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Simulation and education

CPR Quality Officer role to improve CPR quality: A multi-centred international simulation randomised control trial

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Abstract

Background: An out-of-hospital cardiac arrest requires early recognition, prompt and quality clinical interventions, and coordination between different clinicians to improve outcomes. Clinical team leaders and clinical teams have high levels of cognitive burden. We aimed to investigate the effect of a dedicated Cardio-Pulmonary Resuscitation (CPR) Quality Officer role on team performance.

Methods: This multi-centre randomised control trial used simulation in universities from the UK, Poland, and Norway. Student Paramedics participated in out-of-hospital cardiac arrest scenarios before randomisation to either traditional roles or assigning one member as the CPR Quality Officer. The quality of CPR was measured using QCPR® and Advanced Life Support (ALS) elements were evaluated.

Results: In total, 36 teams (108 individuals) participated. CPR quality from the first attempt (72.45%, 95% confidence interval [CI] 64.94 to 79.97) significantly increased after addition of the CPR Quality role (81.14%, 95% CI 74.20 to 88.07, p = 0.045). Improvement was not seen in the control group. The time to first defibrillation had no significant difference in the intervention group between the first attempt (53.77, 95% CI 36.57–70.98) and the second attempt (48.68, 95% CI 31.31–66.05, p = 0.84). The time to manage an obstructive airway in the intervention group showed significant difference (p = 0.006) in the first attempt (168.95, 95% CI 110.54–227.37) compared with the second attempt (136.95, 95% CI 87.03–186.88, p = 0.1).

Conclusion: A dedicated CPR Quality Officer in simulated scenarios improved the quality of CPR compressions without a negative impact on time to first defibrillation, managing the airway, or adherence to local ALS protocols.

Keywords: Out-of-hospital cardiac arrest, CPR quality, Quality Officer, Resuscitation

Introduction

Across Europe, the reported incidence of out-of-hospital cardiac arrest (OHCA) is 38.0 to 55.0 per 100,000 person-years.[1] There are clear and evidence-based guidelines for managing OHCA. However, the quality of Advanced Life Support (ALS) and Cardio-Pulmonary Resuscitation (CPR) varies depending on the delivery setting and the operator, with an impact on patients.[2–5] Emergency Medical Services (EMS) around the world play a pivotal role in the delivery of ALS out of hospitals and the latest European Resuscitation Council guidelines deem high-quality CPR and early defibrillation the priority in these cases.[6] There is some evidence suggesting that CPR delivered by EMS crews is substandard.[7–9]

EMS systems and researchers have been developing strategies to improve OHCA patient outcomes. The quality of CPR is deemed high when the chest is pushed down by at least 5 centimetres at a rate of 100–120 compressions per minute, allowing full recoil of the

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chest.[10] Unnecessary interruptions in chest compressions or a chest compression factor (CCF) below 80% are agreed among experts to be a poor indicator of CPR performance; however, the evidence is of low or very low confidence.[11,12] Both American and European resuscitation guidelines state interruptions should be minimised,[10] and it is recommended that the person who performs chest compressions should be changed every two minutes.[10] Maintaining CCF by use of feedback devices, such as a metronome, is supported by the International Liaison Committee on Resuscitation (ILCOR).[4] The impact of these techniques on patient outcomes is not clear.[4,6] There is emerging evidence that on-scene leadership has a positive impact on the quality of CPR delivered.[13–15] Team leaders are responsible for leading the overall resuscitation effort during cardiac arrest by making high-level decisions, such as determining the cause of cardiac arrest and deciding on the clinical treatment plan.[16]

However, ALS scenarios expose on-scene leaders with levels of cognitive burden exceeding their ability to achieve the highest possible performance.[17,18] In one simulation study, introducing an additional leader with specific quality monitoring responsibilities significantly reduced team leaders' cognitive load and improved CPR quality.[16]

We were interested in adapting the approach of Pallas, Smiles and Zhang[16] to focus on CPR quality improvement and to reflect on the practicalities related to EMS in out-of-hospital settings. In some EMS systems, numerous resources are allocated with several operators in a 'pit-stop' model.[19] However, in many EMS systems, only a single ambulance is sent, crewed by two or three staff. We hypothesised that having one member of the crew, which we have called a CPR Quality Officer, focusing on and taking accountability for the quality of CPR will improve the team's performance. The CPR Quality Officer will support the resuscitation team leader and ensure the delivery of high-quality CPR by providing constructive feedback and encouragement.

Methods

Trial design

The study design was inspired by a trial conducted by Pallas, Smiles and Zhang[16] and adapted to reflect the out-of-hospital care setting. This experimental, multicentre, simulation randomised control trial was approved by the Health-related Research Ethics Committee at Edge Hill University (ETH2122-0031) and subsequently approved and registered at each institution (research centre) where data were collected over five months (January - May 2022). Each research centre had a lead responsible for study quality assurance. Data were collected at three higher education institutions: Edge Hill University (UK), Oslo Metropolitan University (Norway) and Bielsko-Biala University (Poland). As well as increasing sample size to aid statistical analysis, the multi-centred approach allowed testing across three different but comparable healthcare settings to increase generalisability. The homogeneity of variances across centres was analysed to help ensure that the variability in outcomes is not disproportionately influenced by any particular centre (see Supplementary Material).

Participants

The study was advertised to all BLS (Basic Life Support) and ALS-trained paramedic students at the three participating universities. The minimum sample size was calculated with the proportion of interest assumed = 0.7; giving an estimated target recruitment of 62 teams, with 204 participants in total (see Supplementary Material). Recruitment proved to be challenging. Despite challenges, 36 teams and 108 participants were successfully recruited. At this point, further recruitment was not feasible, and a subsequent analysis confirmed that this sample size was sufficient providing statistically significant findings.

Randomisation and blinding

Research teams at each centre undertook training by the principal researcher to ensure that data were collected in the same way in a consistent simulated environment. Participants were randomly allocated to teams of three responders and were asked to respond twice to a simulated scenario of a witnessed cardiac arrest requiring the implementation of ALS shockable rhythm protocol. Participants were presented with identical scenarios and equipment at all centres. After attending the scenario for the first time, teams were randomised into two (control and intervention) groups at each centre. The participants were blinded to the intervention with one team member as a CPR Quality Officer. The groups were randomised using computer-generated codes (https://www.randomizer.org), and the scenario was common to all participants.

Intervention

The intervention groups were assigned one team member as the 'CPR Quality Officer'. Before the second attempt of the scenario, the CPR Quality Officer and their teams received video-recorded training on the role and a checklist highlighting the main elements of high-quality CPR (Appendix A). During the scenario, the CPR Quality Officer was distinguishable with an armband and the role was documented on the patient report form. The control groups were not assigned a CPR Quality Officer or given any instructions on the CPR quality role before the scenario. The teams repeated the same scenario with (intervention groups) or without (control groups) the assigned CPR Quality Officer.

Measurements

The primary outcome measure was chest compression quality by Laerdal's QCPR® score[20] where a percentage score is measured to represent the quality of CPR performed and is based on compression depth, compression rate, incomplete release, hand position, compressions per cycle, and chest compression fraction. The score was presented as an overall percentage which incorporates the quality of performed chest compressions, interruptions, and chest recoil. The use of real-time training software such as Laerdal QCPR® has been validated as a method to measure and compare metrics associated with CPR quality among research participants.[20]

Local protocols and ERC 2021 guidelines were used to determine the participants' ALS performance in addition to CPR quality. Outcomes included the time to delivery of the first defibrillation, the time taken to manage an airway obstruction, and adherence to local drug protocols. All scenarios were video-recorded and assessed by the facilitators, who were experienced paramedic academics, using the task time checklist (Appendix B). A sample of video recordings (n = 16, 20%) was moderated for quality assurance. The assessors were unable to be blinded to the intervention allocation due to the visible nature of the intervention. To limit the impact of measurement bias, an independent internal moderator (KS) evaluated a sample of video recordings and results (n = 16, 20%).

Statistical analysis

The quantitative data from all centres were collated on a central spreadsheet and statistically analysed. Statistical significance was assumed based on $p < 0.05$. Descriptive statistics, including means, standard deviations, and 95% confidence intervals, were calculated for all continuous variables. Categorical variables were summarised using counts and percentages. The independent-samples t-test was used to compare continuous variables between groups. The non-parametric Kruskall-Wallis test was used to compare the medians of the three groups (PL, NO, UK) for each resuscitation phase (CPR attempt 1, CPR attempt 2, defibrillation attempt 1, defibrillation attempt 2, airway management attempt 1, airway management attempt 2). The Bonferroni post hoc test was used to adjust for multiple comparisons following the Kruskal-Wallis test. Calculations were performed in the R statistical environment version 3.6.0, the PSPP software, and MS Office 2019.

Results

In total, 36 teams participated with 108 study participants. All teams contained 3 participants and performed the first attempt of the cardiac arrest scenario before being randomly assigned into the 22 intervention groups and 14 control groups and repeating the scenario. Overall, 16 teams (7 control, 9 intervention) were recruited in Poland, 10 teams (3 control, 7 intervention) from Norway, and 10 teams (4 control, 6 intervention) were recruited from the UK.

Quality of chest compressions

Overall, the quality of the chest compression score did not differ significantly between the control and intervention groups in the first attempt (Table 1). Following the introduction of the CPR Quality Officer and the education on the role, a significant improvement in chest compression results in the second attempt was observed in the intervention group. However, a similar improvement was not observed in the control group. Participants in the intervention group in the first attempt (before the CPR Quality Officer) had an average CPR overall % score = 72.45, while in the second attempt (after the assignment of a CPR Quality Officer), the average value was significantly ($p = 0.045$) higher and amounted to overall % score = 81.14 (Table 1).

Quality of ALS

Early defibrillation in cardiac arrest is vital for restoring a normal heart rhythm, and it is an essential element of resuscitation guidelines. All scenarios involved a shockable rhythm with the expectation that a timely shock was provided. Overall, the time to the first delivered defibrillation did not statistically differ ($p = 0.84$) between the first and second attempts (Table 2). While the inclusion of a CPR Quality Officer during the second attempt in the intervention group did not result in a change in the time to first defibrillation, no significant negative effect on the time was observed.

All scenarios contained an airway obstruction and participants were expected to assess and manage this in line with ERC 2021 guidelines and local protocols.[6] The intervention group decreased the time taken to assess and remove the airway obstruction from an average of 168.95 seconds (110.54–227.37) in attempt 1 to 136.95 seconds (87.03–186.88) in attempt 2; however, this was not statistically different ($p = 0.26$). This was comparable to the control group which took an average of 178.50 seconds (105.27–251.73) in attempt 1, reduced to an average of 146.71 seconds (84.13–209.30) in attempt 2 ($p = 0.1$)(Table 3). A significant difference was observed between the first and second attempts for both groups ($p = 0.006$); however, no significant difference was detected between the intervention and control groups ($p = 0.81$).

Compliance with local drug administration protocols for ALS, including timings, routes of administration and dosages, was also recorded. Of the 36 teams, all but one (control group) were compliant with their local drug administration protocols in both the first and second attempts. The intervention group had no negative impact on compliance with drug administration.

Discussion

The European Resuscitation Council emphasises the importance of early recognition of cardiac arrest, prompt and high-quality CPR, and rapid defibrillation.[6] Early defibrillation and high-quality CPR remain the highest priority for prehospital clinicians to maximise survival following cardiac arrest.[6,21,22] Our study focused on measuring the impact of the CPR Quality Officer role on the quality of chest compressions, time to defibrillation, time to airway management, and adherence to local drug protocols. Previous studies have reported that the quality of chest compressions during resuscitation often falls short of recommended guidelines which is associated with a negative impact on patient outcomes.[7–9] The CPR Quality Officer provided real-time feedback and guidance to the resuscitation team, resulting in significant improvements in the quality of chest compressions during resuscitation efforts in our simulated cardiac arrests. High-quality CPR has been shown to provide better long-term outcomes for cardiac arrest survivors, as it establishes the foundation for further interventions and post-cardiac arrest care.[9] By ensuring adequate blood flow to the heart and brain, high-quality CPR improves the conditions for successful resuscitation and reduces the risk of neurological damage.

Conventional roles in out-of-hospital cardiac arrests often lead to high cognitive demand and burden clinical resuscitation team leaders.[17] The CANLED trial reported that introduction of a nursing team

Table 1 – CPR performance of intervention group before (attempt 1) and after (attempt 2) CPR Quality Officer role assigned.

	Attempt 1			Attempt 2			p
	Average (% QCPR)	SE	CI	Average (% QCPR)	SE	CI	
Intervention	72.45%	3.70%	64.94%–79.97%	81.14%	3.41%	74.20%–88.07%	0.045
Control	77.57%	4.64%	68.15%–86.99%	76.86%	4.28%	68.16%–85.55%	0.998

SE - standard error, *CI* – 95% confidence intervals (lower - upper limit), p - p-value.

Table 2 – Time (seconds) to the first defibrillation

	Attempt 1			Attempt 2			
	Average (s)	SE (s)	CI (s)	Average (s)	SE (s)	CI (s)	p
Intervention	53.77	8.46	36.57–70.98	48.68	8.55	31.31–66.05	0.837
Control	63.71	10.61	42.15–85.28	61.07	10.71	39.30–82.84	0.986

s - seconds, SE - standard error, *CI* – 95% confidence intervals (lower - upper limit), p - p-value.

Table 3 – Time (seconds) to airway management and removing airway obstruction

	Attempt 1			Attempt 2			
	Average (s)	SE (s)	CI (s)	Average (s)	SE (s)	CI (s)	p
Intervention	168.95	28.74	110.54–227.37	136.95	24.57	87.03–186.88	0.1
Control	178.50	36.03	105.27–251.73	146.71	30.80	84.13–209.30	0.26

s - seconds, SE - standard error, *CI* – 95% confidence intervals (lower - upper limit), p – p-value.

leader resulted in an decrease in cognitive load for medical team leaders without increasing the overall cognitive load for the team.[16] Interestingly, the cognitive load of nursing leaders was even lower than that of senior nurse controls. This preservation of cognitive capacity may be attributed to the allocation of specific tasks rather than a loosely defined leadership position. Our study findings suggest that the inclusion of a subsidiary member with specialised education, training, and accountability focused on CPR quality enhances the team's overall performance. The additional focus on quality ensures accountability for individual actions and team performance, fostering a culture of responsibility and motivating the team to deliver high-quality care. Accountability helps identify and reflect on deficiencies or errors, leading to improvements in patient safety and clinical outcomes.[23–25] Similarly, the inclusion of a subsidiary CPR Quality Officer provides additional support to the cardiac arrest leader and improved clinical outcomes in our simulated scenarios. In our study, the presence of a dedicated CPR Quality Officer enhanced the quality of CPR compressions, without adversely affecting the time to first defibrillation, airway management, or compliance with local ALS protocols. The role's effectiveness is comparable to the results seen elsewhere, where implementation of an additional leader who focused on delivery of ALS quality resulted in statistically significant enhancements in metrics, such as compression fraction, time to attach a defibrillator, and promptness in addressing reversible causes.[16]

Participant feedback during debriefing revealed a lack of understanding of the CPR Quality Officer role, among some individuals, highlighting the need for strengthening training in future interventions. Several participants expressed confusion regarding the specific responsibilities and expectations associated with this new role. This lack of clarity resulted in some team members being unsure of how the CPR Quality Officer should collaborate with other team members during resuscitation efforts. This highlights the importance of providing comprehensive and explicit training to ensure a clear understanding of the CPR Quality Officer's role and its significance within the resuscitation team. By addressing this knowledge gap, we can enhance the integration and effectiveness of the role in improving the quality of ALS during out-of-hospital cardiac arrests.

Limitations.

In the current study, simulation is an investigational method where simulation is the environment for research and reported using the guidelines for health care simulation research.[26,27] Furthermore, the same trial conducted in practice would be very costly, take significantly more time, and eliminate ethical concerns about the intervention during cardiac arrest. SRB was used to pilot the trial, test our hypotheses, and inform decisions about future research needed. Limited knowledge of how the CPR quality would differ in clinical practice.

Conclusion

In a simulated environment, CPR Quality Officer did improve the quality of CPR compressions without a negative impact on time to first defibrillation, managing the airway, or adherence to local ALS protocols. The inclusion of a dedicated CPR Quality Officer could improve patient outcomes following cardiac arrest, but this requires confirmation in clinical studies.

CRediT authorship contribution statement

Kacper Sumera: Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Tomasz Ilczak:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Morten Bakkerud:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Jon Dearnley Lane:** Formal analysis, Data curation. **Jeremy Pallas:** Writing – review & editing, Methodology, Conceptualization. **Sandra Ortega Martorell:** Writing – review & editing, Methodology, Conceptualization. **Agnieszka Sumera:** Writing – review & editing, Methodology, Data curation. **Carl A. Webster:** Writing – original draft, Visualization, Conceptualization. **Tom Quinn:** Writing – review & editing, Supervision, Conceptualization. **John Sandars:** Formal analysis, Data curation. **A. Niroshan Siriwardena:** Supervision, Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: [Laerdal™ provided identical mannequins to each research centre free of charge for the data collection period. The company had no part in the design and analysis nor conducted the project.].

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Appendix A. Supplementary material

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