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Comparison of two training programmes on paramedic-delivered CPR performance

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ABSTRACT

Objective To compare CPR performance in two groups of paramedics who received CPR training from two different CPR training programmes.

Methods Conducted in June 2014 at the Hamad Medical Corporation Ambulance Service, the national ambulance service of the State of Qatar, the CPR performances of 149 new paramedic recruits were evaluated after they had received training from either a traditional CPR programme or a tailored CPR programme. Both programmes taught the same content but differed in the way in which this content was delivered to learners. Exclusive to the tailored programme was mandatory precourse work, continuous assessments, a locally developed CPR instructional video and pedagogical activities tailored to the background education and learner style preferences of paramedics. At the end of each respective training programme, a single examiner who was blinded to the type of training paramedics had received, rated them as competent or non-competent on basic life support skills, condition specific skills, specific overall skills and non-technical skills during a simulated out-of-hospital cardiac arrest (OHCA) assessment.

Results Paramedics who received CPR training with the tailored programme were rated competent 70.9% of the time, compared with paramedics who attended the traditional programme and who achieved this rating 7.9% of the time ($p<0.001$). Specific improvements were seen in the time required to detect cardiac arrest, chest compression quality, and time to first monitored rhythm and delivered shock.

Conclusions In an OHCA scenario, CPR performance rated as competent was significantly higher when training was received using a tailored CPR programme.

Key messages

What is already known on this subject?

Despite revised training standards, structured CPR training programmes and industry-regulated CPR refresher training schedules, paramedic-delivered CPR during out-of-hospital cardiac arrests (OHCA) remains inadequate and is rarely in line with established resuscitation guidelines. International resuscitation bodies such as the International Liaison Committee on Resuscitation postulate the need for tailored CPR training programmes in order to improve CPR performance.

What might this study add?

The results of this study indicate that paramedic-delivered CPR performance in an OHCA simulation, at the Hamad Medical Corporation Ambulance service in the state of Qatar, was improved following tailored CPR training. The process of tailoring CPR training to promote improved acquisition and retention of knowledge and skills took into account the operational role, clinical remit and scope of practice, educational background and learner characteristics of paramedics in Qatar.

INTRODUCTION

Despite revised training standards, structured CPR training programmes and industry-regulated CPR refresher training schedules, paramedic-delivered CPR during out-of-hospital cardiac arrests (OHCA) remains inadequate and is rarely in line with established resuscitation guidelines.[1–4]

International resuscitation bodies such as the International Liaison Committee on Resuscitation postulate the need for tailored CPR training programmes in order to improve CPR performance.[5] The aim of this study was to investigate the impact of a tailored CPR training programme designed specifically for the scope of practice, educational background, learner preferences and operational role of paramedics in Qatar, as well as within the country's healthcare system's response to OHCA.

METHODS

This prospective cohort study was approved by the Institutional Review Board at the University of Cape Town, South Africa, and conducted with permission at the Hamad Medical Corporation Ambulance Service (HMCAS), the national Ambulance Service for the State of Qatar.

Participants and recruitment for the study

The first of two groups of new paramedic recruits (n=63) was enlisted into the study to represent the participant cohort that had been assigned to receive traditional CPR training (control group). At the time, this training programme was used by HMCAS to train new paramedic recruits in CPR and existing paramedics who required CPR recertification every 2 years. The second group of paramedics (n=86) had background training and experience comparable to the first group and were recruited into the study after the first group had completed its training and had been signed off for active operational duty. This second group of new paramedic recruits was assigned to receive CPR training from an alternative tailored CPR training programme (experimental group). It should be noted that, apart from the different CPR training

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programmes, all 149 new paramedic recruits underwent exactly the same HMCAS administrative and clinical skill orientation programme.

Similarities and differences between the two CPR training programmes

Both training programmes were 8 h in duration and covered the same subject matter, paramedic scope of practice, resuscitative equipment and sequence of CPR steps, as prescribed by the HMCAS clinical practice guideline for adult cardiac arrest (see online supplementary appendix 1). The overarching difference, however, was in the way in which this subject matter was delivered and the pedagogical activities undertaken by each programme to ensure the acquisition and long-term retention of CPR knowledge and skills by learners. For example, in contrast to the traditional programme, the tailored programme included mandatory precourse work, which required learners to read a locally developed and tailored precourse information booklet, view a video demonstration of expected paramedic-delivered CPR performance at HMCAS and then demonstrate the assimilation of the precourse work through a precourse assignment, which was collected from learners at the commencement of the course. Learners received the precourse work no less than 7 days before commencement of the programme and those who were unable to collect this material were not recruited into the study. The tailored programme also included a pre, midway and postcourse evaluation followed by discussions and feedback at each of the three assessment junctures. This was not the case with the traditional programme, however, which contained only one summative evaluation conducted at the end of the course. In addition, the tailored programme predicated CPR proficiency on multiple practice cycles of eight individual and core skills, as opposed to the traditional programme which required learners to participate in multiple practice rounds of different full-length high fidelity OHCA scenarios.

In order to expose learners to a wide range of OHCA scenarios, where OHCA management might require a slight modification (eg, a pregnant, geriatric or trapped patient, overdose, hypothermic, etc), participants in the tailored programme were given theoretical scenarios and asked to discuss and explain how they would manage these less frequent and largely exceptional cases. In contrast to the traditional programme the tailored programme ensured strict adherence to allocated time intervals for pedagogical activities, increased attention to the use of non-technical skills like communication, leadership and situational awareness, and the inclusion of mental modelling sessions. These novel pedagogical activities (ie, mental modelling) were exclusive to the tailored programme and had the aim of shaping learners' thinking and behaviour and, ultimately, attempting to establish an approach to solving problems, particularly those problems involving the less frequent, but countless, exceptional OHCA cases that may arise. An overview of both training programmes is presented in table 1. Because the tailored programme was designed to reinforce knowledge acquired through the precourse work as opposed to introducing knowledge during the traditional programme, and due to the smaller candidate-to-instructor ratio, and the absence of multiple practice cycles of full-length high fidelity OHCA simulations, it was possible for the activities outlined in table 1 to be completed in the same 8-h day as was allocated to the traditional programme.

Overview of instructors

Six instructors were recruited to the study, all of whom were at the time working in the training department at HMCAS teaching the traditional CPR training programme. All instructors had the same foundational clinical qualification and had between 3 years' and 5 years' experience as CPR instructors at HMCAS. Three of the six instructors were then randomly chosen to attend the 1-day instructor course for the tailored training programme. This course included in-depth and step-by-step guidance on how the tailored programme should be conducted. This guidance ranged from how and what to prepare for each tailored programme, to employable methods to ensure that all learning objectives were reliably achieved, to the tone and approach to take when providing corrective real-time and postevent feedback. It also emphasised the role of facilitation as opposed to instruction when conducting mental modelling sessions as well as specific techniques to ensure that simulated assessments were conducted in a standardised fashion.

Outcome measures

The primary outcome measure was the rating of competent. This outcome measure reflects the learners' ability to perform high-quality effective paramedic-delivered CPR as defined and presented in box 1.

This ability was evaluated by a paramedic-delivered CPR Rapid Evaluation Tool (RET) (see online supplementary appendices 2 and 3). The tool was based on variables derived from the globally accepted Cardiff list and updated to the European Resuscitation Guidelines 2010 for adult cardiac arrest and consisted of 26 process measures.[5–7] Each measure represents a single or a group of treatment elements within a CPR care bundle, which has been proven by scientific evidence or expert consensus to be most likely to contribute to successful resuscitation.[8] In a separate study, in which the RET was developed and tested, Cohen and Fleiss κ coefficients ranging 0.92–1.00 and 0.75–0.96, respectively, were demonstrated, indicating acceptable intrarater reliability and inter-rater agreement.[6]

Examiners and application of the RET

The same examiner was used to evaluate CPR performance across both training programmes. This examiner also worked at HMCAS as an instructor; however, he had not participated in CPR training at any time in the past nor had he been involved in the development of the tailored programme. He therefore was blinded to the type of CPR training participants had attended and received. Prior to evaluation, the examiner attended a training session in which he received detailed instructions in how to evaluate CPR performance using the RET. To further aid the examiner in applying the RET, he was given a RET assessment rubric which he had on hand during every evaluation. In completing the RET, the examiner was simply required to mark dichotomous ratings by placing either a tick if a process measure was achieved or a cross if it was not. Using the same examiner to score the RET for the traditional and the tailored programme test protocols was decided on as a way of attenuating possible measurement bias, although the use of different raters would have been acceptable based on the tool's demonstrated inter-rater agreement scores.

Statistical analysis

Data were subjected to statistical analysis using SPSS (V.17.0, Chicago, Illinois, USA). Categorical data (dichotomous variables —tick for 'achieved' and cross for 'did not achieve') are reported as proportions. Comparisons of means of process (singular) and composite (grouped) measures between the control and the experimental groups are reported using independent samples t tests, with a p value <0.05 being considered as statistically significant.

Table 1 Overview and comparison of the two CPR training programmes

	Conventional CPR training programme	Tailored CPR training programme
Admission to training programme	New recruit to HMCAS Last CPR training >2 years while employed at HMCAS (Refresher)	New recruits to HMCAS Refresher training for APs
Duration of programme	1 full-day programme (6–8 h)	1 full-day programme (6–8 h)
Required instructor to candidate ratio	No prescribed instructor-to-candidate ratio (Minimum of 6 candidates for programme quorum)	One instructor per 6 candidates (Minimum of 6 candidates and maximum of 12 per class)
Candidate precourse work or reading	None	Read prescribed precourse document Watch prescribed pre-course demonstration of pdCPR Complete precourse assignment Study for precourse test
Programme overview	Course registration Presentation of theory component Skills practice component Practice sessions with different full-length simulated OHCA scenarios Competency assessment includes a full-length OHCA simulation	*Course registration* *Collection of precourse assignment* *Precourse test* *Theory component* *Mark precourse test—discussion* *Simulated OHCA demonstration (Video)* *Skills with peer feedback cycles* *Manage and present paper scenarios* *Simulated OHCA performance* *Postcourse test* *Mental practice and modelling sessions* *Simulated OHCA competency assessment*
Theory component	Key changes in CPR from 2005 to 2010. Evidence supporting changes. Related pharmacology (OHCA and IHCA) Non-technical skills	Reinforce elements from precourse reading and video Role and impact of CPR Physiological consequences of CPR Non-technical skills
Skills component	Supraglottic airway device insertion Intravenous line insertion LUCAS application	Recognition of cardiac arrest Hand positioning for chest compressions Compression rate Compression depth Compression release ratio LUCAS application Airway management Provision of synchronised ventilations
Practice component	Candidates placed in groups of 4 Candidates undertake full length simulated OHCA scenarios Each candidate to perform as team leader in at least 1 full OHCA scenario Postpractice feedback and support provided by instructor	Skill component—individual practice with feedback until mastery achieved Candidates placed in teams of two to complete and demonstrate outcome of paper scenario Mental practice and modelling prior to simulated OHCA assessment
Programme competency assessments	Final assessment Simulated OHCA assessment using a programme-specific assessment tool 100% of total mark	Continuous assessment Precourse assignment: 10% Precourse test: 20% Postcourse test: 20% Simulated OHCA assessment: 50%

AP, Ambulance Paramedic; CPR, cardio-pulmonary arrest; HMCAS, Hamad Medical Corporation Ambulance Service; IHCA, in-hospital cardiac arrest; OHCA, out-of-hospital cardiac arrest; pdCPR, paramedic-delivered CPR.

Study protocol

Study participants were informed about the study and their permission was requested on the day of the training programme at the beginning of their competency assessment for the respective programmes. Each individual participant was told to enter a skills assessment room with only their primary response equipment on hand. This included a primary response bag, an oxygen cylinder and regulator, a Lifepak 15 monitor/defibrillator and a Lund University Cardiopulmonary Assist System (LUCAS) mechanical chest compression device. Participants were also told that when they entered the assessment room, they would see three examiners, two of whom were their training programme instructors and one of whom was there to carry out the function of this study. Participants were also told that the programme instructors would answer any questions about the patient's condition that could not be obtained from this particular type of manikin, for example 'Yes' or 'No' to the possible question 'Is the patient breathing?' They were asked not to direct any questions to the study examiner, and were in fact told to imagine that the study examiner was not even present.

On entering the room the participants encountered a simple resuscitation manikin (Resusci Anne, Laerdal Medical, Stavanger, Norway) connected to an ECG rhythm generator.

Box 1 Definition of paramedic-delivered CPR

In the context of this study, paramedic-delivered CPR is defined as a cardiac arrest treatment bundle that includes manual and/or mechanical chest compressions, defibrillation, airway and ventilator support, as well as advanced cardiac life support drug management that is provided by paramedics who respond to an out-of-hospital cardiac arrest in the official capacity as part of an ambulance service response team in Qatar.

They were asked to imagine the resuscitation manikin to be a 50-year-old male patient lying supine on the floor. They were informed that there were no signs of trauma, no bystanders, and no other history was available or obtainable.

Each participant was accompanied by a basic life support (BLS) partner. The partner was to act only on instruction and was not allowed to perform any skills outside their clinical scope of practice. Participants were told to perform all skills and activities as if this were a real patient. This included everything from insertion of airways to delivery of shocks, establishment of intravenous lines, and loading patients for active transportation onto the long back board and stretcher provided. The simulation briefing was essential as it helped participants be clear on what they should simulate or actually do.[9 10]

To really test participants' understanding of the application of the CPR protocol, none of the participants in either test group (traditional and tailored CPR training programme group) had prior knowledge of the type of cardiac arrest simulation they would encounter, other than that it would be an adult medical cardiac arrest.[10]

RESULTS

The demographics, background training and experience of participants across the two groups were comparable (table 2).

The total proportion of participants rated as competent, as reflected by the RETs, was significantly higher in the experimental group: 61/86 (70.9%) vs 5/63 (7.9%) for the control group (traditional CPR). The experimental group performed significantly better in (1) BLS skills; (2) condition-specific skills; (3) specific overall skills and (4) non-technical skills. These four categories of process measures reflected a CPR care bundle that has been proven by scientific evidence or expert consensus to be most likely to contribute to successful resuscitation (table 3). Aggregated BLS skills (sum of A1 through B1) were performed significantly better ($p<0.001$) by the experimental group ($n=86$; $\bar{x}=8.78$) in comparison to the control group ($n=63$; $\bar{x}=3.89$). Aggregated condition specific skills (sum of B2 through B8) were also performed significantly better by the experimental group ($n=86$; $\bar{x}=6.92$) than the control group ($n=63$; $\bar{x}=2.22$) ($p<0.001$). Specific improvements across the control and experimental groups were seen in cardiac arrest detection time (17.5% vs 98.8%, respectively), and the components of chest compression quality, that is, rate (20.6% vs 98.8%), position (60.3% vs 100%), ratio (14.3% vs 100%), depth (25.4% vs 89.5%); and time to first monitored rhythm (20.6% to 100%) (table 3).

Table 2 Demographics, training and previous work experience for participants across the two groups

	Control group (n=63)	Experimental group (n=86)
Percentage male	89% (56/63)	94% (81/86)
Percentage female	11% (7/63)	6% (5/86)
Age*	29 (3.87) (23–39)	26 (2.51) (24–36)
Percentage with 4 years healthcare-related degree.	100 (63/63)	100 (86/86)
Years of experience in healthcare*	7.14 (3.84) (2–17)	4.66 (2.56) (2–14)
Percentage with previous work as EMT or paramedic.	6.3% (4/63)	10.5% (9/86)
Percentage with previous work as a nurse.	93.7% (59/63)	89.5 (77/86)
Percentage with valid BLS certification.	100 (63/63)	100 (86/86)
Percentage with valid ACLS certification.	87 (55/63)	81 (70/86)
Number of times CPR delivered (During simulation)*	6.32 (1.32) (4–10)	6.55 (0.85) (6–10)
Number of times CPR delivered (in real patients)*	8.17 (5.43) (1–33)	5.99 (3.59) (1–21)

*Expressed as a mean (SD) (range).
ACLS, advanced cardiac life support; BLS, basic life support; EMT, Emergency Medical Technician.

DISCUSSION

There is agreement that paramedic-delivered CPR quality is often suboptimal and changes are needed to improve OHCA outcomes.[1–4] Tailoring CPR training with the aim of improving the acquisition and retention of knowledge and skills has long been recommended as one strategy for improving performance.[6 11 12] The result of this study contributes, in part, to validating this recommendation, demonstrating that tailoring CPR training to the operational role of a healthcare practitioner within a healthcare systems response to OHCA, the practitioners' clinical scope of practice, educational background, and learner characteristics, would likely ensure improved acquisition and retention of CPR knowledge and skills, with subsequent improvement in CPR performance during a simulated OHCA assessment.

This study also showed that while new resuscitation guidelines appear to have improved the process of CPR, overall performance following traditional CPR training, as evaluated in a simulated OHCA assessment, remains poor, as seen in the low proportion (7.9%) of participants that were rated as competent following the traditional CPR training programme. This finding is consistent with previous reports.[12]

The tailored programme's approach in preparing learners before the course by using precourse reading and a precourse assignment appears to have reduced the need for long formal lectures during actual course time. Although reports indicate that precourse reading or work is unlikely to improve overall performance,[13 14] the absence of long formal theoretical components during the tailored programme allowed participants more time for structured cycles of actual hands-on practice which, as previous reports indicate, is correlated to enhanced skill retention.[15 16]

In addition, the use of continuous assessments comprising written and practical evaluations, and the provision of cycles of structured feedback from peers and the instructor in a consistent and measured fashion appear to have allowed the tailored CPR training programme group to rectify identified knowledge and skill gaps promptly in the apportioned time. This finding is also consistent with earlier reports supporting the use of constant feedback to improve CPR performance.[17 18]

Furthermore, the inclusion in the tailored CPR training programme of a short locally developed and custom-made video of HMCAS staff demonstrating CPR in a simulated OHCA appears to have been successful in reinforcing the sequence of steps and the quality standard of CPR that the experimental group was expected to perform at. The traditional CPR training programme did not include a video, and an understanding how to perform in an OHCA appears to have been left to participants' own interpretation. While videos that instruct and/or demonstrate CPR during training may not be essential, reports have often indicated superior overall CPR performance when videos are used.[19] As opposed to a live demonstration which

Table 3 Observed proportions of participants achieving process measures after training

Process measures		Control group Per cent	n/63	Experimental group Per cent	n/86	p -Value
A1	Loud shout and shake used to determine unconscious state in <5s	74.6	47	95.3	82	0.000
A2	No or agonal breathing detected on visual inspection of chest in <10 s	79.4	50	95.3	82	0.002
A3	Compressions started <15 s from patient contact	17.5	11	98.8	85	0.000
A4	Chest compressions given: 100 in total ≤1 min	20.6	13	98.8	85	0.000
A5	Chest compressions given: Correct position—lower half of the sternum	60.3	38	100.0	86	0.000
A6	Chest compressions given: Correct ratio—50: 50 and no leaning	14.3	9	100.0	86	0.000
A7	Chest compressions given: Correct depth—third of chest depth	25.4	16	89.5	77	0.000
A8	Rhythm analysis <1, 20 s from patient contact	20.6	13	100	86	0.000
B1	Rhythm identification correct	76.2	48	100	86	0.000
B2	Composite measure B2	28.6	18	100.0	86	0.000
B3	Composite measure B3	23.8	15	91.9	79	0.000
B4	Composite measure B4	42.9	27	100.0	86	0.000
B5	Composite measure B5	30.2	19	100.0	86	0.000
B6	Composite measure B6	28.6	18	100.0	86	0.000
B7	Composite measure B7	34.9	22	100.0	86	0.000
B8	Composite measure B8	33.3	21	100.0	86	0.000
C1	Correct sequence of events	74.6	47	100.0	86	0.000
C2	Interruptions in chest compressions <10 s	57.7	36	91.9	79	0.000
C3	LUCAS position correct throughout cardiac arrest event	25.4	16	98.8	85	0.000
C4	Ventilations <10/min	20.6	13	100.0	86	0.000
C5	Medications correct: time/dose/interval	46.0	29	98.3	82	0.000
C6	Rhythm treatment correct	95.2	60	91.9	79	0.419
C7	Defibrillation correct: time/safe/joule	82.5	52	91.9	79	0.086
D1	Non-technical skills—Good leadership and scene control	56.6	35	89.5	77	0.000
D2	Non-technical skills—Good situational awareness	22.2	14	93.0	80	0.000
D3	Non-technical skills—Good communication	54.0	34	89.5	77	0.000
Observed proportions rated as overall competent		7.9	5	70.9	61	0.000

may include elements that distract the audience, the images presented on a screen can be selected to focus the attention of the audience on specific aspects.

The tailored CPR training programme also required participants to work in pairs, to discuss and then to present their ideal management of different OHCA theoretical scenarios to the entire group. It also required them to undergo brief sessions of mental modelling before the final simulated assessment. The three interdependent pedagogical interventions (think through, talk through and act out) appear to have created a holistic learning experience tailored to challenge OHCA preconceptions while, more importantly, also improving the acquisition and retention of knowledge and skills. This appears to have offset the limitation of one isolated pedagogical intervention and as a result ensured that the set team-based paramedic-delivered CPR learning objectives were reliably achieved.

Addressing potential sources of bias

By enrolling the entire population of paramedics from each of the two new recruitment groups, the potential for selection bias was minimised. In addition, none of the study investigators themselves played any part in actual facilitation or teaching in either of the two training programmes (other than the initial instructor course and examiner training), nor were they permitted to examine participants during the actual data collection phases.

Study limitations

Despite measures taken to address all anticipated sources of bias, the nature, size and novelty of the tailored CPR training programme made it difficult to blind instructors to the type of training provided to participants. The instructors for the traditional CPR training programme were notified and asked to enrol in this study at the same time as the participants were informed (ie, at the end of the programme, just before participants had to undertake the final competency evaluation). This was not the case for the instructors of the tailored programme group who underwent a tailored CPR training programme instructor course and probably became aware of the study from other participants and instructors. Although there was no evidence to suggest that this happened, it is possible that the tailored CPR training programme instructors were not just better trained because of the trainer course, but also more motivated and more interested in training so a better training output result could be achieved. While in this study the examiner was blinded, a consideration and opportunity for further study is blinding instructors and examiners.

The use of a manikin with limited interactive features together with RET, and the CPR analysis it provides, does not adequately reflect clinical reality but was judged sufficient for the learning objectives being tested.[5 20] Although computerised methods of measuring compression depth are available, they also have limitations owing to the dependency of the underlying surface,[4] so the use of skill-reporting software is likely to provide more exact quantitative information about the quality of compressions performed. This presents an opportunity and consideration for further research. Another opportunity for further study is to examine the sustainability of the tailored CPR training programme from an economical and patient outcome perspective as it is notably far more resource-intensive and requires more work on the part of the instructors, when compared with traditional CPR programmes.

And lastly, while not a specific objective of this study, the lack of follow-up on retention, or competence in the field post training is a notable limitation and should also be included as a goal for further study.

Conclusions

The results of this study indicate that paramedic-delivered CPR performance in an OHCA simulation, at the HMCAS in the state of Qatar, was improved following tailored CPR training. The process of tailoring CPR training to promote improved acquisition and retention of knowledge and skills took into account the operational role, clinical remit and scope of practice, educational background and learner characteristics of paramedics in Qatar. Further research is required to determine the testing methods that relate classroom performance post tailored training to actual performance in the field, and to assess whether CPR performance rated as competent persists over time.

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Contributors All authors (KG, KS-H, LW and YP) have participated sufficiently in the work to take responsibility for the content. KG, KS-H and LW were involved in the study design, study protocol and writing of the manuscript. KG and YP were involved in the study implementation, data collection and analysis. All authors have reviewed, edited and approved the final submission.

Competing interests KG and YP are employed by HMCAS.

Patient consent Obtained.

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Data sharing statement All collected raw data and analysed data output is available on formal request from the University of Cape Town (UCT). This request can be made via the corresponding author, or directly with the institutional review board at UCT.

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