AN INNOVATIVE RESUSCITATION TRAINING STRATEGY FOR PRIMARY CARE NURSES: FEASIBILITY STUDY FOR A RANDOMISED CONTROLLED TRIAL

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Finally, I would like to dedicate this thesis to the memory of Dr Scott Brown – I told you I would do this research.

ABBREVIATIONS

ACLS Advanced Cardiac Life Support

ADDIE Analysis Design Development Implementation and Evaluation

AED Automated External Defibrillation

AGP Aerosol Generating Procedure

ALS Advanced Life Support

ANP Advanced Nurse Practitioner

BLS Basic Life Support

CoSTR Consensus on Science with Treatment Recommendations

COVID-19 Coronavirus Disease 2019

CPR Cardiopulmonary Resuscitation

GP General Practitioner

GRAMMS Good Reporting of A Mixed Methods Study

HCP Healthcare Professional

ILCOR International Liaison Committee on Resuscitation

ILS Immediate Life Support

MCQ Multiple Choice Questionnaire

MRC Medical Research Council

NGT Nominal Group Technique

NHS National Health Service

OSCE Objective Structured Clinical Examination

PC Primary Care

PI Principal Investigator

PICO Population Intervention Comparison Outcome

PIS Participant Information Sheet

PPE Personal Protective Equipment

PRISMA Transparent Reporting of Systematic Reviews and Meta-Analysis

QCPR Quality Cardiopulmonary Resuscitation

RCT Randomised Controlled Trial

RCUK Resuscitation Council United Kingdom

SARS Severe Acute Respiratory Syndrome

SIV Self-Instruction Video

TCI Traditional Classroom Instruction

UK United Kingdom

USA United States of America

VR Virtual Reality

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ABSTRACT

Unexpected cardiac arrest remains a significant cause of out-of-hospital death world-wide, and prompt recognition of cardiac arrest and initiation of resuscitation is the predominating factor in quadrupling survival from out-of-hospital cardiac arrest. Patients with more complex needs are being cared for in primary care, yet primary care nurses lack access to a dedicated cardiac arrest team. An annual resuscitation training interval is frequently recommended, but the optimum resuscitation training interval is not known. Globally, resuscitation knowledge and skill retention is notoriously poor, and skills decay takes place well before the commonly adopted 12 month re-training interval.

The primary aims were to develop and refine a new intervention with involvement of relevant stakeholders, determining the feasibility and acceptability of proposed study procedures and outcome measures. The secondary aim was to determine whether useful data were likely to result from the main study. The intended outcome was that the following post-doctoral, statistically-powered, full-scale randomised controlled trial to assess the effect of the new resuscitation training intervention will deliver maximum benefit. The development of a cost-effective, optimal model of resuscitation training should provide the best care for patients, resulting in more lives being saved.

A stakeholder meeting gained consensus on the design of the strategy, content, delivery method and frequency of training, consistent with current Resuscitation Council UK guidelines. Consensus from the stakeholder meeting was the addition of the Lifesaver app as the intervention. A mixed methods design was adopted. Participants engaged in a scenario using a manikin and a scenario from the Lifesaver app to demonstrate resuscitation including defibrillation skills. Quantitative data were collected using the Lifesaver app, scenario observations sheets, QCPR app and questionnaires. Narrative data were elicited at each visit from a short, in-person focused interview. The study was conducted at a variety of NHS sites.

Sampling worked well. Additional primary care roles were included during recruitment due to demand and feedback from participants. All data collection modes were

effective and resulted in robust data. Minor changes were highlighted for the main study: removing ambiguity from the true/false questionnaire and improving the layout of the this and the observation sheet for easier completion. Participants were positive about the interactive app as the intervention. Debriefing was essential, and participants valued repeated practice as unconscious competence was revealed. Resuscitation knowledge and skills were maintained over time. Modifications to the study necessitated by the COVID-19 pandemic allowed the study to continue. This will inform essential training during future pandemics.

The procedures used in this study were deemed to be feasible and acceptable, such that the main study can proceed. Application of the intervention at three-monthly intervals promoted maintenance of resuscitation knowledge and skills over time. This suggests sufficient justification to proceed to the main intervention study.

CHAPTER ONE: INTRODUCTION

A CLINICAL PROBLEM

Cardiac arrest

Unexpected cardiac arrest remains a significant cause of out-of-hospital death world-wide (Andresen et al., 2012; Joglar & Page, 2016; Zheng & Giles, 2001), and unless effective cardiopulmonary resuscitation (CPR) is initiated in a timely manner, death is inevitable (Garza et al., 2009). In Sweden, immediate initiation of basic resuscitation has been shown to quadruple survival from out-of-hospital cardiac arrest (Hasselqvist-Ax et al., 2015). Furthermore, the prompt recognition of cardiac arrest, initiation of CPR, and automated external defibrillation (AED) has been identified as the predominating factor in patient survival (Baekgaard et al., 2017). The majority of primary care nurses have direct contact with patients. It is necessary, therefore, that they have the knowledge, skills and attitude to be able to act swiftly and effectively should a patient need to be resuscitated. This is the case regardless of the clinical setting. Currently, no data exist for the number of cardiac arrests in primary care areas. However, the incidence of out-of-hospital cardiac arrest in the United Kingdom (UK) is reported to be approximately 55 per 100,000 people (Resuscitation Council UK [RCUK], 2021).

Relative risk of cardiac arrest

All patients have the potential to suffer cardiac arrest (Saiboon et al., 2016), albeit some more than others. Critical care patients are at a greater risk of cardiac arrest than patients being cared for in a non-acute area. Consequently, nurses working in non-acute clinical areas may not have as much experience as some other nurses of dealing with this emergency (Saiboon et al., 2016). However, increasing demand is being placed on primary care services and, as a result, more patients are being cared for in primary care than ever before (Watson et al., 2017). It is also the case that patients with more complex needs are being cared for in primary care, and such patients are at a greater risk of cardiac arrest.

Lack of access to resources and support

Nursing staff who care for patients in a primary care environment lack access to a dedicated cardiac arrest team that would be available in a large hospital. Primary care is considered to be an out-of-hospital environment, as it is away from the main hospital

(Tobase et a., 2017). This includes the large integrated care centres such as urgent care centres and walk-in centres that may also house their own radiology department.

The requirements for improved survival after cardiac arrest in primary care

Survival rates exceeding 50% have been reported when defibrillation and basic life support (BLS) were carried out promptly by primary care clinicians (RCUK, 2015). The possibility of significantly raised chances of survival for patients in cardiac arrest, even when away from the resources of large hospitals, suggests that attention focussed on ensuring competence in resuscitation in nurses who work in primary care centres might be effective and productive. These nurses need to be empowered with the knowledge and skills to be able to act swiftly, with confidence and conviction, should a patient suffer a sudden cardiac arrest. Nurses working in a non-acute area, such as primary care, are often the first health care professionals to respond when a patient collapses (Saiboon et al., 2016).

RESUSCITATION TRAINING

Although CPR of some description (and varying efficacy) has been available for over 60 years (Kardong-Edgren & Adamson, 2009), the UK resuscitation guidelines are reviewed every five years in order to advise on the most effective practice (RCUK, 2021). Regular training is needed in order to maintain competence according to the latest guidelines and to promote retention of resuscitation knowledge and skill (Bukiran et al., 2014). However, resuscitation training differs world-wide in terms of content, delivery and frequency (Mosley et al., 2012).

Re-training strategies are usually in place in care organisations. However, there are barriers to attendance at refresher training sessions, including lack of time due to work commitments, inadequate support from colleagues, and insufficient availability of re-training sessions (Shahhosseini & Hamzehgardeshi, 2014). Traditional instructor-led resuscitation re-training sessions require significant resources. However, alternative re-training strategies could be designed which are as effective while overcoming some of the barriers. Research conducted in Malaysia has demonstrated the effectiveness of alternatives to instructor-led re-training sessions (Saiboon et al., 2016).

Despite evidence from Canada suggesting that three-monthly re-training intervals may increase knowledge and skill retention (Anderson et al., 2012), annual resuscitation training intervals are frequently recommended (Finn et al, 2015). However, some healthcare organisations stipulate longer mandatory resuscitation training periods of every two or even three years (Mosley et al., 2012). The optimum training intervals for CPR, including defibrillation, are not known (RCUK, 2015; RCUK, 2021). Many studies have demonstrated that resuscitation knowledge and skills decline well before 12 months (Passali et al., 2011). Accordingly, shorter training intervals are needed, potentially as frequently as every three months (Sutton et al., 2011).

The public expects healthcare professionals to be competent in CPR skills (Dwyer & Williams, 2002). However, copious evidence exists from across the globe demonstrating that resuscitation knowledge and skill retention is notoriously poor (Al-Rasheed et al., 2013 [USA]; Castillo et al., 2018 [Spain]; De Regge et al., 2008 [Belgium]; Marzooq & Lyneham, 2009 [Bahrain]; Montgomery et al., 2012 [USA]; Smith et al., 2008 [USA]; Srither & Lateef, 2016 [Singapore]). The decline has been found as early as two weeks (Davies & Gould, 2000) and most significantly within three to six months after initial training (Soar et al., 2010). This indicates that skills decay takes place well before the commonly adopted 12 month re-training interval. Knowledge and skills retention must be considered separately. Knowledge is retained slightly longer than skills, although not for the duration of the re-training interval (Gass & Curry, 1983; Smith et al., 2008; Yang et al., 2012). The issue is that retention of usable resuscitation knowledge and skills is limited to a short time after training. This is important since poor skill retention has been associated with decreased patient survival (Passali et al., 2011; Stiell et al., 2012).

The International Liaison Committee on Resuscitation (ILCOR) describes the vital role that education has in the implementation of current resuscitation guidelines (Wyckoff et al., 2021). Furthermore, ILCOR advises that educational principles should be used in resuscitation training (Chamberlain & Hazinski, 2003; Wyckoff et al., 2021). In terms of outcomes, it is clear from ILCOR (Nolan et al., 2020) that implementation of resuscitation training has resulted in improved patient survival from cardiac arrest. Evidence suggests further that the quality of resuscitation education contributes to patient outcome and survival from cardiac arrest (Perkins, 2007). Poor patient

outcomes have also been reported, possibly resulting from inadequate training (Deakin et al., 2009; Mosley et al., 2012).

Understanding what is most efficacious in promoting resuscitation knowledge and skills retention is therefore of great importance. RCUK guidelines are not under review or debated in this thesis, but rather the training strategy that employers use in terms of delivery and frequency for primary care nurses. The implementation of a resuscitation training strategy that is fit-for-purpose for primary care nurses is paramount for patient survival in out-of-hospital cardiac arrest.

Defining BLS and AED

The Resuscitation Council UK exists as a professional body to provide scientifically based, peer-reviewed resuscitation guidelines which contribute to saving patients' lives through education and training. The RCUK, formed in 1983, is accredited by the National Institute for Health and Care Excellence with the aim of ensuring high-quality resuscitation practice for patients in every care setting.

Adult cardiac arrest is diagnosed when an unconscious patient is not breathing normally and has no sign of life (RCUK, 2021). Adult BLS is the process in which external cardiac compressions and usually artificial ventilations are given by the rescuer in order to maintain oxygenated blood flow to the vital organs, thus saving the patient's life (RCUK, 2021). This is also referred to as basic CPR or basic resuscitation. An AED may also be used by the rescuer during adult BLS to deliver a controlled electrical current to attempt to restart the patient's heart. This is achieved by defibrillating a shockable heart rhythm as determined by the AED to allow a cardiac rhythm that is compatible with life to be restored. Patients in sudden cardiac arrest need prompt and effective resuscitation, including early defibrillation, in order to survive. Survival rates in adults of 50-70% can be achieved if defibrillation is attempted within the first 3–5 minutes of cardiac arrest (Valenzuela et al., 2000). The importance of prompt BLS and early defibrillation is represented in the chain of survival (RCUK, 2015) (figure 1).

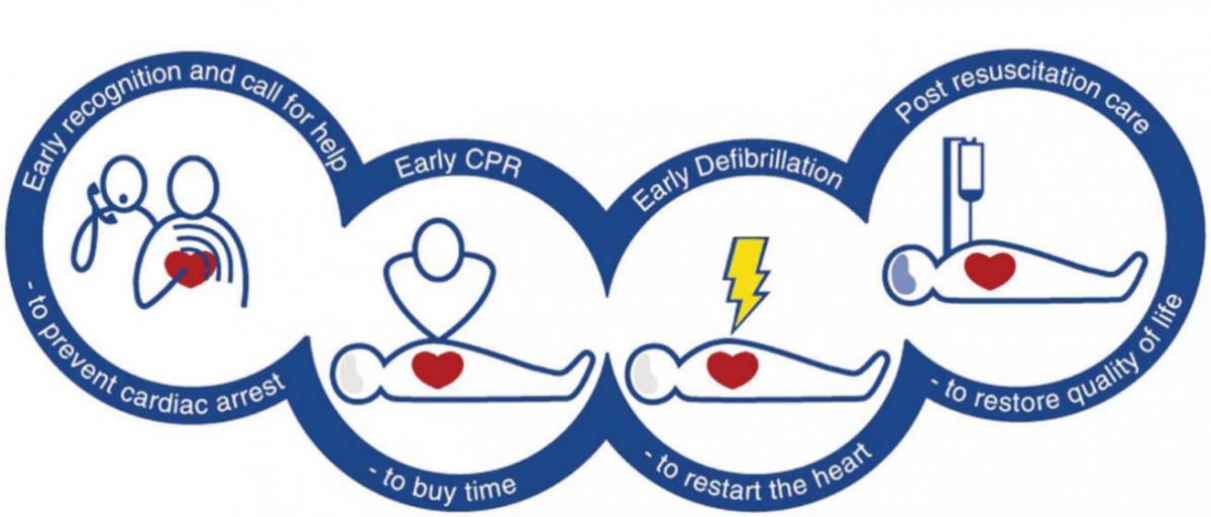

Figure 1: The chain of survival (RCUK, 2015)

Clarifying the definition of BLS in this thesis

The subject of BLS in this thesis refers to CPR performed on adult patients but not paediatric or neonatal patients. Paediatric and neonatal CPR have a different focus to that of adult CPR because of the different causes of respiratory or cardiac arrest in children (RCUK, 2015; RCUK, 2021). Consequently, these are not included in this thesis.

Basic life support throughout this thesis should also not be confused with fluid resuscitation. Fluid resuscitation is a term frequently applied to the management of fluid loss or fluid volume deficits in critically ill patients (O'Neill & Perrin, 2002). This, too, is not pertinent to this thesis. Similarly, trauma resuscitation (the initial approach to a patient who has been involved in trauma) differs significantly from the response to cardiac arrest and is often more complex than that for collapse with no involvement of trauma or injury (Nolan, 2005).

Defining BLS and AED training for primary care nurses

Primary care nurses include all nurses with a professional registration employed to work in a primary care setting (figure 2). Primary care nurses do not always have the immediate availability of an on-site dedicated cardiac arrest team. It is essential that these nurses know how to perform effective, immediate resuscitation. This is particularly important in primary care, as the nurse may be the first member of staff to respond to a patient in cardiac arrest (Rajeswaran et al., 2018). Resuscitation training

is usually included in annual mandatory training requirements. However, the content, delivery and frequency of this training differ amongst employers and National Health Service (NHS) organisations. For example, AED training is not always included in BLS training, but is recommended by RCUK (2015; 2021). The Resuscitation Council UK offers guidelines for resuscitation training which include recommendations from the ILCOR Consensus on Science with Treatment Recommendations (CoSTR) (Soar et al., 2010; Nolan et al., 2020). The ILCOR CoSTR guidelines are considered to be the gold standard for resuscitation treatment and education world-wide (Yang et al., 2012).

Practice Nurse	Nurse Matron
Advanced Clinical Practitioner (Nurse)	Mental Health Nurse
Nurse Practitioner	Dental Nurse
Advanced Nurse Practitioner	Specialist Nurse
Lead Nurse	Research Nurse

Figure 2: Titles of nurses working in primary care

Clarifying the nature of BLS and AED training

Basic life support refers to two components:

1. Initial CPR involving external cardiac chest compressions and expired air or bag and mask ventilations; and
2. Defibrillation involving the use of an AED.

Basic life support training involves these two components, but does not include Immediate Life Support (ILS) training or Advanced Life Support (ALS) training, which include additional content over a longer course (RCUK, 2015; RCUK, 2021).

THE PROCESS OF ADULT LEARNING

How adults learn is often referred to as andragogy (Reece & Walker, 2000). Andragogy focuses on the basic principle of the adult as the student, where the adult learner takes personal responsibility for their learning (Sanchez & Cooknell, 2017). The role of the teacher in this process is to facilitate student-led learning (Reece & Walker, 2000), rather than to dominate the session by emphasising the delivery of received wisdom.

Resuscitation training uses an andragogic approach by encouraging understanding leading to a change in behaviour as a result of an improved level of knowledge and skills (Mosley et al., 2012). However, the concept of behavioural change may need to

be developed further in resuscitation training in order to understand how knowledge and skills are retained and what factors influence retention (Bukiran et al., 2014). Understanding this is key, with likely benefits being improved preparedness for sudden cardiac arrest management and thus improved resuscitation practice.

The concept of experiential learning including reflection is a well-established approach in the theory of adult education (Sanchez & Cooknell, 2017). The resultant improved cognitive and psychomotor skills have been shown to increase confidence, and this transfers well into improved resuscitation practice (Hoadley, 2009). A key point is that resuscitation education needs to translate into effective resuscitation practice, and for the duration of the re-training interval. This change in behaviour and attitude can be attributed to Kolb's learning cycle (Kolb, 1984) (figure 3).

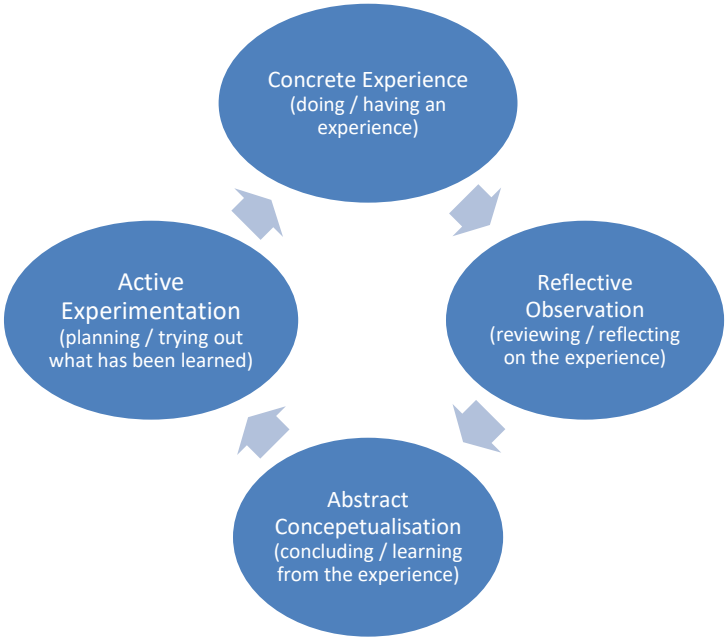

Figure 3: Kolb's experiential learning cycle

There are many educational theories, theoretical frameworks, educational strategies, interventions, resources and modalities of adult learning (see chapter 2: literature review). Given that adult learning is so diverse, instructional design models are useful when considering resuscitation education strategies. The Japanese "analysis, design, development, implementation and evaluation" (ADDIE) model (Ono, 2014) is of particular benefit in the field of resuscitation (Tobase et al., 2017) (Table 1). All stages of the ADDIE model were followed when designing the new training strategy used in this feasibility study.

Table 1: The ADDIE instructional design model

Stages	Involvement
1. Analysis	Identification of audience learning needs, activities and programme
2. Design	Identifying objectivities, content, instructional methods, learning activities and resources required
3. Development	Detailing the learning materials required
4. Implementation	Implementation of the programme
5. Evaluation	Identification of how well the programme was delivered and what improvements can be made

Evaluating knowledge and skills acquisition

In resuscitation training, knowledge acquisition is usually measured using a printed true/false questionnaire. Skill acquisition is usually measured by observation of a scenario performance using a pre-defined, rigorous assessment tool with critical actions. Kirkpatrick's (1983) 4-level training evaluation model is summarised in table 2. This model is particularly useful in measuring effectiveness of resuscitation training (Perkins, 2007). The first two levels of the model were followed in this feasibility study, to determine participant reaction to and learning from the new training strategy. The instruments used to determine reaction and learning were the interview and scenario observation respectively (see chapter 3: study design).

Table 2: Kirkpatrick's training evaluation model

Level	Description
1. Reaction	How did the trainees react to the training? Was the training valuable? Was the training well-received?
2. Learning	What have the trainees learned? Has their knowledge increased? How long do they retain the knowledge and skills for?
3. Behaviour	How have trainees applied the new information and changed their behaviour during cardiac arrest management in practice?
4. Results	What are the final results of the training? What impact does the training have on patient survival from cardiac arrest?

PROBLEM DEFINITION

A frequently recommended resuscitation training interval is 12 months (Finn et al., 2015). However, it is clear from a recent review of the literature (Chalk et al., 2018 Unpublished) that annual training intervals are not sufficient. This is because not all nurses can retain resuscitation knowledge and skills for the 12 months in between training (Hamilton, 2005), a view that was supported during a study conducted in Korea (Oh & Han, 2008). The optimum training interval is not known.

There is considerable heterogeneity in the literature regarding how resuscitation training is delivered. Consequently, the best approach to delivering CPR and AED training is uncertain. Inadequate primary care resuscitation training strategies have previously been found by Nurmi and Castren (2004), with irregular training intervals being documented as a contributing factor. What is clear is that further research is needed to design optimum training to promote retention of resuscitation knowledge and skills amongst primary care nurses. This includes exploring potential barriers such as anxiety and lack of confidence to promote swift, competent initial resuscitation in this group of nurses. Regular, high-frequency, low-fidelity approaches show promise but require further research.

Assumptions

The following assumptions were made at the beginning of this study:

1. Resuscitation knowledge and skills decline over time and before 12 months following training.
2. Primary care nurses want more frequent resuscitation training.
3. Optimum training should be short (content); interactive (educational style and delivery) and regular (frequency) whilst following current RCUK guidelines.

Outcome

The outcome is a training strategy which will promote retention of resuscitation knowledge and skills in primary care nurses for the duration of the re-training interval. This should then translate into prompt and effective resuscitation for primary care patients, ultimately impacting on increased patient survival from cardiac arrest. Brief, frequent, low-fidelity resuscitation training could reduce skill decay (Finn et al., 2015).

A structured primary study

A feasibility study was required to design an innovative intervention with key stakeholders to derive the best way forward that was most suited and most effective for primary care nursing staff. Specifically, stakeholders were needed to provide consensus in terms of resuscitation training content, following RCUK guidelines, delivery method and frequency of training. A mixed methods approach was needed to determine the feasibility and acceptability of the proposed study procedures including outcome measures. Furthermore, it was necessary that the intervention was able to

address both cognitive and psychomotor functions related to resuscitation knowledge and skills.

The intended outcome was to ensure the rigour and feasibility of a post-doctoral statistically-powered full-scale randomised controlled trial (RCT) to assess the effect of the new resuscitation training intervention. This was expected to lead to the development of an optimal model of resuscitation training in order to provide the best care for patients, resulting in more lives being saved.

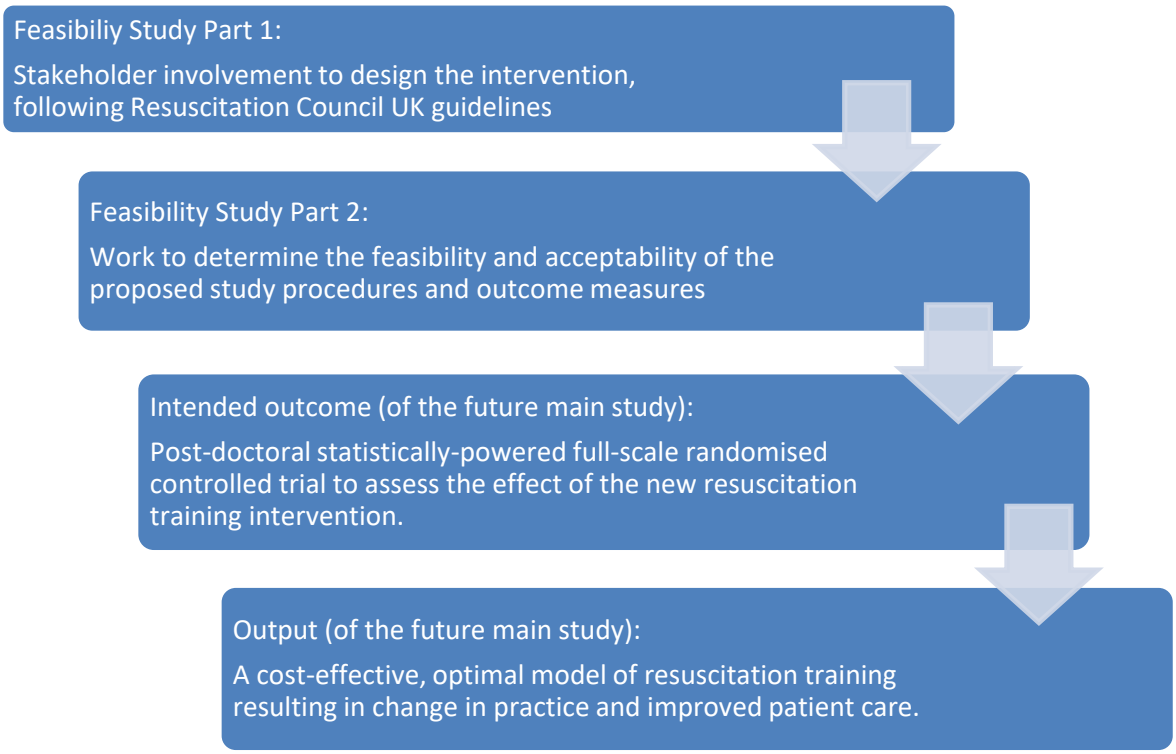

Figure 4: Flow chart representing the path to outcomes from the future main study

THE RESEARCHER'S ENGAGEMENT WITH THE PROBLEM

The issue of ensuring that primary care nursing staff remain competent in delivering BLS and defibrillation for the duration of the training interval is clearly important. Having delivered resuscitation training for over 20 years, I was aware that the current training strategy was in some ways inadequate. This was because some staff expressed concerns around resuscitation knowledge and skill retention and therefore felt apprehensive when faced with a cardiac arrest. However, organisations are reluctant to change training strategies without evidence to demonstrate the need for change.

A gap in the literature had been identified that needed to be filled in order that resuscitation knowledge and skill retention, and hence resuscitation practice, could improve. The research reported in this thesis was the first step in presenting a new resuscitation training strategy to primary care organisations ultimately to improve patient survival from cardiac arrest.

I will continue researching the best means of providing robust resuscitation strategies with built-in resilience to challenging circumstances after completing the Professional Doctorate. The substantive study for which this work was undertaken will test the new approach, particularly exploiting the potential of the Lifesaver app. This future intervention study will examine if the new resuscitation training strategy improves knowledge and skill retention amongst primary care nurses. As I currently deliver resuscitation training to primary care nurses, I am ideally placed to perform the research that is needed. Furthermore, my strategic position will help drive the change needed to be able to implement any new training strategy swiftly as a result of the research findings. I also work with other resuscitation experts regionally and nationally, so dissemination of the research findings to those who will be delivering resuscitation training outside the locality will be more readily achieved. This will allow for rapid implementation of any new training strategies on both a regional and national level.

THE STRUCTURE OF THIS THESIS

Chapter 2 – Literature Review. The search strategy is detailed and the review identifies the gap in the literature, exposing the need for a new resuscitation training intervention for primary care nurses.

Chapter 3 – Study Design. The overall approach to the feasibility study is described in this chapter, including detail of the sample as well as data collection methods and the means of data analysis. This is followed by explanations of efforts to enhance rigour and the limitations of the study. Finally, ethical considerations and access to participants are described.

Chapter 4 – Findings. The findings from the feasibility study are presented in this chapter. This includes findings from the scenario observations, questionnaires and interviews. Data extracts are included as evidence from the interview transcripts.

Chapter 5 – Discussion. In this chapter a number of issues from the findings are considered in more depth, placed in the context of current evidence, and possible explanations for some issues are hypothesised. Issues for the design and conduct of the next (intervention) study are also highlighted.

Chapter 6 – Conclusion. This chapter is focussed on the conclusions and key messages from this feasibility study.

SUMMARY

Retention of knowledge and skills in resuscitation amongst nurses is problematic. Furthermore, knowledge and skill retention amongst primary care nurses who do not have the provision or support of a cardiac arrest team in their workplace is a key concern. Nurses retain resuscitation knowledge and skills for varying periods of time, but evidence suggests that most nurses' retention is less than the usual re-training period of 12 months. The training strategy has a direct impact on nurses' knowledge and skill retention. Furthermore, this may affect the survival rate of patients from unexpected cardiac arrest.

Implementation of the current Resuscitation Council UK guidelines requires an effective training strategy for primary care nurses. Given that the optimum resuscitation training strategy in terms of content, delivery and frequency was not clear, it was vital that research should address this issue. It is important that there is a training strategy for primary care nurses that is fit-for-purpose and effective. This will ensure patients have the best chances of survival when they suffer from a sudden cardiac arrest in a primary care environment.

CHAPTER TWO: LITERATURE REVIEW

INTRODUCTION

With an ever increasing number of publications available, assessing and reviewing all of the available information in order to inform evidence-based practice can be a considerable challenge (Pautasso, 2013). A comprehensive literature review using a systematic approach is useful, following principles outlined by Pope et al. (2007). Literature reviews can identify both strengths and gaps in practice, which can then be addressed through research (Boote & Beile, 2005). The original search was completed before data collection. It was then supplemented and updated at the point of finalising the thesis once the findings were clear and additional insights had been gained. These items appear in the discussion chapter.

SEARCH STRATEGY

For the review process to begin, a focused review question is needed in order to structure a robust search for the available evidence. The Population Intervention Comparison Outcome (PICO) framework exists to aid the formulation of such a question (Hastings & Fisher, 2014). The review question for this literature review was:

What evidence exists about nurses' (P) **knowledge and skill retention** (O) **at varying intervals** (C) **following resuscitation training** (I)**?**

Databases

Search terms and strings were generated such that relevant information would not be missed. Synonyms were identified (table 3).

Table 3: Keywords and identified synonyms

Resuscitation	Training	Learning	Assessment of learning
Cardiopulmonary resuscitation	Education	Retention	Observation
Basic life support	Teaching	Knowledge	Evaluation
Defibrillation		Skills	
Automated external defibrillation			

The identified synonyms were then written into search strings using Boolean operator OR to combine the words within the strings (table 4). The four strings were finally

combined with AND (table 5) to yield 63,296 references from selected databases (table 6).

Table 4: Search strings using Boolean operators

String Number and Theme	Boolean Terms
String 1 (skill)	cardiopulmonary resuscitation OR resuscitation OR basic life support OR defibrillation OR automated external defibrillation NOT "fluid resuscitation" NOT trauma
String 2 (teaching)	training OR education OR teaching
String 3 (learning)	learning OR retention OR knowledge OR skill
String 4 (assessment)	observation OR assessment OR evaluation
String 5 (population)	nurs* NOT neonat* NOT p#ediatric

Table 5: Strings combined with Boolean operator

	String 1	String 2	String 3	String 4	String 5
String 1		AND	AND	AND	AND
String 2			AND	AND	AND
String 3				AND	AND

Table 6: Database results

Database	Initial Results
Medline Ovid	933 papers
Medline Ebsco	1,958 papers
British Nursing Index	16,872 papers
Cochrane Library	5 reviews
Cochrane Library	385 papers
Web of Science	2,026 papers
CINAHL Ebsco	1,582 papers
Scopus	39,535 papers

Inclusion and exclusion criteria for the studies

Inclusion and exclusion parameters were added using Boolean operators 'AND' or 'NOT' respectively, in an attempt to refine the search. 'Nurse' was added as a term as the focus was nurses specifically. Similarly, exclusions were applied to ensure identification of publications that included CPR and not fluid resuscitation, nurses rather than lay persons, adult patients rather than neonatal or paediatric patients. 'Trauma' was also excluded as the treatment for cardiac arrest when trauma is involved is different to cardiac arrest due to other issues. This served to improve the relevance of the results.

Some of the databases had in-built limiters that filtered the results even further. The limiter ‘humans’ was selected as evidence involving animals would not be relevant to the study. ‘English language’ was also selected as no translation service was available in this time-limited professional doctorate study with few financial resources.

The focus of this review was resuscitation of adults. Consequently, the ‘adult’ limiter was selected as literature focusing on paediatric and neonatal BLS were not relevant. The “chain of survival” algorithm changed in 2005 (Nolan et al., 2006), hence 2005 was selected as a limiter for ‘date’ and reports published before this date were not included. ‘Publication type’ was also selected as a limiter as only research evidence was considered relevant. While any study design was acceptable, opinion articles and news items were excluded.

Outcome of the search

The final results for relevant publications that were retrieved from the specific databases are shown in table 7. The searches were re-run prior to finalising the results, to ensure that relevant research pertaining to ‘dental nurses’ had not been excluded, given that dental nurses were in the inclusion criteria of the population in the protocol. The search process is summarised in a Transparent Reporting of Systematic Reviews and Meta-Analysis (PRISMA) flowchart (Moher et al., 2008) (figure 5). The included publications are detailed in table 8.

Table 7: Summary of relevant publications retrieved from specific databases

Database	**Number of relevant publications retrieved**
Medline Ovid	10
Medline Ebsco	11
BNI	5
Cochrane Library (reviews)	1
Cochrane Library	8
Web of Science	4
CINAHL Ebsco	7
Scopus	7
Total	**53**

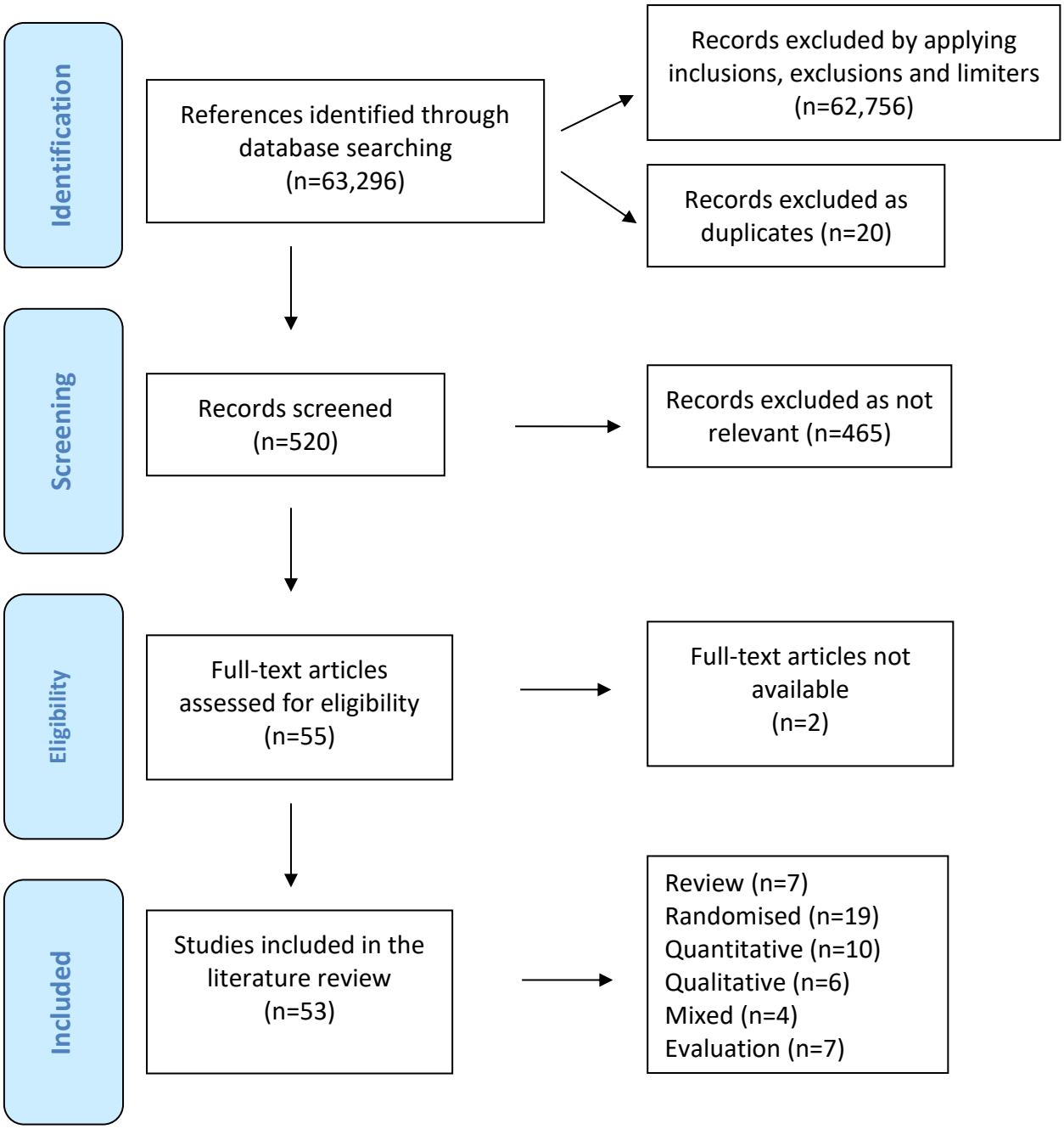

Figure 5: PRISMA flowchart

Table 8: Publications included in the review

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
Mohamed and Daylami (2005) Bahrain	Evaluation of in hospital CPR	Review of forms	207 cases	Guidelines not followed.
Einav et al. (2006) Israel	Performance of department staff in the window between discovery of collapse to cardiac arrest	Debriefings following cardiac arrests	240 events	Staff do not perform BLS AED well initially (prior to emergency team arriving).
Madden (2006) Ireland	Acquisition and retention of CPR knowledge and skills	Quasi-experimental time series design using multiple choice questionnaire (MCQ) and observation	18 student nurses	CPR knowledge and skills decline after 10 weeks. Local CPR instruction needs addressing to develop competent practitioners.
Makinen et al. (2006) Finland	Can distance learning be a substitute for traditional small group learning (theory and practice for 4 hours) for teaching BLS to nurses?	RCT Objective structured clinical examination (OSCE)	56 nurses	Distance learning cannot substitute for traditional small group learning. Internet group performed similarly to group without training, which was worse than traditional small group with theory and practice. The study suggests that the Internet course may serve as re-training if the OSCE is not passed.
Noordergraaf et al. (2006) Holland	Quality of chest compressions by trained personnel: the effect of a feedback device in a RCT using a manikin model	Unannounced, randomised, single blinded manikin study with a non-cross over design	224 hospital staff	Need feedback devices in all arrests. Frequency of training inadequate to guarantee adequate continuing skills.
Makinen et al. (2007)	Methods of assessing CPR skills: a systematic review	Systematic review	25 papers	Assessment methods had methodological shortcomings. Most compared participants with each other not against a standard or a defined pass level. Evidence is needed that uses well-defined study populations, standardised study settings and explicit, comparable outcomes.
Roessler et al. (2007) Austria	Practical impact of the European Resuscitation Council's BLS algorithm 2005	Randomised cross over trial	60 Healthcare Professionals (HCP) and non-HCP	The 2005 sequence is easier to learn and retain. Shorter time elapse before starting chest compressions when applying 2005 guidelines.

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
De Regge et al. (2008) Belgium	BLS refresher training – are individual and group training equally effective?	Randomised two group study	120 non-critical care nurses	No difference immediately and 10 months after training. Total training time did not increase in the 1:1 instructor: student group. However, the training time per nurse was only 1/5th the time in the 1:1 instructor: student group.
Smith et al. (2008) United States of America (USA)	Evaluation of retention of advanced cardiac life support (ACLS) and BLS skills	Repeated measures, quasi-experimental design	133 nurses	Nurses retain knowledge but skills decline quickly. ACLS skills decline faster than BLS skills. 30% passed ACLS at 3 months compared to only 14% at 12 months. Nurses are unable to perform ACLS and BLS skills to the standard expected for the entire certification period. More frequent refresher training is required. Further research on ACLS and BLS course content, design, management and execution is needed.
Vries et al. (2008) Holland	Self-training vs instructor led in the use of AED	Randomised two group study design.	30 general ward nurses	No significant differences between the groups was seen. The self-instruction is more cost-effective, but long term retention was not assessed.
Xanthos et al. (2008) Greece	Nurses are more efficient than doctors in teaching BLS and AED in nurses	A randomised study with OSCE	18 Nurses 18 Doctors	Nurses are more efficient than doctors in training nurses.
Bradley et al. (2009) UK	Inter-professional learning of resuscitation skills	Mixed methods, quasi-experimental approach	120 medical students 45 nursing students	There was no significant difference in resuscitation skills when taught via inter-professional education or uni-professional settings.
Bruce et al. (2009) USA	Collaboration between under and post graduate nursing students using a computer assisted simulator	Quantitative feedback from participants	107 under-graduate students 11 graduate students	Computer assisted simulation is effective in resuscitation training. More research needed regarding specific outcomes. Participants were satisfied with the use of the computer assisted simulator.
Hoadley (2009) USA	Effects of low and high-fidelity simulation (HFS) in ACLS	Experimental, two group design	53 HCP	HFS was not significantly higher than low-fidelity simulation. However, results trended in that direction. Further research is needed with more participants collecting qualitative data to determine if HFS is a passing technological phase or a glimpse of improved healthcare provision.

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
Keys et al. (2009) USA	Resuscitating training with accelerated learning	Service evaluation	318 staff	Application of adult learning theory and accelerated learning techniques enhanced staff readiness and confidence to handle real-life emergency situations.
Paul (2010) UK	Student nurses' thoughts and experiences of using a video-recording to assess their performance of CPR during a mock OSCE	Descriptive study	14 student nurses	Formative feedback via video-recorded OSCE was useful as students 'saw' how they performed.
Soar et al. (2010) UK / Europe	Education, implementation and teams. 2010 International Consensus on CPR and Emergency Cardiovascular Care Science with Treatment Recommendations	Evidence evaluation		Significant opportunities to improve resuscitation education. Knowledge and skills can deteriorate in as little as 3-6 months. Refresher training recommended. Short video/computer self-instruction courses with hands on practice can be considered as an effective alternative to instructor led courses.
Hui et al. (2011) Hong Kong	Nurse perception of constraints and anticipated support to practice defibrillation	Qualitative, descriptive, exploratory study with semi-structured interviews	12 nurses	There is a need for a consistent policy for nurse-led defibrillation.
Husebo et al. (2011) Norway	Educating for teamwork – nursing students' coordination in simulated cardiac arrest situations	Explorative and descriptive design	81 nursing students	Simulation allows interplay of verbal and non-verbal communication modes.
Oermann et al. (2011) USA	Does brief monthly practice (6 minute voice advisory manikin training) on nursing students' CPR skills effect performance at 3, 6, 9 and 12 months?	RCT Scenario assessments	606 nursing students	Ventilation: no difference at 3 months, but at 6 months better retention in the intervention group and this continued to improve. The control group skills declined. Compressions: the control group had a progressive loss of skill between 9 and 12 months. By practicing 6 minutes/month, skills maintained or improved over the 12 months.

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
Passali et al. (2011) Greece	Are nurses' and doctors' knowledge of CPR guidelines related to professional background as well as CPR training?	Descriptive, quantitative design 30 minute questionnaire	216 nurses and doctors	Nurses and doctors have BLS and ALS knowledge gaps. Nurses scored significantly better on 4/5 BLS questions; doctors scored significantly better on 3/10 ALS questions. Those working in high-risk areas scored better than those from low-risk areas. Those with experience (more than 5 patient cardiac arrests in 12 months) scored better.
Pozner et al. (2011) USA	CPR feedback improves quality of chest compressions provided by hospital HCP	Non-blinded, randomised, controlled study manikin scenarios	25 non-critical care nurses	A handheld accelerometer based feedback device significantly improved the quality of chest compressions.
Semeraro et al. (2011) Italy	Does an iPhone app improve chest compression rate and is the app acceptable by HCP and lay people?	Scenario observations Questions	50 HCP and lay people	An iPhone app is acceptable and also significantly improved chest compression performance.
Yeung et al. (2011) UK	AED training and its impact on skill acquisition, retention and performance: a systematic review of alternative training methods	Systematic review	285 articles	Alternative methods of AED training are supported.
Meaney et al. (2012) Botswana	Effectiveness of CPR training to retain CPR skills for 6 months in a resource-limited setting. Do novel teaching methods have similar training effectiveness compared to instructor-led traditional training?	Quasi-randomised interventional trial	214 HCP	There was a low cognitive score and a need for skill remediation but instructor method did not impact on CPR skill performance. Novel techniques with increased instructor: student ration and feedback manikins were not different compared to traditional training. CPR skills were retained at 3 months but not 6 months.
Montgomery et al. (2012) USA	Student satisfaction and self-report of CPR competency	Additional findings of end of study satisfaction and feedback from participants of a year-long study	606 nursing students	Monthly practice results in increased confidence and satisfaction.
Mosley et al. (2012) UK	Impact of structured resuscitation training (SRT) on healthcare practitioners, clients and the wider service	Systematic review with qualitative synthesis and a narrative summary	105 articles	SRTs result in an improvement in knowledge and skills. Deterioration in skills and to a lesser extent knowledge is highly likely as early as 3 months following SRTs.

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
				Refresher sessions may improve knowledge and skill retention after training, but the timing and frequency of these in different disciplines is yet to be determined. More research is needed to determine if learning is transferred into behavioural change in clinical practice.
Perkins et al. (2012) UK & Australia	Improving efficacy of ALS training	Open label, non-inferiority, randomised trial	3732 HCPs	Inclusion of e-learning led to a slightly lower pass rate for cardiac arrest skills but similar scores on knowledge and reduced costs.
Yang et al. (2012) Taiwan	Adult ALS knowledge and skills retention in healthcare providers	Systematic review	11 papers	There is a lack of large, well-designed studies. Knowledge and skills decline by 6-12 months after training. Skills decay faster than knowledge. Further research is needed to provide evidence for assessment of knowledge and skills. Further research is needed to assess the need for refresher training to maximise maintenance of ALS competency.
Al-Rasheed et al. (2013) USA	Simulation intervention with manikin-based objective metrics improves CPR instructor chest compression performance skills without improvement in chest compression assessment skills	RCT	30 Instructors	It could be argued that reduced retention is due to Instructor incompetence. Real time compression feedback during simulation improved chest compression performance skills without comparable improvement in chest compression assessment skills.
Roh et al. (2013) Korea	The effects of simulation-based resuscitation training on nurses' self-efficacy and satisfaction	Comparative study design Random assignment to modalities	38 nurses	Simulation based training was positively embraced. Computer based simulation may be beneficial for acquiring resuscitation skills and decision making skills. There is a need for more research to verify the effects of simulation based resuscitation training with more rigorous outcomes.
Sankar et al. (2013) India	To compare the impact of a 6 hour CPR training programme on knowledge and skills of in-service and pre-service nurses at specific time points: immediately after training and 6 weeks later	Repeated measures quasi experimental study	74 nurses: (28 in-service, 46 final year)	Initial assessment: in-service nurses had significantly higher knowledge whilst pre-service had significantly higher skills scores. Immediately after training, all scores improved. Six weeks later: decline in performance in both groups although in-service still had better knowledge scores than pre-service and pre-service had better skills scores than in-service. In-service nurses retained knowledge better with time; pre-service nurses retained skills better with time.

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
Bukiran et al. (2014) Turkey	What is the retention of nurses' knowledge following 8 hours BLS/ ACLS training at immediate, 6 and 12 months after training intervals?	Longitudinal quasi-interventional study 25 item MCQ	225 nurses	Significant improvement pre-initial training and post-initial training. Scores higher if increased experience, similar prior training and critical care background. Knowledge levels decreased over time - although levels at 12 months were higher than at pre-training baseline. The optimal frequency for refresher training is unclear. Pedagogical reasons may include instructor competence, teaching modes, frequency of updates.
Na et al. (2014) Korea	BLS skill improvement with newly designed renewal programme: small group discussion vs practice while watching method	Cluster, randomised study	2169 hospital staff	Small group discussions renewal programme (video of own practice the discussion/debrief) is more effective for improving BLS skills as it is more personalised.
Attin et al. (2015) USA	Potential impact of nursing characteristics prior to in-hospital cardiac arrest	Self-reported study	55 nurses	Efficacy of more frequent training not supported by this study. Training all nurses at the same frequency was questioned. Self-reported information of nursing characteristics may be a limitation.
Baldwin et al. (2015) UK	Use of the learning conversation improves instructor confidence in life support training.	Open randomised, cross over trial comparing teaching feedback mechanisms	640 healthcare students	Learning conversation favours skill acquisition.
Boada et al. (2015) Spain	Using a serious game to complement CPR instruction in a nurse facility	Evaluation	109 undergraduate nursing students	Students using the 'game' gave significantly better learning acquisition scores.
Dempsey et al. (2015) Ireland, USA, Canada	Standardised formal resuscitation training (SFRT) programmes for reducing mortality and morbidity	Systematic review	14 studies with qualitative synthesis 5 studies with quantitative synthesis	SFRT programmes improve outcomes. Innovative educational methods that enhance knowledge and skills and teamwork behaviour should be evaluated. There is a need for more research for retention in terms of: content, frequency, delivery.

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
Finn et al. (2015) Europe	The key PICO questions related to timing of BLS re-training	Systematic review	3 RCTs 2 non-RCT	Rapid decay in BLS skills within 3-12 months after initial training. Skills decay before the currently recommended 12 month re-training interval. High-frequency, low-dose training could reduce skill decay but more research is needed.
Kardong-Edgren et al. (2015) USA	Expert modelling, expert / self-modelling versus lecture: a comparison of learning, retention and transfer of rescue skills in health professions students	3 x 4 mixed design study	43 student nurses	Expert modelling may help, but more research is needed.
Kemery et al. (2015) USA	Brief bedside refresher training to practice CPR skills	Descriptive evaluation of a quality improvement intervention. Pre-post test debrief	46 nurses	In-unit brief (171 seconds average) CPR refresher training is effective.
Sullivan (2015) USA	Instructional strategies to improve nurses' retention of CPR priorities. Is there a more effective training method to improve CPR retention of priorities vs traditional training?	Literature review	183 from Pubmed, EMBASE and CINAHL	Brief, frequent (monthly), repetitive, simulation, deliberate/structured practice (mock cardiac arrest scenarios) may increase retention. Skills decline at 6-12 months after training. Video and e-learning effective on immediate attainment of skills.
Cant et al. (2016) Australia	Improving the non-technical skills of hospital emergency teams using an assessment measure	Prospective descriptive study	104 nursing and medical staff	The assessment measure is a valid, reliable and easy-to-use tool for both training and clinical settings.
Everett-Thomas et al. (2016) USA	The impact of high-fidelity simulation on the retention of BLS / CPR knowledge	25 question written CPR examination	Convenience sample 57 out-patient department HCPs	There were no significant differences between any of the total mean percent scores for all time intervals. High-fidelity simulation alone does not support CPR knowledge retention. Further research needed to establish strategies to help HCP with retention of CPR knowledge.

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
Generoso et al. (2016) USA	Simulation training in early emergency response	Prospective, single-centre, mixed methods, quasi experimental study	147 nurses	Deliberate practice is effective in increasing confidence, initiating life-saving measures and empowering nurses to manage emergencies. Further study needed to overcoming barriers to high-quality emergency care.
Saiboon et al. (2016) Saudi	Effectiveness of teaching AED using a traditional classroom instruction (TCI) vs self-instruction video (SIV) in non-critical care nurses	Prospective single-blind randomised study	80 nurses	SIV is as good as TCI in providing knowledge, competency and confidence in using an AED.
Srither and Lateef (2016) Singapore	A novel CPR training method using a smartphone app	Randomised two group study	309 trainees	App is readily available. Smartphones are widely owned.
Tobase et al. (2017) Brazil	Instructional design in the development on an online course on BLS	Technological production research of an online course	12 expert nurses 62 students	A virtual learning environment and online learning contributed to BLS teaching. An instructional design model is appropriate based on andragogy and the meaningful learning theory.
Castillo et al. (2018) Spain	BLS and AED competences after instruction and at 6 months comparing face-to-face and blended training	Randomised 2 group trial	129 first year medical and nursing students	The blended method (self-training, video, website, moodle, manikin and instructor practice) provides the same or even higher levels of knowledge and skills than standard instruction both immediately and 6 months later.
Haukedal et al. (2018) Norway	Impact of a new pedagogical intervention on nursing students' knowledge acquisition in simulation based learning	Quasi-experimental study	190 student nurses	Significant improvement with new intervention. There is a need to: 1. Improve student prerequisites for learning 2. Strengthen debrief after simulation.
Kim and Suh (2018) Korea	Effects of an interactive nursing skills mobile application on nursing students' knowledge, self-efficacy and skills performance	RCT	66 nursing students	Mobile app is effective and can be used across all nursing students. A mobile app is recommended.
Munezero et al. (2018) Uganda	Assessment of nurses' knowledge and skills following CPR training	Prospective pre-post intervention design	32 nurses	Statistically significant improvement in both knowledge and skills of CPR for all nurses after training. Significant change in skills than in knowledge after training.

Author(s), date and country	Research question / theme	Research approach	Participants	Findings/outcomes
Rajeswaran et al. (2018) South Africa	Assessment of nurses CPR knowledge and skills within 3 district hospitals in Botswana	Quantitative, quasi-experimental study	154 nurses	There is poor knowledge and skills amongst nurses. The pre-test average score was 48% The immediate post-test score had a 26% increase. Only 85 nurses attempted the 6 month test, where results dropped. BLS and AED skills not retained at 6 months.

Quality Appraisal

The quality of the evidence was assessed using the Hawker et al. (2002) appraisal tool and corresponding review scale. This was used as it can be applied to all study designs. Hawker et al.'s review score incorporates descriptive grades and uses nine questions as a method of systematically reviewing literature. The questions relate to the following areas: abstract and title, introduction and aims, method and data, sampling, data analysis, ethics and bias, results, transferability or generalisability and implications and usefulness. Furthermore, each question can score 1 (very poor), 2 (poor), 3 (fair) or 4 (good), and a paper can have a total score between 9 and 36.

The Hawker et al. (2002) appraisal tool has a number of strengths. It is systematic yet focused and easy to use. The progression of the questions flows with the layout of most publications and most importantly, the tool can be applied across all research disciplines. However, there are also some weaknesses. The Hawker et al. (2002) appraisal tool includes sections for scoring on ethics and bias, but some journals do not ask for these to be included. Consequently, the score for these sections will be low. It must also be acknowledged that prior to 2002, journals may not have expected the same level of writing as more recent publications. Hence the overall scores will be lower in the older publications.

Assigning a total score for each publication allowed a clear indication of the strengths and weaknesses of each paper according to the Hawker et al. (2002) scoring system (table 9). To create the overall quality grades, the following definitions were applied: good quality, 30–36 points; fair quality, 23–29 points; poor quality, 16–22 points; very poor quality, 9-15 points. The quality of the papers was fair overall (n=26) and no papers were of very poor quality. The lowest Hawker et al. (2002) score was 19/36 and the highest 36/36, with 17 papers scoring 30/36 or above.

Table 9: Quality Appraisal Scores (* denotes poor quality score)

Reference	Score
Attin et al. (2015)	19*
Bruce et al. (2009)	21*
Mohamed and Daylami (2005)	21*
Rajeswaran et al. (2018)	21*
Keys et al. (2009)	22*
Srither and Lateef (2016)	22*
Cant et al. (2016)	23
Einav et al. (2006)	23
Montgomery et al. (2012)	23
De Regge et al. (2008)	24
Hoadley (2009)	24
Al-Rasheed et al. (2013)	25
Bukiran et al. (2014)	25
Everett-Thomas et al. (2016)	25
Kemery et al. (2015)	25
Na et al. (2014)	25
Haukedal et al. (2018)	26
Kim and Suh (2018)	26
Paul (2010)	26
Pozner et al. (2011)	26
Smith et al. (2008)	26
Xanthos et al. (2008)	26
Makinen et al. (2007)	27
Roh et al. (2013)	27
Roessler et al. (2007)	27
Tobase et al. (2017)	27
Baldwin et al. (2015)	28
Boada et al. (2015)	28
Generoso et al. (2016)	28
Vries et al. (2008)	28
Yang et al. (2012)	28
Husebo et al.(2011)	29
Noordergraaf et al. (2006)	29
Saiboon et al. (2016)	29
Sankar et al. (2013)	29
Sullivan (2015)	29
Bradley et al. (2009)	30
Kardong-Edgren et al. (2015)	30
Semeraro et al. (2011)	30
Yeung et al. (2011)	30
Madden (2006)	31
Makinen et al. (2006)	31
Meaney et al. (2012)	31
Oermann et al. (2011)	32
Passali et al. (2011)	32
Castillo et al. (2018)	33
Finn et al. (2015)	33
Munezero et al. (2018)	33
Hui et al. (2011)	34
Soar et al. (2010)	34
Perkins et al. (2012)	35
Dempsey et al. (2015)	36
Mosley et al. (2012)	36

Overview of the literature

The studies were from a number of different countries. There was a high proportion from Europe (40%), compared to 30% from the United States of America and the remaining 30% from the rest of the World. The literature included a range of study designs. Sixteen studies were described as RCTs. However, whether some of these studies (Al-Rasheed et al., 2013; De Regge et al., 2008; Pozner et al., 2011; Srither & Lateef, 2016; Xanthos et al., 2008) were true RCTs as per the Consolidated Standards of Reporting Trials guidelines (Moher et al., 2008), remains unclear. This was largely due to inadequate explanation and description of methods, and in some review guidelines these should be downgraded in quality assessment. Similarly, it was unclear if some of the studies described as prospective designs met the criteria. There were only 12 descriptive studies compared to 31 experimental studies. However, there were six systematic reviews and a literature review. The remaining literature reviewed was an evidence evaluation, a review of clinical documentation and a service evaluation.

The sample numbers tended to be small and there were some common limitations across the studies which contributed to the lower scores. These included limited information and descriptive details of the sampling strategy, and inadequate justification of the sample size. There was also a lack of explanation relating to transferability or generalisability to other contexts and settings across the studies.

A number of different teaching approaches were used in the literature reviewed. These included instructor-led teaching, peer-led instruction, self-instruction, deliberate practice, computer-led simulation, instruction via apps, virtual learning environments, e-learning, group discussion, and debriefing and feedback including playback of video recorded sessions. Scenario simulations using high and low-fidelity manikins were used widely in the studies, and there was frequent use of multiple choice questionnaires and interviews.

Outcome of the review

Four main themes were extracted from the literature reviewed: retention period of knowledge and skills; characteristics associated with skill retention; pedagogy and teaching style; and frequency of training.

RETENTION PERIOD OF KNOWLEDGE AND SKILLS

There is plentiful international evidence on retention of knowledge and skills following resuscitation training. From this literature, it is clear that knowledge and skills decline during the currently recommended annual re-training interval, typically within weeks or months of training. However, the extent of skills decline and exactly when this becomes significant remains unclear.

Sankar et al. (2013) concluded that nurses' basic CPR knowledge and skills in India declined just six weeks after training. A short retention period for basic CPR skills was also reported by Madden (2006) who found that student nurses in Ireland retained knowledge and skills for only 10 weeks. There is strong evidence from a systematic review conducted in the UK (Mosley et al., 2012) and evidence evaluation from the UK and Europe conducted by Soar et al. (2010) that resuscitation knowledge and skills are retained for approximately three months. Other studies from Europe suggest that knowledge and skills decline over 12 months, with a rapid decay after the three months mark (Finn et al., 2015).

Evidence from Botswana studying healthcare professionals concluded that resuscitation skills were retained at three months but not at six months (Meaney et al., 2012). Resuscitation skills not being retained at six months was also found by Rajeswaran et al. (2018), following their study of nurses' CPR knowledge and skills in South Africa. However, this evidence was poor quality because of limited information regarding the sampling strategy, study methodology, attrition rates and transferability or generalisability to other contexts.

Conversely, there is evidence that knowledge and skills decline later, after six months. In a literature review conducted in the USA, Sullivan (2015) found evidence that nurses' CPR skills were maintained for six to 12 months after training. This was supported by evidence from Taiwan (Yang et al., 2012). Other studies reporting knowledge and skill retention up to 12 months after training include Oermann et al. (2011), who examined US nursing students' CPR compression skills retention in a RCT. The study revealed a progressive loss of compression skill between nine and 12 months after intervention (Oermann et al., 2011).

Other evidence suggests that knowledge and skills decline is even slower. In a study in Turkey, the retention of nurses' knowledge following basic and advanced CPR training at immediate, six and 12 months after training intervals was explored in a longitudinal quasi-interventional study (Bukiran et al., 2014). Although the study showed knowledge decrease over time, at 12 months knowledge was still higher than at the pre-training baseline, but minimally adequate (Bukiran et al., 2014).

Although retention periods often refer to resuscitation knowledge and skills synonymously, it is important to recognise that some studies have reported knowledge and skills as separate entities. Consequently, international evidence exists to support the phenomenon that healthcare professionals' resuscitation skills decay at a faster rate than that of knowledge (Mosley et al., 2012 [UK]; Munezero et al., 2018 [Uganda]; Smith et al., 2008 [USA]; Yang et al., 2012 [Taiwan]).

CHARACTERISTICS ASSOCIATED WITH SKILL RETENTION

A number of characteristics appear to be associated with better resuscitation knowledge and skill retention. These predictors might indicate that specific groups of learners need more frequent knowledge and skills training.

Professional background seemed to be an indicator of good resuscitation skills. Sankar et al. (2013) explored basic CPR skills amongst nurses in India and found that the best predictor of skills was being a nursing student. Sankar et al. (2013) also found that with time, qualified nurses retained knowledge better and student nurses retained skills better. This could be attributed to qualified nurses' ongoing exposure to CPR as part of their job roles. However, the qualified nursing staff possibly learnt incorrect skills in the workplace whereas the student nurses kept the skills they were taught during training. Passali et al. (2011) also examined the trainee's professional background in Greece. When nurses' and doctors' knowledge of CPR guidelines were compared using questionnaires, nurses scored significantly better on 4/5 basic CPR questions whilst doctors scored significantly better on 3/10 advanced CPR questions (Passali et al., 2011).

Another characteristic associated with retention is prior exposure to and experience of cardiac arrest management (Bukiran et al., 2014). In this study amongst nurses in Turkey, retention of resuscitation knowledge was better in nurses with more

experience and those from a critical care background. Similarly, in a study researching trainee nurses' theoretical knowledge of CPR guidelines in Greece, Passali et al. (2011) found that those working in high-risk areas scored better than those from low-risk areas, and that those with experience of more than five cardiac arrests in 12 months also scored better.

Einav et al. (2006) conducted debriefings following hospital cardiac arrests in Israel, finding that hospital staff, including nurses, did not perform CPR and AED well initially, prior to the arrival of the cardiac arrest team. The reasons for this may be linked to findings from Bukiran et al. (2014) relating to an individual's experience of cardiac arrest management, as well as characteristics of the rescuer.

Trainee characteristics including attitude and confidence levels have been examined in studies researching resuscitation training. During a nurse self-reported study in USA, it was highlighted that nurses questioned a generic training frequency. It was concluded that nurses felt the training frequency should be reflected by their characteristics including how confident they felt with their resuscitation knowledge and skills (Attin et al., 2015). However, a limitation of this study was that the nurses' self-reports of their characteristics may not be an accurate reflection of their actual performance during a cardiac arrest scenario. This evidence was also scored as poor quality because of limited information regarding the sample size, study design, and generalisability.

A number of characteristics as predictors for good resuscitation knowledge and skill retention have been studied across the literature, although not all of the characteristics were examined in a single study. The studies suggest that certain subgroups of trainees may need more frequent practice in order to maintain their resuscitation knowledge and skills.

PEDAGOGY AND TEACHING STYLE

A number of different CPR and AED training techniques featured in the literature, and there was variation in their effectiveness. However, the interventions used were not always described in detail. What was clear was that poor skill retention amongst learners can be attributed to teaching strategies and instructor input (Bukiran et al., 2014).

Traditional resuscitation training is also referred to as instructor-led training, and is often reported as a 1:6 instructor to learner ratio. Typically, traditional instructor-led training comprises group teaching and practice of skills on a training manikin before knowledge and skills testing (Roppolo et al., 2007). Instructor-led training has been discussed widely in the literature, usually as the comparator group in studies. De Regge et al (2008) found no difference when they studied group and individual instructor-led training in Belgium. This suggests that the instructor to learner ratio is not relevant in traditional training. This was supported by Meaney et al.'s work (2012) in Botswana studying effectiveness of increased instructor to student ratios on skill retention amongst healthcare professionals.

Distance learning in resuscitation education has also been considered in the literature. Makinen et al. (2006) examined if e-learning could be a substitute for traditional in-person resuscitation training. The study demonstrated that the e-learning group performed similarly to the group without training, suggesting that in-person training may be superior. This was supported by work in the UK and Australia which found that e-learning did not improve skill acquisition and similar levels of knowledge were demonstrated when compared to traditional training (Perkins et al., 2012). However, studies in the USA and Brazil reported good results in terms of immediate skills acquisition through e-learning (Sullivan, 2015; Tobase et al., 2017). Although long-term retention was not commented on, this evidence supports e-learning being an adjunct with practical training.

Self-led versus instructor-led training strategies have also been researched. In Semeraro et al.'s study (2011) in Italy it was found that self-instruction using a mobile app provided immediate and adequate CPR skills. Similarly, self-instruction via video was found to be as good as traditional classroom instruction amongst nurses in Saudi Arabia (Saiboon et al., 2016). These results were also echoed by Vries et al. (2008) when they researched nurses in The Netherlands. This could suggest that self-instruction CPR training may be more cost-effective than instructor-led training. However, long-term retention was not addressed in these studies.

Instructor competence and the specific skills needed for effective resuscitation educators have also been acknowledged (Bukiran et al., 2014). In a study conducted

in Greece, Xanthos et al. (2008) found that having instructors belonging to the same profession as the learners promoted better outcomes. Conversely, Bradley et al. (2009) found no difference in the UK with intra-professional training. This would suggest that instructor competence rather than the profession of the instructor impacts on skill acquisition.

High-fidelity simulation versus low-fidelity simulation was also addressed in the literature. Simulation is described as controlled clinical practice without compromising patient safety, allowing learners the responsibility for managing cardiac arrests including knowledge, skills and attitudes in a structured, systematic manner (Perkins, 2007). Patient simulation uses body manikins as clinical simulators to facilitate a targeted scenario allowing integration of knowledge, skills and human factors. This is often referred to as high-fidelity patent simulation with computer-driven simulation and feedback. Conversely, low-fidelity patient simulation is often used to describe simulation which is instructor-driven. Computer assisted simulation has been shown to be effective in resuscitation nurse education internationally (Bruce et al., 2009 [USA]; Haukedal et al., 2018 [Norway]; Husebo et al., 2011 [Norway]). However, the evidence presented by Bruce et al. (2009) in the USA was assessed as poor due to lack of details regarding their sampling strategy and chosen research design for the study.

Low-frequency, high-fidelity teaching using clinical scenarios and advanced manikins is often used for CPR and AED training (Generoso et al., 2016; Hoadley, 2009). However, Hoadley (2009) did not find that the results were significantly better than using low-fidelity simulation during an experimental study in the USA amongst healthcare professionals. There is also evidence from Europe to suggest that higher frequency training, using less technical manikins may be better for CPR and AED training (Finn et al., 2015).

The quality of resuscitation education contributes to patient outcome as survival from cardiac arrest (Perkins, 2007). However, transfer of knowledge from simulation to patient care is not always demonstrated (Perkins, 2007). More research is needed to demonstrate the optimum strategy for simulation training in order to maximise long-term skill retention (Sullivan, 2015). Everett-Thomas et al. (2016) researched the impact of high-fidelity simulation on the retention of basic CPR knowledge amongst out-patient healthcare professionals at various time points. They found no significant

differences between any of the total mean percent scores for all time intervals. This would suggest that high-fidelity simulation alone does not support CPR knowledge retention amongst out-patient healthcare professionals. A concern may be that staff fear simulation teaching. However, in a study conducted in Korea, Roh et al. (2013) found that simulation based training was positively embraced.

Low-fidelity voice advisory manikins, with CPR feedback, have been used to evaluate resuscitation skill retention. In a RCT in USA, Pozner et al. (2011) concluded that the CPR feedback component significantly improved the quality of chest compressions by nurses. This was echoed in a study conducted on Rhode Island amongst resuscitation instructors (Al-Rasheed et al., 2013). These studies support the move to include feedback components as an alternative adjunct to traditional instructor-led resuscitation teaching.

Other alternative teaching styles were also explored amongst the literature (Boada et al., 2015; Kardong-Edgren et al., 2015). Sullivan (2015) evaluated instructional strategies to improve nurses' retention of CPR priorities. The study looked at high versus low-fidelity simulation using e-learning with video instruction. Again, this study emphasised the positive impact of simulation style training. The study also suggested that video and e-learning are effective in achieving immediate attainment of skills.

The use of video has also been demonstrated to be beneficial when used in a different format. Na et al. (2014) researched hospital staff in Korea and found that when individual resuscitation practice was video-recorded then individual performance was discussed in small groups, this improved BLS skills. The evidence available would suggest that the use of discussions with learners has value in resuscitation education. This is echoed in work from the UK, where the learning conversation improved resuscitation skills amongst healthcare students (Baldwin et al., 2015).

The use of mobile apps has become a popular training platform in recent years, and their use in resuscitation training is no exception (Srither & Lateef, 2016). The mobile apps adopted in Italy demonstrated significant improvement in chest compression performance (Semararo et al., 2011). Furthermore, nurse education in Korea actively encourages mobile apps as a way of improving knowledge and skill performance (Kim & Suh, 2018).

Many educational interventions currently exist for delivery of resuscitation training (Yeung et al, 2011). There is evidence to suggest that frequent instructor-led, low-fidelity simulation training may be appropriate for basic resuscitation training, with computer based learning as a useful adjunct (Cook, 2005). However, a combination of other modalities such as self-training, video, e-learning and manikin practice, as with the blended method described by Castillo et al. (2018), may also be effective.

It is important to acknowledge that efficacy of training could be attributed to the structure of the training strategy (Dempsey et al., 2015; Keys et al., 2009; Mosley et al., 2012). Furthermore, national resuscitation councils adopted a structured approach in an attempt to improve knowledge and skill retention (RCUK, 2015; Roessler et al., 2007).

Assessment is also addressed in the literature, with studies acknowledging that the assessment method used in resuscitation training requires further research (Makinen et al., 2007). However, there is evidence to support the use of the Objective Structured Clinical Examination (OSCE) method as a useful way of providing feedback on performance (Paul, 2010).

FREQUENCY OF TRAINING

Although there is strong evidence across the literature reviewed that resuscitation skills deteriorate rapidly with time, the optimum training intervals for CPR including defibrillation are not known (Bukiran et al., 2014). Most of the literature suggested that a higher than currently recommended frequency re-training period may be optimum. However, it has also been suggested that increasing the frequency of re-training alone may not necessarily be the best way to increase knowledge and skill retention (Noordergraaf et al., 2006). Length of training sessions was featured in a number of studies, suggesting that brief, repetitive practice may be as important as frequency of re-training (Oermann et al., 2011; Sullivan, 2015).

Training as often as every month has been suggested from research conducted in the USA, which included self-reports from nursing students (Montgomery et al., 2012). In a RCT conducted in the USA amongst nursing students, Oermann et al. (2011) found that brief (six minute) training sessions every month resulted in maintained

resuscitation skills over the 12 month period in between re-training sessions. Very short refresher training (121 seconds on average) was also supported by Kemery et al. (2015), when they researched workplace resuscitation training, again in the USA. The use of very brief training sessions to maintain resuscitation knowledge and skills could be argued to be effective as this allows staff to remain in their busy work areas and leave their work area for only very short periods of time.

Brief training has also been supported by Sullivan (2015) in a literature review conducted in the USA, and in a literature review conducted by Yeung et al. (2011) in the UK. Sullivan (2015) suggested that brief, monthly, repetitive practice may be more important than days since last training for nurses but also recommended that methods of re-training should be addressed. This suggests that changing frequency of re-training alone may not necessarily be the best way to increase retention but that the modality of the re-training as well as the frequency may impact on knowledge and skill retention.

Strong evidence is available from Europe (Hawker et al., 2002) to suggest that training every three months may be optimum. This is based on evidence from a systematic review conducted in the UK (Mosley et al., 2012) and evidence evaluation from the UK and Europe conducted by Soar et al. (2010). Both suggest that three months is how long resuscitation knowledge and skills are retained for, and this is supported by evidence from Botswana (Meaney et al., 2012). Other European studies support this timeline by suggesting a rapid decay of knowledge and skills after three months (Finn et al., 2015).

The need for more frequent training than the currently recommended annual interval is well-documented in the literature reviewed here. A study in The Netherlands found that the current frequency of training was inadequate to guarantee adequate continuing skills of nurses (Noordergraaf et al., 2006). This was echoed in a study in the USA where nurses were again unable to maintain resuscitation skills for the duration of the certification period (Smith et al., 2008).

There is strong evidence to suggest that frequency of re-training needs to be addressed, so that optimum training is available, resulting in retention of resuscitation knowledge and skills for the entirety of the re-training interval. An important factor when

considering frequency of training was made by Attin et al. (2015), who questioned training all nurses at the same frequency. Although this evidence was of poor quality because of the sample size and research method, there remains a valid issue to explore. This comes back to the point that resuscitation training strategies may differ dependent upon staff experience of managing cardiac arrests and areas of work.

The key messages from each main theme are listed in table 10.

Table 10: Key messages from the themes

Theme	**Key Messages**
Retention period of knowledge and skills	1. Knowledge and skills decline rapidly between 3 and 12 months after training, with some evidence that decline is sooner than 3 months 2. Knowledge and skills decline before the recommended re-training interval 3. The current re-training interval is too long
Characteristics associated with skill retention	1. Certain subgroups of BLS and AED trainees may need more frequent practice to maintain their resuscitation knowledge and skills 2. Those subgroups may be the inexperienced or those with less exposure to cardiac arrest events
Pedagogy and teaching style	1. Instructor-led, practical, high-frequency, low-fidelity simulation training may be appropriate 2. Computer-based learning may be a useful adjunct to hands-on training
Frequency of training	1. The optimum frequency of re-training is not known 2. Re-training intervals must be reviewed, to ensure that resuscitation knowledge and skills remain at an adequate level. 3. The optimum re-training interval may be every 3 months

DISCUSSION

Although the individual papers were generally of good quality, the literature review process showed that the newer studies (from 2012 onwards) were generally of better quality according to the Hawker et al.'s (2002) score. This could be attributed to the development of guidelines for conduct and reporting of trials (Moher et al., 2008).

It is clear that educational and behaviour change theories must be considered when designing CPR training, in order to understand how resuscitation knowledge and skills are retained and what pedagogical factors influence retention (Bukiran et al., 2014). A number of theories have been used in resuscitation training to date: 'reasoned action and planned behaviour' (Ajzen, 1988), 'attitudes and subjective norms' (Walsh,

Edwards & Fraser, 2009) and Bloom et al.'s taxonomy (Bloom et al., 1956). However, although a number of studies in this literature review were indicative of educational theory, they were implicit rather than clearly explicit of the educational principles used and the interventions were not always described in detail. Consequently, the origin of interventions and the nature of the pedagogy platform are not always clear. This then questions how appropriate the strategies are for the individual stakeholders.

The evidence revealed four main themes as educational strategies for resuscitation training: retention period of knowledge and skills; characteristics associated with skill retention; pedagogy and teaching style, and frequency of training. These themes are inextricably linked, however the fourth theme, frequency of training, is key. It was noted that there was little overlap of the publications in the different themes in this literature review. This was due to the different publications having a distinct focus, rather than each publication addressing several of the themes. Professional background seemed to be an indicator of effective resuscitation skills. Although this was only addressed in three publications, they were of high-quality (Hawker et al., 2002).

While there is a considerable amount of research on this topic, there is also substantial heterogeneity in terms of study designs, interventions, outcome measures and recommendations within the literature reviewed. It is not clear what single intervention is best or how long knowledge and skills last. However, what is clear is that some parts of the interventions work, and knowledge and skills are retained for a period of time, although exact points of decline are not as clear. Therefore, optimum training intervals for CPR including defibrillation are not known. It is accepted that skill retention declines rapidly within three to six months after initial training and skills decay happens before the frequently recommended 12 month re-training interval. However, whilst annual CPR and AED training intervals may not be sufficient, the optimal content and frequencies for refresher resuscitation training remain unclear.

The focus of the feasibility study was initially exclusively nurses, although this changed after the study had started to include support staff due to participant request. Consequently, lay people were excluded in the literature search. However, a substantial amount of literature focused on lay people without a professional healthcare qualification. It was legitimate to include the findings from the paper involving both healthcare professionals and lay people in the review, as the results are

considered generalizable amongst healthcare professionals, although more evidence is needed from healthcare professionals. Of note, none of the studies addressed the clinical outcomes of knowledge and skill performance during actual resuscitation attempts on patients or the impact on patient survival from resuscitation.

The evidence suggests that refresher training every three months may be optimal and that short, computer-based, self-instruction with or without hands-on practice may be an effective alternative to traditional instructor-led training. Furthermore, where feasible, training should be offered more frequently than every 12 months to those likely to encounter a cardiac arrest. What is pivotal is that local CPR instruction must be provided in order to develop competent practitioners, which may include short, frequent yet effective re-training sessions (Madden, 2006).

Although scenario teaching is appropriate for CPR and AED teaching (Generoso et al., 2016; Hoadley, 2009), higher frequency training, using less technology, may be better than infrequent, annual, high-fidelity training (Finn et al., 2015). Furthermore, video or computer based self-learning with or without hands-on practice may also be an effective adjunct to the traditional instructor-led training.

The studies were limited as they do not separate out the training effect from other factors which may affect knowledge and skill retention. Furthermore, there was no evidence specifically for primary care. Consequently, further research involving key stakeholders is recommended.

Table 11 details how the four main themes from the literature review informed the feasibility study.

Table 11: How the themes from the literature review informed the feasibility study

Theme form Literature Review	**How the Theme Informed the Feasibility Study**
Retention period of knowledge and skills	The literature suggested that nurses do not retain resuscitation knowledge and skills for the length of time between the current re-training episodes. Research is needed to determine what an optimum training strategy may look like, that will enable maintenance of resuscitation knowledge and skills between re-training. The feasibility study was the required first step to be able to address this issue in the main study.
Characteristics associated with skill retention	Primary care staff have infrequent exposure to cardiac arrests. The literature supported training more frequent than annually for such a staff group. The feasibility study needed to determine the acceptability and feasibility of re-training intervals more frequent than annually.
Pedagogy and teaching style	The literature supported the inclusion of instructor-led, practical, high-frequency, low-fidelity simulation training with some computer-based learning. The feasibility study needed to incorporate these modalities and determine the acceptability and feasibility of the procedures and outcome measures to determine if they could be used in the main study.
Frequency of training	The literature supported more frequent than annual re-training. The feasibility study needed to address the acceptability and feasibility this.

LIMITATIONS

Limitations of this literature review have been identified. The chosen methodology was not a meta-analysis, as this would not have been possible due to the nature of the work being studied. The Hawker et al. (2002) scoring system is also not without its limitations. For example, although very unusual now, if no reference to ethics was required by the selected journal, then the paper scored low in this section.

CONCLUSION

There was strong evidence provided by the literature in each of the four main themes derived from the literature review, with the 11 out of the 17 reports rated as ‘good’ contributing to pedagogy and teaching style findings. There were also a number of reports (Meaney et al., 2012; Mosley et al., 2012; Oermann et al., 2011) that provided strong evidence of both frequency of training and retention period of knowledge and skills in their studies. Poor quality evidence came from a minority of papers. There was no poor quality evidence regarding frequency of training, and only one poor quality study in each of the other three themes. Where there was poor evidence for computerised assisted simulation and retention periods, there was good quality evidence which found similar results. Hence, the poor evidence did not affect the overall findings. Evidence for self-reports of characteristics contributing to performance during a resuscitation attempt was found, but this needs to be taken with caution as the evidence was of poor quality.

There was substantial heterogeneity in the literature for educational interventions and time points for assessment. However, scenario-based assessments were used as the standard for most studies, and skill retention was shown to decline over time, within three to 12 months after BLS training.

Brief, frequent, deliberate, low-fidelity training could reduce skill decay, but more research is needed to demonstrate this. The way forward was a feasibility study using a mixed methods approach to design an intervention with stakeholders. It was thought that this would generate the optimum study in terms of resuscitation training content and frequency which is acceptable in practice.

There was a significant gap in the evidence base regarding primary care. This substantiated the need for a feasibility study to determine when and why knowledge and skills in CPR and AED decline in primary care, and how this decline should be corrected. Although primary care was absent in the literature reviewed, the themes derived from the literature review were still used to inform the design of the feasibility study. This feasibility study was designed to address the problems and challenges faced by primary care nursing staff in order that training would meet the needs of the workforce, and through this benefit patient care. This should lead to the development

of a cost-effective, optimal model of training in order to provide the best care for patients, resulting in more lives being saved.

CHAPTER THREE: STUDY DESIGN

INTRODUCTION

This chapter details the approach to the study, sampling and recruitment, data collection, data analysis, ethical issues, and limitations imposed by the study design.

OVERVIEW

Process evaluation is an essential part of developing a complex intervention (Moore et al., 2015), and the Medical Research Council (MRC, 2019) has revised the guidance for developing and evaluating a complex intervention (figure 6). The MRC framework was consulted to ensure that the study design chosen in this thesis met its recommendations for a rigorous and systematic approach to the study.

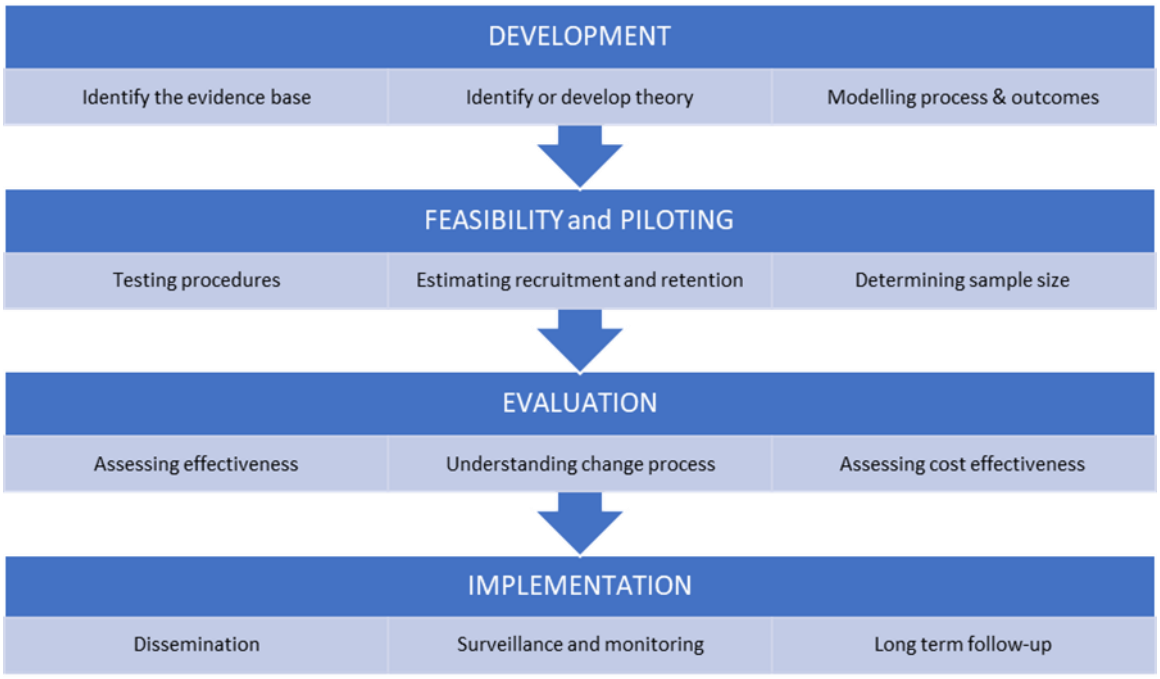

Figure 6: The MRC (2019) key stages for development of a complex intervention

The development phase was not required since these issues had already been addressed. This work began in the second phase of the MRC framework, eliciting feasibility and acceptability of proposed study elements. A feasibility study was required, including a literature review, stakeholder consultation, and a mixed methods phase, to design an intervention with stakeholders and test the planned study procedures. The involvement of stakeholders ensured selection of a resuscitation training strategy that addressed the needs of the workforce and the problems and challenges that staff face, in order to benefit patient care. Mixed methods were used

to determine the feasibility and acceptability of the intervention and proposed study procedures including outcome measures.

In the topic area of this study, neither qualitative nor quantitative studies alone would have yielded the results needed to understand the complex issues around knowledge and skill retention among nurses. Accordingly, a mixed methods approach was used in order that the range of enquiry could be broadened, and deeper understanding of the phenomenon gained (Creswell & Plano Clark, 2018). Mixed methods research has also been described as multi-strategy research (Bryman & Bell, 2011).The quantitative data were needed to answer feasibility questions around the conduct of the objective assessments and to give an indication of results that may be found in the main study. The qualitative data were needed to answer feasibility questions on study procedures and gain insight from participants to understand the results of the quantitative assessments.

There are numerous ways in which quantitative and qualitative research can be mixed while demonstrating that the different components are clearly integrated. However, it is also acknowledged that mixed methods researchers tend to emphasise one component over the other (Bryman & Bell, 2011), as in this study. The study design for this study was a feasibility study using a mixed methods approach, with a qualitative priority. The mixed methods design was focused around a convergent parallel typology to guide the approaches (Creswell & Plano Clark, 2018). The main reason for choosing this convergent design was that there was a sole researcher. Much is written about practical considerations during qualitative data collection including the huge amount of data that may be collected and the time taken to generate such data (Denzin & Lincoln, 2011). However, as Silverman (2013) claims, the key is narrowing down the data to produce meaningful results.

The purpose of this convergent design was to obtain data from multiple sources on the same topic which could then be used together during the phase of interpretation of results (Morse, 2012). The resultant design was matched specifically to the research question, whilst allowing a simple framework to guide the implementation of the research in a logical fashion. In the convergent design, the quantitative strand was run concurrently with the qualitative strand. The strands were kept independent from each other during data collection and analysis, but the two approaches could be mixed

during the final stage of interpretation of results (figure 7), a phase which is often lacking in research which is claimed to adopt mixed methods. Lack of, or only partial, integration of findings during mixed methods research has been roundly criticised (Bryman & Bell, 2011). Objective assessments were made of resuscitation knowledge and skills during the quantitative arm of this study and links between the themes from the qualitative results within the quantitative findings were made. However, as a feasibility study, the mixed methods approach was only used to demonstrate the feasibility of each component in this study and integration of findings will be conducted in the main study.

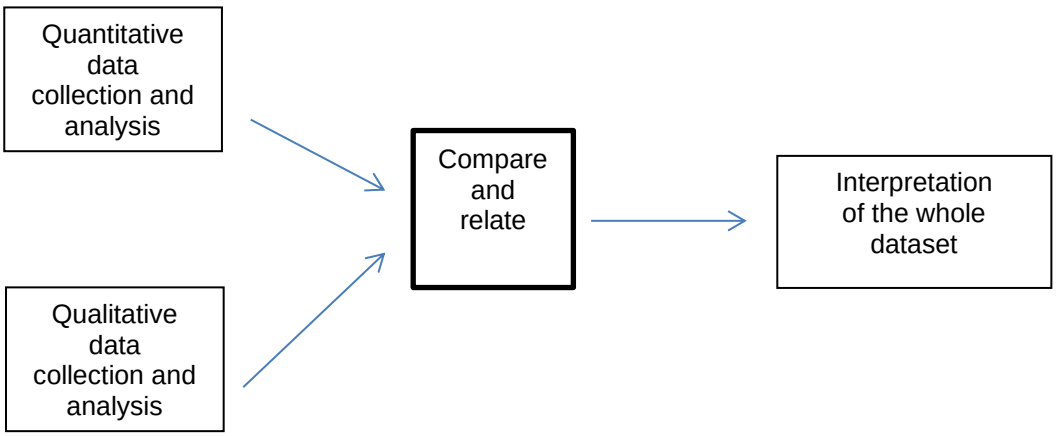

Figure 7: Study diagram – convergent parallel design

In the empirical arm of the study each participant demonstrated their skills of caring for a simulated patient. This was achieved through use of a training manikin which was programmed to demonstrate sudden collapse and cardiac arrest. The manikin was a Laerdal Medical resuscitation training manikin with Quality CPR (QCPR) technology (Laerdal Medical, 2019). The QCPR technology allowed the instructor to review CPR performance and measure chest compression depth, compression rate, release depth and efficacy of ventilation. The data were captured on the QCPR Instructor app (figure 8), and the results were downloaded to enable analysis.

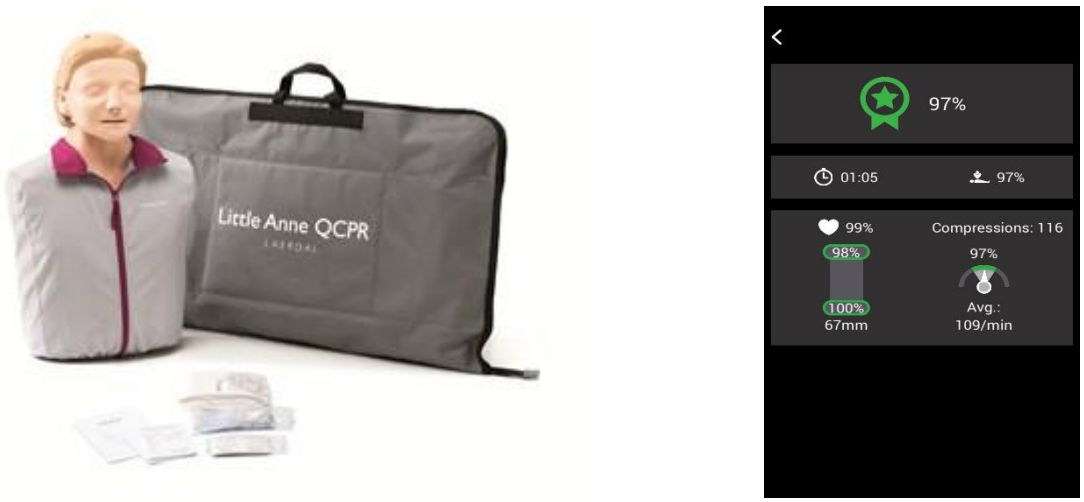

Figure 8: Laerdal Medical QCPR Manikin and QCPR Instructor App

The participant was observed during a 10 minute simulation-based scenario. A pre-prepared proforma of 20 critical action assessment indicators based on current RCUK guidelines was used during the observation. The observation was conducted at baseline (before the initial training session), again immediately after the session, and then at three, six, nine and 12 months after initial training. Each visit was scheduled within a range of +/- seven days of the due date for the visit.

The initial training was delivered by the Professional Doctorate student as the Principal Investigator (PI), using the same model of manikin and observation scenario each time. No corrections were made to the participant's performance during the observation, but a referral was made for remedial training to the participant's manager if unsafe practice was observed. Referral for remedial training was noted on the observation sheet. After each observation the participant demonstrated their knowledge of adult BLS and defibrillation by completing a true/false questionnaire of five questions, each with four parts.

Qualitative content analysis was used to elicit participants' individual views and their interpretation of the feasibility and acceptability of the training strategy. Content analysis allows direct examination of what was said using text, so remaining close to the data (Cavanagh, 1997). The narrative data were gathered after each scenario in the form of a short, semi-structured, focused, in-person interview with the participant, using a topic guide. Interviews are one of the main methods used in qualitative research (Silverman, 2013). The topic guide was developed in supervision, and the interview questions decided upon that would best facilitate the interviews, in order to

answer the research questions for this study. The use of the short interviews explored participants' attitudes, views, descriptions and statements of variables such as confidence levels after training and how this may have been transferred into clinical practice and performance. Participants were asked about their exposure to cardiac arrest in their clinical practice. They were also asked about their views of the training, the true/false questionnaire and the observation in terms of the content, duration, structure and frequency. Participant comments were elicited on the personal effect of the training and if they would change any aspect.

Interviews were audio recorded, a technique recommended in the literature (Chun Tie et al., 2019), and stored securely in a personal university hosted storage area. The interviews were easily retrieved and listened to over and over, so that notes and quotes could be made on their content whilst also respecting the context. Although grounded theory was not used explicitly, adopted grounded theory techniques were used (Glaser, 1992). The need for constant comparison of data and to keep going back to the original audio recordings from the interviews is a well-recognised technique from grounded theory (Chun Tie et al., 2019).

Figure 9 details the structure of the feasibility study.

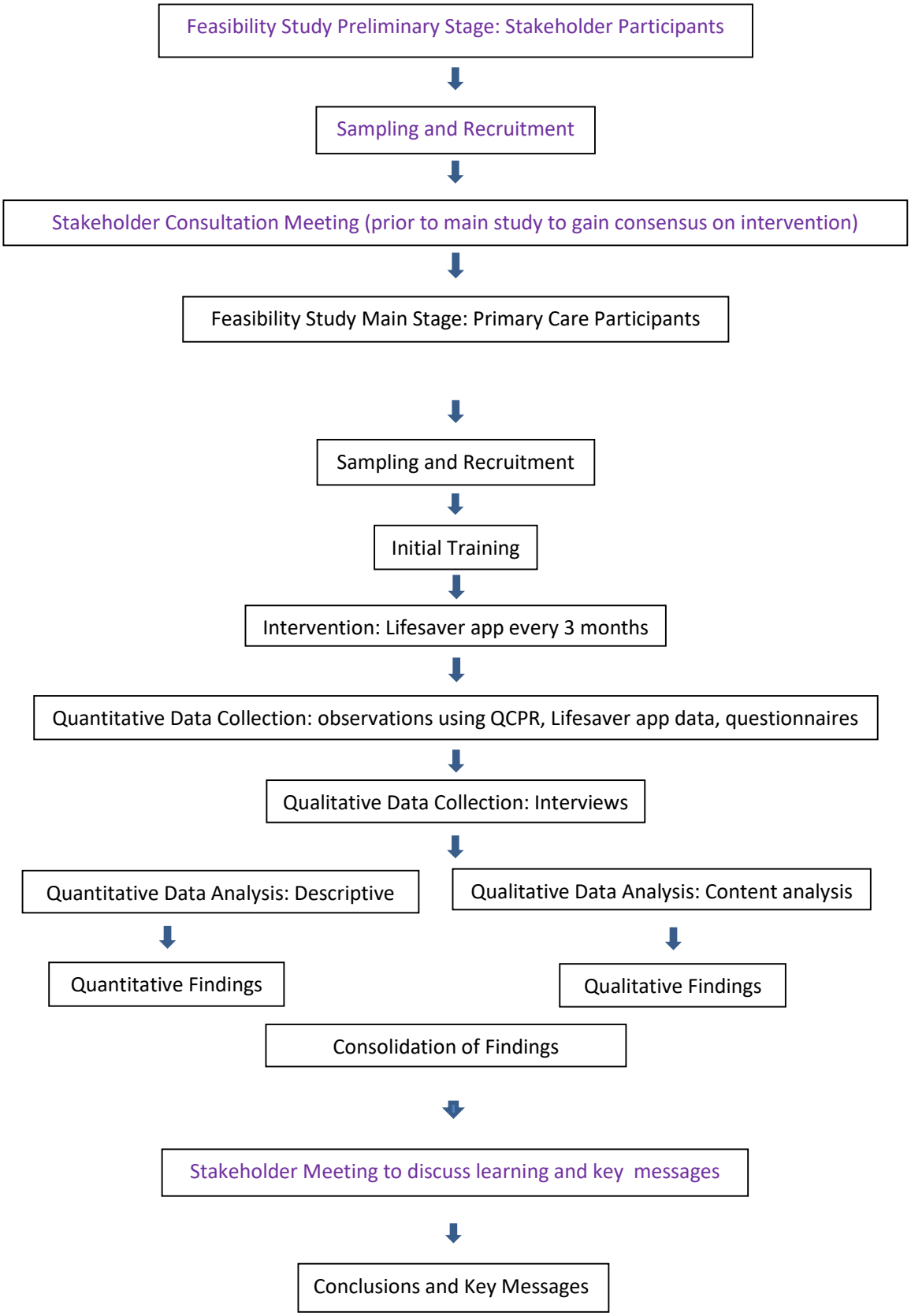

Figure 9: Feasibility Study Flow Chart

AIMS

The primary aims were to develop and refine a new intervention with involvement of relevant stakeholders and to determine the feasibility and acceptability of proposed study procedures and outcome measures. The secondary aim was to determine whether useful data were likely to result from the main study.

RESEARCH QUESTIONS

The following research questions were used to determine if the components of the feasibility study work:

1. What do stakeholders hold to be optimal presentation and frequency of intervention for resuscitation training for primary care nurses?

2. Are the study procedures for recruitment, data collection and data analysis robust and effective for use in a future main study?

    i. Is the planned sampling and recruitment strategy effective and responsive to unforeseen issues?
    ii. Can the observation schedule be completed in real time without disrupting the flow of the scenario?
    iii. Is the true/false questionnaire completed fully and without confusion or mistakes by participants and to what degree is the true/false questionnaire able to expose increase in knowledge over time?
    iv. Are useful data generated from the interview topic guide?

3. Are the outcome measures feasible to use in a future main study?

    i. Does the intervention in the form of the new training strategy result in knowledge and skill retention over time?

4. Are the study procedures acceptable to the participants?

5. Are the outcome measures acceptable to the participants?

SAMPLE

Stakeholder group participants

A stakeholder group of 15 members was invited to attend meetings to design the initial intervention. The size of this group allowed for potential attrition. The participants were experienced staff from the following areas of expertise: primary care nurses, resuscitation experts, resuscitation instructors, and managers of primary care nursing staff. The setting was dependant on what was most convenient for the participants, and choices were given for the meeting venue as either Layton Medical Centre in Blackpool, the University of Salford, or via a video teleconference from the participants' workplace. The participants agreed on Layton Medical Centre in Blackpool as the venue of choice for the first meeting. The final sample size was 13 participants. One potential participant did not respond to the invitation and one other declined to take part in the meeting due to work commitments.

Recruitment

Stakeholders were contacted by the PI from contacts in primary care, the RCUK and the University of Salford using the potential stakeholder invitation letter (appendix 1). The stakeholder potential participant availability form was completed (appendix 2) which detailed contact activity with the potential participant. Permission was also gained to contact the potential participant at their convenience but no sooner than 24 hours after receipt of the participant information sheet (PIS) (appendix 3) to discuss participation. A date and time to meet was then agreed. After any questions had been answered, consent was evidenced in a private room, using the participant consent form (appendix 4). The participant enrolment log detailed those stakeholders enrolled into the study. Any information that became available that may have been relevant to continued participation in the study was given to the participant by their preferred method of contact.

Primary care participants

The sample size was up to 100 primary care nursing and support staff. As a feasibility exercise, the statistical part of this study did not require a formal sample size calculation. The sample size was based on the research activities involved and the constraints of time available during the doctoral programme. The sample was large enough to determine an expected rate of decline over time in knowledge and skills, and thus inform determination of sample sizes for future studies. This was a

convenience sample, and the participants were drawn from different primary care areas. The participants were registered nurses, health care assistants, and support staff including receptionists, administration staff and practice managers. Examples of primary care units are general practitioner surgeries, walk-in centres, urgent care centres, community hospitals, nursing homes, research centres and dental surgeries.

Inclusion criteria

1. Nursing and support staff working in primary care.
2. Successful completion of annual mandatory training in resuscitation in the previous 12-18 months. Resuscitation training could include adult resuscitation/CPR/AED training, adult BLS training, ILS training or ALS training.

Exclusion criteria

1. Previous participant in a similar research study.
2. Role in resuscitation training or updating.

Recruitment

Potential primary care participants were identified by their managers following the inclusion and exclusion criteria. No potential participants met any of the exclusion criteria when they were recruited to the study. Managers approached nursing staff initially to determine if they were interested in finding out more about the study. Managers briefly introduced the study, emphasising that the results of the observations, true/false questionnaire and interviews would be confidential, and that the researcher would speak personally to potential participants to explain the study. The same procedure then applied as for the recruitment of stakeholder group participants (appendix 5 and 6).

The setting for the primary care participants was dependant on what was most convenient for them. This was anticipated as either Layton Medical Centre in Blackpool, the University of Salford, or the participants' workplace. Both the medical centre and the university had purpose-built meeting and teaching rooms. The participants chose their individual workplaces for all visits, which meant that the first study visit was attended by all participants from that particular workplace and not as a single large group from various workplaces as originally anticipated.

INSTRUMENTS

Intervention

The stakeholders reached consensus that a short, interactive cardiac arrest scenario via a computer or mobile phone app, undertaken at three-monthly intervals would be the intervention of choice. Furthermore, it was agreed that the existing Lifesaver app from the RCUK (2017) would be ideal. Most stakeholders were already familiar with the Lifesaver app as it was already in use. The Lifesaver app is an interactive game providing resuscitation education through realistic scenarios. The app is available online and as well as being available for use on computers and laptops, can also be used on mobile devices including tablets and mobile phones. The app can also be displayed on a TV screen as well as a computer monitor. The app has quality visuals, with professional actors playing the roles of the victim and the rescuers, and gives realistic feedback when the user answers questions or performs actions during the interactive video or ‘game’.

A more recent version of Lifesaver is available, Lifesaver Virtual Reality (VR) (RCUK, 2020a). However, Lifesaver VR requires the use of equipment such as headsets and a manikin, rather than just the app. It was decided during the stakeholder meetings that the use of headsets would not be advisable due to the additional costs to purchase initial and replacement headsets, since they might create issues around infection control. Furthermore, the stakeholders reached consensus that an app alone would be the ideal intervention.

It was noted that the Lifesaver app is usually aimed at non-clinical staff as it focuses on mouth-to-mouth ventilation (where the rescuer presses their mouth around the victim’s mouth and blows air into their lungs) during resuscitation and omits the use of a pulse check when diagnosing cardiac arrest. However, the RCUK reiterates that the Lifesaver app is appropriate for clinical and non-clinical staff. Furthermore, mouth-to-mouth ventilation is still in the BLS guidelines for clinical staff as is the option to omit a pulse check if staff are not confident to rely on their performance of carotid pulse checks (RCUK, 2015; RCUK, 2021).

Observations

Observations of the scenario was managed and scored using the observation assessment sheet (appendix 7).

Questionnaire

The true/false question paper (appendix 8) and true/false answer sheet (appendix 9) were used to administer and score the true/false questionnaire.

Interviews

Demographic data were collected during the in-person interviews. The interviews were conducted using the topic guides (appendix 10 and 11).

DATA COLLECTION

Stakeholder Meeting

Nominal group technique (NGT) is a structured method for group brainstorming that encourages contributions from each member of the group to reach a quick agreement on the issue being discussed (Olsen, 2019). Generally, group members generate ideas, award scores, then select the idea with the highest score as the final decision. Delphi methods, however, use rounds or a staged process to build up to the final, well-informed decision, taking account of the views and results from the previous round. This is arguably a more in depth process when compared to NGT as Delphi methods encourage debate rather than superficial gathering of information. Whilst both techniques use consensus methods to involve a group of experts to determine stakeholder views, Delphi methods are more widely used when generating healthcare guidelines (Powell, 2003).

Delphi methods were considered more appropriate for this study and were intended to be adapted to draw on expert opinions to develop the new resuscitation training intervention (Cook & Birrell, 2007; Powell, 2003; Rowe & Wright, 1999). Delphi methods are flexible and the data collection episodes (usually as postal/e-questionnaire or in-person meetings) are known as ‘rounds’. The initial round consisted of a presentation of existing strategies and resuscitation training modalities including apps and immersive technology. The presentation also detailed what is held in the literature to be optimum training intervals, content and delivery methods. This was followed by eliciting of participants’ opinions by scoring. It was intended that after each

round the researcher would email a summary of the experts' forecasts from that round, including the rationale suggested. The total number of rounds should be dictated by the progression towards consensus amongst the experts of what the intervention should look like.

It was envisaged that there would be a maximum of three rounds (four weeks apart) to reach the consensus. However, consensus was reached at the end of the first meeting. This was thought to be because the stakeholders were experts in either resuscitation or primary care and therefore already aware of the current issues. Furthermore, the stakeholders already had ideas of what was required for improvement in primary care resuscitation education, and were keen to use this forum to voice their opinions and drive change. This highlighted that stakeholder involvement was key and explained why there was such ready agreement at this single round. A single round was not an issue, but given that there was only one meeting, the single round Delphi survey could be more accurately described as a stakeholder consultation meeting.

The Lifesaver app was the one of choice as it was already in use and was the leading technology in UK resuscitation education.

Primary Care Participants

Lifesaver App

The Lifesaver app generated a report upon completion of a selected scenario, which indicated the participants' overall performance, the number of correct answers, the speed of answers and the accuracy of speed of chest compressions performed. The participants completed the Lifesaver intervention and reports were generated at months three, six, nine and twelve.

Observations

Each participant demonstrated their skills of caring for a simulated patient, using a training manikin which was programmed to demonstrate sudden collapse and cardiac arrest. The same model of training manikin was used for each scenario. The structured observation of the participant activity was conducted by the researcher and was non-participant and overt in nature. Strengths of the researcher not participating in the scenario include allowing the researcher to focus on participant actions during the scenario. This also allowed the researcher to observe participant body language. The

researcher can be more open minded during non-participant observation, as the researcher is an outsider looking in and therefore arguably less likely to feel sympathy. Furthermore, no ethical issues are created if participants are aware that they are being observed, as in this study.

Weaknesses of non-participant observation include the possibility of a Hawthorne effect, where participants change behaviours and stated views because they know they are under study or being observed (Sedgwick, 2012). Similarly, impression management could also be present, in which the participant may concentrate on self-presentation and self-promotion to be viewed as competent (DuBrin, 2018). These potential biases were considered during the planning stage, but due to the scope of the study and sample size, it was decided to trade-off between range of centres and range of staff in centres. Fewer regional primary care areas were purposively sampled to cover the range of centres and size of practices within them, but all staff from each were targeted. Performance bias may also have been introduced by the participants if they decided to study resuscitation more just because they were in a study and attending study visits in which they knew they would be asked about the topic being studied. Furthermore, the participants who were willing to take part might have been more motivated to learn and thus perform better during the observation (Oermann et al., 2011; Ruesseler et al., 2010). To guard against this potential bias, it was accepted that some staff may usually undertake additional study, but participants were not asked to perform any additional study in between study visits.

A common mistake with non-participant observation is that of subjectivity (Mills et al., 2010). In non-participant observation the researcher may not have clarity about certain actions, as questions to the participant are not permitted. The resultant risk of lack of understanding and possible misinterpretation is a potential problem with non-participant observation and may introduce observer bias. Observer bias may have been an issue as all the observations were delivered by the PI. However, the same pre-written observation scenario was used each time. This reduced observer bias as the observation assessment sheet was reliable and included everything needed in an objective manner. The use of an objective assessment sheet during the observations ensured that pre-defined criteria were applied to each participant's achievement of specific tasks. The design of the assessment sheet reduced subjective assessment: seeing what should have been seen rather than what was actually seen (Lewis-Beck

et al., 2004). The use of QCPR technology reduced observer bias further by providing an objective assessment of the chest compression and ventilation skills, rather than relying on a subjective instructor assessment of skill performance, which may have compromised the data.

The 10 minute observation was a simulation-based criterion assessment, using a pre-prepared proforma of 20 critical action assessment indicators (appendix 7). The proforma was based on current RCUK guidelines and the same scenario and proforma were used during each of the six observations. The four page proforma detailed demographics on the front page then consisted of the assessment scoring sheets. As there were three sections to the assessment, each section was detailed on a single sheet to aid the flow of the assessment process and ease the scoring activity. Each criterion assessment had a separate line in the ‘structure’ column to detail the skill description. The next column addressed the ‘process’ which detailed the action that the candidate was required to demonstrate competently during the skills practice. The third column detailed the desired skill outcome, and the last two columns allowed the assessment to be documented by answering ‘yes’ or ‘no’ in the ‘achieved?’ column as well as the column for additional comments. A similar proforma had been used by the researcher previously and so was not tested beforehand. The proforma worked well throughout the study.

Consistency of observation and scoring was maintained as the assessment involved a binary answer (yes or no) for actions demonstrated or voiced by the participant. Training was given at the time points dictated in the study design and no practice was offered prior to the observation assessment. One participant did not achieve adequate scores in some sections of the assessment. However, the issue was the lack of opportunity to practice rather than the need for remedial training. This was concluded as immediately after the assessment, the participant commented (without being prompted by the researcher) that their mind went blank momentarily and they detailed the correct actions that should have been performed. The observation assessment scores remained as per the initial assessment. No participants were referred for remedial training throughout the study.

Questionnaire

After each observation the participant demonstrated their knowledge of adult BLS and defibrillation by completing a true/false questionnaire (appendix 8). The Resuscitation Council UK (2016) emphasises the need for all resuscitation training to comply with a standardised approach. The questionnaire was in licensed use and only five questions were analysed for this study (appendix 8). The average time to complete the questionnaire was approximately 10 minutes. True/false questionnaires have a very simple structure, are convenient to use and are easy to score. However, the participant has only two options for a correct answer and if the participant does not know the answer, the probability of guessing correctly is high at 50%. Weaknesses of this style of questionnaire include ambiguity, which may occur if reality is not necessarily given to a binary choice. Even though in regular use, it was important to check for ambiguous items in the questionnaire. Bias could have been introduced into the study if participants memorised the questions, as the same questionnaire was used at each time point. To guard against this, participants were not made aware that the same questionnaire would be used. The maturation effect was also considered, where participant answers to the same questions may change over time.

Interviews

Narrative data were elicited after each scenario in the form of a short, semi-structured, focused, in-person interview with the participant, using a topic guide (appendix 10 and 11). The topic guide comprised 10 questions carefully selected to elicit participant information and views based on the needs of the study. The questions were influenced by the stakeholders, RCUK guidelines, the literature review and the experience of the researcher.

Semi-structured interviews are a powerful technique when trying to understand what is important to someone (Denzin & Lincoln, 2000; Polit & Beck, 2014). They allow the interviewer to prepare questions in advance, and can be used to help guide the conversation and keep participants on topic. Two way communication is encouraged and open ended questions allow for more in-depth information to be elicited from the participant. The use of a pre-written topic guide provides consistency to allow data to be compared when more than one interview is being conducted. However, there may also be some weaknesses with semi-structured interviews. Enough participants need to be interviewed to enable analysis of the data, drawing conclusions and making

comparisons. Open ended questions can be time consuming, but this was not the case in this study. Resources may be needed in terms of private areas to meet and voice recording facilities. However, these were not regarded as extensive resources nor were they a problem for this study.

Interviewer bias refers to how information is gained, recorded or interpreted (Davis et al., 2009) and may be introduced if the interviewer has preconceived ideas of what answers they want to elicit. Interviewer bias is reduced in a prospective study, where the outcome of topic is not yet known (Pannucci & Wilkins, 2010). This was reduced further in this study by using the pre-written set of questions during each interview with every participant, to guide the interview. However, leading questions were avoided in the topic guide to minimise bias by influencing the participant to provide a particular response. In order to seek clarification of what the participant meant during the interviews, participants were frequently asked to reword their answers, so that I was clear what the participant was saying. As a recognised technique from Mero-Jaffe (2011), this was done to strengthen the data and reduce bias from misunderstanding.

The interviews were conducted in a private room in the same location where the observation was conducted. Where the interviews were conducted remotely due to the Coronavirus Disease 2019 (COVID-19) pandemic, this was done using speaker phone, again maintaining privacy as both the participant and investigator were in private rooms. The average time taken to complete the interview was 10 minutes (minimum three minutes, maximum 16 minutes). Interviews were audio recorded using a hand-held digital voice recorder. The recorder was placed on the table near to the investigator and participant, and was small enough not to distract the participant. Recordings were removed from the hand-held audio recorder after the interview and stored on the PI's university hosted personal storage area.

Table 12: Participant study visit pathway

	Visit 1 (V1) Month 0 Baseline	Visit 2 (V2) Month 3 after initial training	Visit 3 (V3) Month 6 after initial training	Visit 4 (V4) Month 9 after initial training	Visit 5 (V5) Month 12 after initial training
Visit window	+/- 7 days	+/- 7 days	+/- 7 days	+/- 7 days	+/- 7 days
Informed consent	x				
10 minute (pre-training) simulated scenario observation	x				
10 minute (pre-training) true/false questionnaire	x				
10 minute (pre-training) in-person focused interview	x				
Resuscitation and AED initial training	x				
10 minute Lifesaver app training		x	x	x	x
10 minute (post-training) simulated scenario observation	x	x	x	x	x
10 minute (post-training) true/false questionnaire	x	x	x	x	x
10 minute (post-training) in-person focused interview	x	x	x	x	x

In summary, each primary care participant followed the study pathway detailed in Table 12.

DATA ANALYSIS STRATEGY

Stakeholder groups

It was intended that qualitative, exploratory, sequential analysis would determine the progression from the exploratory aspects to the rating of resulting ideas (Ozawa & Pongpirul, 2014). Content analysis was used (Silverman, 2013), but also data transformation by counting occurrences of statements (Migiro & Magangi 2011). It was anticipated that consensus would narrow during rounds, and on any issues where consensus was not clear, final decisions would be taken based on discussion with the supervisory team. However, consensus was reached at the end of round one.

Following a presentation of existing training modalities and strategies, the stakeholders were asked to write on a sticky note what their ideal training strategy would consist of in terms of three aspects: content, delivery and frequency. The sticky notes were put in the relevant column (1 column for each aspect) on a large white board and occurrences counted. The results were unanimous during this first round and as such,

the results were fed back to the group as a whole during this meeting. The group was satisfied that consensus was clear and so no rating of results needed to be performed.

Primary care participants

Data collected during the empirical part of the study were subjected to descriptive analysis to assess changes between the following 11 time points (table 13).

Table 13: Time points

Time point number	Time point
1	Month 0 pre-test v Month 0 post-test
2	Month 0 post-test v Month 3
3	Month 0 post-test v Month 6
4	Month 0 post-test v Month 9
5	Month 0 post-test v Month 12
6	Month 3 v Month 6
7	Month 3 v Month 9
8	Month 3 v Month 12
9	Month 6 v Month 9
10	Month 6 v Month 12
11	Month 9 v Month 12

Data from the Lifesaver App

The participants completed the Lifesaver intervention at months three, six, nine and 12, and reports were generated. The results produced data in the following areas: number of correct answers, speed of answers (in seconds) and accuracy of CPR (as a percentage of correct speed of compressions). Data from the reports were analysed descriptively to assess changes between time points. Changes in achievement across the sample between time points were summarised using bar charts.

Observational Data

An overall score across all 20 items on the proforma was calculated for each participant. For each participant, the 20 critical action assessment indicators in the proforma were assessed as fully achieved or not (a dichotomous variable), and changes in full achievement across the sample between time points were summarised using bar charts.

As the feasibility study was not powered for detecting significant changes, test results were interpreted with due caution, and more emphasis was placed on the descriptive

analysis. Referral for remedial training would have been noted and accounted for during analysis as the observation scores could have changed due to the remedial training. However, no such referrals were necessary.

Further evidence from the Laerdal Medical QCPR reports was included in the analysis to determine the chest compression fraction (percentage of time chest compressions were in progress). Cheng et al. (2018) state that participants in a BLS course would be expected to achieve a chest compression fraction of more than 80%. Furthermore, Laerdal Medical (2019) benchmark 75% as the acceptable standard based on compressions and flow fraction. The benchmark of 75% was accepted in this study, as the Laerdal Medical QCPR Instructor app was used to collect and assess compression and ventilation activity. The Laerdal Medical QCPR reports were used to confirm chest compression speed, depth and recoil; compression to ventilation ratio, and ventilation adequacy. Changes in achievement across the sample between time points were summarised using bar charts. The data were then analysed in the same way as that for the observational data.

The potential clinical impact of practice must also be considered. Not all staff would achieve each of the 20 critical action indicators, but that is not to say that practice would be subsequently compromised. For example, the current resuscitation guidelines state that chest compressions are optimum when the adult chest is compressed 5-6 cm in depth. However, not all participants would depress the chest 5-6 cm all of the time. Similarly, not all of the ventilations attempted would be achieved. There is a direct link between CPR in accordance with current guidelines and patient survival from cardiac arrest (Meaney, 2013). However, it remains to be established what determines a minimum standard of competency, at what point practice may be compromised and at what point it matters clinically. Currently, the minimum standard of competency is not referenced in the literature in terms of percentage of correct compressions or ventilations during training or in clinical practice. It was accepted that a 75% benchmark would be used in this study, since that was the benchmark in the app used in this study to collect the data (Laerdal Medical, 2019).

Questionnaire

Data from the true/false questionnaires were analysed descriptively based on total scores to assess changes between time points. An overall score across all 20 items

on the proforma was calculated for each participant, and changes in the median overall score across the sample between time points were estimated. The data were analysed in the same way as the observational data.

Narrative Data

The qualitative data were analysed using inductive content analysis (Elo & Kyngas, 2008). Inter-rater reliability measures were planned for this study, but were not completed due to the pandemic. Although not a problem for this study, reducing potential bias during analysis and coding will be included in the study design for the main study.

The inductive content analysis process consisted of three phases for handling the data: preparation, organisation and reporting (figure 10) (Elo & Kyngas, 2007). Data were collected in the initial phase by writing down a number of headings to capture all aspects of the interview data: a technique recognised by Hsieh & Shannon (2005) as open coding. Making sense of the data began during the organisation phase where categories were created which represented the concepts. The creation of categories is well-documented by Burnard (1991), and requires a process that allows grouping of data into larger categories such that the vast amount of data is managed to generate new knowledge (Cavanagh, 1997). Throughout the content analysis process, data were organised into broad groups with sub-categories, generic categories and main categories, before abstraction of results (Robson, 1993). Finally, in the reporting phase, results were described by the content of the categories (Polit & Beck, 2004).

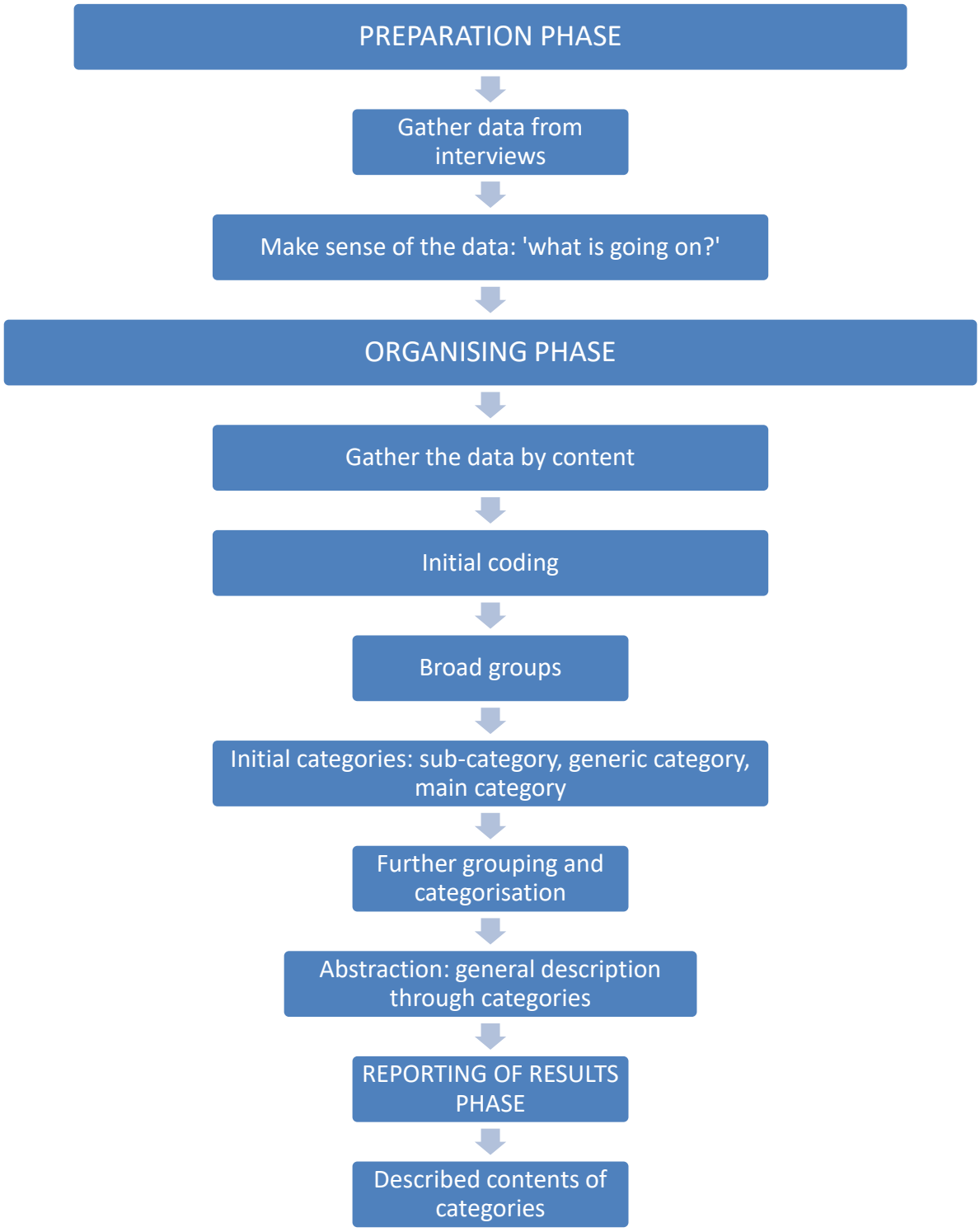

Figure 10: Inductive approach in the content analysis process

A schematic diagram was produced which aided interpretation of the data generated from the participants whilst remaining true to the original data. Associations and relationships between results were explained in terms of why the patterns may have occurred and what the relationships were. The resultant associations reflected the attitudes, beliefs, values and views of the participants.

The relationship of experience and exposure to patients in cardiac arrest on retention was considered descriptively by comparing data with the demographics. These included staff attitudes to training and its effect on clinical practice (such as confidence) and transfer and use of knowledge and skills in clinical practice. These data also determined the acceptability to participants of the intervention and assessments as a way of measuring retention of skills and knowledge. The relationship of experience and exposure to patients in cardiac arrest on retention were also considered descriptively by comparing data amongst the demographics.

A consensus meeting was set up with a number of the original stakeholders in the same way that the consultation meeting was arranged. This meeting was to confirm the learning from each part of the elements of the study and agree on what the key messages were for the main study. Eight of the original stakeholders attended this meeting.

ETHICAL ISSUES

The Approach to Ethical Issues

A risk-analysis strategy was adopted (Long & Johnson, 2007), with potential risks to participants identified and actions planned to neutralise, minimise or respond quickly to actualisation of any of these risks.

The risk of stress or psychological distress

There was potential for participants to become mildly distressed if the observation scenario or the true/false questionnaire became personally challenging. The risk of this was minimised by creating and maintaining a relaxed environment throughout the study procedures, emphasising the exercise as extra practice and access to further training, rather than creating an assessment or test environment.

During the interviews the participants were asked if they had engaged in resuscitation of a patient in cardiac arrest since their initial training or their last point of observation in the study - whichever was the most recent. Witnessing or being actively involved in such clinical situations can be distressing for some staff, particularly if they have built up a rapport with the patient beforehand. This experience could have caused staff distress as they reflected on the encounter. Addressing such upset and stress was a

routine part of the researcher's practice. Should the distress have required more intervention than the researcher could manage, then more formal counselling was available locally for NHS staff.

The potential risk of distress for participants was also minimised by planning time for attending the study visits with the participants' line manager. This allowed work duties to be taken over by another staff member whilst the participant attended the visits.

The risk of perceived coercion

Junior staff being asked to participate by those in a senior position may be perceived as coercion and the participant may have thought there would have been a risk of harm to employment if they did not take part in the study. The staff being approached may also have perceived (unintended) compulsion to participate if they were asked to participate by their manager. To address these issues, the voluntary nature of participation was emphasised and involvement from the participant was clarified through the PIS. Signed confirmation of consent was also sought through the consent process and documented on the consent form. Ongoing consent was also checked at each study visit. Participants expressed their pleasure at having the opportunity to undertake training and make a difference to clinical practice.

The risk of breach of confidentiality

Where personal comments were made by participants, these were kept anonymous. Since participants included NHS employees and resuscitation competence was a compulsory requirement, there was the risk to participants of being identified as lacking competence. The participants understood from the start that the need for remedial training would be reported in order to secure the training opportunity but would not result in disciplinary action.

Formal Review

Formal approval was gained from the University of Salford Research Ethics Panel (Appendix 12). Although NHS Research Ethics Committee approval was not necessary or available (since under Health Technology Assessment guidance the work constituted "service evaluation"), local approval was given by the relevant manager before potential primary care participants were approached.

POTENTIAL BIAS

Bias can occur at any stage of the research process, and it is important to acknowledge potential bias in order to enhance the quality of the research throughout the study design and data collection and analysis (Pannucci & Wilkins, 2010). Furthermore, actions to prevent or reduce potential bias at all stages of the research process are pivotal, to ensure a robust study design and implementation (Pannucci & Wilkins, 2010).

Studies where the outcome is unknown at the time of recruitment are less prone to potential selection bias (Pannucci & Wilkins, 2010). However, participation in this study was voluntary and therefore a selection bias may have been present as those who did not want to participate may have different views that could not be captured. In order to reduce this, the study was explained in a non-threatening way, with guaranteed confidentiality of results, and the observations and questionnaires were not described as assessments.

Instructor bias was considered as the initial training was always delivered by the PI. However, adult BLS and AED training is objective based on current RCUK guidelines, with training being standardised. Furthermore, the PI is a RCUK Instructor and delivers training to RCUK standards. Therefore, instructor bias was not considered an issue of concern.

RIGOUR

Research studies must be critiqued and examined in order to establish the worth of the research (Long & Johnson, 2000). Valuable and meaningful research is that which is found to be rigorous. However, appropriate tools must be applied in order to meet the stated aims and objectives of the research. Criteria need to be met in order to establish research rigour. Furthermore, the specific criteria will differ dependent upon the aims and objectives of the study and the study design. Rigorous research must also be both transparent and explicit, so that the researcher can describe what was done and how it was done in clear, simple language. Such explanations help bring rigour to the research.

Regardless of the study design, core principles exist, and guidelines are used to enhance the quality of the research (www.equator-network.org/) (Groves, 2008). The framework used to check the quality of the mixed methods research reported in this

thesis was the Good Reporting of A Mixed Methods Study (GRAMMS) guideline (O'Cathain et al., 2008). GRAMMS focuses specifically on the following points and these six issues have been addressed in this thesis about this feasibility study:

1. Justification for using a mixed methods approach
2. Study design in terms of the purpose, priority and sequence of methods
3. Each method in terms of sampling, data collection and analysis
4. Where and how integration has occurred
5. Limitation of one method associated with the presence of the other
6. Insights gained from mixing or integrating methods.

It is key to acknowledge that rigour is not applied solely to hypothesis-driven research. Principles and standards of rigour can also be used for exploratory and descriptive research, as with this study.

Reliability and Validity

The assessment of two particular concepts, reliability and validity, is a vital process when trying to establish rigour (Long & Johnson, 2000). Whilst reliability and validity were of equal focus during the quantitative part of the study, it was accepted that validity might be stronger in the qualitative element of this study. This could be because knowledge and skill retention over time and clinical experience may affect the concept of reliability in participant responses during the interviews. The focus for the qualitative part of the study was, therefore, to enhance the validity.

Brink (1991) described three aspects of reliability: stability, consistency and equivalence. Stability refers to repeatedly asking a participant the same question at different time points and receiving a consistent answer (Long & Johnson, 2000). How consistent an instrument is at measuring the attribute it has been designed to measure is a key component in assessing reliability and hence the confidence of the data (Polit & Hungler, 1989). The consistency can be further enhanced by using different observers with the same standardised instrument to demonstrate how the instrument yields the same results (Hammersley, 1992). Equivalence is described as using alternative words, but with the same meaning, to ask the participant a question during an interview (Long & Johnson, 2000).

The validity of a quantitative instrument is based on whether the instrument actually measures what it is intended to measure (Lobiondo-Wood & Haber, 1990) and to what degree this is achieved (Polit & Hungler, 1989). Long and Johnson (2000) describe three aspects of validity: content validity, criterion-related validity and construct validity. Content validity is dependent upon the sample population and the instruments used in the study. As such, they need to be appropriate and allow aspects of the topic being researched to be captured. Criterion-related validity is associated with comparing the findings using the instrument with actual performance. In this study, criterion-related validity was difficult to establish given that actual clinical performance on patients is not being measured with the instruments used in the study. Construct validity is concerned with detailed explanations of the research design and implementation of the study in order to assess the efficacy of the study procedures.

The data collection tools or instruments used in this study produced inclusive information of what was being examined. The instruments generated data with the appropriate degree of detail for the stated level of analysis. Furthermore, the data analysis strategies collected the full range of themes and topics at an appropriate level such that relationships among themes and topics were found.

Intervention

An intervention was needed that was standardised and repeatable. The interactive training material was taken from the Lifesaver app (www.life-saver.org.uk), developed by the RCUK. This ensured validity of the instrument as it is already used in existing resuscitation education (RCUK, 2015; RCUK 2021) and gave the participants the learning material that was needed within the study design. The intervention was reliable as it was a standardised, repeatable set of interactive scenarios that was offered to all participants. Furthermore, the intervention met the three criteria for reliability as described by Brink (1991).

Observations

A valid observation scenario and assessment tool was designed to measure BLS and AED skills. This was based on the format used in existing validated resuscitation education and used a standardised criterion-based assessment tool modelled on current RCUK guidelines (RCUK, 2015; RCUK, 2020b; RCUK 2021). Validity of the observations was increased by reducing researcher interpretation error, as objective

rather than subjective assessments were required. The instrument was used to measure the two variables of ‘achieved’ or ‘not achieved’ against the 20 specific action points. The same observation scenario and assessment sheet were used throughout the study, demonstrating repeatability and reliability.

Questionnaire

BLS and AED knowledge were measured by questionnaire. The true/false questionnaire format and questions were modelled on the current RCUK teaching and guidelines (RCUK, 2015; RCUK, 2021). The same true/false questionnaire was applied throughout the study in order to maintain stability and consistency. Using the same questions and available answers in the questionnaire format promoted reliability. However, the potential problem of repeating a test must also be considered. Participants may learn as they remember the question and what the answer should be. There may also be a risk of contamination if participants discuss amongst themselves when back in the workplace. Whilst repeating a test makes it reliable, repeating the same test also introduces a potential risk of participants exerting an impact on that risk.

Interviews

In order to gather information, comments and thoughts from the participants about the same topics, interviews were used. A private environment was created for the interviews where the researcher built a rapport with the participants and encouraged them to be open, honest and frank with their responses. In order to get the maximum benefit from the interview and increase validity, a rapport was important to develop a relationship and trust. Engagement between the interviewer (the researcher) and the participant is described by Petty et al. (2012) as a means of aiding the relationship between the two. This allowed for more rigorous data. It was important not to create an ‘examination’ or ‘manager – employee’ type environment, but a more informal atmosphere where nothing would impact on the openness of the discussion. It was also made explicit that there were no right or wrong answers and that all the responses were valuable. The researcher needed to get the participants ‘on board’ to not only facilitate genuine responses but also so that participants felt like they wanted to return for subsequent visits.

The use of the topic guide ensured that the interview yielded the information that was needed for the study and hence increased the validity of the interview data. The same

topic guide was used throughout the study in order to demonstrate reliability and stability of the instrument.

LIMITATIONS

As this was a feasibility study, a mixed methods approach was used, but demonstrating the feasibility of each component was more important than combining the results. This will be done in the main study. Integrating the findings at this stage and pursuing analysis of the specific data too thoroughly would be unwise given the lack of control group and statistical analysis.

CONCLUSION

A study design was adopted to determine the feasibility and acceptability of the intervention and proposed study procedures including outcome measures. Specifically, important information was gained from this feasibility study in relation to recruitment, consent, drop-out rates, as well as data from the overall mean and median scores.

A stakeholder meeting gained consensus on the design of the strategy, content, delivery method and frequency of training, consistent with Resuscitation Council UK guidelines (RCUK, 2015). A convergent, mixed methods study design was adopted where participants engaged in a scenario using a manikin to demonstrate resuscitation including defibrillation skills. Criterion assessment was undertaken through observation of practice. Knowledge was tested by a true/false questionnaire and narrative data were elicited at each visit from a short, in-person focused interview.

Sampling worked well in this study and additional primary care roles were included during recruitment due to demand and feedback from participants. There were no issues with the consent process and the drop-out rate was zero. A robust risk-analysis strategy was also used in this feasibility study, to identify and minimise potential risk in terms of ethical issues and bias.

Rigorous and effective data collection instruments were used in this study. Quantitative data were collected using the Lifesaver app, scenario observations sheets, QCPR app and questionnaires. Qualitative data were collected during the interviews, driven by the topic guide and audio recorded.

Robust data analysis was also undertaken in the study. Quantitative data were analysed descriptively, and inductive content analysis was used to generate results from the qualitative data. As this was a feasibility study, demonstrating the feasibility of each component of the mixed methods approach was more important than integrating the findings, which will be done in the main study.

CHAPTER FOUR: FINDINGS

INTRODUCTION

This chapter details the findings from the stakeholder meeting and participant activities. Interesting results were yielded from both the quantitative and qualitative parts of the study which included the stakeholder meeting, Lifesaver interactive videos, scenario observations, QCPR performance, true/false questionnaires and interviews. However, the qualitative findings were particularly attributable in terms of feasibility and new contributions.

PARTICIPANTS

Stakeholders

Thirteen stakeholders attended the stakeholder meeting to design the intervention. The area of work for each stakeholder is detailed in table 14.

Table 14: Demography of stakeholder participants

Participant Number	Area of Work	Job Title
1	General Practitioner (GP) Primary Care Centre	Practice Manager
2	GP Primary Care Centre	GP
3	Research: GP Primary Care Centre	Research Nurse
4	GP Primary Care Centre	Advanced Nurse Practitioner (ANP)
5	Resuscitation Education Secondary and Primary Care	Senior Resuscitation Officer
6	Primary Care Walk-In Centre	Clinical Lead ANP
7	GP Primary Care Centre	ANP
8	Community	Nursing Matron
9	Resuscitation Education Secondary and Primary Care	Resuscitation Officer - Director
10	Resuscitation Education Secondary and Primary Care	Lead Nurse / Resuscitation Officer
11	Community	Nursing Sister
12	Community	Nursing Sister
13	Research: Primary Care	Research Nurse

Primary Care Participants

Thirty-seven participants were recruited to the study. Table 15 details the demographics of the participants.

Table 15: Demography of primary care participants

Participant Number	Months since last BLS training (if not 12 months)	Time since qualifying as a qualified nurse (or N/A)	Time in primary care (PC)	Number of BLS training sessions attended in PC	Number of adult cardiac arrests attended in PC
1		>30 yrs	6-10 yrs	5	0
2		21-30 yrs	6-12 months	1	0
3		>30 yrs	21-30 yrs	8	0
4		N/A	6-10 yrs	6	2~
5		N/A	6-12 months	1	0
6		21-30 yrs	2-5 yrs	4	0
7		N/A	6-10 yrs	3	0
8		N/A	2-5 yrs	1	0
9		N/A	2-5 yrs	5	0
10		N/A	11-20 yrs	15	0
11		N/A	11-20 yrs	15	0
12		N/A	2-5 yrs	3	1~
13		6-10 yrs	6-10 yrs	10	0
14		N/A	2-5 yrs	4	1~
15		11-20 yrs	11-20 yrs	20	2~
16		N/A	11-20 yrs	15	1~
17		N/A	6-10 yrs	1	0
18	13-18	>30 yrs	11-20 yrs	19	0
19		N/A	2-5 yrs	5	1~
20	13-18	>30 yrs	11-20 yrs	15	0
21		21-30 yrs	13-18 months	15	0
22	13-18	21-30 yrs	11-20 yrs	10	0
23	13-18	6-10 years	2-5 yrs	6	0
24		>30 yrs	11-20 yrs	20	0
25		21-30 yrs	21-30 yrs	8	0
26		11-20 yrs	21-30 yrs	20	0
27		21-30 yrs	21-30 yrs	28	0
28		N/A	21-30 yrs	21	0
29		21-30 yrs	21-30 yrs	23	0
30		>30 yrs	21-30 yrs	21	1~
31		>30 yrs	21-30 yrs	15	0
32		>30 yrs	>30 yrs	41	0
33	13-18	11-20 yrs	2-5 yrs	4	0
34		11-20 yrs	11-20 yrs	12	1~
35		21-30 yrs	6-10 yrs	6	2~
36	13-18	21-30 yrs	2-5 yrs	2	1~
37	13-18	19-23 months	19-23 months	1	0

~ (prior to initial training in study)

Requests were made by some nurse managers from the start of the study to open recruitment to other members of the primary care team since each multi-professional team (including unqualified and administrative staff) would usually update and train together. Review of these requests led to the conclusion that this would both ensure a positive response to participant engagement feedback and reflect the true context more accurately in the main study. Accordingly, participation was widened to include primary care support staff: receptionists, administrative staff, health care assistants and pharmacists. These staff members were also required by their employer to undertake annual BLS updates.

OUTCOMES FROM THE STAKEHOLDER CONSULTATION

Using sticky notes, the stakeholders wrote their ideal new intervention for the training strategy in terms of three aspects: content, delivery and frequency. These responses were categorised into issues regarding content, delivery and frequency (Figure 11, Table 16). All three aspects were addressed with comparable diligence, though most detail was offered about content.

Table 16: Frequency counts of stakeholder opinions

Stakeholder Opinions	Presentation of Content	Mode of Delivery	Frequency
Short duration	8	2	
Interactive	4		
Immersive	3		
App (computer or phone)		9	
3-6 monthly			1
3-4 monthly			2
3 monthly		1	7
Monthly			2
Final recommendation	Short (10 minutes) interactive scenario	app	3 monthly

The recommendations were unanimous during this first round and the results were fed back to the group as a whole during this meeting. The group was satisfied that consensus was clear and so no rating of results needed to be performed. Consensus of 70% in agreement is generally accepted within Delphi methods (Vogel et al., 2019).

The new intervention for primary care nurse resuscitation training (support staff were not yet included in the study) was agreed during the discussion as a short, interactive scenario via an app delivered every three months. There was consensus that three-monthly would be optimum, and that four or six monthly would be second best. Some

stakeholders also expressed that monthly training would be beneficial, but this was generally considered in the discussion as unachievable. Consensus was also achieved on the platform. It was decided that the Lifesaver app from the RCUK (2017) would be the new intervention.

Figure 11: Categorised responses from the stakeholder meeting

DATA FROM THE LIFESAVER APP

The participants completed the Lifesaver intervention at months three, six, nine and 12, and reports were generated for the number of correct answers, speed of answers (in seconds), and accuracy of CPR (as a percentage) (figure 12).

Data from the reports were analysed descriptively to assess changes between time points. The number of Lifesaver questions per scenario was different on different dates, as the app was updated in 2020 (RCUK, 2020a). However, this was inconsequential as percentage of correct answers was used in the analysis and the change in the denominator was minimal.

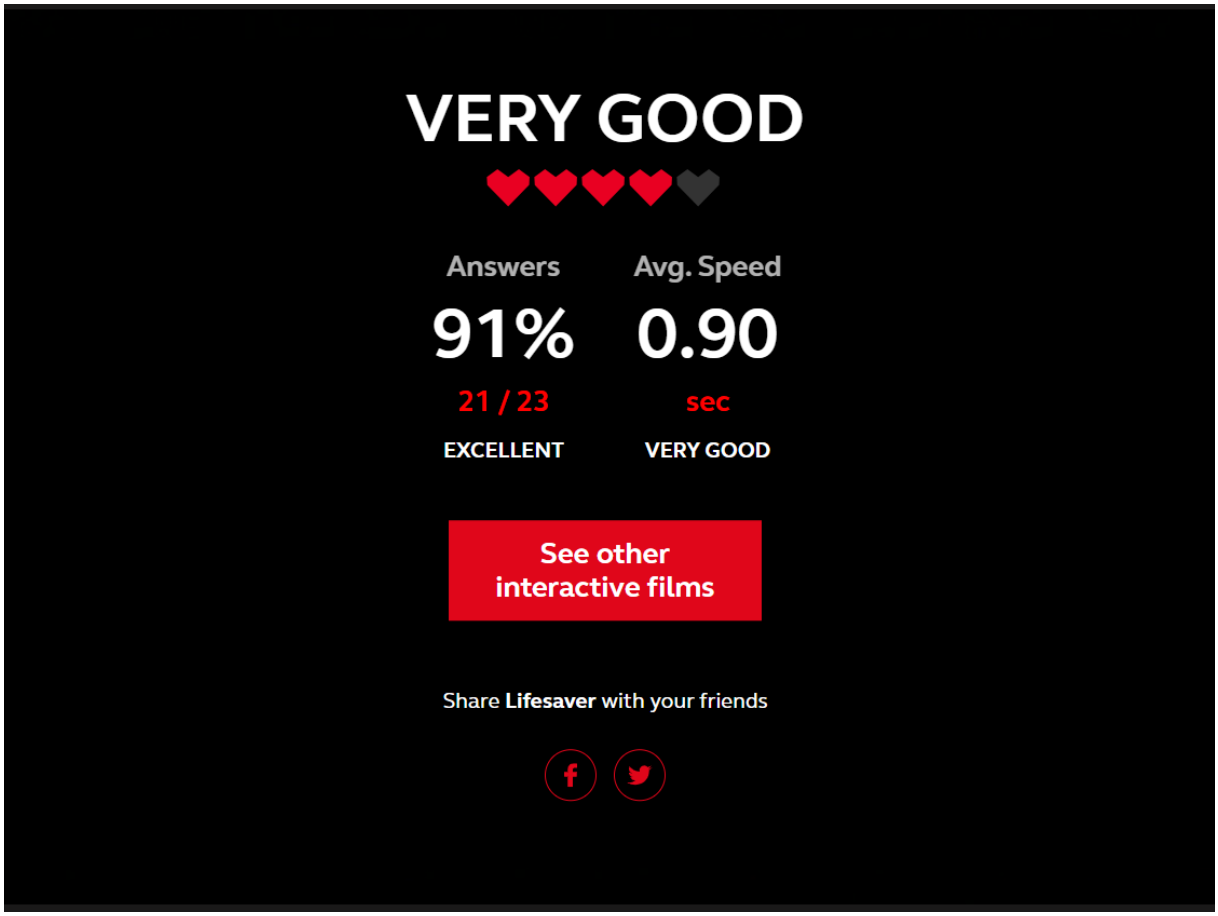

Figure 12. Data display from the Lifesaver app

Figure 13 details the median percentage of correct answers to the Lifesaver questions at the different time points for both nurses and support staff. This shows that nurses and support staff retained and maintained knowledge across the time points. Overall, support staff had a slightly higher median percentage of correct Lifesaver answers than nurses (figure 14). This marginal increase may be attributed to support staff having better resuscitation knowledge than nurses. However, the difference was not striking and was not sustained at the final test point. No explanation was established for the phenomenon.

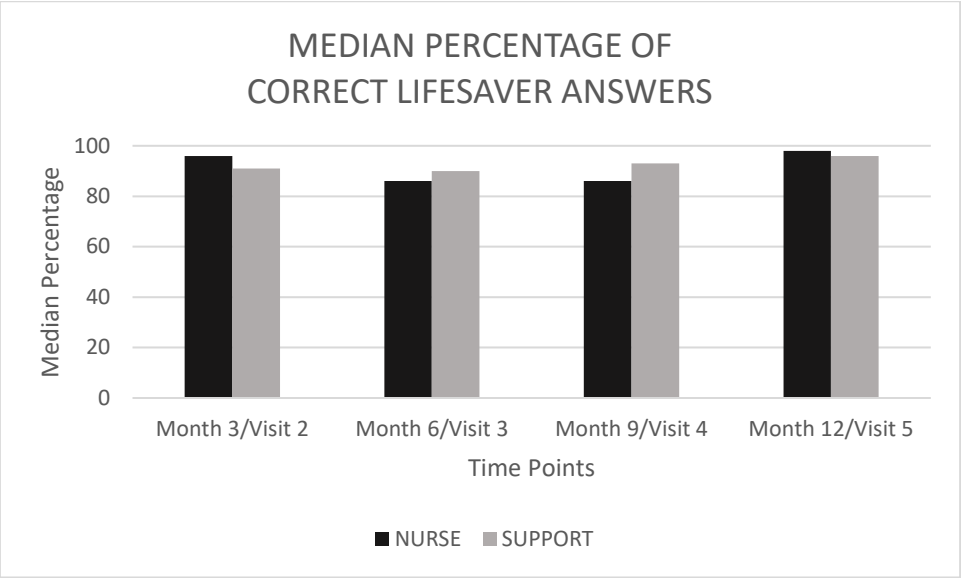

Figure 13: Median percentage of correct answers from Lifesaver scenarios at the different time points

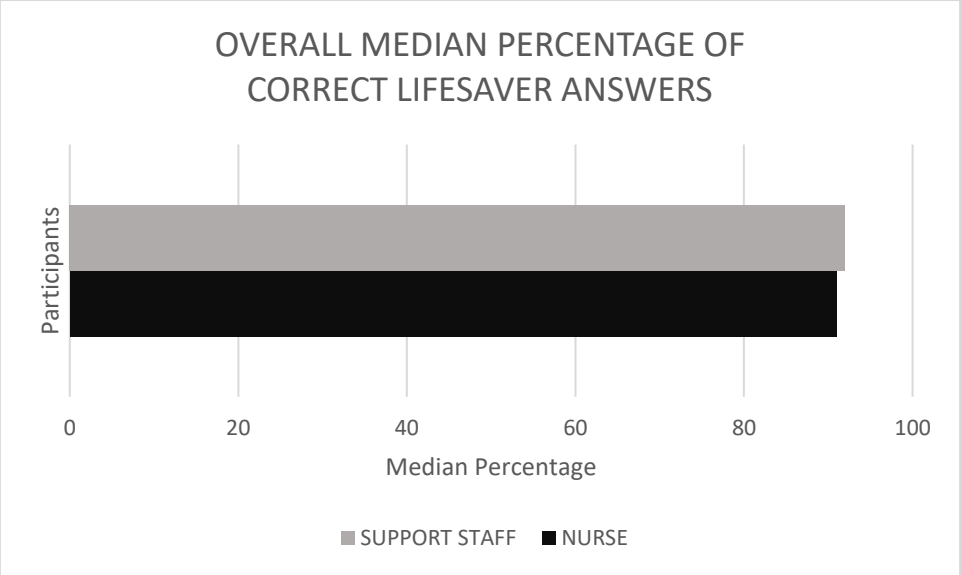

Figure 14: Overall median percentage of correct answers from Lifesaver scenarios

Figure 15 shows the mean speed to answer each question. Support staff were quicker at all time points apart from the month 12 visit. Figure 16 shows support staff to be generally marginally quicker at answering the questions. Nurses may have been slower until month 12 because they were aware of and were considering more factors. However, once again, the difference was not striking, it was not sustained, and no explanation was found. There was also the same reversal at 12 months.

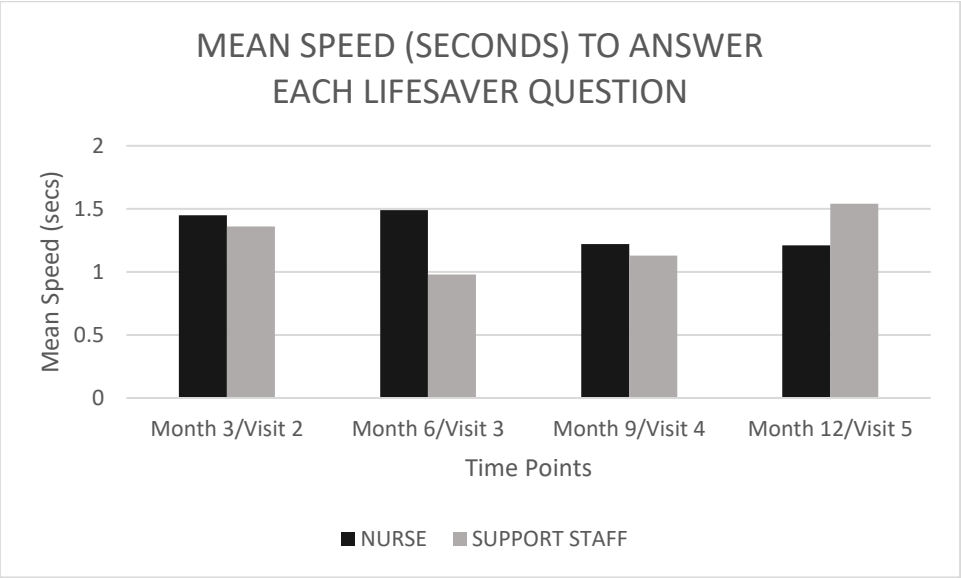

Figure 15: Mean speed in seconds to answer each Lifesaver question at the different time points

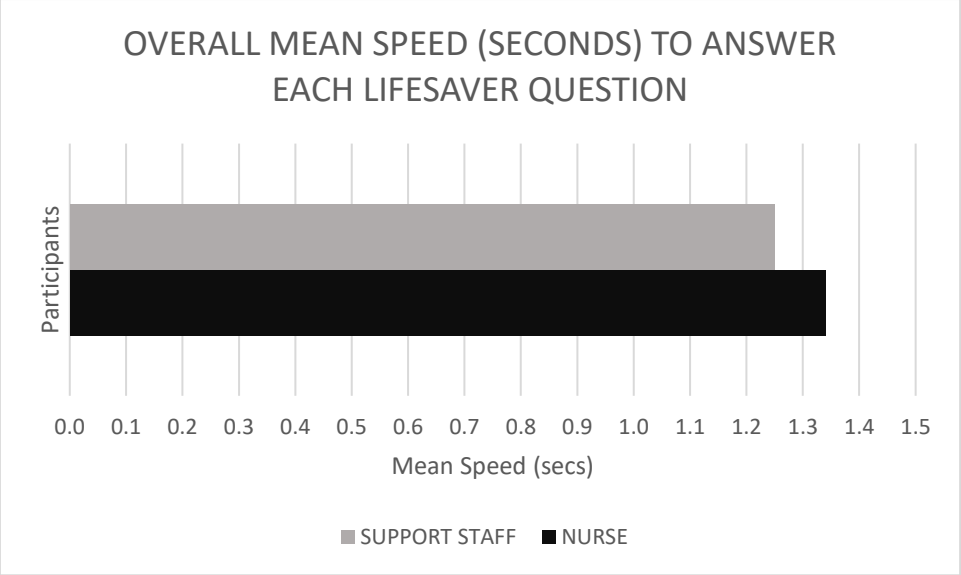

Figure 16: Overall mean speed in seconds to answer all Lifesaver questions

The bar chart in figure 17 shows the mean accuracy of chest compression rate as a percentage. This shows that all staff sustained improvement over time, with support staff making the most improvement.

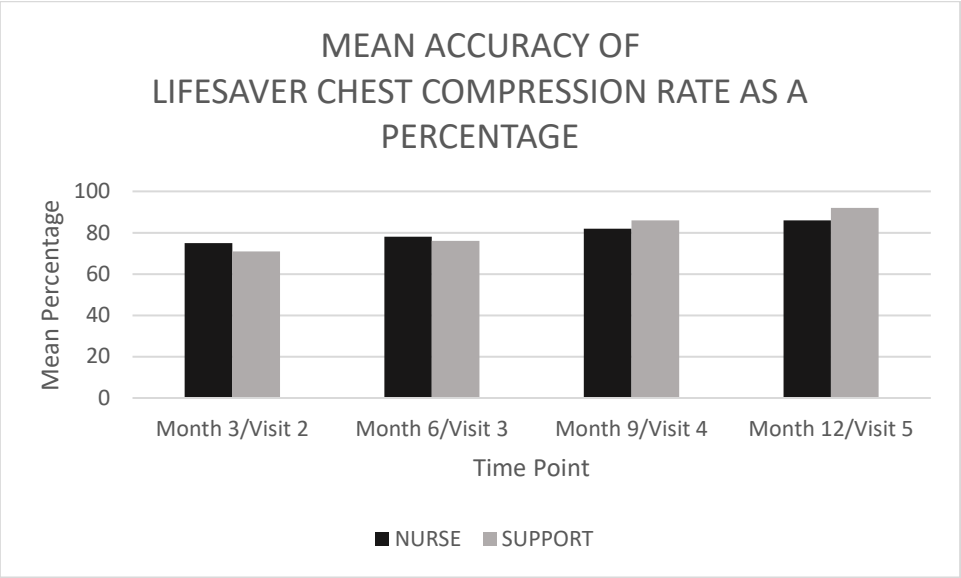

Figure 17: Mean accuracy of Lifesaver chest compression rate as a percentage at different time points

The bar chart in figure 18 shows the overall accuracy in chest compression rate was marginally better amongst support staff. However, this was chest compression rate as calculated by pressing two keys simultaneously on a computer or moving a device such as a tablet or mobile phone to dictate the chest compression rate. It is important to note that the skill of performing chest compression depth, recoil, fraction flow and rate by physically performing the skill of chest compressions on a manikin was not assessed using this method.

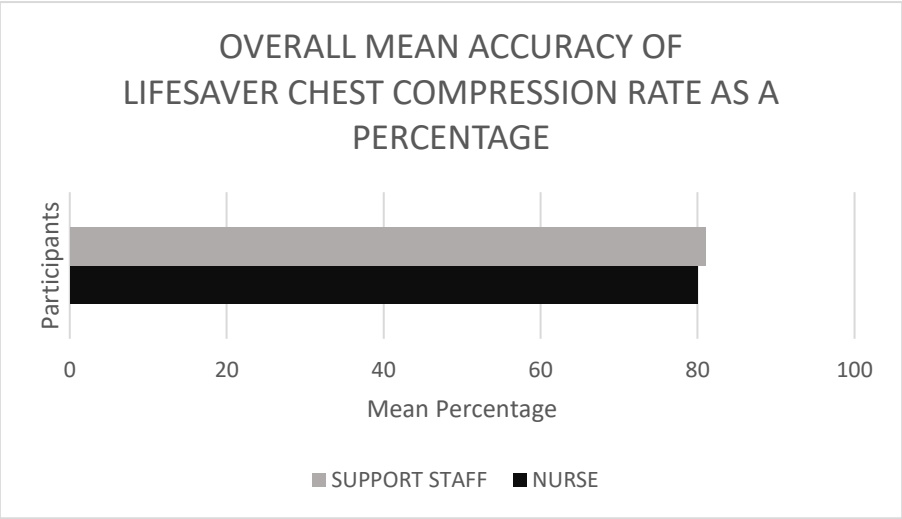

Figure 18: Overall mean accuracy of Lifesaver chest compression rate (percentage)

Missed Visits

There were a small number of visits for which there were no data as staff were unable to attend (figure 19). The incidence of this was increased due to the pandemic. However, this was accounted for in the analysis and did not affect the results of the study. There was no obvious impact on data analysis as the numbers of missed visits were low and there was no pattern in terms of participant characteristics who missed the visits or particular visits that were missed.

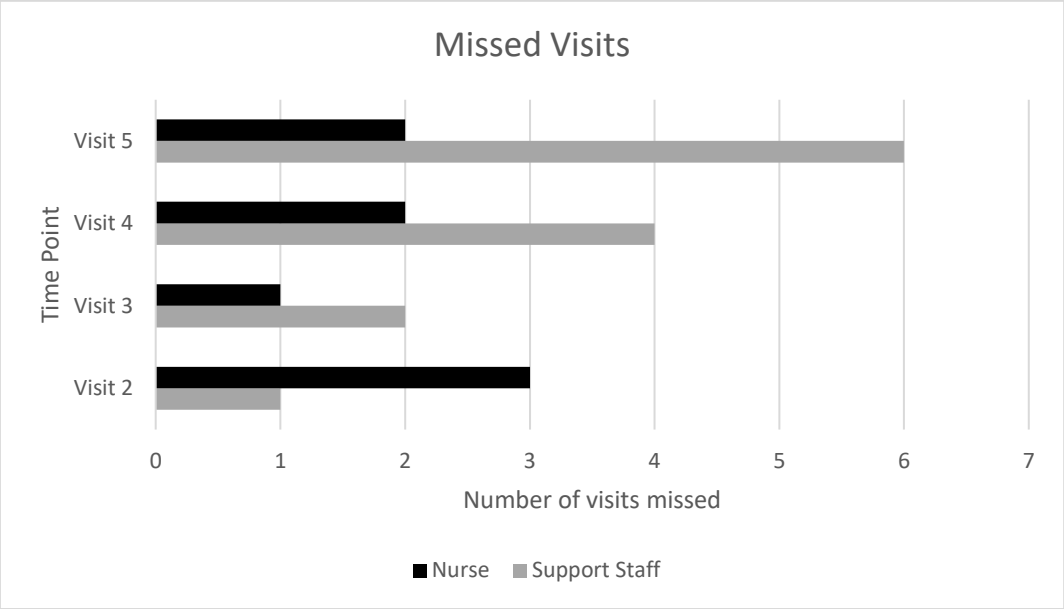

Figure 19: Number of nurses and support staff who missed visits.

DATA FROM OBSERVATION

The observation assessment proforma was easy to use in real time and did not disrupt the flow of the scenario. However, it could be made even easier for the researcher to use by adding in a tick (√) or cross (x) box option to the column for achieved / not achieved, for speed of completion. This revision to the observation assessment sheet could be made for the main study.

For each participant, the 20 critical action assessment indicators in the proforma were assessed as fully achieved or not (a dichotomous variable). An overall score across all 20 items on the proforma was calculated for each participant, and changes in the mean overall score across the sample between time points was estimated.

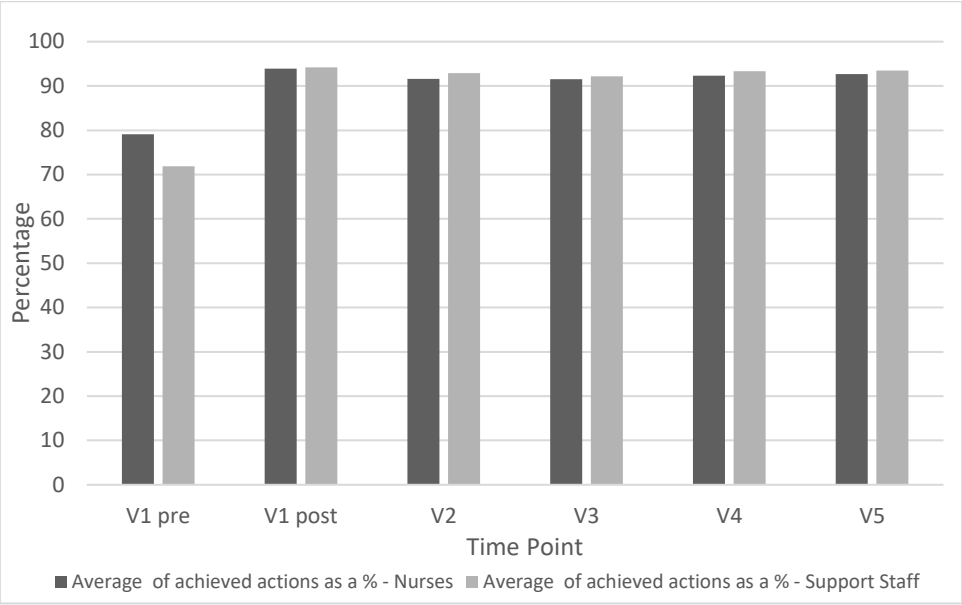

Figure 20: Percentages of correct observation actions for nurses and support staff across all visits

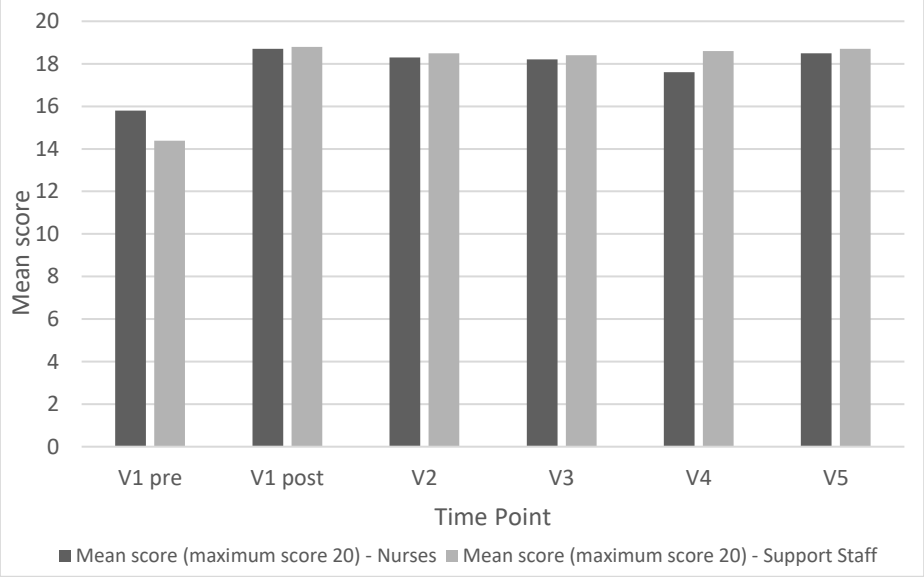

Figure 21: Observation mean scores for nurses and support staff across all visits

The bar charts shown in figures 20 and 21 detail the percentages of correct actions and mean scores in the observation scenarios for all participants. Nurses had more correct actions than support staff before the initial training, suggesting that nurses had better resuscitation skills at the start of the study. However, after the initial training, support staff had more correct answers than nurses throughout the remainder of the study. The bar charts demonstrate that skills were improved after the initial training and were maintained throughout the study. The three-monthly video intervention may have

been the explanation why skills were maintained. Although both nurses and support staff maintained skills, support staff maintained more skills than nurses.

The clinical reality is that resuscitation attempts need not be performed perfectly for survival to be secured. All staff in this study met the standard of 75% achievement after training, which is key. Improvement in the degree of achieved/not achieved is not as important. The main study will be aimed at achieving the greatest number of participants being adequate at resuscitation and maintaining knowledge and skills over time rather than aiming for perfection.

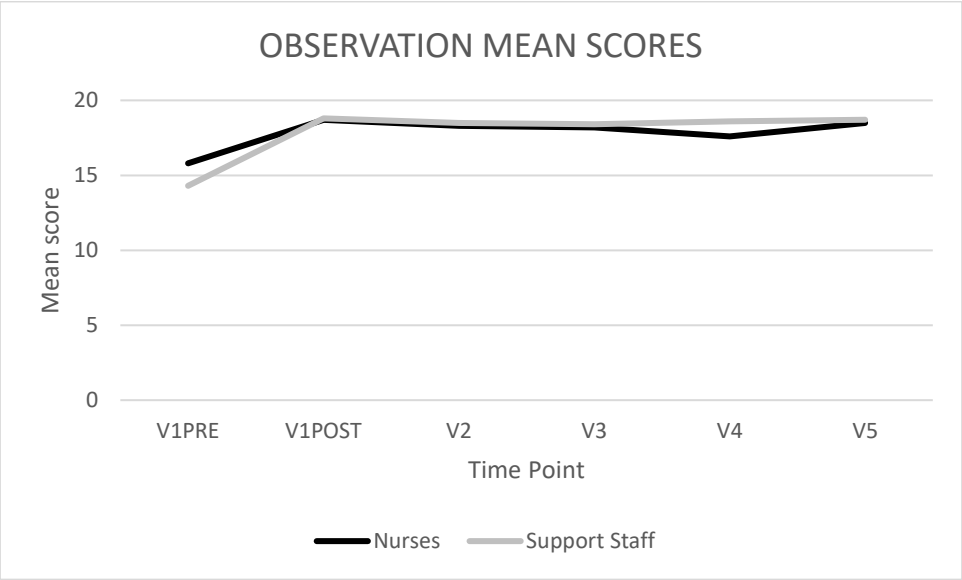

Figure 22: Observation mean scores of correct actions for nurses and support staff across all visits

The line chart in figure 22 details the observation mean scores for all participants across all visits and time points. The data were reviewed rigorously, and assessed against both demographic data and potential extraneous variables, but nothing could be found to account for the change at visit 4 for nurses. As there was no obvious sub-set of the sample, no obvious characteristic was common to those whose performance or knowledge dipped at this point. Furthermore, review of contemporaneous notes indicated no change in context or physical circumstances in the testing regime. Consequently, it was concluded after thorough investigation that likely explanations could be discounted.

No remedial training was needed, although one participant asked to repeat the scenario immediately after it was completed, believing that adequate skills had not been displayed. The original data were used for the study.

Further evidence from the Laerdal QCPR reports was included to determine the chest compression depth, recoil, speed and flow fraction (percentage of time chest compressions were in progress). The Laerdal QCPR app uses 75% as an acceptable benchmark for performance, which was also adopted for this study.

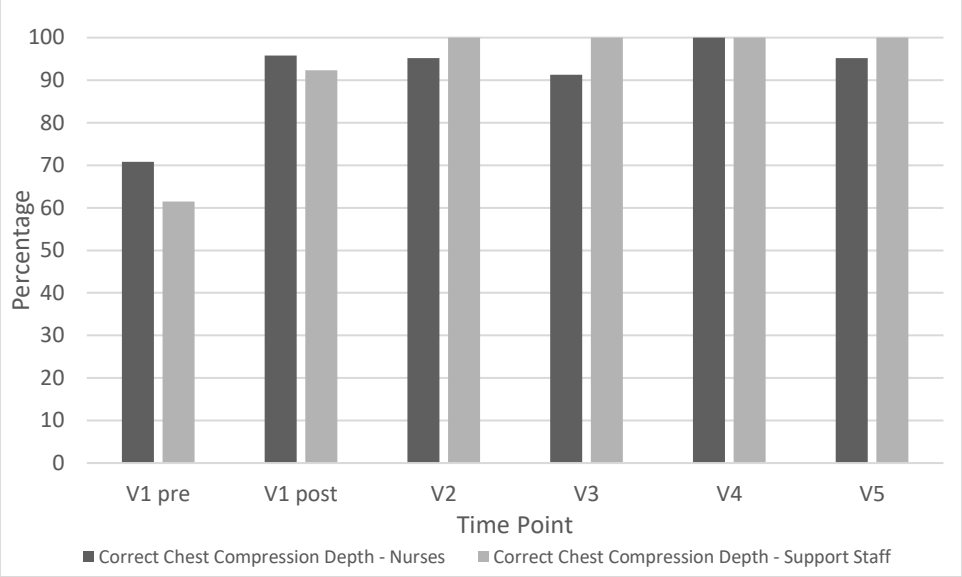

Figure 23: QCPR data showing percentage of nurses and support staff who achieved the correct chest compression depth at each visit

Figure 23 shows the percentage of participants who achieved an acceptable level of correct chest compression depth of 5-6 centimetres during the observation scenario at each time point. Overall, chest compression skills were maintained over time and support staff performed better than nurses in relation to both chest compression depth, and recoil (figure 23) and speed (figure 24). Similar findings were found during the Lifesaver videos, where support staff performed marginally better than nurses during chest compression rate (figure 18, page 79).

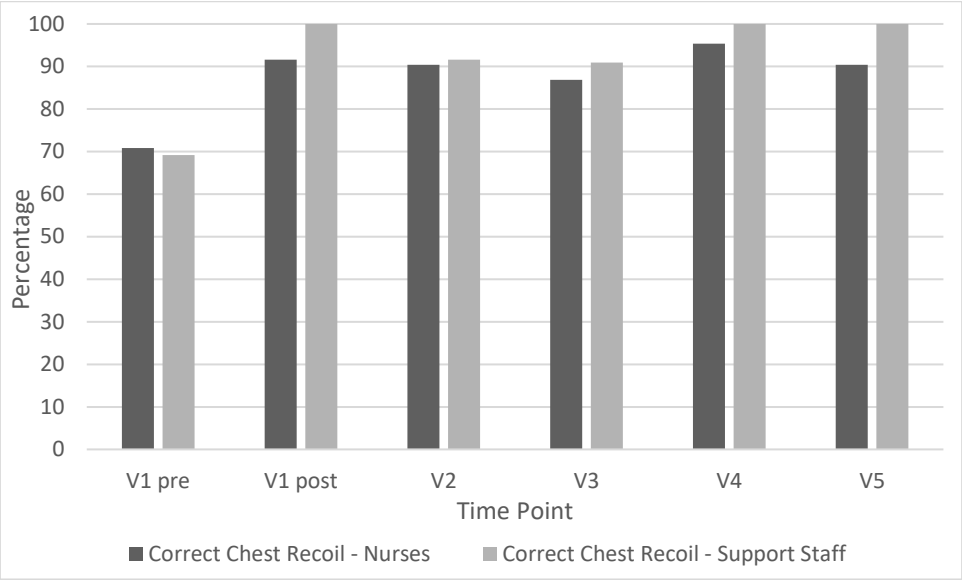

Figure 24: QCPR data showing percentage of nurses and support staff who achieved the correct chest recoil at each visit

Figure 24 shows the percentage of participants who achieved an acceptable level of correct chest recoil during the observation scenario at each time point.

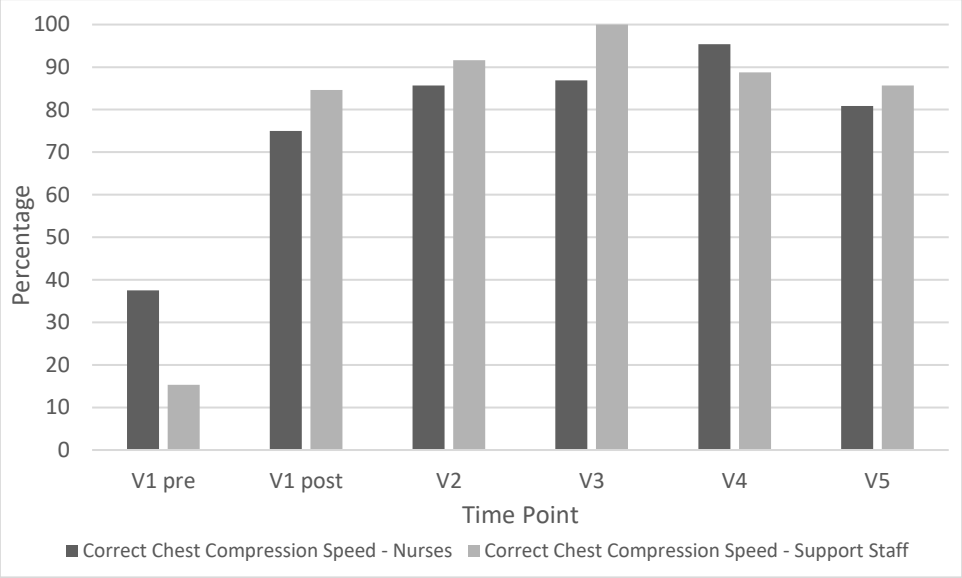

Figure 25: QCPR data showing percentage of nurses and support staff who achieved the correct chest compression speed at each visit

Figure 25 shows the percentage of participants who achieved an acceptable level of correct chest compression speed of 100-120 compressions per minute during the observation scenario at each time point. All participants improved their performance after the initial training and maintained the skill throughout the study. Support staff

performed better than nurses at each time point apart from visit 4, when nurses performed better in chest compression speed than support staff .

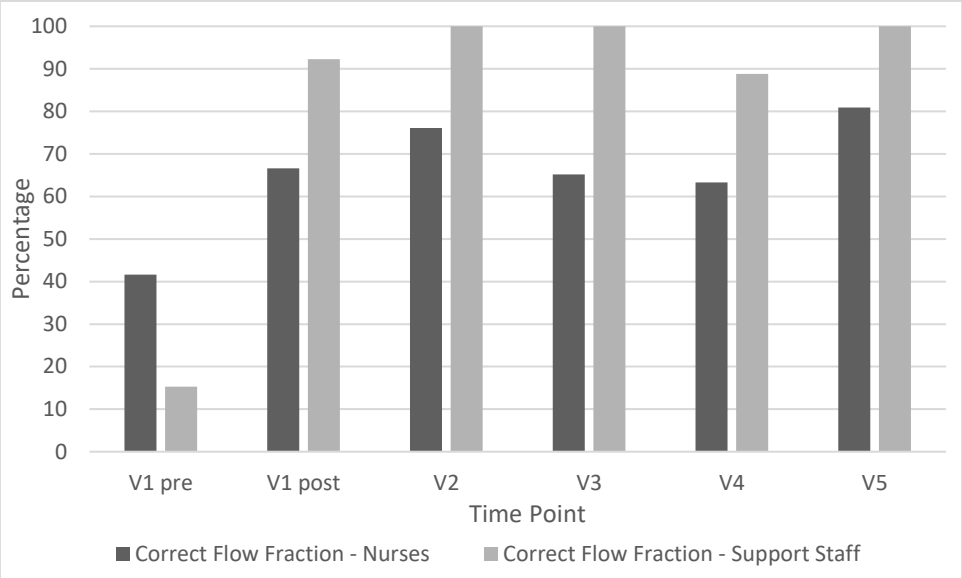

Figure 26: QCPR data showing percentage of nurses and support staff who achieved the correct chest compression flow fraction at each visit

Figure 26 shows the percentage of participants who achieved an acceptable level of correct chest flow fraction during the observation scenario at each time point. Whilst all participants improved their performance after the initial training, support staff were better. Nurses did not maintain this skill at all visits following initial training. However, support staff did maintain this skill throughout the study and performed better than nurses.

The data from the QCPR app suggest that whilst support staff perform better overall than nurses in resuscitation skills, support staff also have better resuscitation skills after training and are able to transfer training into practice in terms of chest compression flow fraction.

QUESTIONNAIRE DATA

The questionnaires were completed in full by each participant at every study visit attended. However, the answer grid was not used all of the time and caused some confusion for participants despite written information given for completion. Some participants chose to write ‘true’ or ‘false’ next to the individual statement on the

question sheet. The layout of the questionnaire could therefore be revised for the main study to include dedicated space for answers on the same page as the statements.

Data from the true/false questionnaires were analysed descriptively based on total scores to assess changes between time points. An overall score across all 20 items on the proforma was calculated for each participant, and changes in the median overall score across the sample between time points was estimated. The full dataset was used to expose any increase in knowledge over time.

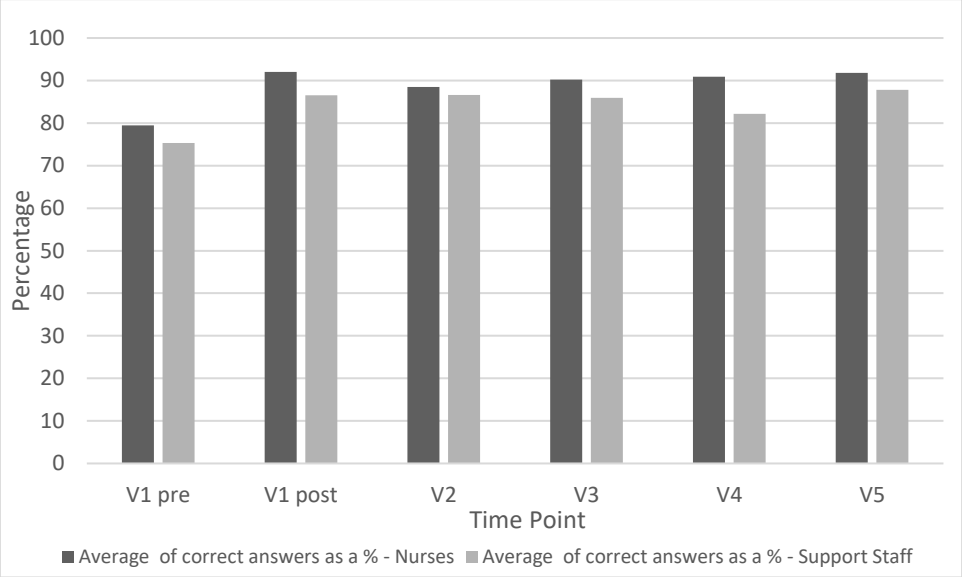

Figure 27: Percentages of correct questionnaire answers for nurses and support staff across all visits

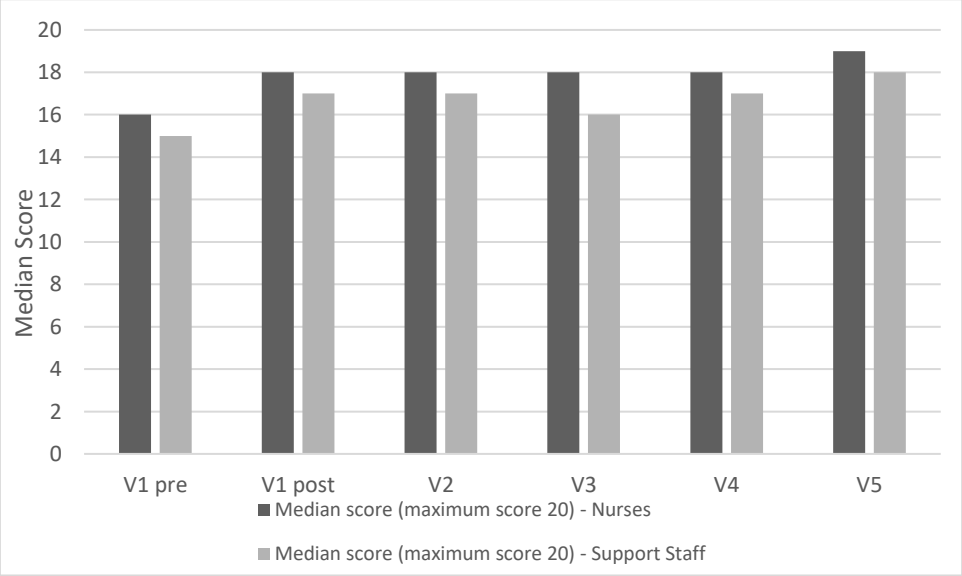

Figure 28: Questionnaire median scores for nurses and support staff across all visits

The bar charts shown in figures 27 and 28 detail the percentages of correct answers and median scores in the true/false questionnaires for all participants. The bar charts demonstrate that knowledge was improved after the initial training, suggesting the initial training was effective. Knowledge was also maintained throughout the study. The three-monthly video intervention may have been the explanation why knowledge was maintained. Both nurses and support staff maintained knowledge throughout the study, however, nurses maintained more resuscitation knowledge than support staff. This was not the case with the Lifesaver questions, where support staff answered slightly more correct answers overall (figure 14, page 77).

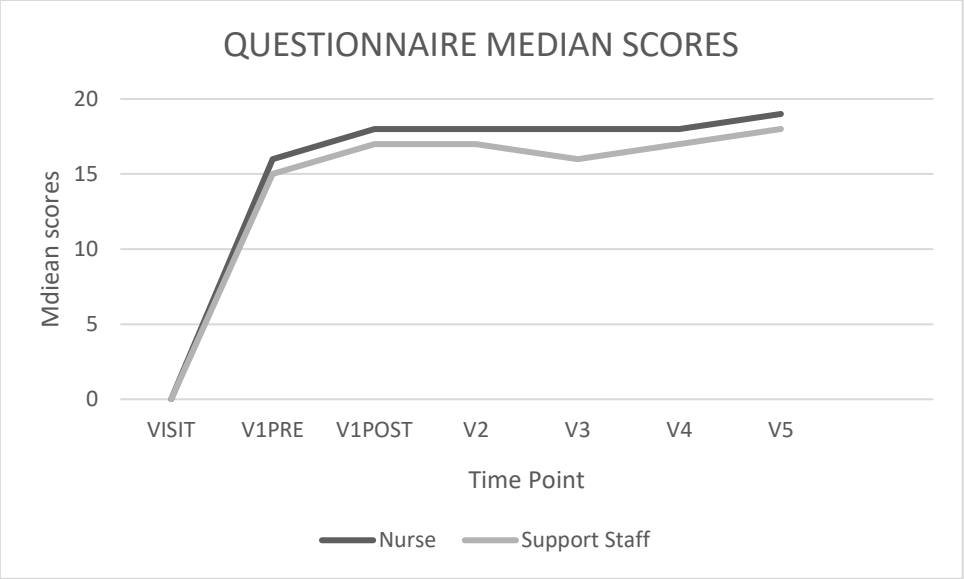

Figure 29: Questionnaire median scores for all participants across all visits

The line chart in figure 29 details the questionnaire median scores for all participants across all visits and time points. The data were again reviewed rigorously, and assessed against both demographic data and potential extraneous variables. Nothing could be found to account for the change at visit 3 for support staff. There was no obvious sub-set of the sample, so no obvious characteristic was common to those whose knowledge dipped at this point. There was also no change in context or physical circumstances in the testing regime. Hence it was concluded, after thorough investigation, that likely explanations could again be discounted.

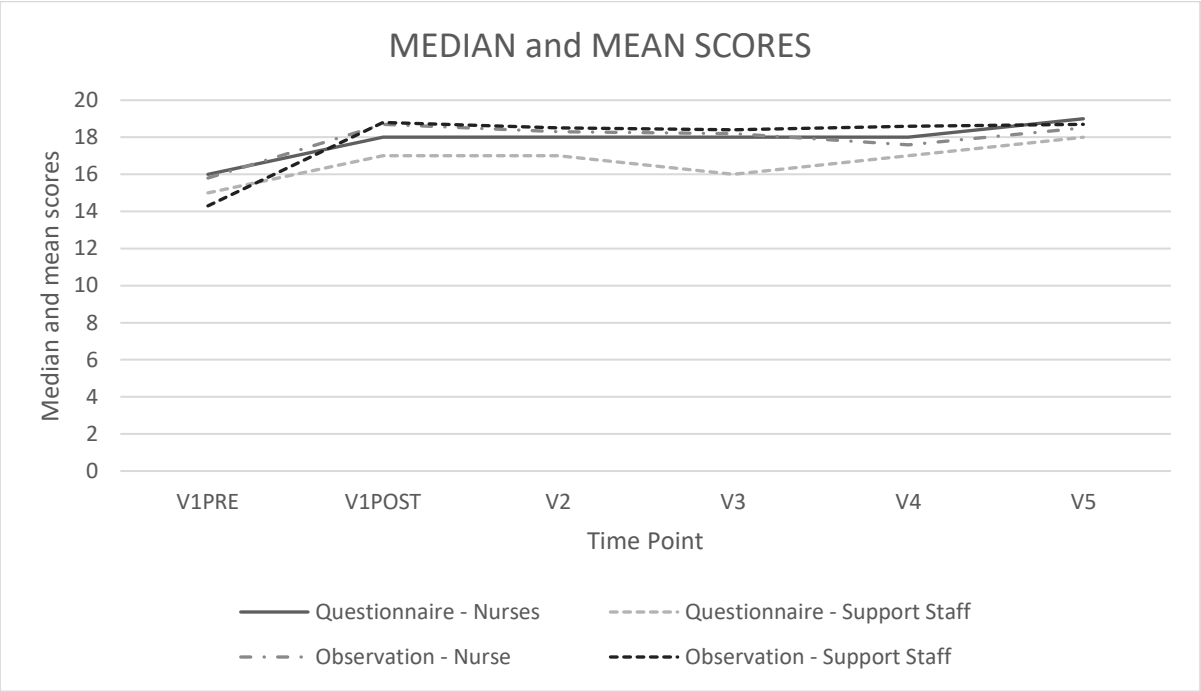

Figure 30: Questionnaire and observation median and mean scores for all participants across all visits

From figure 30, it can be seen that all participants improved their knowledge and skills after initial training. Nurses maintained more knowledge over the 12 month period, whilst support staff maintained more skills.

DATA FROM INTERVIEWS

The topic guide worked well and helped with the flow of the interview and the questions to be asked. However, whilst the interviews generated useful data that were captured on voice recording, it was noted that the topic guide proforma could be revised to include space for handwritten researcher comments. This would enable quick notes to be written at the time to capture participant non-verbal gestures, for example, which could add to but not be captured on the voice recording.

The qualitative data were analysed using inductive content analysis (Elo & Kyngas, 2008). The process consisted of three phases for handling the data: preparation, organisation and reporting. During the data organisation phase, open coding was completed using initial notes and quotes data from the interviews (table 17).

Table 17: Initial notes and quotes from interviews

Question from interview guide	Notes V1 pre-test	Notes V1 post-test	V2	V3	Quotes	Initial Thoughts
If you had been involved in a cardiac arrest, in what way do you think your last training session would have prepared you?	Increased confidence. Re-enforces previous training. Prepared if it happened quickly after training. More prepared. Well-prepared.	Helped a lot. Much more confident. Well-prepared. Very well-prepared. More confident. Very confident. Would have all the knowledge.	I would know what to do. It allowed more practical experience and thinking through scenarios. More knowledgeable. Fresh in mind. Helped a lot. Immensely. More confident. Very well-prepared for sequence of events. Fully prepared me.	Very well. Fairly well, not as well as if was immediately afterwards. Well, more confident, would go through the steps. Well, straight forward. I would have known what to do. Well.	'if it [the cardiac arrest] was quickly after training then yes [prepared]' 'I would have known what to do' 'working as a team is a good thing' 'made me a lot more confident and I would know what to do' 'good, fresh in my mind' 'It would have prepared me' (V1 pre) 'Immensely, it was a good refresher and more' (V2) 'I would have helped' (V2) 'not as confident as I am with refreshers in-between the re-training' (V3) 'the sequence of what to do would prepare me well' (V3)	Positive impact - useful
How confident would you have been if you had responded to an adult cardiac arrest?	A lot more confident. More confident. Confident. Not confident - training was too long ago. Quite confident.	Very confident. 90% confident. A lot more confident. 8/10 confident. More confident.	Made me a lot more confident. Very – 9/10. Very. 7/10. 8.5/10 Fairy confident.	A lot more confident. Reasonably. Pretty confident, I would start CPR. Very. More confident with three-monthly training. Confident. Fairly confident. Quite confident, flowed easily.	'would be more confident if training was more frequent' 'a lot more confident' (V1 pre) 'not confident as the training was too long ago.' (V1 post) 'I would be happy to help someone'. (V3) 'I want a refresher every week'.	Positive impact - useful

What was good about your last training session?	Scenarios. Practical. 1:1 Easy to understand and remember. Not complicated. Makes you aware of what to do.	Interactive and informative. Involved the non-clinical staff too. Was a good refresher. Comprehensive. Practical. Explained well. Practical. Easy to understand.	Hands-on. Visual. Update. Scenario practice. 1:1 Thorough. Not complicated. Easy to understand. Enjoyable. Clear, appropriate. Interactive and informative.	Hands-on, well-explained. Thorough, in-depth, group work. Explained in layman's terms. Concise, straight to the point, well-delivered. Informative, involved, easy to understand. Practical. Orientation, AED.	'it was easy to understand' 'it was easy to remember' 'it was explained clearly and kept simple'	Positive impact - useful
Would you change anything?	No. Do more 1:1. Do more frequently. Add in Lifesaver.	No	No. Do more often. Do monthly. I prefer Lifesaver	No. Do more frequently. Prefer Lifesaver.	'do more frequently' 'Lifesaver is more realistic' (V2) 'I prefer the video training, I can visualise and it is more realistic' (V3)	Majority wanted more frequent training.
Was the length of your training session right?	Yes.	Yes. Fine.	Yes. Perfect.	Right. Good. Yes.		Positive impact - useful
What about the content of it?	Scenarios using the manikin were good. Good. Just right. Perfect.	Ok. Good. Very good. Thorough.	Good Ok. Very good. Fine.	Pitched right. Excellent. Good, thorough. Concise. Really good. Enjoyed it.	'scenarios with manikin were good'	Positive impact - useful
What about the frequency of the training?	Ideally 3-4 times per year. Want more training per year. At least every 6 months. Want more frequent training. Could be 6 monthly.	Should be more frequent. Want 3-4 monthly. Want every 6 months. Want every 3 months. Should be more frequent, 3 monthly.	Needs to be more frequent. 3 or 4 times per year in small amounts. 3 monthly would be good. Yearly not enough, need every 3 months.	Prefer 3 monthly. Needs to be every 3 months. Twice a year would be better. Need 6 monthly. Yearly not enough, needs to be 3 monthly.	'need more than annual [training]' 'more often [than annual training] would be better' 'should be more frequent, every 3 month' 'annual is rubbish –it needs to be a lot more frequent, a small amount 3 or 4 times per year'	All participants wanted more frequent training than annual. Annual training is not frequent enough to be

		Fine. Needs to be every 6 months. 6 monthly would be better than annual.	6 monthly would be better than annual. Needs to be monthly. Should be every 6 months via computer. 3-6 monthly would be better. Needs to be 2-3 times per year. Annual not enough – needs to be every 3 months. 3 monthly would be better.	The confidence comes from repeated training annual not enough, needs to be ideally 3 monthly, minimum 6 monthly. It should be twice per year or 3 monthly. Should be more frequent as cardiac arrest isn't something that happens a lot. Prefer 6 monthly.	'3 monthly is a good idea' 'annual is good, but 6 monthly better' 'I would like 1/4ly' (V1 post) 'Needs to be 2-3 times per year' (V2) 'annual is too long to wait' (V3) 'annual isn't enough' (V3) 'the confidence comes from repeated training'(V3) 'I prefer 3 monthly to keep on top' (V3) 'Annual not adequate. Should be more frequent, and like Lifesaver. I would like 3 monthly in a team meeting. I would be more confident with order if more frequent' (V3) 'I prefer 6 monthly. I would become unfamiliar if any longer because it is important' (V3)	able to remember it.
Did you understand the questions in the true / false questionnaire?	Yes. Some questions were ambiguous. Some used medical jargon.	Yes. Majority. One ambiguous.	Yes	Yes. Most – some had similar wording. Some wording is ambiguous.	'yes, mostly' 'all but one'	True/false questionnaire was well-received but possibly need to look at wording. (Questionnaire was initially designed for clinical staff)

How did the structure of the observation work for you?	Good. Fine. Really good.	Ok. Good	Very good. Good. Great.	Yes. Brilliant. Worked well for me.	'I like practical'	Positive impact - useful
Is there anything that would help you retain knowledge and skills?	More scenarios. More frequent training. Would like handout. Making written notes. A wall chart.	No. More practical sessions. Repeated more frequently. Poster for theory work. Algorithms around the workplace. Small [candidate] sessions.	Visual helps as in a video. Lifesaver is very good. A prompt on your phone every 2 weeks asking: do you want to watch a video? More regular sessions. Flowchart to look at daily. More practical opportunities. Short, frequent refresher training.	Lifesaver is good but some people may have problems with being 'timed' for answers e.g. added pressure or dyslexia. More scenarios and cardiac arrest trolley familiarisation sessions. Flowcharts to look at daily. No. Frequency of training should be 3 monthly. Lifesaver works well for me.	'more practical sessions' 'a prompt on your phone every 2 weeks asking: do you want to watch a [Lifesaver] video?' '10 minutes refresher training every 3 months would be better' V2 quote 'I feel better doing Lifesaver every 3 months' V3 quote 'The video was good. It's visual and that works for me. A reminder' V3 quote	All participants wanted more frequent training. More frequent scenario practice wanted.
Researcher Comments	1-10 included	1-10 included	1-10 included	Missing: 5 (compassionate leave)		Lifesaver well-received. Participants want more frequent than annual training.

Throughout the content analysis process, data were organised into groups and categories before abstraction of results. Initially, three broad groups were created from the interview data: mode of training, questionnaire and observation. Figures 31, 32 and 33 detail the processes and subsequent abstraction of results from the three broad groups.

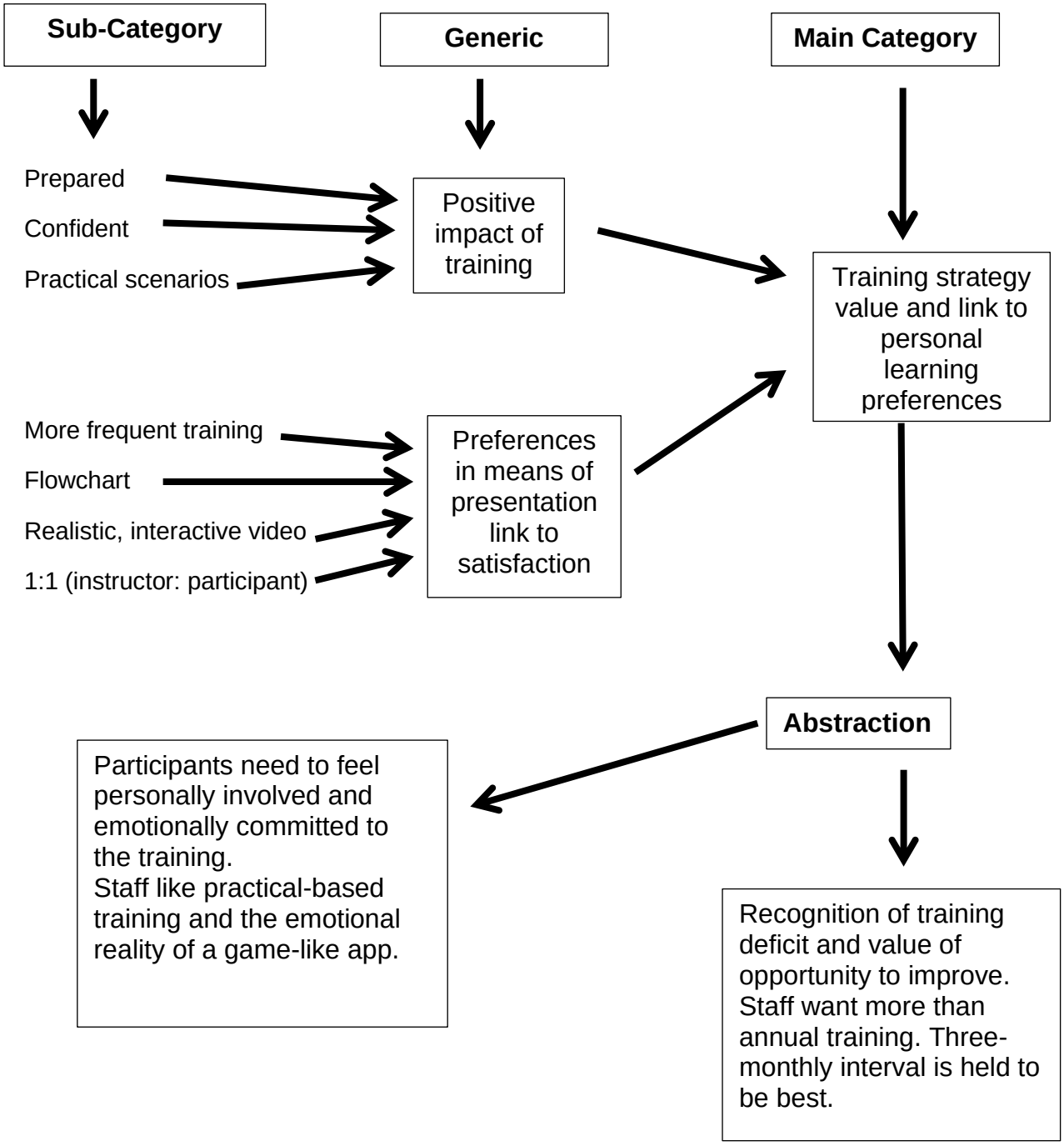

Figure 31: Content analysis for broad group 1, mode of training

Tables 18-23 detail the frequency counts of participants answering which training frequency was considered the optimum. Training every three months was held to be best. Table 18 shows that as the study progressed, more participants felt that training every three months was best. When three-monthly training was not held as being best, all other participants decided that more frequent than annual was needed apart from one participant who upheld that annual training was still adequate throughout the study. This participant did not maintain knowledge and skills over time in this study.

Table 18: Frequency counts and percentages of occurrences when three-monthly re-training interval is held to be best

Three-Monthly Re-Training Interval	Visit 1 pre-test	Visit 1 post-test	Visit 2	Visit 3	Visit 4	Visit 5
Occurrences	6/37	7/37	21/33	22/34	22/31	21/29
Percentage	16%	19%	64%	65%	71%	72%

Table 19: Frequency counts and percentages of occurrences where monthly re-training interval is held as best

Monthly Re-Training Interval	Visit 1 pre-test	Visit 1 post-test	Visit 2	Visit 3	Visit 4	Visit 5
Occurrences	0/37	1/37	0/33	0/34	1/31	1/29
Percentage	0%	3%	0%	0%	3%	3%

Table 20: Frequency counts and percentages of occurrences when four-monthly re-training interval is held to be best

Four Monthly Re-Training Interval	Visit 1 pre-test	Visit 1 post-test	Visit 2	Visit 3	Visit 4	Visit 5
Occurrences	1/37	4/37	0/33	0/34	0/31	1/29
Percentage	3%	11%	0%	0%	0%	3%

Table 21: Frequency counts and percentages of occurrences where six-monthly re-training interval is held as best

Six Monthly Re-Training Interval	Visit 1 pre-test	Visit 1 post-test	Visit 2	Visit 3	Visit 4	Visit 5
Occurrences	12/37	12/37	8/33	8/34	4/31	3/29
Percentage	32%	32%	24%	24%	13%	10%

Table 22: Frequency counts and percentages of occurrences where more often than annual re-training interval is held as best, but no specific frequency detailed

More Than Annual Re-Training Interval	Visit 1 pre-test	Visit 1 post-test	Visit 2	Visit 3	Visit 4	Visit 5
Occurrences	8/37	5/37	3/33	3/34	3/31	2/29
Percentage	22%	14%	9%	9%	10%	7%

Table 23: Frequency counts and percentages of occurrences where annual re-training interval is still held as best

Annual Re-Training Interval	Visit 1 pre-test	Visit 1 post-test	Visit 2	Visit 3	Visit 4	Visit 5
Occurrences	10/37	8/37	1/33	1/34	1/31	1/29
Percentage	27%	22%	3%	3%	3%	3%

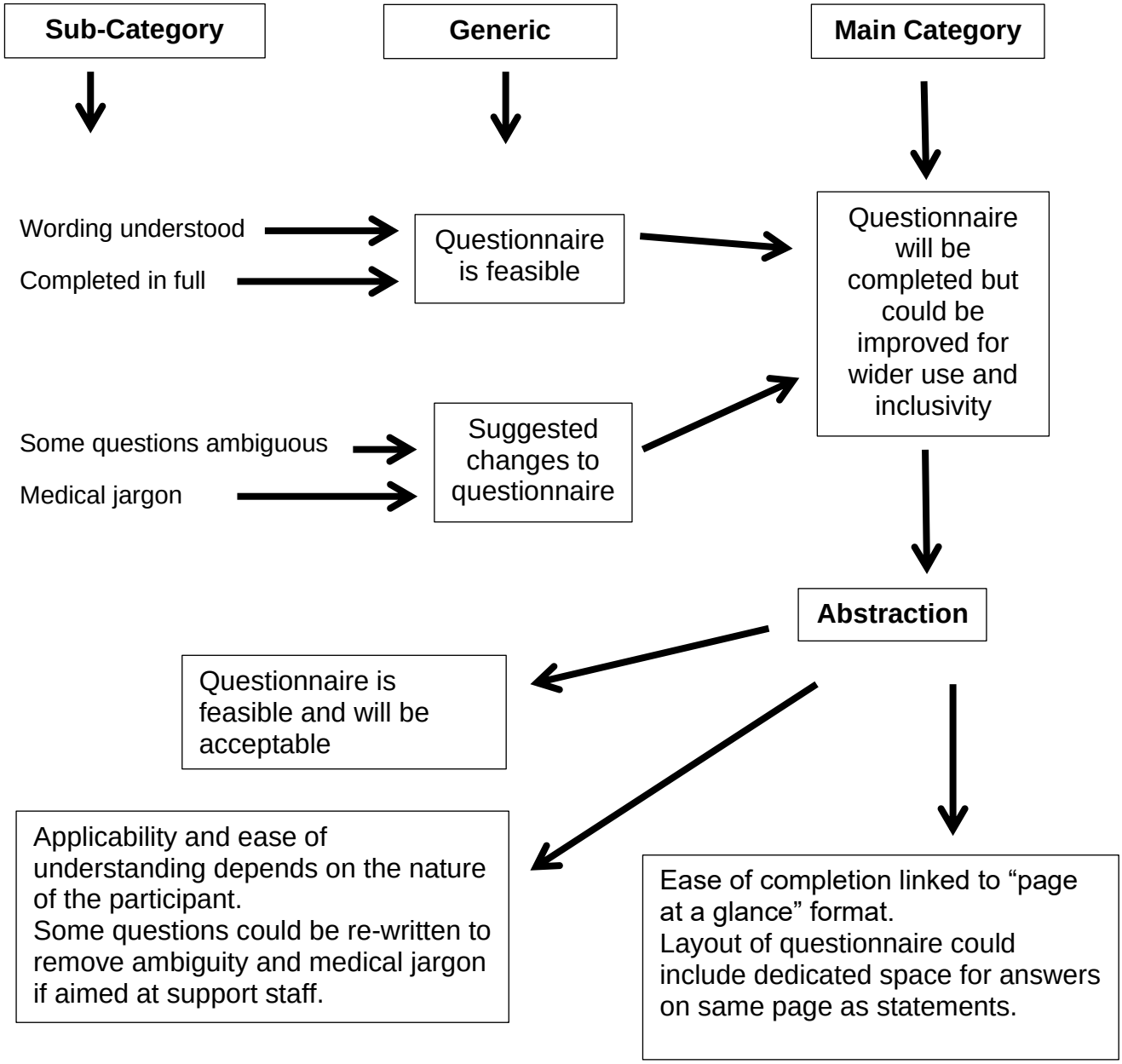

Figure 32: Content analysis for broad group 2, questionnaire

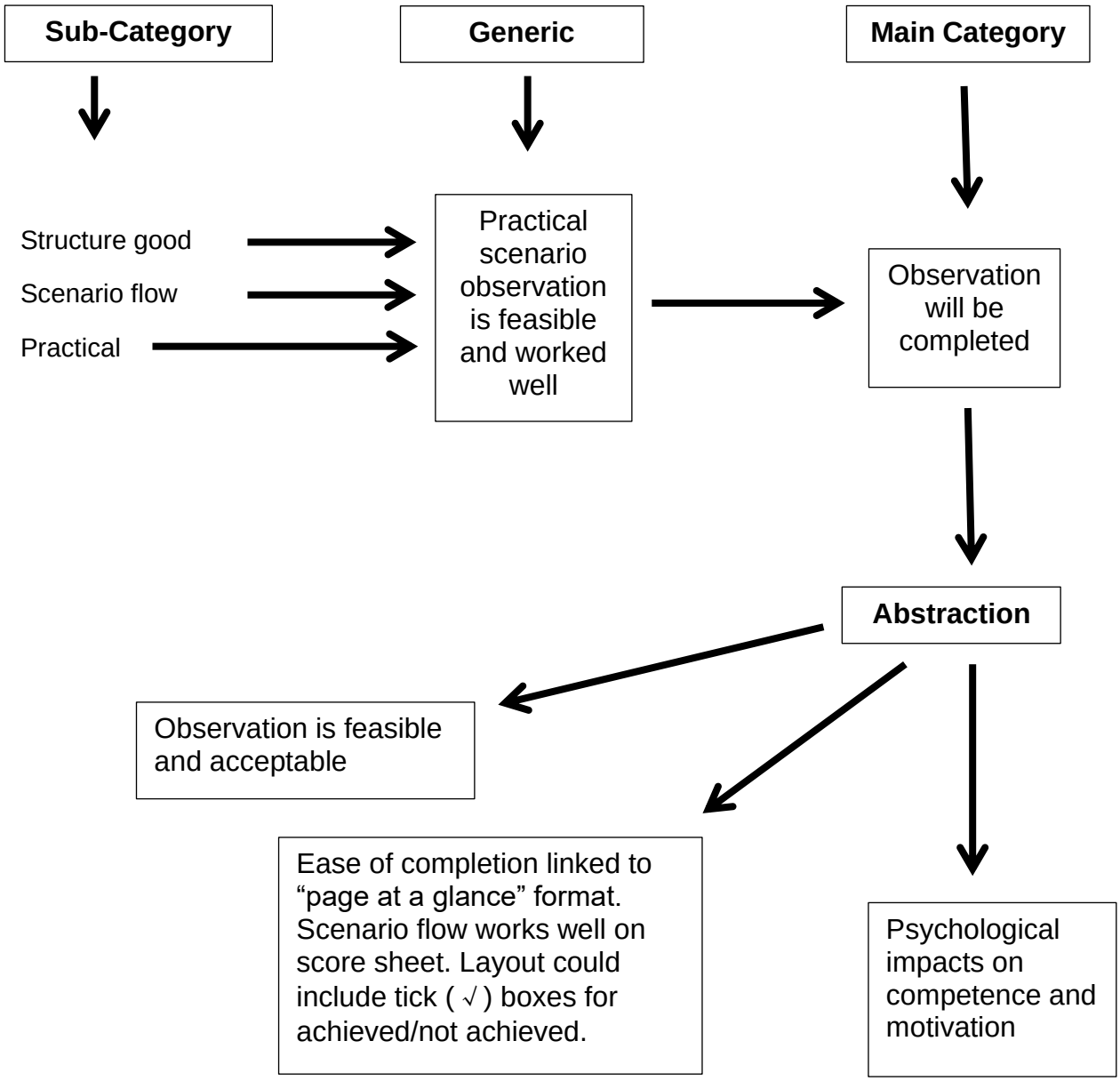

Figure 33: Content analysis for broad group 3, observation

The initial abstraction demonstrated staff attitudes to training. Further analysis detailed the effect of attitudes to training on clinical practice, including confidence and transfer and use of knowledge and skills in clinical practice. The content analysis demonstrated the acceptability to participants of the intervention and assessments as a way of measuring retention of skills and knowledge. The relationship of experience and exposure to patients in cardiac arrest on retention was also considered descriptively by comparing data amongst the demographics.

Tables 24 and 25 detail the best performing nurse and support staff participants overall in the scenario observations and questionnaires. No correlation could be made between the characteristics of experience and exposure to cardiac arrests and performance during this study.

Table 24: Best three performing nurse and support staff participants overall in the scenario observations

Nurse or support staff	Time since last BLS training	Time since qualifying as a qualified nurse	Time in primary care (PC)	Number of BLS training sessions attended in PC	Number of adult cardiac arrests attended in PC
Support Staff	12 months	Not applicable	2-5 years	5	0
Support Staff	12 months	Not applicable	11-20 years	15	0
Support Staff	12 months	Not applicable	6-12 months	1	0
Nurse	13-18 months	21-30 years	2-5 years	2	1~
Nurse	13-18 months	6-10 years	2-5 years	6	0
Nurse	13-18 months	6-10 years	2-5 years	6	0

~ (prior to initial training in study)

Table 25: Best three performing nurse and support staff participants overall in the questionnaires

Nurse or support staff	Time since last BLS training	Time since qualifying as a qualified nurse	Time in primary care (PC)	Number of BLS training sessions attended in PC	Number of adult cardiac arrests attended in PC
Nurse	13-18 months	6-10 years	2-5 years	6	0
Nurse	12 months	21-30 years	2-5 years	4	0
Nurse	12 months	>30 years	11-20 years	20	0
Support Staff	12 months	Not applicable	2-5 years	5	0
Support Staff	12 months	Not applicable	11-20 years	15	0
Support Staff	12 months	Not applicable	21-30 years	21	0

FINDINGS FROM THE INTERVIEWS

Environmental and Psychological Factors

Environmental factors

Staff do not experience frequent exposure to patients suffering cardiac arrest in the physical environment of primary care. The precise incidence is not known, but is described as being uncommon (Bury et al., 2009; Francis, 2021; Mitchell at al., 2020; Rashford, 2002; RCUK, 2020b). However, participants in this study recognised that regular training would prepare them and increase their confidence in managing a cardiac arrest. They did not feel immersed in an environment where medical emergencies, including cardiac arrest, are common. As a result, if a cardiac arrest occurs, staff might be paralysed with fear, feeling incompetent, unprepared or inept. The participants wanted and would benefit from more regular training than is offered currently. The increased frequency of training would help them to have confidence to trust their training to ensure an effective response. One participant gave the following explanation regarding the ideal frequency of training.

> *"It feels like 12 months is always too long for CPR updates. I forget after a couple of months as I don't see them* [cardiac arrests]*, so I'm not as confident in what to do. I'd still give it* [CPR] *a go, but just a short refresher every three months would be great. I'd feel much more confident."* (Participant 15)

The need for repeated training was made clear both for better memory and for reducing anxiety.

> *"I always feel like I've forgotten something if I only have training every year. You think you know it* [sequence of BLS] *but you don't. I need repetition. Repeating it four times a year would really help me remember. Twelve months is too long to go. I need it repeating regularly or it just doesn't stick in my memory*." (Participant 18)

> *"With regular training every few months, it's fresh in my mind and I'm not filled with anxiety about the thought of one* [cardiac arrest]. *I feel calmer and I'm more methodical and well-thought out because it's more regular, so it's fresh in my mind."* (Participant 36)

O'Donoghue et al. (2015) found that staff who do not have regular exposure to cardiac arrests have reported stress and 'freezing' when faced with the emergency. Varughese and D'Silva (2018) found staff recognise that regular CPR training is necessary to maintain resuscitation skills. However, as Ciurzynski et al. (2017) report, the optimum frequency of regular training is yet to be determined but should probably be more frequent than annually.

Fidelity

Primary care participants were lacking the emotive and realistic attachment to the notion of intervening at a cardiac arrest. They recognised that they needed this psychological and environmental fidelity to feel immersed in the scenario. This gave them a sense of realism and emotional attachment to the training**.** The participants not only discovered this but also found that they had the capability to embrace this adaptation.

> *"The videos paint a more encompassing picture. The urgency* [to respond to the cardiac arrest] *of the actors is what does it, I think. They draw you in to the moment and are so emotive that it really does feel true to life. It's exactly what we need as we don't see arrests in GP Land. This is actually the nearest we get to seeing one for real. As you know, cardiac arrests can be unpredictable, so the different scenarios in the videos are great: they really draw you in to try and save their life as the arrest unfolds in the different settings."* (Participant 23)

Participants cared about giving someone the best chance of survival and were determined to do the best that they could. Those aspects of the programme exerted a deep impact on participants when they realised that someone's life could be dependent upon their skill and knowledge. The use of emotive and realistic video games in training for participants who do not have exposure to resuscitation episodes or experience of them was important. They linked experience of cardiac arrests to maintenance of resuscitation skills and knowledge. However, when exposure was limited, as in primary care practice, these specific videos had a positive effect on maintenance of resuscitation skills, knowledge and performance. Participants valued the positive effects of the videos in resuscitation training and viewed these aspects as powerful in the ability to enhance resuscitation training.

The benefits of emotional stimulation by use of videos and games in resuscitation learning is not new (Ghoman et al., 2020; RCUK 2021). However, the degree to which emotive aspects are beneficial in primary care resuscitation education is not documented. This study demonstrates that the emotive factor is important in a primary care resuscitation training strategy.

Pedagogy

Blended learning

The participants recognised that lack of exposure to cardiac arrest scenarios in practice affected their learning needs. They wanted resuscitation training that included an emotive aspect, and held that a combination of an interactive video and hands-on skills practice would be optimum. They embraced the blended learning strategy used in this study, describing the hybrid of e-learning, using interactive videos, and hands-on practice of CPR and AED skills as the best approach. Participant 34 offered the following view about the style of teaching needed.

> *"The videos are really good, they're really get you into it* [the cardiac arrest scenario] – *like, the hairs on my arms were standing up. Brilliant acting, really hits the spot, because we don't see it at my surgery. But you need to practice the compressions and breaths, too: you can't do that so good with just the computer. What would be really good is to have a mixture of the videos and then the practice on the doll. Yeah, that would be the best thing, I think."* (Participant 34)

The combined approach gave participants exposure to the interactive aspects afforded by the videos. They needed the cognitive aspects and the new knowledge or updating, but they also needed to understand what happens physiologically and why things need to be done. The technical skills and scenario practice were essential so that they could react confidently when the very rare phenomenon of cardiac arrest in primary care occurs. A combination of hands-on skills practice and interactive videos was held as being the best training strategy. The interactive videos gave participants exposure to the emotion and realism involved in dealing with a cardiac arrest.

Blended learning is not new in resuscitation training and is an effective approach to teaching and learning (Te Pas et al., 2010). The Resuscitation Council UK (2021)

recommends the use of blended learning in resuscitation education. However, its effectiveness specifically in primary care resuscitation training had not been documented. This study suggests that it would be well-received and effective.

Unexpected Outcomes

Debriefing

The staff wanted to reflect, debrief and share the positive aspects of training. They were remarkably emotive and engaged, and although reflection is common practice amongst nurses to identify ways of improving practice (Nursing and Midwifery Council, 2021), participants were keen to discuss how they felt about the increased resuscitation practice afforded by the study. They were eager to communicate their discovery over time of the value and need for regular training, and the different strategy employed to maintain knowledge and skills.

One participant gave the following account after a scenario.

> *"It's funny isn't it: you think you know something but you actually don't. I thought 12 months* [BLS training interval] *was fine, but I didn't realise how quickly I forgot the sequence. It's quite scary, you know. It's not until I did this [study] with you that I realised I need it much more often. And the videos; they are so good, aren't they? It's much better than just the doll* [manikin]*. It's like you are there. I did feel like I was there, and I cried at the Harry one* [video]. *The actors were just so good, really realistic. I was panicking for them ….. I feel like I can remember it* [BLS] *better now. Because the videos give different versions* [cardiac arrest scenarios]*, I keep playing them in my head, so when it happens* [cardiac arrest in work environment]*, I'll just think of the video and get right into it* [BLS]*. I don't think I'll panic now. It's great. I've never seen an arrest*, *but the videos make me feel like I have."* (Participant 24)

Lessons learned in simulation may apply to BLS training in primary care, and formal longer debriefing may be beneficial. The level of engagement and attachment to the training needs to be both harnessed via reflection and supported via supervision. This would enable and encourage the link between the cognitive, behavioural and sensory/emotive elements. Helping trainees to make sense of it all and to be comfortable psychologically is vital. Formal debriefing has not previously been

implemented as part of a primary care resuscitation training strategy, but this study found that it could add value.

Debriefing is a lengthy period of reflection, discussion and feedback following a simulated scenario, led by learners and facilitated by teachers, which is purposeful and structured (Flanagan, 2008). Feedback is an intrinsic component of the debriefing process (Szyld & Rudolph, 2013) in which positive behaviour is strengthened and less effective behaviour curtailed (Thornbury, 2017). The intended outcome is for learners to gain a clear understanding of actions and thoughts to enhance their clinical practice (Abulebda et al., 2021). Although the RCUK recommends the use of debriefing in resuscitation training, for BLS this is usually a learning conversation incorporating feedback rather than the lengthy debriefing explained by Flanagan (2008). A more formal debriefing process may be beneficial in BLS training.

Evidence-Based Strategy Formation

Being research-appreciative

Those who took part were grateful for the exposure and opportunities afforded by participation in the study to discuss their resuscitation training needs. In an environment where many primary care staff are divorced from explicit involvement in research, the participants were keen to understand the process once they came into contact with this research study. They were also committed to the study and eager to take part. Participants voiced their appreciation of research.

> *"I think it's great what you are doing. We need to do research stuff. It's important, and I've always said we need more resus training. I like the three-monthly thing with you because it's hopefully going to change things where I work. I've told everyone we need more of this* [BLS training] *for ages … My manager lets me do this, too, as she's said we need to do research, because it can help us improve things."* (Participant 9)

Some of the participation was accepted as transactional, as annual resuscitation updates are mandatory for nurses. However, participants also recognised the need for research and 'owned' it as their need since they wanted to be able to intervene more effectively in an emergency. This study highlighted that the primary care participants were positive about taking part in research. It was important to them, and they valued

being involved in research in order to develop a more relevant resuscitation training strategy.

Franks-Meeks (2020) found that nurses value research in terms of advancing evidence-based practice, but also highlighted that very few nurses actually take part in research themselves. This study emphasised the importance of nurse participation in research to improve practice. Furthermore, it demonstrated that nurses and the wider primary care participants were engaged with research and wanted to drive staff participation forward for the benefit of both staff and patients.

Co-design of the strategy

Primary care participants, including nurses, recognised the need for systematic change in their resuscitation training strategy. They were willing to be active partners in this co-creation so that a resuscitation training strategy would be produced that would be effective for all primary care staff. It was important to the different designations of the primary care participants involved in this study that there should be change, with development of a more effective resuscitation training strategy for primary care. The participants were willing to be involved in this collaborative process, in which disciplines joined together to drive forward a positive change to the current primary care resuscitation training strategy. The notions of co-design and collaborative work were expressed.

> *"You know, when this* [study] *is finished, can we and the nurses have more training together? It would be nice to do it together more often, like this, so we can help them when this* [cardiac arrest] *happens at work. We could always do it like this now* [every three months]. *It would be much better. We can save a life now you know."* (Participant 10)

> *"It's really important to involve all the team in our resus training because we are a small team and when it comes down to it, we will all rely on each other, so it's important we all train together, even the admin staff."* (Participant 36)

The benefits of adopting co-design principles in healthcare with people's needs in mind is not new (Ward et al., 2018). Co-production is valued by the NHS (2020), since a collaborative approach and engaging service users results in more effective, person-

centred delivery of care. Also referred to as co-creation (Rezaei Aghdam et al., 2020), the interactions among stakeholders results in development of effective strategies that add value through involvement of service users themselves. In education, collaborative working is emphasised by O'Connor et al. (2018), who describe how co-production can be embedded into the pedagogical process for nurses. A novel, collaborative approach such as used in this study to develop a resuscitation training strategy in primary care had not been documented before.

FEASIBILITY OF THE STUDY DESIGN FOR THE MAIN STUDY

Recruitment and retention

The ability to recruit participants and to retain them in the study was the first issue. The organisations that were expected to collaborate did so, and there was no shortage of participants. Indeed, the upper limit of recruitment was increased in response to this demand. Twenty participants were planned, but (prior to the disruption caused by the COVID-19 pandemic) this was increased to (up to) 100. The planned sampling and recruitment strategy could be revised to acknowledge the need for additional primary care participants including support staff. No participants withdrew from the study. However, 17 participants missed a total of 21 visits due to various unavoidable reasons during the COVID-19 pandemic.

Consent process

The informed consent process worked well in this study and there were no suggestions that there will be any problems with the same consent process in the main study.

Instruments

A new intervention for optimal resuscitation training for primary care nurses was found, which could be used in a future main study. The new intervention was well-received and participants expressed that they would like to see this in a future training strategy.

The observation scenario was feasible and acceptable to the participants, and participants expressed that they liked the practical aspect of resuscitation training. Furthermore, the observation schedule was completed in real time, without disruption

to the flow of the scenario, and can be used in the main study with minor revisions to improve efficacy.

The true/false questionnaire was acceptable to participants and was always completed. The questionnaire is feasible to use in the main study and suggestions have been made for minor revisions to improve the efficacy for completion. The questionnaire also exposed increase in knowledge over time.

The audio recorded interview was acceptable to participants and the topic guide is feasible to use in the main study, again, with minor revisions to improve efficacy. A large amount of useful data were generated from the interviews which also included unexpected issues. The topic guide was flexible enough to allow data to be captured about the new intervention, for example, which were not specifically included in the guide.

The outcome measures for the observation, questionnaire and interview are feasible to use in the main study and were acceptable to participants.

Since there has been no study to validate the reliability and validity of the instruments used in this feasibility study, reliability and validity of the instruments could not be assumed. The instruments were, however, used widely in resuscitation training. It was beyond this feasibility study to undertake the reliability and validity testing. As the instruments worked well in this study and were well-received by the participants, reliability and validity testing needs to be completed as preparatory work prior to the main RCT study.

Data collection

The data collection methods for both the quantitative and qualitative parts of the study were robust and effective for producing quality data. The methods were acceptable to the participants in this study and there are no suggestions that the data collection methods need to be changed for the main study.

Data analysis

The data analysis methods for the observations, questionnaires and interviews were effective and produced quality results in this study. Useful information was generated so the same data analysis approach will be retained for use in the main study. However, although it could not be done with the data from this study, the data in the next study would most likely support stronger statistical analysis. For example, changes in achievement across the sample between time points were summarised in this study using bar charts, but in the future study differences in paired percentages are likely to be calculated with 95% confidence intervals. Changes in the median and mean overall score across the sample between time points could also be estimated, with 95% confidence levels and effect sizes. Repeated measures within-subjects ANOVA parametric tests could be used to establish any changes in scores between any two time points (on the means of the observational scores) in the continuous data. Where this shows that there is a statistically significant difference then a series of Tukey post-hoc tests could be conducted to establish between which components there is a significant difference. Non-parametric Kruskal-Wallis tests could also be used for the ordinal data (Lifesaver correct answers and questionnaire data) to establish any changes between time points. As the future study will be powered for detecting significant changes, test results could also provide more information than just the confidence intervals and effect sizes, and if these are in the expected direction.

Framework analysis was originally planned as the method for analysing the qualitative data (Ritchie et al., 2003; Ritchie & Spencer, 1994). However, due to the large quantities of data that were generated from the interviews, content analysis was deemed more appropriate and better suited to the study (Elo & Kyngas, 2008). The content analysis generated useful results and it is anticipated that this method will be effective for use in the main study.

CONCLUSION

Stakeholders reached a consensus quickly that a short, interactive scenario via an app delivered every three months would be an ideal new intervention to add to the existing resuscitation training strategy for primary care nurses.

The study created a lot of interest in primary care from the start of recruitment, so it was widened to include support staff as well as registered nurses. Recruitment and retention are not expected to be problematic in the future main study. The consent process also worked well in this study and is expected to do so in the main study. All aspects of the study interventions and instruments, including outcome measure, were well-received by the participants and deemed feasible for a main study with minor modifications. Likewise, the data collection and analysis methods for both the qualitative and quantitative parts of the study worked well and would also be appropriate for future work. This includes the use of content analysis for the interview data and use of stronger statistical analysis for the quantitative data.

The Lifesaver app, as the new intervention, was welcomed as an emotive, interactive adjunct to existing training and was held as being needed in primary care with a frequency of three-monthly. Lifesaver data from this study showed that support staff were more knowledgeable, quicker at responses, and better at compression speed than nurses. However, these results should be taken with caution as this study was not powered to demonstrate statistical significance.

The observations showed that all staff maintained RCUK BLS guideline knowledge and skills, but support staff had better resuscitation skills that the nurses. However, statistical significance was not shown. These findings were echoed by the Laerdal QCPR data.

Participants found the questionnaire acceptable and feasible in terms of determining and improving knowledge base. However, it was concluded that the questions should be re-written to avoid ambiguity and medical jargon if used with staff groups other than nurses. The questionnaires showed that all staff maintained resuscitation knowledge, but that nurses had more knowledge than support staff. However, the Lifesaver data demonstrated that support staff had marginally better knowledge that nurses. Again, statistical significance was not calculated.

The interviews were approved by participants and yielded copious amounts of rich data that were not anticipated at study set-up. The participants were keen to use the interviews to voice their concerns and commitment to both research and the thirst to

improve their resuscitation strategy. They took ownership of their training strategy and independently debriefed following the observation scenarios and expressed options for strategies in which they wanted to collaborate.

Preparatory work identified to test for reliability and validity of the instruments will need to be completed in order to support the main study.

It was clear that the participants wanted a more relevant and effective resuscitation training strategy. They wanted more frequent training, ideally three-monthly, combining practical scenarios using the manikins and the emotional reality of the app. Fidelity was important to the participants. They were articulate that an improved training strategy was needed to benefit them by empowering staff to be better prepared, and to improve confidence so that they were better equipped to deal with the infrequent exposure to cardiac arrests in primary care.

The study design demonstrated that it could be adapted to continue during a pandemic and that effective mandatory training could also be adapted to include modifications dictated by the pandemic.

CHAPTER FIVE: DISCUSSION

INTRODUCTION

The COVID-19 pandemic developed part way through data collection (World Health Organisation, 2020). The impact clinically and for ongoing research studies was considerable, with delays, additional restrictions, and lack of time to pursue the doctorate. Other studies to test new vaccines had to be prioritised by myself, with great pressure of time and stressful deadlines. This was a period of potentially serious interruption and even inability to complete this study. The unavoidable response from the university (following government requirements) was that no doctoral studies should be pursued during the pandemic unless part of a wider funded study by an established researcher. Prioritisation by the NHS of COVID-19 research, and general reluctance or inability of NHS staff to take part in other studies initially, were, inescapably, placed before this study. However, the study continued, with significant challenges to be overcome. This was possible mostly because the study procedures were part of my normal professional role, as well as performing compulsory training for NHS staff.

LIMITATIONS

Three potential shortcomings were identified; however, they did not impact significantly on the study outcomes.

i. Sampling Decision

Thirty-seven participants were recruited to the study. Recruitment ended in December 2020, but data collection continued until winter 2021. There needed to be a trade-off between number of participants enrolled and number of data collection time points for visits. The trade-off was between fewer participants recruited with all visits completed and more participants recruited with some time points for data collection not completed. It was decided that more participants would give richer data in terms of more views about the feasibility and acceptability of the study procedures. However, the duration of the study write up allowed for all participants to complete all planned study visits. While a sample of 37 for the empirical part of the main study would be inadequate (making analysis particularly weak), this was not an issue for this feasibility study (Billingham et al., 2013). The purpose was to establish whether the planned study procedures would work. A sample size of 37 was more than acceptable for this

as the outcomes were mainly measured descriptively (Arain et al., 2010; Orsmond & Cohn, 2015; Tickle-Degnen, 2013). A sample size of 37 may be thought large for the qualitative aspect of this study (Billingham et al., 2013). However, content analysis was decided upon for analysis of the qualitative data, with the flexibility to handle large quantities of data when compared to thematic analysis or framework analysis.

ii. Lost data

In total, 17 participants missed a total of 21 visits due to various unavoidable reasons: bereavement leave during the COVID-19 pandemic, staff remained furloughed during the pandemic (primary care dental staff) and were not available for virtual visits, sick leave and staff moving roles and unable to carry on in the study. Some visits were conducted remotely due to isolation and working from home. This resulted in the hands-on scenario observation using the QCPR function being omitted for 11 episodes of intended QCPR data collection. However, the affected participants provided verbal explanations of what their actions would have been if undertaking the scenario, demonstrating knowledge and understanding if not actual manual skills. Consequently, the QCPR data were missing for these 11 virtual visits. Although this caused loss of this single element of data, the loss was not enough to impact on the overall outcome since all other participants completed this part.

iii. Consideration of threats

There was a risk of bias due to missing QCPR data during the COVID-19 pandemic. However, this affected only 11 out of the possible 222 opportunities for QCPR data collection (5%), based on a sample of 37 and was sufficiently small to be considered negligible.

There was a potential threat to evidence of preference for training interval. Three-monthly training was considered to be optimum interval by the majority of participants. On reflection, this may have been influenced to a degree by the study design and the wording of the participation information sheet. However, other options were offered by participants, and so data were generated to probe why the stated interval was chosen. No reference was made by any participant to the influence of the information sheet.

STUDY DESIGN FOR A FULL-SCALE STUDY: REVIEW OF THE RESEARCH QUESTIONS

Research Question 1: What do stakeholders hold to be optimal presentation and frequency of intervention for resuscitation training for primary care nurses?

A new strategy for optimal resuscitation training for primary care nurses was found, and participants expressed a preference for the interactive video to be included in a future training strategy. The effectiveness of interactive videos in training is well-documented in existing literature (Castillo et al., 2018; Soar et al., 2010; Sullivan, 2015). Participants also wanted training to be more frequent than annually. They realised that if staff are not exposed to cardiac arrests in the workplace, as is usually the case in primary care, confidence and recall of practical knowledge and skills decline over time. This concept is supported in the literature (Einav et al., 2006) and whilst it may relate specifically to primary care, it may also be a consideration in other non-NHS healthcare settings, or non-acute areas in secondary care that do not experience cardiac arrests often. The important factors are the need to rely on training, lack of experience of cardiac arrest events and isolation from immediate expert intervention.

A three-monthly interval was perceived to be the best frequency for training, providing frequent repetition and is supported within the literature (Soar et al., 2010; Sutton et al., 2011). The three-monthly time frame was considered optimal in terms of maintaining knowledge and skill recall, but also held to be achievable in terms of managing the workplace training strategy. The preferred strategy was a mixture of formal annual in-depth training, including team scenario practice followed by individual review of interactive videos every three months. These three-monthly follow-up videos would allow the staff member to take control of their own learning and to complete the online videos on a device that would be available in the workplace and would fit in with their workload. It was also acknowledged that although adding in the three-monthly videos would increase training time by a total of 45 minutes per staff member over the year, this was far more beneficial in the long term. The result would be competent staff ready to care for a patient in cardiac arrest, rather than an inadequate training strategy that could impact negatively on patient outcomes. Some staff also expressed that hands-on practice after the three-monthly videos would be beneficial, however, the

logistics of facilitating this raised concern in terms of additional resources this would demand.

The most frequent explanation given for inclusion of the interactive videos was the realism and emotion associated with the professional acting, a view also shared by Bland et al. (2014). Participants acknowledged that the videos provided an authentic learning experience using scenarios that represented real-world learning. Participants expressed that the real time scenarios were not possible with the manikin alone but were key to their learning. Participants frequently explained that trying to recall training from a real-life scenario, as in the video, was much more useful that trying to remember from training in a false scenario on a plastic manikin. This is linked to the notion of development of thinking skills in Bloom's taxonomy of learning (Bloom et al., 1956), as creativity was enhanced with the realistic videos.

A more realistic experience was gained from the videos which allowed the participant to prepare emotionally for what may come and what they may be presented with in the workplace. Primary care staff typically have less exposure to patients suffering cardiac arrest, so the prospect of having to manage a cardiac arrest is much more daunting. The video offers emotional preparation for realistic distractions and obstacles with which staff may then be presented in the workplace. Participants were explicit that this would then result in increased confidence and an increase in ability to respond effectively to the emergency.

The notion of participating in and learning from real-world authentic experiences is not new and focuses on decision making using role-play as well as participating in practical skills (Lombardi, 2007). Lombardi (2007) describes learning by 'doing' as superior to the traditional didactic teaching method and it is considered the most effective way of learning. Simulated learning, as in the scenario observations in this study, offers participants one method of real-world learning (Gaba, 2004). Simulation is widely used in nurse education and is well-documented as a positive learning strategy for skill acquisition (Bland et al., 2011; Murray et al., 2008).

Situated learning, where learning occurs in the same context as it would in practice, has been applied to simulation and real-world learning (Wyrostok et al., 2014).

Arguably, it is the construction of knowledge which occurs during physical and social contexts that enables learning. Hence, the importance of real-world learning during both the video scenarios and the practical manikin scenarios. Authentic reality and transfer of theory to practice occurs during the training strategy proposed from the findings of this study. Furthermore, the importance of psychological safety by seeing, hearing and doing the practical skill is highlighted in authentic learning and is paramount to any effective training strategy (Lombardi, 2007). This also relates back to the importance of experiential learning and this concept being key within resuscitation education (Kolb, 1984).

Research Question 2: Were the study procedures for recruitment, data collection and data analysis robust and effective for use in a future main study?

Sampling and recruitment

Recruitment to the study was straight forward and timely, and this can be expected to be replicated in the main study. There were no issues with collaboration from the primary care organisations, and there was no shortage of participants. There was significant interest in the study that the upper limit of recruitment was increased in response to the demand from potential participants. It is important to acknowledge the strength of the study design, which allowed for the increase in participant numbers.

No participants withdrew from the study; however, ten participants missed a total of ten visits due to unavoidable consequences of the COVID-19 pandemic. There were a further seven participants who missed a total of 11 visits due to various reasons: sick leave, compassionate leave, annual leave or participants left their position and were unable to continue with the study in their new post. The total number of missed visits throughout the study were 21 out of 222 possible visits, equating to 9% of data that were missing.

Was the planned sampling and recruitment strategy effective and responsive to unforeseen issues?

The study design was responsive to unforeseen circumstances caused by the COVID-19 pandemic from March 2020. Recruitment was paused initially during the pandemic, but this was largely due to staff not wanting to take part in the study. However, as soon

as staff felt comfortable with the safety measures in place, recruitment resumed. While the nature of the threat and the safety of participation remained unclear, resuscitation was still classed as essential training by NHS employers. A strength of this study design was that even through a pandemic, study recruitment, essential training and virtual visits for data collection could continue. The Resuscitation Council UK (2020b) revised the current resuscitation guidelines to accommodate the droplet precaution approach needed during resuscitation of COVID-19 confirmed or suspected patients (appendix 13). The emphasis was on reducing transmission of the virus and the RCUK highlighted the need to don appropriate levels of personal protective equipment (PPE), recognising the threat from aerosol generating procedures (AGP) such as chest compressions, airway management and bag-mask ventilations. However, lack of AGP level PPE in primary care was recognised by the RCUK (2020b) and emphasis was placed on the importance of avoiding close contact with the patient's face to assess breathing together with the critical role of early defibrillation and chest compression-only CPR in an adult cardiac arrest. Bag-mask ventilations were avoided unless AGP PPE was available.

These changes were reflected in the data collection and were also accounted for in data analysis. In-person data collection was maintained for visit 1, as this was considered to be essential training for staff by employers. Government guidelines were followed to maintain social distancing and hand hygiene for these visits (Public Health England, 2020). Likewise, Resuscitation Council UK (2020b) guidelines were followed for delivery of teaching and cleaning and maintenance of manikins during the COVID-19 pandemic. Some visits were completed remotely via telephone after completion of the online Lifesaver scenario and return of completed questionnaires via email.

The ability to solve problems and work with agility is an explicit part of doctoral study. Under especially challenging circumstances, the recruitment strategy proved to be adaptable and responsive to both individual and service needs. Compliance with national guidance was still possible and was part of the means of reassuring participants of the safety of continued participation.

Data collection methods

The data collection methods used in this study were feasible and effective. Appropriate data were collected, and the subsequent data analysis confirmed that no additional data collection was necessary. New RCUK guidelines were published in May 2021 (RCUK, 2021), but did not affect data collection. The observation schedule for the main study may need to be changed to account for future changes to the national resuscitation guidelines.

Could the observation schedule be completed in real time without disrupting the flow of the scenario?

The schedule was completed as planned, and without noticeable disruption to the flow of the scenario. However, minor revisions could be made to improve efficacy when used in the main study. The assessment column on the observation assessment sheet for the participant's demonstration of a certain skill required the researcher to document 'yes' or 'no' for 'achieved?'. Due to the speed at which the participant may work through the described skills, it would be much easier for the flow of the assessment to ask the researcher to indicate with a tick (√) when a certain skill had been achieved or enter a cross (x) if the skill were not achieved.

A particular strength of the observation schedule was that it allowed for comments to explain why an action was omitted due to the current COVID-19 pandemic (for example, ventilations when the appropriate PPE was not donned). However, for the main study, 'not applicable' could be added to the 'achieved?' column in the schedule.

To what degree was the true/false questionnaire completed fully and without confusion or mistakes by participants?

The questionnaires were always completed in full, however, the answer grid was not always used. Some participants chose to write 'true' or 'false' next to the individual statement on the question sheet. Therefore, the layout of the questionnaire could be revised for the main study to include dedicated space for answers more explicitly, possibly next to each statement. This might improve and simplify the process and negate the use of the answer sheet which caused confusion for some participants.

Were useful data generated from the interview topic guide?

The interviews flowed readily, with participants often having much to say, sometimes in an animated manner. More data than expected were generated. This was, in part, aided by the flexibility of the topic guide. Data were also captured about the new intervention, which was not specifically included in the guide. It was from the qualitative data, particularly, that the new understandings emerged. Participants were completely responsive to the interview as an opportunity to voice their thoughts and wishes regarding resuscitation training. They also described what would be feasible in their workplace and what would supplement their own learning style. The importance of having a training strategy that involved more frequent sessions presented in a format that facilitated learning was emphasised, as none of the participants had exposure to an adult cardiac arrest throughout the study.

The design of the interviews was also important as they allowed the participants to experience the maturity effect. The repeated interview gave staff an opportunity to truly reflect on their resuscitation learning experience. Staff frequently expressed that it was only with the repetition of the training in the study, which was not the current norm, together with the opportunity to reflect frequently on the process, that they were able to appreciate over time what they had forgotten. Participants stated that this was an especially positive outcome of taking part in the study.

In the latter part of the study, the topic guide allowed for exploration of participants' thoughts regarding the new findings from the study and if they would be feasible to adopt in the workplace. Staff were, again, very responsive and expressed how this had afforded them the opportunity to participate in a new training strategy, which they thought could be beneficial to both staff and patients.

Participants were keen to discuss their learning experiences during the interviews. This led to participants commencing the debriefing process on their own initiative and emphasised the value that discussions with learners have in resuscitation education. The learning conversation is a process for providing feedback that is widely used in resuscitation education and focuses on learner refection of performance. The instructor facilitates an informative and relevant dialogue to encourage learning through sharing perspectives on issues that emerge. The learning conversation is

particularly useful when time constraints are present. In contrast, the debriefing process after simulation practice usually lasts at least twice as long as the simulated scenario. The planned structure is explained to the learner and reflects the learning outcomes whilst engaging with the key stages of description, evaluation and synthesis. In this study, the learning conversations were fruitful and supported the potential use of debriefing in a BLS training strategy.

Data analysis methods

The data analysis methods were robust and effective for this feasibility study. They produced useful, important results which will be used to inform the main study. However, the future main RCT will need input from a statistician and more complex data analysis strategies will need to be applied to fit the aims and objectives of the main study.

Research Question 3: Were the outcome measures feasible to use in a future main study?

The outcome measures of resuscitation knowledge and skill maintenance over time are feasible to use in a future study. The observation schedule of items 'achieved' or 'not achieved' provided a simple way of recording the measure of practice against current RCUK guidelines. The questionnaire answers for true or false were marked as correct or incorrect, and, again, allowed for a simple way of collating overall scores of correct responses for each statement.

Did the intervention result in knowledge and skill retention over time?

The questionnaire was effective in measuring change in knowledge over the period of participation. More specifically, the analysis of the questionnaire responses also exposed at which time points there were fluctuations in knowledge in terms of increase, decline and maintenance. The observation was effective in identifying at which time points there were fluctuations in skills performance, whether improved, maintained or reduced.

Resuscitation knowledge and skill were improved and sustained over time. Maintenance of resuscitation knowledge and skills amongst nurses has previously been contested in existing literature (Al-Rasheed et al., 2013; Castillo et al., 2018; De

Regge et al., 2008; Marzooq & Lyneham, 2009; Montgomery et al., 2012; Smith et al., 2008; Srither & Lateef, 2016). The overall score of skills ‘achieved’ over all time points in this study was 93.2% for support staff and 92.4% for nurses. Knowledge was also retained to a high degree and the overall score of correct answers in all questionnaires was 90.7% for nurses and 85.8% for support staff.

The study showed that nurses performed better overall than support staff in the questionnaires, demonstrating better knowledge of BLS and defibrillation. However, data from the observation of practice indicated that support staff performed BLS and defibrillation skills better overall than nurses. The most important factor is all these scores were acceptable and hence will increase the chance of patient survival. All scores were above the 75% standard set in the Lifesaver app. What is less important is how close to 100% the scores were. Acceptable scores, regardless of how acceptable, translate into increased chance of patient survival from cardiac arrest.

Although support staff, including receptionists, performed better than qualified nurses at BLS, the reasons for this should be explored. This may be because support staff do what they are taught in training and transfer this into practice on the manikin, without adding in their own interpretations of the RCUK guidelines. However, there may also be other explanations. A skill may be read about, and knowledge gained, but then may not be performed correctly in practice. Conversely, a skill may be performed well, but knowledge may be lacking. If resuscitation is not a normal part of support staff activity and skill set, they may be predisposed to follow the rules and to do exactly as told. The important point is that the link between knowledge (the questionnaire) and practical ability (the scenario) may be more complicated.

The outcome was that a new intervention for optimal resuscitation training for primary care nurses was found by adding three-monthly interactive videos to existing annual training. This new intervention resulted in maintenance of competence in both resuscitation knowledge and skills. The participants also felt that this new intervention would be accepted as a new training strategy in their workplace.

Research Question 4: Were the study procedures acceptable to the participants?

The acceptability of study processes was determined during the interviews. The Lifesaver video was extremely well-received and was always completed. Participants liked the videos and found them very useful, as the reality and emotion of the scenario aided their learning experience. The Lifesaver app was also well-received as a remote learning tool and may have more significance in the future as a means of continuing training and providing updates in unexpected contexts similar to the COVID-19 pandemic. The only other comment from two participants was that it was sometimes difficult to press P and the Q for compressions on the keypad simultaneously without also hitting another letter on the keypad. However, this is unavoidable and cannot be changed when using a computer with a keypad, which is usually the case with NHS hardware.

The participants proposed no changes to the scenario observation and welcomed the opportunity for frequent practice of BLS and defibrillation skills. The true/false questionnaire was well-received, though some participants thought the wording of some of the questions were ambiguous. Removal of ambiguity could be an action point before use of the questionnaire in the main study. However, participants did not comment on the same set of questions being used at each time point during the study. Rather, participants welcomed the opportunity to have questions that prompted them to think about resuscitation at each time point.

All participants expressed that more frequent than annual training would be better. The three-monthly interval for re-training was held to be optimal by most participants. This could be because of the re-training interval used in the study, however other time intervals were proposed by participants.

Research Question 5: Were the outcome measures acceptable to the participants?

No adverse comments were made about the outcome measures, and participants appeared to be in agreement with the importance of the selected measures, as judged by their comments in the interviews. The participants completed the true/false questionnaire in a quiet room and expressed no concerns about how the questionnaire

would be scored. The participants were aware that each answer would be assessed for being correct or incorrect.

UNIQUE CONTRIBUTION

EDUCATIONAL APPROACH ISSUES

Conscious and Unconscious Competence

Psychological impacts on competence and motivation were present during this study. The notion of four stages of learning or of achieving competence has been considered in psychology at least since the late 1960s, although the origin of the notion has been lost over time. Cutrer et al (2013) offers a clear explanation of the central notions (Figure 34).

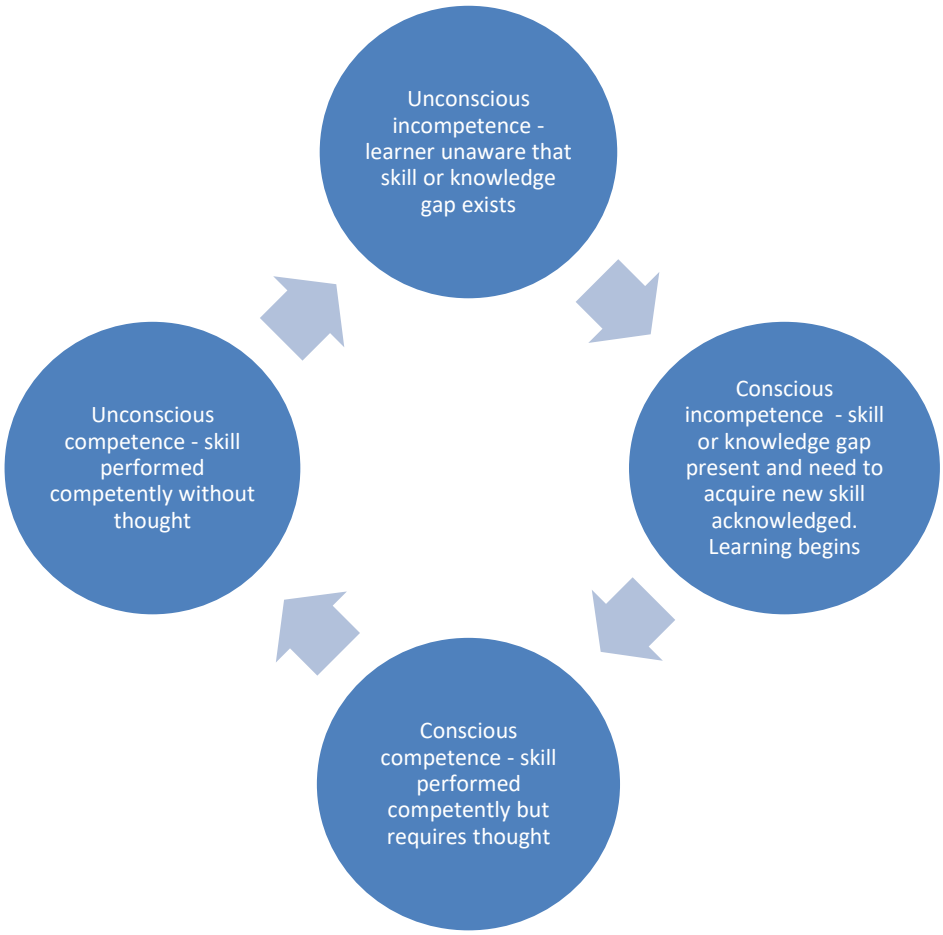

Figure 34: The four stages of competence illustrated as a cyclical process

Some of the reception staff displayed 'conscious incompetence' during the skill learning process, realising they had a measure of their deficiency in resuscitation knowledge and skills. However, due to their commitment to learning, they quickly progressed onto the 'conscious competence' stage, which was demonstrated during the scenario observation. The likelihood of unconscious competence gradually degrading into unconscious incompetence implies that the model is more of a loop then a simpler linear process. Frequent repetition of training helps staff to detect this in themselves. One participant gave the following demonstration of unconscious incompetence.

> *"I didn't realise that I didn't remember it over the 12 months until I did this study."* (Participant 24)

With this realisation, the learner is able to move onto the next stage where the knowledge gap is acknowledged so learning can begin.

Cognitive dissonance

Cognitive dissonance occurs when the expected level of performance and the actual performance delivered has a noticeable gap (Festinger, 1957). There may be an expectation, for example, that nurses perform better resuscitation skills than non-nurses. However, the reality, as found in this study, was that support staff had better CPR skills. This may be explained by a lack of experience in and exposure to cardiac arrest management in primary care. Hence, this group of nurses do not actually perform as well as expected when compared to non-nursing staff. The explanation that support staff perform better may be linked to the absence of expectation for the non-nurse group of primary care staff, resulting in better performance.

Repetition as a learning need within the new intervention

A new understanding was made clear during the latter part of the study. Repetition is key and repeating often is a most important point. One participant at visit 4 was animated and very passionate about repetition.

> *"I've just discovered that I need repetition for me to learn. It's the only way I can remember it."* (Participant 25)

As time went by, it became clear that the participants were unaware of what they did not know. It was only as participants entered the second half of the study that they

came to realise this phenomenon, experiencing Gestalt moments (Koffka, 1921; Perls, 1992). Whilst participants initially thought that their knowledge and skills would be maintained over the 12 months period, this proved not to be the case. This new understanding supported my decision to be less concerned about complete follow-up for the duration of the study, but rather, to concentrate on recruiting more primary care staff to the study, albeit that follow-up might not last the full 12 months duration.

Since the discovery of this new understanding, I have arguably become more 'in tune' to the concept of repetition being key. One participant who was recently recruited, described in their interview how they needed repetition as a learning tool. It is possible that repetition has been highlighted by participants previously, but I had not yet acknowledged this in the analysis. The positive influence of repetition in healthcare skill acquisition has been described by Larsen et al. (2008) and is important to acknowledge as it links to existing knowledge. Deliberate practice is recognised as a technique to be able to reach expert performance and is not a new concept in learning (Ericsson et al., 1993). Deliberate practice to achieve mastery learning in skill acquisition is also well-documented (Gonzalez & Kardong-Edgren, 2017). Furthermore, simulation offers a safe learning environment for deliberate practice (Maran & Glavin, 2003). The participants in this study recognised that simulation and repeated practice influenced their retention of resuscitation skills.

The above highlights how the study responded to the needs of the learner, to develop a learning strategy that meets the resuscitation educational needs of primary care staff.

The importance of emotion and realism to engage with learners during training

Towards the end of the study, clarity was also given on the importance of emotion and realism to learners. The realistic nature of the video game is powerful because it is emotionally stimulating and is well-documented in existing literature (Bland et al., 2014). Actors cried, actors were scared, participants saw the victim actually collapse to the floor from standing. Some participants have never seen this before and the manikin is not capable of giving the reality of what it would actually be like and what emotions others around them may have. Staff have to deal with all of that during a cardiac arrest. Participants expressed that the videos gave them the emotional reality

and so felt more prepared if/when they will be faced with a cardiac arrest. This is considered as a high-level psychological fidelity where the extent to which a person feels that something is real, in terms of their emotions, feelings and physiological responses (Maran & Glavin, 2003).

The emotional activation and its subsequent influence on the learning process has been acknowledged by Kuckuck et al. (2018) in resuscitation training. There is also evidence to suggest that self-motivation and self-determination is increased when emotions are activated and that this transfers into the learning environment for healthcare professionals (Kusurkar et al., 2011). However, Kuckuck et al. (2018) emphasise that more research is needed around emotional stimuli to promote its use in resuscitation training.

Human factors are the non-technical skills which affect our personal performance and improve safety outcomes (Flin et al., 2008). Non-technical skills are critical during resuscitation and include communication, teamwork, decision making, situational awareness, leadership and task management (RCUK 2015). The promotion of human factors by use of the video was a great benefit. The participants had rarely experienced that exposure to realism and emotion before as they had minimal experience of dealing with a cardiac arrest in practice. Traditional training typically uses a plastic, lifeless manikin which involves no emotion other than the nurse's apprehension of being watched performing CPR on a manikin (Nielsen & Harder, 2013). The videos provided the human factor element that can be lacking from traditional training.

The participants felt emotion as they watched the video, some participants reported that they cried, some felt apprehension, some panicked, some felt threatened, some got nervous but wanted to 'help' and others got totally absorbed in the situation. The emotion of the scenario in the video came from relating the victim to their own family member. The actors were 'real' people acting out an emotional scenario in realistic environments such as subways, homes and public parks, not a staged training room.

The level of real-world enquiry is well-documented as being superior when visual media is used compared to digital audio, as the authenticity and learner engagement is greater (Conlon & McIntosh, 2020; Gaba, 2004). However, it is important to

remember that authenticity and fidelity are not equivalent, as authenticity can be produced with low-fidelity (Bland et al., 2014). The key is the use of realism within a training strategy that is underpinned by sound educational principles (Bland et al., 2014). The participants reported being able to remember the scenario in the video and they then remembered the steps for CPR because they related back to the video and the realistic situation they saw. This could be because the standardised patient and rescuers (actors) in the videos were a similar age to the participant and so highlighted the effect of reality and personalism. Or it could have been because the victim of the cardiac arrest in the video was a similar age to a loved one. This could be the actual stimulant which then imposes the realism. The use of a standardised patient, where a human role player / actor portrays a patient in a learning scenario or simulation is not new (Brin, 2017). However, the interaction and engagement it produces is powerful because it increases realism for the learner by way of provoking emotions (Dawson et al., 2021).

Some nurses have never seen a cardiac arrest before, so the video equates to seeing an actual cardiac arrest. Consequently, the participants learn and remember what to do because they want to be prepared and act competently should they be faced with a patient in cardiac arrest. Staff attend annual resuscitation training but it is not as real as the video, where the actors respond to the actions of the rescuer. Furthermore, the Lifesaver video ‘scores’ the participant on the chosen action and gives positive audible feedback for correct actions, which has been reported as a real boost for the participant.

After the video, participants still wanted to ‘have a go on the doll’ and have a practice scenario on the manikin. Participants reported that this was to consolidate practical skills of ventilations and chest compressions that they ‘performed’ in the video. Participants expressed that they would relate back to the video when managing the scenario with the manikin, which again emphasises the powerful nature and effectiveness of the video. If the instructor worded the manikin scenario to mimic the scenario on the video, this may reproduce the important emotion that the participant felt when they watched the video. This could arguably then make the manikin scenario more realistic.

Engaging with the learner is of utmost importance, and doing this encourages changes in behaviour, as within the learning process. Existing attitudes of the learner are influenced by the opinions of others to promote a change in behaviour which results in intentions being turned into actions. This process is highlighted in the learning theories of 'reasoned actions and planned behaviour' (Ajzen, 1988) and 'attitudes and subjective norms' (Walsh, Edwards & Fraser, 2009), which were evident in this study in how the participants responded to the new intervention.

SECURING RESUSCITATION TRAINING DURING A PANDEMIC

Coronaviruses are a large family of viruses that cause illness ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome and Severe Acute Respiratory Syndrome (SARS), which are severe flu-like illnesses. An outbreak of COVID-19 caused by the new type of coronavirus (SARS Coronavirus 2) began in Wuhan, Hubei Province, China in December 2019 and spread to many countries world-wide. In COVID-19, patients have flu-like symptoms such as fever, coughing, sore throat, fatigue, nasal discharge, and shortness of breath. Serious cases of COVID-19 can progress to pneumonia and death. The transmission of COVID-19 is mainly via respiratory droplets of an infected person generated through coughing and sneezing. Individuals can also be infected from touching contaminated surfaces. Hence, government and local guidelines existed to reduce transmission by regular hand hygiene, wearing of face masks, social distancing, and effective manikin hygiene. These COVID-19 safety measures have subsequently had an impact on delivery of in-person resuscitation training.

The COVID-19 pandemic forced transformation of in-person teaching and learning to an online provision in March 2020 as universities closed their doors (Miller & Guest, 2021). Some training was lost during the start of the pandemic, where in-person training seemed like the only option. Meanwhile, the RCUK (2020b) released guidelines for continuing resuscitation training with certain modifications. The result was that delivery of mandatory resuscitation training could continue in primary care, but not for all areas. Some primary care centres chose to cease all training despite the modifications that were allowed. In primary care, essential training was generally not happening, but it could happen, and it could happen safely and effectively.

Those involved in this study were grateful that resuscitation training could continue both online and in-person through the pandemic, albeit with some modifications. One of the participants made this comment about training during the pandemic.

> "*I didn't think you'd come now with all this* [COVID-19 pandemic] *going on. I was dead chuffed when you said you were coming. So I can't blow into the doll* [manikin] *now, no*?" (Participant 12)

This study highlighted that resuscitation training and learning can continue effectively during any future pandemic or scenario, as long as the relevant modifications are made and training strategies are adapted. Effective resuscitation training strategies had not been written previously for primary care staff that could accommodate the restrictions dictated by a pandemic. However, the way in which resuscitation training was adapted to allow delivery throughout the COVID-19 pandemic shows that similar principles can be applied to allow learning in other, as yet unforeseen, scenarios.

The Lifesaver video was helpful during the pandemic and provided effective training where personal attendance training was not possible or was not as effective. The Lifesaver video gave a score of CPR performance though the keyboard, as the participant was able to simulate compressions, for example, by pressing Q and P together for each compression. This meant commencement of CPR time was captured, as were speed of compression. However, depth assessment of compressions was not assessed. Airway opening was assessed by 'dragging' the curser back to open the airway and the computer indicated if this was done adequately or if more head tilt chin lift was needed by dragging the cursor further across the screen. The video did not, however, capture the hands-on practical aspect of skill performance.

One key reason for in-person training being less effective during the pandemic was because of mandatory mask wearing. When wearing a face mask, you are unable to see the instructors face and mouth. This can arguably negatively affect learning and teaching as it may dehumanise the learning experience and impede communication and interaction (Landau, 2020). However, where a face covering was not a mandatory requirement, the wearing of a transparent face shield overcame this issue, but it was dependent upon local and NHS Trust policy. Some participants argued in their

interviews that the Lifesaver video was just more beneficial than the in-person training. Their rationale was that in-person training involved a plastic manikin and this lacked the emotional impact that was experienced with the videos.

As numbers of COVID-19 rose again in November 2020 and the UK headed towards the second national lockdown, which was implemented by the government on 5th January 2021, more and more participants were unavailable for the study visits. Staff were isolating, on sick leave, had left the NHS and did not want to be contacted or were working from home. Some staff who were working from home were still unavailable as they were home schooling their children as well as working. Some staff were just too busy to have time with me as the pressures of working in the NHS meant they had no time for training at all. Some surgeries were closed to visitors and some participants did not want to come to my workplace. These factors meant participants were unavailable or unable to have their in-person visit including hands-on scenario observation using the manikin. The other aspects of the study were still conducted where they could over FaceTime, Zoom, WhatsApp, Microsoft Teams or telephone. However, participants expressed that they wanted to 'see' me, therefore video call was preferable. The training videos were very well-received during this time as it gave the participants exposure to realistic scenarios. However, the quantitative psychomotor skill assessment via the manikin was lost and so some quantitative data were missing.

Considering the future for resuscitation training in primary care, it is unlikely that a COVID-19 model relying solely on a hands-off approach will continue. It is also unlikely that the training strategy will revert to the pre-COVID-19 era. During the pandemic, instructors and primary care staff have experienced the freedom and opportunity of different learning modalities and the flexibility of learning from various locations. This has created a springboard for change. A new balance between in-person and online simulation is one solution for the way forward post pandemic, whilst also preparing for any future situation.

The Resuscitation Council UK (2021) highlights that hands-on practical training is important, whilst the government has highlighted the importance of virtual reality simulation (Department of Health and Social Care, 2021). It is well-documented that simulation is key in resuscitation training (RCUK, 2021) and post pandemic, this could

involve both online and in-person simulation training. This study brings a new solution to primary care and presents an innovative training strategy that is feasible and includes both in-person and remote simulation.

UPDATED LITERATURE REVIEW

There were no articles which included primary care in the results of the updated literature search. Table 26 details the literature that was found, however no new information was elicited.

Table 26: Results from updated literature review

Author/s, year of publication and country	Research Question / Theme	Research Approach	Participants	Findings	Comments
Botes & Moepeng 2020 South Africa	To investigate nurses' knowledge of evidence-based guidelines for CPR	Descriptive cross-sectional survey	96 hospital adult critical care nurses	CPR knowledge is suboptimal in nurses. Further training needed	Similar finding found in original search
Oermann et al. 2020 USA	Training interval in cardiopulmonary resuscitation	Randomised pre-test post-test study	475 year 1 nursing students	Optimum re-training intervals are unknown. Daily or weekly intervals may be beneficial.	Similar findings found in original search
Vidmanić et al. 2021 Croatia	To determine the level of knowledge of CPR by level of education and to determine the relationship between knowledge level and additional training and work experience	Cross-sectional descriptive multicentre study	91 emergency room nurses from three hospitals	Resuscitation training strategy needs remodelling to improve practice	Similar findings found in original search
Dick-Smith et al. 2020 Australia	Comparing real time feedback modalities to support optimal CPR	Quasi-experimental cross-over study	64 nursing students	Real time feedback modalities improve CPR performance	Similar findings found in original search
Charlier et al. 2020 Belgium	Comparing student nurse knowledge and performance of basic life support algorithm actions	An observational post-retention test design study	169 general nursing students	CPR skills not maintained at 4 months post-training	Similar findings found in original search
Arrogante et al. 2021 Spain	Deliberate practice in resuscitation training using a feedback device, and the effects of the physical characteristics of the rescuer on the acquisition and retention of CPR skills	RCT	60 nursing students	BLS skills decline rapidly after training. Deliberate practice with feedback devices improves CPR skills and retention	Similar findings found in original search

Author/s, year of publication and country	Research Question / Theme	Research Approach	Participants	Findings	Comments
Knipe et al. 2020 USA	Evaluation of repetitive training using deliberate practice and simulation on nursing student BLS team skills	An exploratory study	7 teams of senior nursing students	BLS skills decline rapidly without frequent practice. Deliberate practice and simulation increase skills	Similar findings found in original search
Demirtas et al. 2021 Turkey	Effectiveness of simulation-based CPR training programs on fourth-year nursing students	Mixed methods study	89 year 4 nursing students	Simulation improves resus knowledge and skills. Simulation improves confidence.	Similar findings found in original search
Sok et al. 2020 South Korea	Effects of a simulation-based CPR training program on knowledge, performance, and stress in clinical nurses	A quasi-experimental pre-test post-test control group design	60 clinical nurses	Simulation based CPR training increases knowledge and skills and decreases stress	Similar findings found in original search
Kim et al. 2021 Korea	Effects of the non-contact CPR training using smart technology	Prospective single-blind, randomised and controlled trial with repeated measures	64 nursing students	During the COVID-19 pandemic, non-contact CPR training using smart technology increases BLS skills	No stakeholder involvement. Only two outcomes recorded and two post-tests. No attempt to establish why this worked or which parts worked better. Hospital-based with students who expect to do CPR training routinely and may work in clinical areas where cardiac arrest is likely and cardiac arrest team available

Author/s, year of publication and country	Research Question / Theme	Research Approach	Participants	Findings	Comments
Panchal et al. 2020 USA	Low-dose, high-frequency, case based psychomotor CPR training improves compression fraction for patients with in-hospital cardiac arrest	A prospective before-after intervention study	155 nurses and HCA	Low-dose, high-frequency (every 3 months) CPR training improves resuscitation skills	Clinical training in a hospital setting. No attempt to understand why it worked and therefore how it could be used elsewhere. Significant findings reported for only two elements
Tuzer et al. 2020 Turkey	Effect of high and medium-fidelity simulator in CPR training on nursing students' knowledge and performances	Quasi-experimental study	90 nursing students	Simulation based resuscitation training increases performance	Similar findings found in original search
Habibli et al. 2020 Iran	The effect of simulation-based education on nursing students' knowledge and performance of adult basic CPR	RCT	49 nursing students	Simulation based resuscitation training increases performance at 3 months, when integrated with traditional training	Similar findings found in original search
Smereka et al. 2019 Warsaw	The TrueCPR device in the process of teaching CPR	A randomised simulation study	94 student nurses	Feedback CPR training increases skill performance	Similar findings found in original search

Real time feedback devices are useful during training as they give objective feedback to the instructor and learner on CPR performance (Arroganye et al., 2021; Dick-Smith et al., 2020). During the feasibility study reported in this thesis, the QCPR app was used to measure participant performance rather than to guide or prompt the participant during the scenario practice. This was designed to avoid performance bias. However, the future main RCT could include a feedback device in one of the groups to determine its effect on skill retention over time.

Panchal et al. (2020) found that low-dose, high-frequency (every three months) CPR training improved resuscitation skills. However, unlike the feasibility work in this thesis, there was no attempt to understand why it worked and therefore how it could be used elsewhere.

Kim et al. (2021) found that during the COVID-19 pandemic, non-contact CPR training using smart technology increased BLS skills. However, they did not work with stakeholders to establish the preferred training means and timing, nor did they try to establish why this worked or which parts worked better.

CONCLUSION

A single modality may not suit every learning style, but a training strategy that involves realism, authenticity and deliberate practice with simulation is well-received and valued by nurses (Brannan et al., 2016; Fountain & Alfred, 2009; Shinnick & Woo, 2015; Tutticci et al., 2016). The training strategy used in this study incorporates these principles and encourages critical thinking so the nurse can recognise cardiac arrest and act quickly yet effectively. The design of this study was responsive to the challenges, reflexivity, adaptation and change to practice caused by the COVID-19 pandemic. The cost-effective use of video productions in resuscitation training can provide an effective alternative to in-person training, where classroom based training is not always possible in situations like a pandemic. The learning process may be further enhanced where assessment is incorporated into the video game. There is evidence to suggest that students place a greater emphasis on learning when they know they will be tested later (Wormald et al., 2009). Furthermore, evidence exists to support testing as a positive tool to promote successful learning (Olde Bekkink et al., 2012).

Important information from this feasibility study was in relation to recruitment, consent and drop-out rates, as well as data from the overall median and mean scores. This study has given clarity and explanations about the issues that I intended to learn about, so the full study can be made to work effectively. However, I also gained new understanding of issues that matter to staff undergoing training, as well as how to continue to provide a successful, well-received training service in unusual circumstances. What I have found is new and important: repeated three-monthly training involving realistic scenarios and deliberate practice is best and grade of staff is not an indicator of how well resuscitation skills are performed.

The design of this study allowed for continuation of research and clinical skills training during the current pandemic. This study also demonstrated that when faced with a similar situation in the future, researchers and educators will be prepared to implement the necessary modifications.

CHAPTER SIX: CONCLUSION

REVIEW OF AIMS

The primary aims were to develop and refine a new intervention with involvement of relevant stakeholders and determine the feasibility and acceptability of proposed study procedures and outcome measures. The secondary aim was to determine whether useful data were likely to result from the main study.

The process for establishing the nature, format and presentation of the new intervention led to a product that was valued by the participants. Study design, recruitment, data collection and analysis, and associated procedures all worked effectively. The study design allowed for an increase in participant numbers, which allowed for comparison of knowledge and skill retention between nurses and support staff. Furthermore, the means were devised to continue vital personal attendance elements of resuscitation training through a pandemic when most training was cancelled or replaced with online learning.

The study revealed that the new intervention resulted in retention of knowledge and skills and was well-received by primary care staff. The dataset produced in this study was robust with only minor loss of quality due to missing items. While only limited analysis was possible in this study due to sampling and incremental learning during the pandemic, the indicators are strong for sufficient recruitment and robust datasets to allow more complex analysis in the main study.

This all supports the proposed full-scale RCT.

REVIEW OF RESEARCH QUESTIONS

1. **What do stakeholders hold to be optimal presentation and frequency of intervention for resuscitation training for primary care nurses?**

Both stakeholders and participants in the study held a combination of interactive videos and hands-on practical scenarios at three-monthly intervals to be best. The argument for this increase in frequency is due to primary care staff not seeing cardiac

arrest frequently or at all, hence the realism of the potential scenario needs to be captured in training.

2. **Are the study procedures for recruitment, data collection and data analysis robust and effective for use in a future main study?**

Participants were recruited to the study without difficulty, and no participants withdrew from the study. Furthermore, staff were grateful for the exposure and practice afforded by participation in the study. Data collection and analysis yielded useful results that informed development of the future study.

3. **Are the outcome measures feasible to use in a future main study?**

The outcome measures of resuscitation knowledge and skill maintenance over time were recorded as planned and required no amendment to be feasible for use in the main study.

4. **Are the study procedures acceptable to the participants?**

The participants proposed no changes to the study procedures, however, removal of potentially ambiguous questions could improve the true/false questionnaire.

5. **Are the outcome measures acceptable to the participants?**

The participants appeared to be in agreement with the importance of the selected measures, as judged by their comments in the interviews, which did not include any adverse comments.

KEY MESSAGES AND UNIQUE CONTRIBUTION

Primary care staff want more frequent resuscitation training than is offered currently, and they realise that frequently repeated training is needed for retention.

Primary care staff want to be empowered to respond effectively to the infrequent emergency of an adult in cardiac arrest. Participants have recognised that by adopting more frequent training than annual, retention is improved. This related to both cognitive (resuscitation knowledge) and practical (resuscitation hands-on skills) elements of learning and retention. Ericsson et al. (1993) explain that when subjects

are given well-structured opportunities for repeated practice of the same task, accuracy and speed of performance on cognitive and practical skills are improved and retained. This is due to the notion that the more someone practices, the better they become, with the aim of achieving mastery (Ericsson et al., 2006). Three-monthly training was held to be the best interval by the participants in this study and should be considered in future training strategies. Staff believed that repeated training resulted in remembering the sequence of actions and maintenance of practical skills namely chest compressions, ventilations and use of the AED. When knowledge and skills are maintained, staff reported that this increased their confidence for providing effective BLS and defibrillation.

This finding may relate specifically to primary care since this was the sole location of the study. However, the crucial facets were lack of experience of cardiac arrest events, with consequent need to fall back on reasonably recent training, and isolation from expert intervention, necessitating effective and immediate local response. Similar factors may be present in other clinical environments beyond primary care.

Participants acknowledged the importance of and need for research and were keen to take part in the study. They recognised this research study as an opportunity to influence change in their resuscitation training provision. There is no other documented evidence that an effective resuscitation training strategy has been developed in conjunction with primary care nurses incorporating what the primary care nurses held to be best. This study highlights that all disciplines in primary care could collaborate to co-design an effective resuscitation training strategy. Participants expressed a desire to be involved in a collaborative approach to change their resuscitation strategy so that all service users, which includes patients would benefit. Offering multiple methods of training over shorter periods of time may be the solution for an effective resuscitation training strategy in primary care. A further study is needed to determine the significance of investing in more frequent than annual resuscitation training for this group of staff.

Training strategies that include a realistic and emotional element such as an interactive video are a powerful addition to hands-on practice involving simulation.

The use of emotive and realistic video games in training for staff who are divorced from the experience of resuscitation episodes is important. The staff groups in this study benefited from experiencing the enhanced realism of an adrenaline surge and meaningful engagement with feedback through the Lifesaver app. They valued this aspect of training and recommended that it should be included in a resuscitation training strategy alongside deliberate practice. Closer approximation during training to the shock and anxiety of an unheralded collapse, with the need for immediate decision-making and intervention was held to be more useful preparation than standard training practices. Staff continued to value the need for traditional personal attendance training to practice hands-on skills with simulation but felt that the video game added a vital element to the training strategy.

This is new knowledge because a resuscitation training strategy that addresses the specific concerns of primary care staff and is acceptable for this group of staff has not been documented previously. A further study is needed to determine if this primary care training strategy results in maintenance of resuscitation knowledge and skills.

Recognising social psychology amongst staff and acknowledging cognitive dissonance were found to be important factors in resuscitation training. Reality did not always fit with staff perceptions of resuscitation events and levels of knowledge and skills.

Support staff performed better than registered nurses during resuscitation training in this study: grade of staff was not an indicator of performance in resuscitation skills. Recognising that those who should do best may not do so may be explained by cognitive dissonance in qualified staff and conscious incompetence in support staff. Nurses attend mandatory resuscitation training but may never be involved in a cardiac arrest situation throughout their career. If this group of staff are relied upon during a resuscitation attempt, their inexperience coupled with any anxiety of being the responsible professional may alter how they perform. Conversely, support staff may didactically perform the skills taught unaffected by the additional pressure of responsibility, as this staff group are not expected to be the resuscitation experts. No

other published account was found of this explanation of differential performance. If the proposed explanation is borne out in further study, then it will support additional intervention for staff groups to address issues through psychological and educational theory.

QCPR is a robust means of showing effectiveness of compressions and emphasised that the recoil element of providing chest compressions may need to be improved.

QCPR is an effective platform for feedback of chest compression performance and objectively supports the instructor's subjective assessment. Primary care staff performed the compression depth element more effectively than they did full chest recoil in this study. Both elements of the chest compression duty cycle are as important as each other to perfuse the vital organs, including the heart and brain (RCUK, 2021). Therefore, chest recoil performance could be improved and could be a focus in the future study.

Manikin feedback is not new in resuscitation training but could be more widely used, particularly in primary care resuscitation training. Furthermore, emphasis on full chest recoil could have more emphasis in the primary care resuscitation training strategy. This study used QCPR for assessment purposes, but its routine use beyond this study, as a teaching and learning device could also be considered. Combining QCPR with the Lifesaver app could enable instructor-free training which could be enhanced with instructor supported training annually. This could be appealing as a cost-effective primary care resuscitation training strategy.

Debriefing is vital after resuscitation training.

The learning conversation has been used effectively in resuscitation education for over a decade. As a method of learner-focused feedback, the conversation encourages reflection to facilitate learning. However, a longer debrief similar to that used in high-fidelity simulation may have additional benefits for BLS training. Although not a planned element of this study, it became apparent that debriefing would be useful as a way to enhance performance through communication and feedback. Participants voluntarily immersed themselves in how the video and scenario practice made them feel and what they learned, without specifically being asked for feedback. Structured

debriefing to promote further learning will be included in the following research study. Although a common practice in simulation training, formal debriefing has not been reported previously as part of standard BLS resuscitation training, and it is not included in current BLS guidelines from the RCUK. This suggestion will be made to the Chair of the Council.

Resuscitation training in a pandemic.

Although most training was cancelled or moved to an online approach, effective training of this practical skill was still achieved during a pandemic through a personal attendance mode. Through smaller class numbers and a review of equipment use during deliberate practice, an amended strategy was adopted to overcome the problems of social distancing and enhanced equipment hygiene. For the researcher, this meant required amendment of ventilation provision in order that safe resuscitation practice could still be achieved. The resuscitation guidelines during the pandemic did not allow rescue breaths or use of a pocket mask to provide ventilations. Measurements and observational findings, together with feedback from participants, indicated that there was no significant impact on the training experience. These eventualities and responses will be factored into ongoing resuscitation training strategies and the planning of the next study.

CONCLUDING COMMENTS

Primary care staff need to respond quickly and competently to cardiac arrest to optimise patient outcome. In order to change and improve practice, an effective training strategy is vital. A single modality may not suit every learner, but a training strategy that involves realism and deliberate practice is needed. One way of achieving this is by incorporating a video game alongside simulation practice. This study has given clarity and explanations, so the full study can be made to work effectively. The unique contributions from this study are important as they offer understanding of issues that matter to staff undergoing training, as well as how to continue to provide a successful training strategy in unusual circumstances.

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APPENDIX 1: Stakeholder invitation letter

Layton Medical Centre

200 Kingscote Drive, Blackpool, FY3 7EN
www.laytonmedicalcentre.co.uk

Dear Colleague 09Aug2019

Thank you for your interest in taking part in a research study to design a new resuscitation training strategy for primary care nurses.

I have enclosed a 'participant information sheet' (and a copy of the 'informed consent form').

Please take your time to read the information and if the stakeholder meeting is still something that you would like to take part in, we will need to meet to sign the consent form before the first stakeholder meeting.

If you would like more information about the study, please contact me via email mandy.chalk@nhs.net or via telephone: 01253 951947 or 07881871867.

The details of the first stakeholder meeting are as follows:

Date: Thursday 26th September 2019

Time: 1000-1100

Venue: Meeting Room, Layton Medical Centre, 200 Kingscote Drive, Layton, Blackpool, FY3 7EN

Thank you for taking the time to read this letter.

Yours sincerely

Mandy Chalk

Senior Research Nurse, Layton Medical Centre, Blackpool; Professional Doctorate Student, University of Salford

APPENDIX 2: Potential participant availability form

Potential Participant Availability Form

An innovative resuscitation training strategy for primary care nurses

Potential Participant Initials	Potential Participant Area of Work	Dates Potential Participant Contacted – Contact Made?	Does Potential Participant Want to be Sent a PIS?	Does the Participant Want to Take Part in the Study?

APPENDIX 3: Stakeholder participant information sheet

An innovative resuscitation training strategy for primary care nurses

Participant Information Sheet – Stakeholder

Introduction to the study

We would like to invite you to take part in our research study. The study forms work being completed as part of a Professional Doctorate qualification. Before you decide, we would like you to understand why the research is being done and what it will involve. Please take time to read the following, which we suggest will take approximately 5 minutes. Talk to others if you wish. Please ask us if there is anything that is not clear.

What is the purpose of the study?

Adult resuscitation training is mandatory for primary care nurses. This training serves to equip them with the knowledge and skills to care for patients in cardiac arrest. The aim is to optimise patient survival. However, it is known that knowledge and skill retention could be improved. We want to design a new resuscitation training intervention that will increase knowledge and skill retention, so that we can give our patients the best care possible. It has been suggested that resuscitation training every year is not enough. We want to know what your thoughts are in terms of a resuscitation training strategy that is fit-for-purpose for primary care nurses.

Why have you been asked to take part?

You have been asked to take part because you are a stakeholder for primary care nurses and your expert opinion is vital in deciding what the resuscitation training strategy should look like for these nurses. We want the training strategy to be fit-for-purpose in terms of what primary care nurses need and what the stakeholders would like.

Do you have to take part?

No. It is up to you to decide whether to take part or not. If you decide to take part, you can withdraw at any time without giving a reason. This will not affect any relationships with the research team or the standard of training that nurses receive in the future.

What will happen if you take part?

You will be invited to attend for a maximum of three short stakeholder meetings, one month apart. During the first meeting, evidence will be presented as to why we need to design a new resuscitation training strategy for primary care nurses. We will then explore options available for the innovative strategy, and you will be asked to think about these options for the next meeting. During the second meeting, we will decide what the new training strategy should look like. During the final meeting, the innovative training will be presented and any necessary changes decided. This training strategy will then be used during a feasibility study with primary care nurses to determine if the new training strategy is feasible.

What are the disadvantages of taking part?

We are not aware of any disadvantages to taking part in the study. The meetings will be scheduled at a convenient location, date and time to suit all participants. If travelling to the meeting is a problem, we can explore using a video conference call system to enable participation.

What are the possible benefits?
This study is primarily about increasing patient safety and improving patient outcome from cardiac arrest. More demand is being placed on primary care services and sicker patients are being cared for in primary care. Nurses need to act confidently and competently should a primary care patient suffer a sudden cardiac arrest. However, the literature suggests that the current training strategy may not be the optimum for nurses. By designing an innovative resuscitation training strategy in primary care to increase nurses' knowledge and skill retention, we hope to provide optimum care for patients.

Will your taking part in the study be confidential?
Yes. Any information which leaves the meeting room will have your name removed so that you cannot be recognised.

What if new Resuscitation Council UK guidelines become available during the study?
If such guidelines are released, these will be incorporated into the training content.

What happens with the results?
The study is for an educational project and will involve production of a thesis. The results of the feasibility study will be made available to you and we also aim to publish the study findings in medical journals. Your personal data (name) will be destroyed as soon as possible upon completion of the Professional Doctorate. Study data will be anonymised and stored in the university server in case of use for further studies.

Who has reviewed the study?
The University of Salford Research Ethics Committee and the NHS Health Research Authority have both given a favourable opinion for this study.

Contacts for further information or in case of concern:
If you would like to discuss the study, please contact the researcher
Mandy Chalk: mandy.chalk@nhs.net, 01253 951947.
If you would like to discuss any concerns with the doctoral supervisor
Amanda Miller: a.miller@salford.ac.uk, 0161 2952701.
If the matter is still not resolved, please forward your concerns to
Professor Susan McAndrew: Chair of the Health Research Ethical Approval Panel, Mary Seacole Building, University of Salford, Salford, M6 6PU, s.mcandrew@salford.ac.uk, 0161 295 2778.
If you wish to complain formally, you can contact the independent contact
Sam Mathers: Practice Manager, Layton Medical Centre, 200 Kingscote Drive, Blackpool, Lancashire FY3 7EN, sam.mathers@nhs.net, 01253 951955
You can complain formally through the NHS complaints procedure via to
https://www.nhs.uk/using-the-nhs/about-the-nhs/how-to-complain-to-the-nhs/

Thank you for reading this Participant Information Sheet

APPENDIX 4: Stakeholder informed consent form

An Innovative Resuscitation Training Strategy for Primary Care Nurses

Informed Consent Form - Stakeholder

Participant Number: _____ **Researcher:** Mandy Chalk

Participant to read each statement:	Participant to initial each box:
1. I confirm that I have read and understood the participant information sheet Version 1.0 dated 15JAN2019 for this study. I have had the opportunity to consider the information and ask questions, and have had these questions answered satisfactorily.	☐
2. I understand that my participation in this study is voluntary, and that I can withdraw at any time without giving reason and without my legal rights being affected.	☐
3. I understand that participation will involve up to 3 meetings.	☐
4. I understand that relevant sections of data collected during the study may be reviewed by individuals from the study's research team or regulatory authorities. I give permission for this.	☐
5. I understand that my personal details will be destroyed on completion of the Professional Doctorate but anonymous data from the meetings may be kept and used by the University of Salford in future studies.	☐
6. I agree to participate in the above study.	☐

Participant name _____ Signature_____ Date_____

Researcher Signature _____ Date_____

APPENDIX 5: Primary care participant information sheet

An innovative resuscitation training strategy for primary care nurses
Participant Information Sheet - Primary Care Participant

Introduction to the study
We would like to invite you to take part in our research study. The study forms work being completed as part of a Professional Doctorate qualification. Before you decide, we would like you to understand why the research is being done and what it will involve. Please take time to read the following, which we would suggest will take approximately 5 minutes. Talk to others if you wish. Please ask us if there is anything that is not clear.

What is the purpose of the study?
Adult resuscitation training is mandatory for primary care nurses. This training serves to equip them with the knowledge and skills to treat patients in cardiac arrest. The aim is to optimise patient survival. However, it is known that knowledge and skill retention could be improved. We want to design a new resuscitation training intervention that will increase knowledge and skill retention, so that we can give our patients the best care possible. It has been suggested that resuscitation training every year is not enough. We want to know your thoughts about a resuscitation training strategy that is fit-for-purpose for primary care nurses.

Why have you been asked to take part?
You have been asked to take part because you are a primary care staff member and your opinion is vital in deciding what the resuscitation training strategy should look like for primary care nurses. We want the training strategy to be fit-for-purpose in terms of what nurses need.

Do you have to take part?
No. It is up to you to decide whether to take part or not. If you decide to take part, you can withdraw at any time without giving a reason. This will not affect any relationships with the research team or the standard of training you receive in the future.

What will happen if you take part?
You will be invited to attend for a total of five study visits at either Layton Medical Centre in Blackpool, the University of Salford, or your workplace, wherever is most convenient for you. During the visits you will receive resuscitation training followed by a short, simulated resuscitation scenario which will be observed. During this the researcher will observe you caring for a simulated adult patient in cardiac arrest using a training manikin. The observations will take place before and after initial training at the first visit and then during each subsequent visit which will be 3, 6, 9 and 12 months later. Short refresher training sessions will be delivered during these subsequent visits, but the frequency of the refresher training will only be decided during the stakeholder meetings at the start of the study. Primary care nurse participants may also be participants in the stakeholder meetings, but this is not compulsory.
Following each observation, there will be a short true/false questionnaire and a short face-to-face interview with you and the researcher. During this interview you will be asked for your thoughts about the training. With your permission, the interviews will be recorded to help with accurate reproduction of your thoughts.
If at any point you or the researcher thinks that you would benefit from additional training, this will be arranged at the time. We will go ahead with the six observations and six interviews as long as you continue to want to participate.

What are the disadvantages of taking part? We are not aware of any disadvantages to taking part in the study. You will continue to receive the same standard of mandatory resuscitation training whether you take part in the study or not.

What are the possible benefits?
This study is primarily about increasing patient safety and improving patient outcome from cardiac arrest. More demand is being placed on primary care services and sicker patients are being cared for in primary care. Primary care nurses need to act confidently and competently should a patient suffer a sudden cardiac arrest. Participating in the study will provide you with additional opportunities for resuscitation training throughout the 12 month period of the study. The study may also impact on future training strategies for primary care and other nurses.

Will your taking part in the study be confidential?
Yes. However, we would like to have permission to inform your line manager of your participation in the study. This will allow for adequate staff to remain in your area whilst you attend for the short scenario observations and face-to-face interviews. Information collected about you will not be shared with anyone else, unless patient safety becomes compromised and you require additional training following one of the short scenario observations. In this situation, your line manager will be notified and additional training arranged. However, any need for additional training will be kept confidential between the researcher, yourself, the person delivering the additional training and your line manager. Any written information which leaves the research site will have your name removed so that you cannot be recognised.

What if new Resuscitation Council UK guidelines become available during the study?
If such guidelines are released, these will be incorporated into the training content.

What happens with the results?
The study is for an educational project and will involve production of a thesis. The results of the feasibility study will be made available to you and we also aim to publish the study findings in medical journals. Your personal data (name) will be destroyed as soon as possible upon completion of the Professional Doctorate. Study data will be anonymised and stored in the university server in case of use for further studies.

Who has reviewed the study? The University of Salford's Research Ethics Committee and the NHS Health Research Authority have both given a favourable opinion for this study.

CONTACTS FOR FURTHER INFORMATION OR IN CASE OF CONCERN

If you would like to discuss the study, please contact the researcher
Mandy Chalk: mandy.chalk@nhs.net, 01253 951947.

If you would like to discuss any concerns with the doctoral supervisor
Amanda Miller: a.miller@salford.ac.uk, 0161 2952701.

If the matter is still not resolved, please forward your concerns to
Professor Susan McAndrew: Chair of the Health Research Ethical Approval Panel, Mary Seacole Building, University of Salford, Salford, M6 6PU, s.mcandrew@salford.ac.uk, 0161 295 2778.

If you wish to complain formally, you can contact the independent contact
Sam Mathers: Practice Manager, Layton Medical Centre, 200 Kingscote Drive, Blackpool, Lancashire FY3 7EN, sam.mathers@nhs.net, 01253 951955

You can complain formally through the NHS complaints procedure via https://www.nhs.uk/using-the-nhs/about-the-nhs/how-to-complain-to-the-nhs/

Thank you for reading this Participant Information Sheet

APPENDIX 6: Primary care participant informed consent form

An Innovative Resuscitation Training Strategy for Primary Care Nurses

Informed Consent Form - Primary Care Participant

Participant Number _____ **Researcher:** Mandy Chalk

Participant to read each statement:	Participant to initial each box:
1. I confirm that I have read and understood the participant information sheet Version 2.0 dated 28JUN2019 for this study. I have had the opportunity to consider the information and ask questions, and have had these questions answered satisfactorily.	☐
2. I understand that my participation in this study is voluntary, and that I can withdraw at any time without giving reason and without my legal rights being affected.	☐
3. I understand that participation involves 5 training days during which I will complete true/false questionnaires, be observed practising resuscitation on 6 occasions, and be interviewed briefly on 6 occasions.	☐
4. I understand that relevant sections of data collected during the study may be reviewed by individuals from the study's research team or regulatory authorities. I give permission for this.	☐
5. I agree to my line manager being contacted to arrange additional training should this be needed.	☐
6. I agree to my line manager being informed of my participation in the study and any additional training that may be arranged for me.	☐
7. I agree to the interviews being audio recorded.	☐
8. I agree to anonymised direct quotations from my interviews being used as study data.	☐
9. I understand that my personal details will be destroyed on completion of the study but anonymous data from the observations and interviews may be kept by the University for future studies.	☐
10. I agree to participate in the above study.	☐

Participant name _____ Signature_____ Date_____

Researcher Signature _____ Date_____

APPENDIX 7: Observation assessment sheet

An Innovative Resuscitation Training Strategy for Primary Care Nurses

Observation Assessment Sheet

Participant Number _____

Visit Number (please tick √):

Visit 1 Pre-Test	Visit 1 Post-Test	Visit 2	Visit 3	Visit 4	Visit 5

Researcher Name _____ Date _____

Instructions:

The Researcher must complete the observation assessment sheet during every observation.

Script for participant:

"You have been asked to come to see a patient who has suddenly collapsed in your area. If you ask for any equipment, you will be given it. Please show me what you would do"

Structure Skill description	Process The action that the candidate demonstrates competently during the skills practice	Outcome Desired skill outcome	Assessment Achieved? Yes or No	Comments
1.Initial approach to cardiac arrest management	a. Ensures personal safety	Safe approach		
	b. Shouts for help (to bring AED, airway adjunct and supplemental oxygen)	Effective initial management by summoning help		
	c. Assessment to identify cardiac arrest (unresponsive and not breathing / not breathing normally with open airway +/- pulse check)	Patient assessment and diagnosis of cardiac arrest		
	d. Dials 999 / 112	Summon expert help		
	e. Starts CPR appropriately	Prompt commencement of CPR		

Structure Skill description	Process The action that the candidate demonstrates competently during the skills practice	Outcome Desired skill outcome	Assessment Achieved? Yes or No	Comments
2.Correct delivery of high-quality chest compressions and ventilations	a. Correct hand position	Effective hand position for chest compressions		
	b. Correct depth	Effective chest compressions		
	c. Correct rate	Effective chest compressions		
	d. Correct duty cycle including recoil of compressions	Effective chest compressions		
	e. 30 effective chest compressions	Effective chest compressions		
	f. 2 effective ventilations with supplemental oxygen if available	Effective ventilations		
	g. Avoids unnecessary interruptions in chest compressions	Effective chest compressions		
	h. Maintains 30:2 compression :ventilation ratio	Supports patient's circulation during cardiac arrest with effective chest compressions and ventilations		

Structure Skill description	Process The action that the candidate demonstrates competently during the skills practice	Outcome Desired skill outcome	Assessment Achieved? Yes or No	Comments
3.Safe and effective use of AED	a. Switches on AED and follows prompts as soon as AED available	Safe and effective use of AED		
	b. Correct chest preparation	Safe and effective preparation for defibrillation		
	c. Correct application of self-adhesive pads	Safe and effective preparation for defibrillation		
	d. Ensures safety of self and team during shock delivery (all clear including oxygen if appropriate)	Safe and effective defibrillation		
	e. Follows AED prompt and ensures swift shock delivery	Safe and effective defibrillation		
	f. Follows AED prompt to immediately start compressions after shock delivery	Safe use of AED to promote coronary perfusion pressure		
	g. Follows AED prompts and continues with effective 30:2 with minimal interruptions	Safe use of AED to promote effective CPR		

APPENDIX 8: True False Questionnaire

An Innovative Resuscitation Training Strategy for Primary Care Nurses

True False Questionnaire

Participant Number _____ Date _____

Visit Number (please tick √)

Visit 1 Pre-Test	Visit 1 Post-Test	Visit 2	Visit 3	Visit 4	Visit 5

Instructions:

Please complete the questionnaire at the start of every study visit and again at the end of every study visit. There are 5 questions in the questionnaire and each question has a, b, c and d response options.

Please mark each question on the separate **True False Questionnaire Participant Answer Sheet** as either 'true' or 'false' using an 'x'.

For example, for the following question:

1. With reference to the colour of fruit:
   a. apples are always red
   b. oranges are usually orange
   c. bananas are pink
   d. strawberries are usually red

The answer grid should be marked:

Question	True	False
1a		x
1b	x	
1c		x
1d	x	

Please turn over to page 2

1. The following indicates a cardiac arrest and the need to start cardiopulmonary resuscitation (CPR):

a. normal breathing in an unresponsive individual

b. purposeful movements and eye opening

c. occasional gasps in a patient who is unconscious and unresponsive

d. the inability of an inexperienced rescuer to easily feel a pulse in a drowsy patient who is breathing normally

2. During cardiopulmonary resuscitation (CPR):

a. a ratio of 2 ventilation breaths to 15 cardiac compressions is correct

b. check for normal breathing for less than 10 seconds to diagnose cardiac arrest

c. the hands should be positioned over the upper third of the sternum to perform chest compressions

d. chest compressions should be 5-6 cm deep at a rate of 100-120 compressions per minute

3. The correct sequence of actions when encountering a collapsed patient is:

a. exclude personal danger, check for a response, shout for help, check for signs of life, place a 999 / 112 call, start CPR if no signs of life

b. exclude personal danger, shout for help, place a 999 / 112 call, check for signs of life, look for patient notes, start CPR

c. shout for help, check for a response, start CPR, place a 999 / 112 call, check for signs of life after 1 minute

d. check for signs of life, shout for help, wait for resuscitation equipment to arrive before starting CPR

Please turn over to page 3

4. Regarding chest compressions:

a. the correct hand position for chest compressions is the middle of the sternum

b. compressions should be at a rate of about two per second with a depth of 5 to 6 cm

c. defibrillation pads should be applied whilst chest compressions are ongoing

d. the person doing chest compressions should switch every 4 to 5 minutes to ensure they do not get tired

5. With reference to defibrillation:

a. defibrillation should be delayed until ventilations have been given

b. an automated external defibrillator (AED) allows rapid defibrillation in areas where staff have limited knowledge of rhythm recognition

c. external defibrillator pads should not be used if the patient has an implanted cardiovascular implanted electronic device (ICD)

d. there should be minimal interruptions in chest compressions.

This is the end of the questionnaire.

APPENDIX 9: True False Questionnaire – Participant Answer Sheet

An Innovative Resuscitation Training Strategy for Primary Care Nurses

True False Questionnaire – Participant Answer Sheet

Participant Number _____ Date _____

Visit Number (please tick √)

Visit 1 Pre-Test	Visit 1 Post-Test	Visit 2	Visit 3	Visit 4	Visit 5

Question	True	False
1a		
1b		
1c		
1d		

Question	True	False
2a		
2b		
2c		
2d		

Question	True	False
3a		
3b		
3c		
3d		

Question	True	False
4a		
4b		
4c		
4d		

Question	True	False
5a		
5b		
5c		
5d		

Thank you for completing the answer sheet.

APPENDIX 10: Topic Guide (Visit 1 pre-test)

An Innovative Resuscitation Training Strategy for Primary Care Nurses

Topic Guide for Focused Interviews

Participant Number _____Date _____

Visit Number:

Visit 1 Pre-Test
√

Participant Demography:

Previous relevant work experience _____

_____

_____

_____

Number of adult basic life support training sessions the participant has attended in primary care _____

Number of adult cardiac arrests the participant has attended in primary care_____

Instructions:

This topic guide must be completed after the observation assessment.

Questions for the participant:

1. Have you been involved in any adult cardiac arrests since your last training session?

2. **(If participant answers 'yes' to question 1)** In what way did your last training session prepare you?

or

(If participant answers 'no' to question 1) If you had been, in what way do you think your last training session would have prepared you?

3. **(If participant answers 'yes' to question 1)** How confident were you in responding to the adult cardiac arrest?

or

(If participant answers 'no' to question 1) How confident would you have been if you had responded to an adult cardiac arrest?

4. What was good about your last training session? Would you change anything?

5. Was the length of your training session right?

6. What about the content of it?

7. And what about the frequency of the training?

8. Did you understand the questions in the questionnaire?

9. How did the structure of the observation work for you?

10. Is there anything that would help you retain knowledge and skills?

APPENDIX 11: Topic Guide (Visit 1 post-test, visit 2, visit 3, visit 4 and visit 5)

An Innovative Resuscitation Training Strategy for Primary Care Nurses

Topic Guide for Focused Interviews

Participant Number _____Date _____

Visit Number (please tick √):

Visit 1 Post-Test	Visit 2	Visit 3	Visit 4	Visit 5

Instructions: This topic guide must be completed at every study visit, after the observation assessment.

Questions for the participant:

1. Have you been involved in any adult cardiac arrests since your last training session?

2. **(If participant answers 'yes' to question 1)** In what way did your last training session prepare you?

or

(If participant answers 'no' to question 1) If you had been, in what way do you think your last training session would have prepared you?

3. **(If participant answers 'yes' to question 1)** How confident were you in responding to the adult cardiac arrest?

or

(If participant answers 'no' to question 1) How confident would you have been if you had responded to an adult cardiac arrest?

4. What was good about your last training session? Would you change anything?

5. Was the length of your training session right?

6. What about the content of it?

7. And what about the frequency of the training?

8. Did you understand the questions in the questionnaire?

9. How did the structure of the observation work for you?

10. Is there anything that would help you retain knowledge and skill

APPENDIX 12: Ethics Approval Letters

Research, Enterprise and Engagement

Ethical Approval Panel

Doctoral & Research Support
Research and Knowledge Exchange,
Room 827, Maxwell Building,
University of Salford,
Manchester

M5 4WT

T +44(0)161 295 2280
www.salford.ac.uk

5 July 2019

Dear Tony,

RE: ETHICS APPLICATION–HSR1819-104 'An innovative resuscitation training strategy for primary care nurses – feasibility study'

Based on the information you provided, I am pleased to inform you that application HSR1819-104 has been approved.

If there are any changes to the project and/or its methodology, then please inform the Panel as soon as possible by contacting Health-ResearchEthics@salford.ac.uk

Yours sincerely,

Dr. Stephen Pearson
Deputy Chair of the Research Ethics Panel

University of Salford MANCHESTER

Amendment Notification Form

Title of Project:		
An innovative resuscitation training strategy for primary care nurses – feasibility study		
Name of Lead Applicant:	**School:**	
Mandy Chalk	Health & Society	
Are you the original Principal Investigator (PI) for this study?		Yes
If you have selected 'NO', please explain why you are applying for the amendment:		
Date original approval obtained:	**Reference No:**	**Externally funded project?**
05/07/2019	**HSR1819-104**	No

Please outline the proposed changes to the project. *NB. If the changes require any amendments to the PIS, Consent Form(s) or recruitment material, then please submit these with this form highlighting where the changes have been made:*

The protocol has been amended to indicate a change in the size of the sample and the include support staff (health care assistants and receptionists). Assessors at the interim assessment recommended strongly that the sample size should be increase up to 100, while clinical staff teams have repeatedly asked if support staff could also be included since they operate as a team and wish to learn and train as a team.

Change 1: Increase sample from 20 to (up to) 100.
Change 2: Add healthcare assistants and receptionists to the sample.

Please say whether the proposed changes present any new ethical issues or changes to ethical issues that were identified in the original ethics review, and provide details of how these will be addressed:

The change is only to extend the sample to include more nurses (in response to assessors' comments and advice at interim assessment) and also to allow inclusion of health care assistants and receptionists (in response to requests from clinical staff). The processes will not change, and there is no additional risk. There is no need to alter the information sheet or consent form.

Amendment Approved:	✓	***Date of Approval:***	**04/12/2019**

Chair's Signature: 

Version 3.0 – Nov 2018

APPENDIX 13: Resuscitation Council UK Infographic: Resuscitation of adult COVID-19 patients in primary care settings