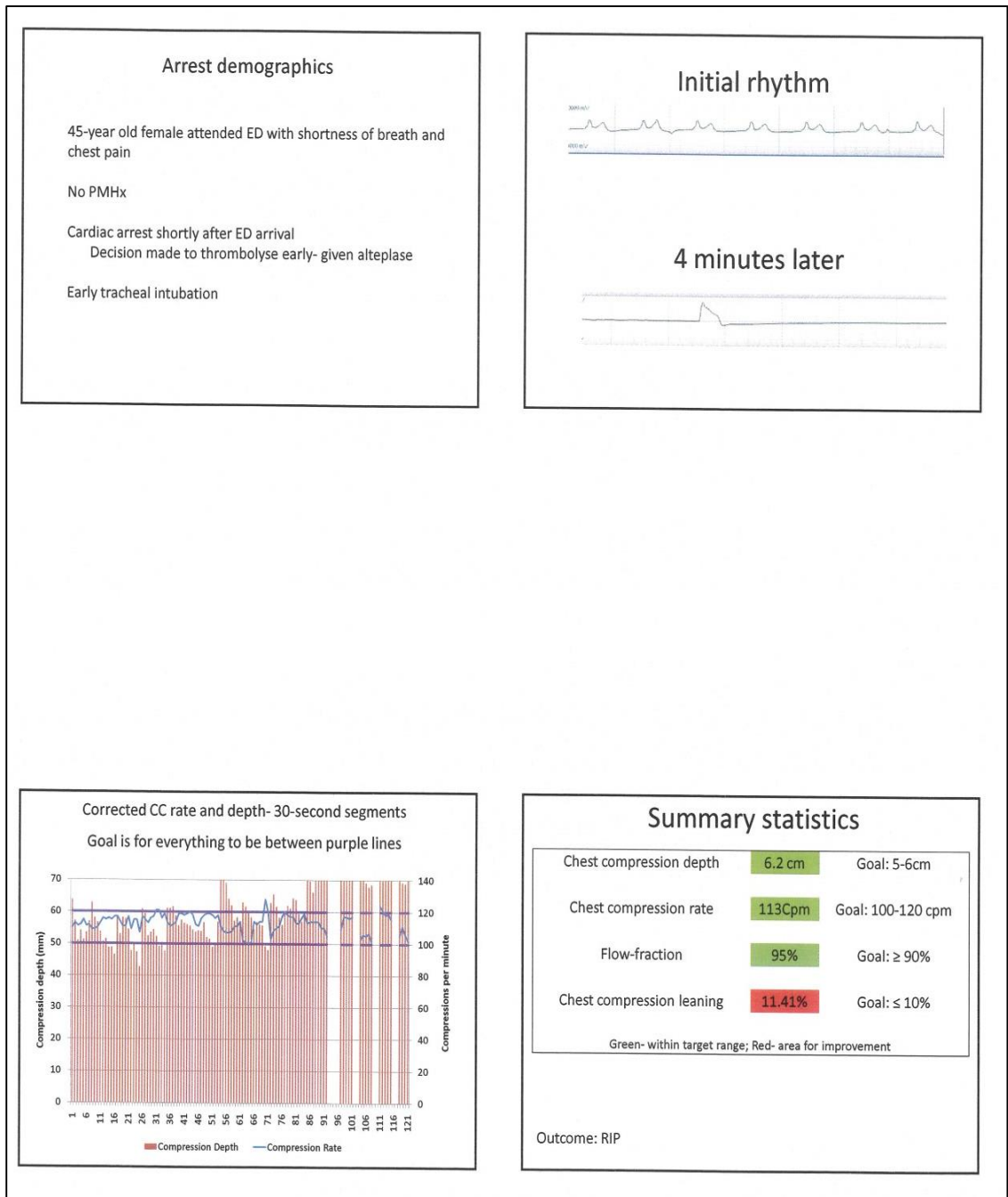
### **Concluding statement**

That is the end of my questions. Is there anything else that you would like to say?

Thank you very much for taking part in this interview.

## 12.4 CODE study

### 12.4.1 Example of debriefing presentation: hospital Two



## 12.4.2 Example of written feedback: hospital Three

### CODE study: CPR quality report

Date/ Time:	██████████	Location:	██████████
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#### Key CPR quality indicators:

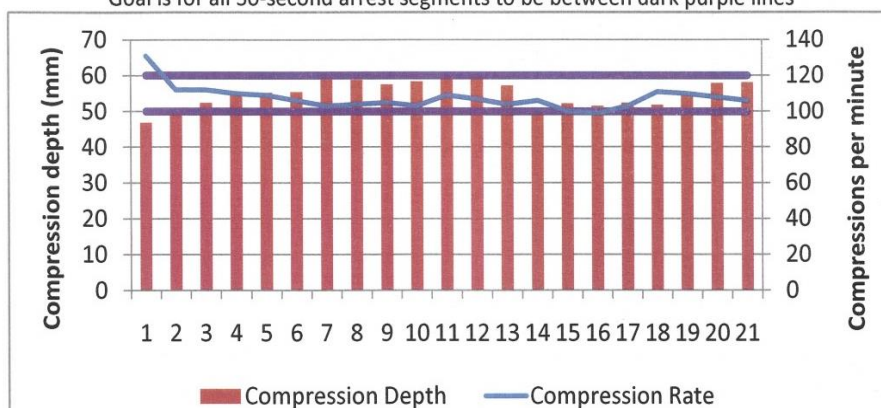
Chest compression depth (corrected)	<b>5.5 cm</b>	Goal: 5-6cm
Chest compression rate (per min)	<b>108 cpm</b>	Goal: 100-120 cpm
Flow-fraction	<b>94.9%</b>	Goal: ≥ 90%
Leaning (not allowing chest recoil)	<b>8.59%</b>	Goal: ≤ 10%
Pre-shock pause	<b>N/A</b>	Goal: ≤ 2.5 secs
Post-shock pause	<b>N/A</b>	Goal: ≤ 2.5 secs

Green- within target range; Red- area for improvement

For definitions of each indicator, please click [here](#).

#### Chest compression quality chart

Goal is for all 30-second arrest segments to be between dark purple lines



#### Comments/ areas to focus on

- This ██████████ patient had an out-of-hospital cardiac arrest witnessed by paramedics. He was initially in PEA, and remained in PEA throughout the arrest. He received 11 minutes of CPR in ██████████.
- The quality of CPR that this patient received excellent- all parameters were in the target ranges! Rhythm checks were brief and compressions were consistently delivered at the correct depth and rate.
- Leaning (not allowing the chest to recoil at the end of each compression) was towards the upper end of the range. It mostly occurred at the start of the arrest, but was then addressed. It is indicated by a star at the top of the compression deflection on the defibrillator display. This is a minor point, but may be something that could have been slightly improved on.
- This was an excellent team performance. Please try and reflect on what particular things you think went well, so this performance can be delivered at future arrests.

This feedback report has been produced as part of the CODE study. If you have any questions about this report or the study, please contact Keith Couper or Prof Gavin Perkins (ext 42966).  
If you have any clinical queries, contact the Trust Resuscitation officers (ext 42478).

## 12.4.3 Process evaluation questionnaires

### 12.4.3.1 Process evaluation questionnaire- Hospital one

Question number	Question	Type of response	Options
1	What is your current role?	Select from list	Doctor- Consultant; Doctor- Registrar; Doctor- SHO; Doctor- FY1; Nurse- Band 5; Nurse- Band 6+; Healthcare Assistant; Critical Care Outreach; Critical Care Practitioner; Resuscitation Officer; Other
2	How long have you been in your current role?	Free-text	
3	What is your highest level of resuscitation training?	Select from list	Advanced Life Support- instructor; Advanced Life Support- provider; Immediate Life Support; Basic Life Support
4	How many cardiac arrests have you attended in the last 4 months?	Free-text	
5	How many debriefing meetings have you attended in the last 4 months?	Select from list	1, 2, 3, 4, 5
Survey text: For questions 6-11, please state your agreement with the following statements.			
6	The meeting was interesting	Likert-type scale list	Strongly agree (5); Agree (4); Neutral (3); Disagree (2); Strongly disagree (1)
7	I felt comfortable contributing to discussions		
8	I would recommend these meetings to others		
9	After attending the meeting(s), my knowledge of resuscitation guidelines has improved		
10	After attending the meeting(s), I am more confident in participating in cardiac arrests		
11	After attending the meeting(s), my cardiac arrest clinical practice has improved		

### 12.4.3.2 Process evaluation questionnaire- Hospital two

Question number	Question	Type of response	Options
1	What is your current role?	Select from list	Doctor- Consultant; Doctor- Registrar; Doctor- SHO; Doctor- FY1; Nurse- Band 5; Nurse- Band 6+; Healthcare Assistant; Critical Care Outreach; Critical Care Practitioner; Resuscitation Officer; Other
2	How long have you been in your current role?	Free-text	
3	What is your highest level of resuscitation training?	Select from list	Advanced Life Support- instructor; Advanced Life Support- provider; Immediate Life Support; Basic Life Support
4	How many cardiac arrests have you attended in the last 4 months?	Free-text	
5	Of these cardiac arrests, for how many did you receive feedback?	Free-text	
Survey text: For questions 6-11, please state your agreement with the following statements.			
6	The feedback was interesting	Likert-type scale list	Strongly agree (5); Agree (4); Neutral (3); Disagree (2); Strongly disagree (1)
7	I would recommend this feedback to others		
8	The feedback prompted me to reflect on the cardiac arrest		
9	After receiving feedback, my knowledge of resuscitation guidelines has improved		
10	After receiving feedback, I am more confident in participating in cardiac arrests		
11	After receiving feedback, my cardiac arrest clinical practice has improved		

### 12.4.3.3 Process evaluation questionnaire- Hospital three

Question number	Question	Type of response	Options
1	What is your current role?	Select from list	Doctor- Consultant; Doctor- Registrar; Doctor- SHO; Doctor- FY1; Nurse- Band 5; Nurse- Band 6+; Healthcare Assistant; Critical Care Outreach; Critical Care Practitioner; Resuscitation Officer; Other
2	How long have you been in your current role?	Free-text	
3	What is your highest level of resuscitation training?	Select from list	Advanced Life Support- instructor; Advanced Life Support- provider; Immediate Life Support; Basic Life Support
4	How many cardiac arrests have you attended in the last 4 months?	Free-text	
5	Of these cardiac arrests, for how many did you receive and read the feedback sheet?	Free-text	
Survey text: For questions 6-11, please state your agreement with the following statements.			
6	The feedback was interesting	Likert-type scale list	Strongly agree (5); Agree (4); Neutral (3); Disagree (2); Strongly disagree (1)
7	I would recommend this feedback to others		
8	The feedback prompted me to reflect on the cardiac arrest		
9	After receiving feedback, my knowledge of resuscitation guidelines has improved		
10	After receiving feedback, I am more confident in participating in cardiac arrests		
11	After receiving feedback, my cardiac arrest clinical practice has improved		