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Innovative Cardiopulmonary Resuscitation Training Strategy for Primary Care Staff which Addressed Pandemic Limitations: Feasibility Study for a Randomized Controlled Trial

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Abstract

Primary care nurses, dental nurses, and support staff rarely attend cardiac arrest and lack crash-team support. International evidence indicates that retention of resuscitation knowledge and skills fades within the common 12-months re-training period. The primary aim was to develop and refine a new resuscitation training intervention, determining feasibility and acceptability of proposed study procedures and outcome measures. The secondary aim was to determine whether useful data should result from the main study. In a mixed-methods study, participants used a manikin with Lifesaver and QCPR resuscitation apps to determine their adult resuscitation and defibrillation skill levels. Data were recorded from the apps, observation and questionnaires. Focused interviews provided narrative data. A diverse sample was secured, and robust data resulted from data-collection activities. Participants reported procedures to be acceptable, and maintenance of skills was enhanced in the three-monthly training schedule. For the full study, minor issues of ambiguity in instructions and improved layout of the observation sheet will be corrected. Debriefing and repeated practice will be specific features. Modifications during the COVID-19 pandemic could guide essential training in similarly disruptive events. Progression criteria were exceeded. Proceeding to the statistically-powered, randomized controlled trial to establish the impact of a novel resuscitation training strategy was indicated.

Keywords: ***cardiopulmonary resuscitation; feasibility study; in service training; pandemic; primary health care; randomized controlled trial***

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Introduction

Nurses and others (such as dental practitioners) in primary care out-of-hospital environments may be first responders when patients collapse (Bjelovucic et al., 2023; Kishimoto et al., 2023; Saiboon et al., 2016), yet they lack access to cardiac arrest teams. Survival rates can exceed 50% with basic life support (BLS) together with prompt defibrillation from primary care clinicians (Resuscitation Council (UK) [RCUK], 2015). However, acting with competence and confidence is crucial. This study addressed the feasibility of conducting a randomized controlled trial to establish the optimum resuscitation training interval and format for clinicians and support staff.

Optimum re-training interval

Evidence from Europe indicates that nurses' retention of resuscitation knowledge and skills fades within the common 12-months re-training period, whilst acknowledging that some institutions may also have a 2-yearly re-training strategy (Finn et al., 2015). In general, the optimum training interval has not been established (Bukiran et al., 2014). Knowledge and skills in basic CPR degraded within six weeks of training among Indian nurses (Sankar et al., 2013). In Uganda, knowledge and +skills retention were noted as separate entities, with skill decay occurring more readily than knowledge (Munezero Tamu et al., 2018). This difference may account for discrepancies in the evidence base.

Repeated practice

Brief, repeated practice could be of the greatest importance (Sullivan, 2015). In the UK, supplementing repeated practice with real-time feedback led to retention of infant chest compression skill (Gugelmin-Almeida et al., 2022). The efficacy of two-minute refresher training was supported in the USA (Kemery et al., 2015). Similarly, low-dose, high-frequency resuscitation training improved CPR performance in China (Jiang et al., 2022). Training on consecutive days or weeks increased US student nurse cardiopulmonary resuscitation (CPR) skill retention (Oermann et al., 2020), and gradual lengthening of intervals after such initial spacing might improve performance (Oermann et al., 2022).

Frequency of training

Maintenance of neonatal resuscitation skills required updates more frequently than two-monthly in a USA study (McCaw et al., 2023). A (somewhat dated) UK systematic review and an international consensus group report suggest that three-monthly training may be optimal (Mosley et al., 2012; Soar et al., 2010), and, indeed, low-dose, three-monthly training promoted improved retention of skills and knowledge in the USA (Panchal et al., 2020). Current guidance by the General Dental Council (2025) requires all dental practitioners to have evidence of training for medical emergencies (including resuscitation), though with no specified timeframe.

Technology during a pandemic

Resuscitation training in UK primary care settings should take place regularly to maintain knowledge and skills. Assessment of recognising cardiac arrest, summoning help and starting resuscitation including defibrillation, where appropriate, are key components of this training. At least annual updates are recommended for both clinical and non-clinical staff, recognising that a local risk assessment may inform the training strategy for non-clinical staff (RCUK, 2021). Standard instructor-led resuscitation training relies on instruction and manikin-based skills practice followed by testing, though this was disrupted by the COVID-19 pandemic.

Replacement of in-person instruction by technology

There was evidence long before the pandemic of the efficacy of technology as part of resuscitation training. Use of a mobile app for self-instruction resulted in adequate CPR skills in Italy (Semeraro et al., 2011), whereas video-based self-instruction was comparable to traditional instruction for nurses in

Malaysia and the Netherlands (Saiboon et al., 2016; de Vries et al., 2008). E-learning also enhanced skills-acquisition in the USA and Brazil (Sullivan, 2015; Tobase et al., 2017).

The value of low-fidelity simulation

Clinical scenario-based, low-frequency, but high-fidelity teaching with advanced manikins for CPR and automated external defibrillator (AED) training in the USA showed no significant improvement over low-fidelity simulation (Generoso et al., 2016). Also in the USA, low-fidelity voice-advisory manikins with CPR feedback were effective alternatives to instructor-led teaching (Al-Rasheed et al., 2013). This supports European consortium evidence for the importance of high-frequency training, and less-enabled manikins for training in CPR and AED (Finn et al., 2015).

Adaptation during the pandemic

During the pandemic, no-contact CPR training facilitated by smart technology improved BLS skills in Korea (Kim et al., 2021). Others have shown feedback via technology to have been vital in determining skill performance (Marks et al., 2023). These factors were highlighted in a Danish literature review by Lauridsen et al. (2022). A joint statement by the Care Quality Commission and General Dental Council noted only that RCUK recommended that dental practitioners and dental healthcare staff should refresh their resuscitation knowledge and skills at least annually - by alternative means if required (Care Quality Commission, 2022). Simulation learning for dental hygiene students in Denmark was well-received and effective, though a discreet dental-focused context was not available (Bjelovucic et al., 2023).

Methods

Purpose, design and aims

The ultimate purpose was to determine the optimum resuscitation re-training period and format for primary care staff in a randomized controlled trial. The primary aim of this concurrent, convergent, mixed-methods feasibility study was to develop an innovative resuscitation training strategy, 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. Teresi et al. (2022) emphasise the need for a strategy to evaluate varied aspects of feasibility including sampling, data collection plans, securing intervention fidelity, and maintaining both adherence and retention.

Objectives to address uncertainties for the conduct of the RCT

Objective 1: Recruit a sample sufficient in size and diversity of characteristics to support conclusions regarding study processes. (Progression criterion: minimum 20 maximum 100 participants; from at least three clinical locations; including at least three grades of nursing staff, registered dental nurses, and at least three support staff roles; and encompassing a range of professional experience from less than 5 years to more than 20 years.)

Objective 2: Establish the acceptability of the intervention to those undertaking training. (Progression criterion: 80% of participants support the content and format of the training strategy.)

Objective 3: Gauge degree of adherence to the study processes. (Progression criterion: maximum 10% loss of data overall and 10% from any individual form of data collection.)

Objective 4: Choice of primary and secondary outcomes. (Progression criterion: clear evidence of explicit agreement among researchers and participants of the suitability of the training strategy together with procedures and outcome measures. Quality of data from each measure determined to be adequate in quality and utility for the RCT.)

Consultation to set the initial intervention

The study was guided by consensus among stakeholders on key issues of design, content, frequency, and mode of training within the guidance from Resuscitation Council UK. An initial intervention was designed as a brief, interactive cardiac arrest scenario in the Lifesaver app from RCUK (2017), accessed by mobile phone and undertaken at three-monthly intervals.

Sample

Since it is normal practice in primary care for interprofessional training to include unqualified and administrative colleagues, a request by nurse managers to adopt this approach was agreed, noting the

Table 1:

Participant details [RN: Registered Nurse, RDN: Registered Dental Nurse].

Participant	Male / Female	RN / RDN / Support	Years since RN / RDN registration	Years of primary care experience	Months since last BLS training
1	F	RN	31	8	12
2	F	RN	30	2	12
3	F	RN	34	23	12
4	F	Support	-	10	12
5	F	Support	-	1	12
6	F	RN	22	4	12
7	F	Support	-	10	12
8	F	Support	-	2	12
9	F	Support	-	5	12
10	F	Support	-	15	12
11	F	Support	-	18	12
12	F	Support	-	4	12
13	F	RDN	9	10	12
14	F	Support	-	4	12
15	M	RN	20	20	12
16	F	Support	-	20	14
17	F	Support	-	6	12
18	F	RN	32	20	16
19	F	Support	-	3	12
20	F	RN	36	15	18
21	F	RN	30	15	12
22	F	RN	27	13	18
23	M	Support	-	4	18
24	F	RN	32	20	12
25	M	RDN	23	25	12
26	F	RDN	20	20	12
27	F	RDN	26	28	12
28	F	RDN	21	21	12
29	F	RDN	23	27	12
30	F	RN	41	25	12
31	F	RN	33	30	12
32	F	RN	41	25	12
33	F	RN	10	4	12
34	M	RN	15	12	12
35	F	RN	29	6	12
36	F	RN	21	2	12
37	F	RN	2	2	16

likelihood of more accurate representation of the natural context, and therefore enhanced validity. A convenience sample of 37 nurses, dental nurses, and support staff was drawn from GP practices, walk-in or urgent care centres, research centres, and dental surgeries for 12 months until December 2020. Registered nurses, registered dental nurses, healthcare assistants, receptionists, administrators, and practice managers constituted the sample (Table 1). All those who expressed an interest in participating were included in the study. Bereavement leave, staff remaining furloughed during the pandemic, sick leave, and changes in staff roles resulted in 21 missed visits among 17 participants. Data collection ended in December 2021.

Baseline training

The initial training in BLS and AED use was always delivered to RCUK standards by the primary investigator, an RCUK instructor. Reliability was high since the intervention was standardised and repeatable. Instructor bias was considered to be low.

Data collection

Resuscitation App

The Lifesaver app, a digital training tool using interactive short films, was developed by the RCUK in 2020 (RCUK, 2021). The app, available online and on computers and mobile devices, teaches learners to make the correct lifesaving decisions in emergency scenarios (RCUK, 2021). The activity involves participants immersing themselves physically and mentally in authentic scenarios, requiring participants to demonstrate adult BLS and AED skills using their phone or keypad. Participants are asked to select quick responses to questions and to use their device to perform skills such as airway opening manoeuvres by moving the cursor, and chest compressions by pressing the P and Q buttons at the correct speed. The app presents data as (1) number of correct answers, (2) speed of answers, and (3) CPR accuracy (specifically as a percentage of correct compression speed).

Demonstration of skills

In this study, trainees used a manikin and the Lifesaver app together with short interactive film technology designed to simulate sudden collapse and cardiac arrest in adults in order to determine skill level in resuscitation and defibrillation. The Quality CPR (QCPR) app, which pairs electronically with Laerdal manikins allowed review of CPR performance while using the manikin: chest compression depth (5-6cm) and rate (100–120 min^{-1}), release depth, and efficacy of ventilation. Data were recorded directly from the Lifesaver and QCPR apps, eliminating unnecessary risk of researcher bias.

Using the same model of manikin for all participants at all time points, objective observation was conducted throughout a 10-minute scenario which remained unchanged throughout the study to reduce confounding variables. A 20-point critical action proforma based on RCUK 2015 guidelines (since updated: RCUK, 2021) was completed at baseline; immediately after initial training (visit 1 = V1); and at three (V2), six (V3), nine (V4) and 12 months (V5). A non-participatory observer stance with highly structured item criteria allowed for greater objectivity, while repeated experiences together with one-to-one interviews could be expected to minimise research participation behaviour (McCambridge et al., 2014).

Demonstration of knowledge

BLS and defibrillation knowledge were elicited using a true/false questionnaire based on five four-part questions, administered after each observation. The instrument was taken from a nationally-adopted licensed questionnaire from RCUK (2015) in order to comply with its expectation that all training should adopt a standardised approach. Doing so also enhanced the validity of this element.

Reflective interviews

After each scenario, short (3-16 minutes), focused, in-person, audio-recorded interviews explored participants' views of confidence after training; potential impact on clinical practice; and content, duration, structure, and frequency of training. The topic guide, structured by stakeholder discussion, RCUK guidelines, and current literature, comprised 10 questions selected to elicit participant information and views, maintaining consistency across data points and participants.

Amendments during the pandemic

Data collection continued into 2021 for a small proportion of participants. During the pandemic, resuscitation actions were restricted to compression-only CPR or 30:2 compression-ventilation ratio with bag and mask. Some episodes were conducted remotely when in-person meetings were impossible. During the remote 'visits', the video and MCQ were accessed in the usual manner. The scenario was discussed and audio-recorded, and the participant gave a verbal description of what they would do. (Data collection using the manikin was not possible and therefore was not collected for the skills.) The interview was completed in a private room, similar to the face-to-face interview but by telephone or video, and audio recorded. The questionnaires were completed by email. There was a risk of bias due to missing QCPR data. 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.

Data analysis

The statistical and narrative datasets were analysed independently, then combined for interpretation. Descriptive analysis was applied to empirical data to identify changes over time. The results were interpreted cautiously since the power of this study was insufficient to detect statistically significant changes. Teresi et al. (2022) warned against using pilot data to plan sample size or to estimate effect size, since even confidence intervals are likely to be unduly large for the moderate samples employed in feasibility studies.

Lifesaver App

The Lifesaver app generated a report upon completion of the scenario at months three, six, nine and twelve. This detailed the participants' overall performance, number of correct answers, speed of answers (in seconds) and accuracy of CPR (as a percentage of correct speed of compressions performed). 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

Twenty action points were observed, relating to the initial approach to cardiac arrest management; correct delivery of high-quality chest compressions and ventilations; and safe and effective use of the AED. The same model of manikin and observation scenario were used throughout the study to reduce confounding variables. Assessment indicators were scored dichotomously (fully achieved or not) and changes in full achievement over time were plotted across the sample. QCPR reported (1) chest compression fraction; (2) chest compression speed, depth and recoil; (3) compression-to-ventilation ratio; and (4) ventilation adequacy. The criterion-based instrument enhanced validity by reducing researcher interpretation error.

Questionnaire

Total scores from the true/false questionnaires were assessed descriptively for changes between time points. Changes in the median overall score across the sample between time points were calculated. Data from the app and observation were analysed in the same manner. Since there was a single observer for all participants at all time points, inter-rater reliability was not an issue to be considered.

Narrative data

Inductive content analysis consisting of three phases (preparation, organisation and reporting) was applied to narrative data according to the well-established method of Elo and Kyngas (2008). Data were collected in the initial phase by recording a number of headings to capture all aspects of the interview data, a technique often recognised from grounded theory as open coding. Inter-rater reliability measures were not possible due to COVID-19 restrictions necessitating only a single interviewer. Making sense of the data began during the organisation phase in which categories were created which represented the concepts. The creation of categories required the grouping of data into fewer, larger, but still meaningful clusters at a higher level of abstraction. Associations between results were considered according to the nature of connections and potential reasons for the occurrence of patterns.

Ethical approval

Formal ethical approval was secured from the University of Salford Research Ethics Committee (HSR1819-104). All staff were required to attend annual training, but participation in data collection activities was voluntary (including follow-up visits) and advised by printed participant information sheets. Signed consent was secured and checked again at each study visit.

Results

Generally, the planned method was effective, allowing for comparisons between groups and time points, although some modifications were identified for the substantive study.

Sampling adequacy (Objective 1)

Thirty-seven participants were recruited despite the pandemic (18 nurses, 6 dental nurses, and 13 support staff): almost double the progression criterion of 20. The requirement for continuation of mandatory training supported this and would, presumably, be unchanged in future emergencies. There was sufficient heterogeneity in staff grades and clinical location, though with a preponderance in the nurses and dental nurses group of more than 21 years since qualification. Years working in primary care showed greater difference for nurses and dental nurses (7 with 5 years or less), but less difference for support staff (6 with 5 years or less). Recruits were based in a walk-in centre, a dental practice, a pharmacy, a research centre and GP practices. Their roles included those of advanced nurse practitioner, dental nurse, health care assistant, medical secretary, nurse, practice manager, receptionist, research nurse, senior nurse manager, and pharmacist. This exceeded the progression criteria (see Table 1).

Observation data (Objective 4)

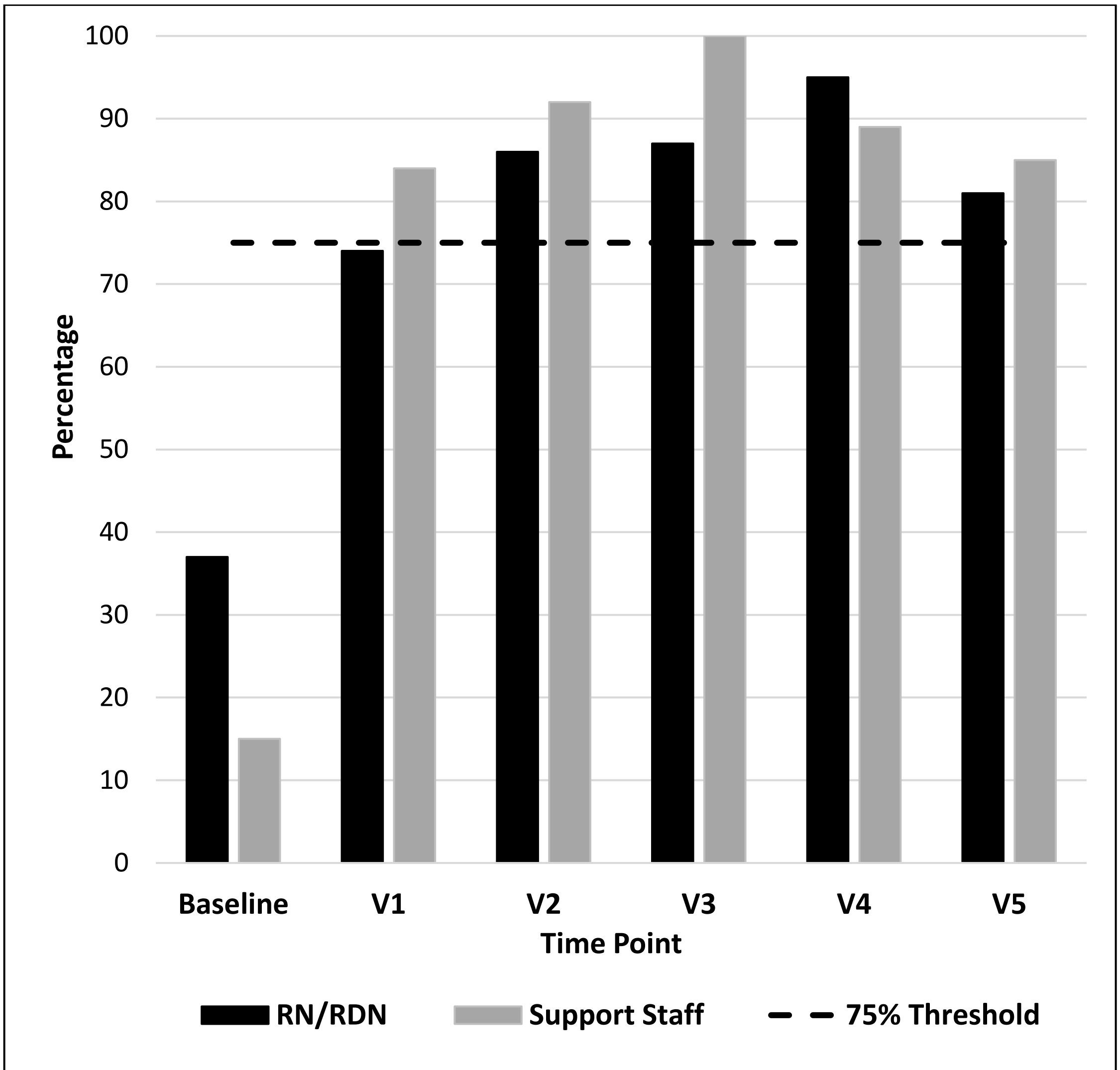
More correct actions regarding dichotomous (achieved or not achieved) variables, for example, in chest compression speed or ventilation adequacy, were seen in nurses and dental nurses than in support staff at baseline. However, support staff had slightly more correct actions thereafter. In real life, it is not essential for resuscitation actions to be undertaken perfectly to secure survival. All participants met the standard set by Laerdal of 75% achievement. The main study will focus on the number of participants achieving this minimum standard on serial measures rather than requiring perfect performance.

Laerdal QCPR data (and Lifesaver App alternative) (Objective 4)

The full range of possible measures was achieved. All participants retained knowledge throughout the study. There was universal, sustained improvement in accuracy of chest compression rate over time (never dipping below 75% after the first visit); support staff improving the most (Figure 1). Laerdal QCPR reports also indicated maintenance of 5-6 cm chest compression skills. Support staff were more accurate than nurses and dental nurses in chest compression depth and recoil (Figure 2), and speed (Figure 3).

Figure 1:

Mean accuracy of QCPR chest compression rate as a percentage at each visit, showing 75% threshold



Lifesaver videos (three-monthly, commencing at visit 2) showed comparable outcomes, with support staff achieving slightly better than nurses in rate of compression. Performance improved in both groups, and they maintained the skill of 100-120 compressions per minute at all time points. Support staff scores were better than nurses' and dental nurses' at all but one time point; nurses scoring better in speed of compression.

Figure 2:

Mean accuracy of QCPR chest compression depth and recoil as a percentage at each visit, showing 75% threshold

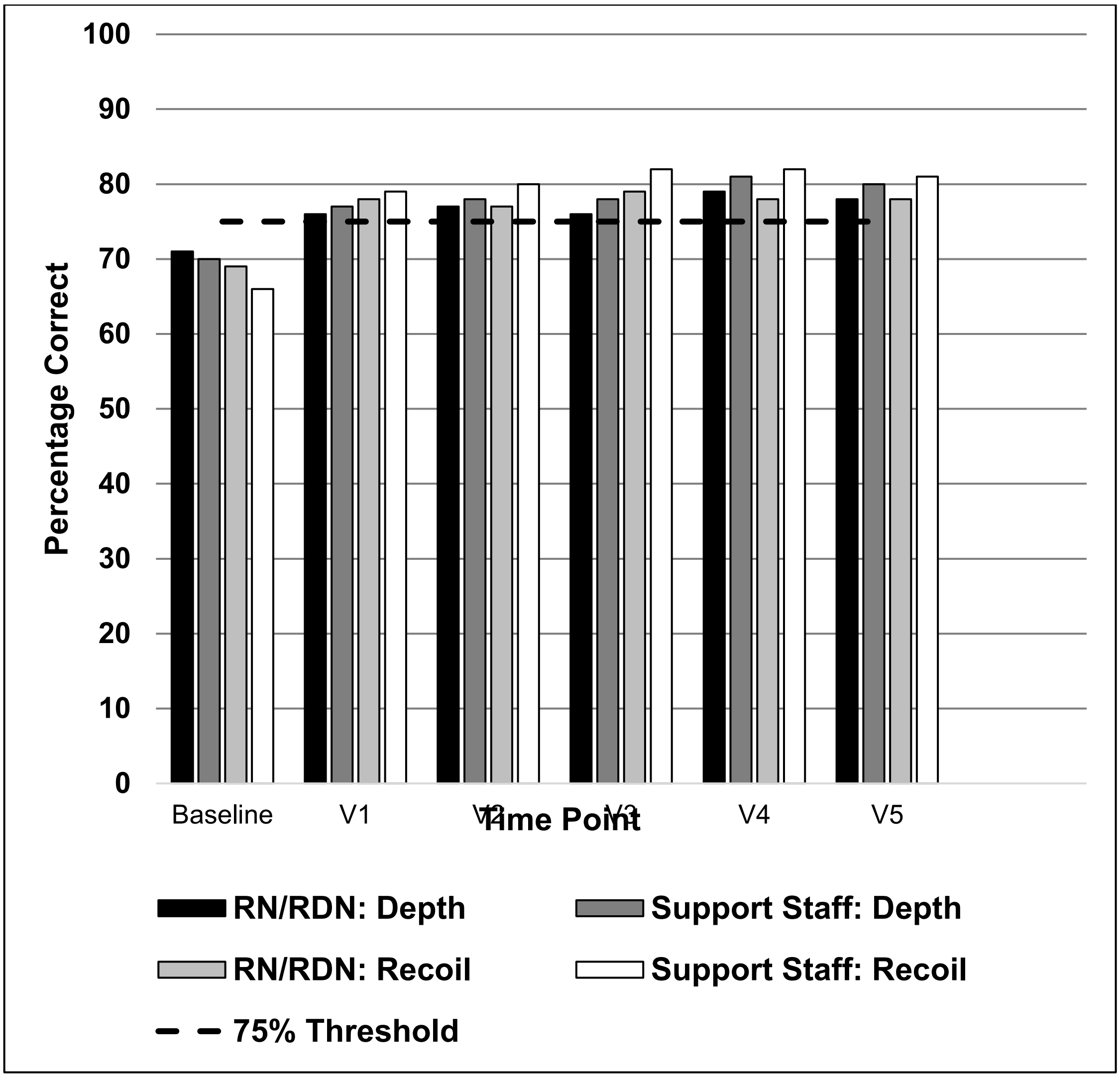


Figure 3:

Mean accuracy of QCPR chest compression speed as a percentage at each visit, showing 75% threshold

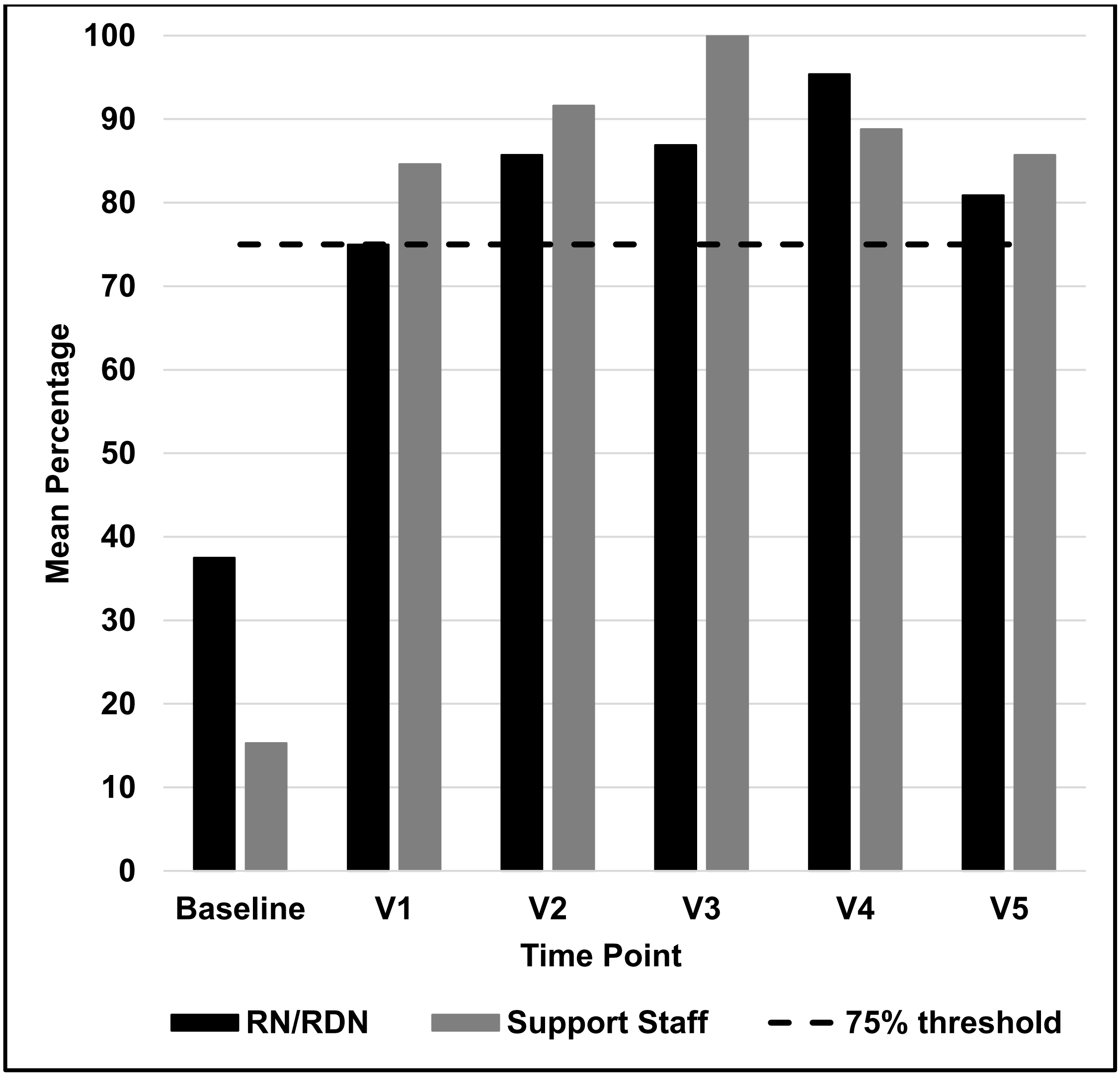
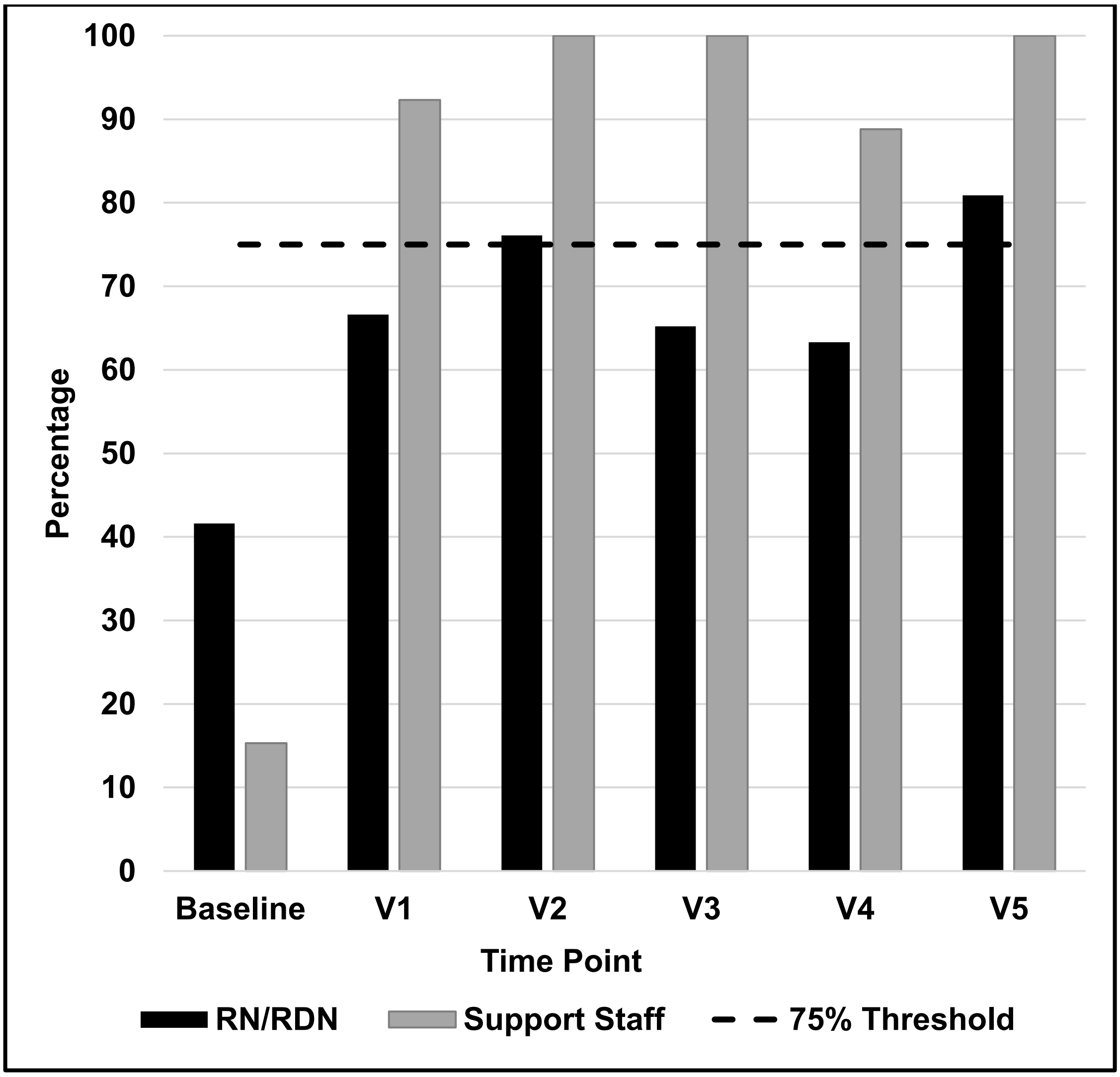


Figure 4 relates to chest flow fraction. Whilst all participants improved, support staff did so strikingly more. QCPR app data suggested that support staff were able to convert learning from training into clinical practice.

Figure 4:

Mean achievement of QCPR correct chest compression flow fraction as a percentage at each visit, showing 75% threshold



Questionnaire data (Objective 3)

The true-false questionnaires were completed without omission by all participants at each study visit. The responses to the questionnaire showed little variation over time after the first post-test. Some degree of confusion was evident in a minority of participants' means of reporting (correct) responses, so minor changes in layout will need to be reviewed before the main study. For these reasons, the planned test-retest calculations were postponed pending further testing after amendments. Knowledge was improved in the immediate post-test, and maintained thereafter by both groups, nurses and dental nurses sustaining resuscitation knowledge somewhat better than support staff.

Interview data (Objective 2)

Participants took part in the interviews with enthusiasm. Staff in primary care roles are often disconnected from direct involvement in research, but those in this study were eager to participate and sought to learn about the research process. Some participation was recognized as being transactional in nature (such as mandatory annual resuscitation updates for nurses and dental nurses), however, there was a desire to engage in research, particularly when beneficial to patients and practice. They acknowledged that their confidence in coping well (involving both reduced anxiety and improved memory retention) should a patient suffer cardiac arrest could be enhanced by regular, more frequent training than was currently the case. Increasingly, more participants concluded that three-monthly training would be optimal. A single participant upheld the adequacy of annual training but failed to maintain knowledge or skills. Participants expressed acceptability of the intervention and assessments. No correlation could be made between exposure to cardiac arrest and resuscitation performance.

Fidelity

In simulation learning, fidelity refers to the degree to which the reality of a clinical environment and experience is replicated by the simulated environment and student cognitive and emotional response. It has been summarised as "the degree of realism created through the selection of simulation equipment, setting, and scenario" (Carey & Rossler, 2023). Participants identified that they had lacked the emotional and realistic reactions of intervening at a cardiac arrest, and they appreciated training that was inclusive of emotional fidelity. The Lifesaver scenarios enabled them to become immersed in the training, through increasing psychological and environmental fidelity. While the impact on practice could not be established in this feasibility study, recent evidence from Palestine demonstrated that both self-confidence and clinical practice were enhanced in mental health nurses by high-fidelity simulation (Jawabreh et al., 2025). Participants valued time to reflect, to be debriefed, and to engage in discussion about their reactions to the enhanced resuscitation experience offered in the study. This went beyond the nurses' and dental nurses' professional requirement to reflect on practice (General Dental Council, 2019; Nursing and Midwifery Council UK, 2021). However, the limited workplace-specific provision for dental practitioners reported by Bjelovucic et al. (2023) suggests the need for more resources to realize these benefits.

Blended learning

In this study, participants expressed a strong preference for the blended training approach, which incorporated e-learning, interactive video components, and hands-on practice of CPR and AED skills. According to Gross et al. (2025) blended learning increases satisfaction and improves performance in comparison to traditional lecture-based learning. Li et al. (2024) found that blended learning when teaching CPR improves self-directed learning abilities and CPR performance in comparison to those who did not receive a virtual online simulation experience. Further, blended learning, particularly the use of video clips alongside classroom lectures, proved effective in helping paramedic students acquire and develop both technical and non-technical skills during neonatal CPR training (Yaylaci and Guven, 2021).

Discussion

Educational approach issues

Allowing that personal learning styles differ, a strategy for training that incorporates simulation with authenticity, realism and deliberate practice was valued and effective by nurses in the USA (Brannan et al., 2016; Shinnick and Woo, 2015) and Australia (Tutticci et al., 2016). Such principles were applied to the study reported here. Video-based materials offer a viable alternative to traditional resuscitation instruction, particularly when classroom-based provision is compromised, as was the case during the COVID-19 restrictions. Incorporating assessment in the same mode may enhance learning even further. British and Dutch research suggests that this prompts greater emphasis on learning by students (Wormald et al., 2009), and this promotes successful learning (Olde Bekkink et al,. 2012). Indeed, German researchers reported an increase in CPR performance by childcare staff through multimodal training programs (Michel et al., 2022).

Feedback devices

Spanish, Australian, Danish, and American researchers have shown that useful objective feedback on performance of CPR for both students and instructors can be obtained from real-time feedback devices (Arrogante et al., 2021; Dick-Smith et al., 2020; Lauridsen et al., 2022; Oermann et al., 2024a, 2024b).

During this feasibility study, the QCPR app was used to not to prompt the nurses but to measure their performance, ameliorating performance bias. In contrast, the full RCT will feature a feedback device in the experimental group to gauge the impact of QCPR on serial retention of skills.

Repetition as a learning need (Objective 2)

Participants acknowledged that repetitive practice through simulation impacted positively on retention of skills in sequencing actions and practical skills. The positive effect of repetition and deliberate practice has been noted in skills acquisition for health care (Ericsson et al., 1993; Larsen et al., 2008). Deliberate practice for mastery learning is well-documented by American scholars (Ericsson, 2006; Gonzales & Kardong-Edgren, 2017). Simulation offered a non-threatening learning environment for deliberate medical practice in Scotland (Maran & Glavin, 2003). Staff in the USA described stress and 'freezing' on encountering rare occurrences of cardiac arrest (O'Donoghue et al., 2015), while other US researchers noted that interval training decreased the time-to-task (from emergency call to starting CPR) for nurses in outpatient settings (Peverini et al., 2023). In India, regular CPR training was identified as essential for skills maintenance (Varughese & D'Silva, 2018).

Emotion and realism

The benefits of emotional stimulation in resuscitation learning have been recognized in the UK (Bland et al., 2014; RCUK, 2021) and Canada (Ghoman et al., 2020). Standard training typically relies upon use of an unreactive manikin which may provoke apprehension of being observed in nurses while undertaking CPR (Nielsen & Harder, 2013). Closer fidelity to the shock and anxiety of witnessing unpredicted collapse, requiring immediate decision-making, was more useful preparation than traditional training. Feelings of reality in emotions and physiological responses represent high-level psychological fidelity (Maran & Glavin, 2003). Such emotional activation has been acknowledged by German researchers (Kuckuck et al., 2018). A review of simulation training and debriefing for dental staff in Japan concurred with these conclusions (Kishimoto et al., 2023). These responses require supportive actions, and RCUK (2015) recommends concise debriefing in resuscitation training as good practice for real events in clinical practice, but formal debriefing has not been added to BLS guidelines. Addressing this might be a valuable improvement.

Securing training during a pandemic (Objective 3)

The pandemic forced changes to delivery of healthcare mandatory training. RCUK (2020) released guidelines regarding essential modifications. In this study, a minority of participants were unable to attend in-person visits, including observation of the hands-on scenario using the manikin, resulting in loss of quantitative data. Mandatory mask-wearing further limited effectiveness of training. Some participants argued that the Lifesaver video was superior to in-person training due to the level of realism. A blended approach of on-line and in-person simulation training is a potential solution during future pandemics. However, its efficacy specific to resuscitation training for staff in primary care has not been examined previously. RCUK (2020) emphasizes the importance of practical training in person, and the British Government has reported the potential impact of virtual reality in simulation (Department of Health and Social Care, 2021). It seems likely that the innovative training strategy pre-tested here combining in-person and remote simulation will be representative of the means to meet these otherwise conflicting requirements.

Limitations

Three possible limitations were recognized, though none exerted significant impact on the outcomes. The first of these was limiting the sample to 37 participants as the pandemic restrictions were enforced. Recruiting fewer participants but without any missing data was preferred to recruiting a larger sample with truncated data points. While a sample of 37 would be inadequate for robust analysis of empirical aspects of the main study, this was not the case for the feasibility study since only descriptive analysis was applied to the outcomes (Billingham et al., 2013; Orsmond and Cohn, 2015; Teresi et al., 2022; Tickle-Degnen, 2013).

Concern was also felt regarding potential bias from missing QCPR data, mostly about substituting remote visits during periods of working at home or isolation. However, since this problem remained small (11 of 222 expected episodes), the impact was not significant. It is possible that this could prove to be more problematic for analysis in the main study, so this should be addressed in sampling decisions.

By far, most participants gauged 3-monthly training intervals to be optimal, but this could have been impacted to some degree by the design of the study. Yet other proposals were suggested, and narrative elements revealed varied reasoning for preferring the interval of three months. This strategy was also most often recommended by other researchers.

Conclusion

Achievement of objectives

Objective 1 related to being able to recruit an adequately sized and diverse sample. Despite the added difficulty of continuing during the pandemic, the progression criteria were exceeded with a large safety margin for all parameters, including total number, number of professional groups, variety in length of experience, and type of primary care workplace.

Objective 2 addressed participants' acceptance of the intervention in content and format. From the interview data it was clear that participant overwhelmingly supported the study design and the role to be played by participants. While one disagreed with the proposed interval between training sessions, they supported the data collection methods. This resulted in less than 1% disagreement, while the progression criterion was 80% in favour.

Objective 3 required no more than 10% loss of data overall and 10% from any individual form of data collection. The greatest loss of data was calculated at less than 5% (for the QCPR element) and was negligible for other aspects of data collection as alternative means were introduced for the small minority who missed a data point.

Objective 4 was focussed on explicit agreement between researchers and participants of the choice of primary and secondary outcomes, with data quality for each measure being adequate in quality and utility for the planned RCT. Participants were wholly supportive in the narrative part of the study about the importance of the primary aim and demonstrated enthusiastic agreement about the focus on primary care staff. While the sampling strategy and size could support only descriptive statistics, the results demonstrated that useful data should be gained in the main study.

Overall outcome

The planned study processes were mostly effective in securing an adequate sample, engaging participants in essential activities, collecting useful data, and offering insights into the main study design. Some modification was needed; for example, to the true/false questionnaire format. QCPR was a robust means to demonstrate the effectiveness of compressions, emphasizing the need for improvement in the recoil element of chest compression. Proceeding to a full-scale, statistically-powered and randomized controlled trial to establish the impact of a novel resuscitation training strategy was indicated.

Additional Learning and Further Research

Debriefing following resuscitation training is vital, offering significant added value to basic life-support education. Responding to the emotional and physiological responses elicited during simulation, key indicators of psychological fidelity, should be considered as a core component of the learning process. Approaches that strengthen emotional engagement and realism, particularly using interactive video, produce meaningful improvements in practical simulation-based learning. The findings also demonstrate that resuscitation training can remain highly effective during a pandemic when supported by carefully considered modifications and the application of blended learning. These elements will be incorporated into the main RCT.

Further research is needed both to understand the mechanisms of efficacy of such strategies, particularly over the longer term, and to investigate additional innovations, potentially including elements of AI. Moreover, although hospital-based simulation increasingly relies on multi-professional team approaches, there is significant opportunity to reconsider the combinations of staff and the diverse scenarios involved in out-of-hospital emergencies.

Declarations

COPE Statement

All authors contributed substantially to conception or design (MC, TL); data acquisition (MC), analysis or interpretation (MC, TL, AM); intellectual content development (MC, TL, AM) critical review (TL, AM); and approved the final version (MC, TL, AM).

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Ethical approval

Ethical approval was secured from the University of Salford Research Ethics Committee (HSR1819-104).

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