African Journal of Emergency Medicine 12 (2022) 344–351

Contents lists available at ScienceDirect

African Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/afjem

ORIGINAL ARTICLE

Training, knowledge, experience and perceptions regarding cardiopulmonary resuscitation of doctors at an academic hospital in central South Africa

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ARTICLE INFO

Keywords:
Cardiopulmonary resuscitation
CPR
Training
Knowledge
Perceptions

ABSTRACT

Background: Cardiopulmonary resuscitation (CPR) improves immediate survival and survival to discharge in patients with cardiac arrest in hospital. Without frequent retraining in CPR, healthcare providers may lose their skills and knowledge earlier than the recommendation of CPR retraining every two years.
Objectives: To determine the competencies of doctors at an academic hospital regarding CPR training, knowledge, experience and perceptions.
Methods: A custom-designed questionnaire reviewed by CPR providers was distributed to doctors to obtain information on CPR training, exposure to and perceptions of CPR retraining, and CPR knowledge. The knowledge component of the questionnaire comprised questions on basic, advanced cardiac, paediatric, neonatal and obstetric life support.
Results: Of the 245 participants, 22.5% achieved competency (a mark of ≥ 80%) for the knowledge component of the questionnaire. The majority of participants had not undertaken retraining after two years, although 96.7% of participants felt that keeping up-to-date with CPR guidelines would improve patient outcomes. The most common reasons provided for not feeling confident in performing CPR were related to training.
Conclusion: Doctors at the academic hospital in this study are currently not adequately trained in CPR, which is reflected by their lack of CPR knowledge. Lack of training seems to be the most common reason for not feeling confident, and being too busy to attend these retraining courses was reported as the most common reason. It further seems that very few of the departments have CPR training for their doctors. A regular in-hospital CPR training program may improve doctor's CPR knowledge.

African relevance

- Poor CPR knowledge and skills of doctors at multiple centres in South Africa and Africa have been reported over a period of time.
- Cost of training is expensive, especially for African centres, and alternatives should be explored to ensure CPR training of healthcare professionals.
- Training to perform CPR appropriately according to the latest CPR guidelines will improve patient outcomes after a cardiac arrest.

Introduction

Cardiopulmonary resuscitation (CPR) is a potentially lifesaving intervention for patients with cardiopulmonary arrest (CPA). Doctors are usually trained in CPR as undergraduate students. It is the responsibility of the doctors themselves to attend retraining and stay up-to-date with the most recent evidence-based CPR guidelines. It has been reported that healthcare providers who have attended CPR training in the past, but have not attended retraining within the preceding two years, have inadequate knowledge of CPR. [1–4] Scientific evidence regarding CPR and patient outcomes are reviewed frequently by the International Liaison Committee on Resuscitation (ILCOR) and updated CPR guidelines are published every 5 years. [5] The current recommendation by the American Heart Association (AHA) is to attend retraining in CPR every 2 years.[6]

An improvement in immediate survival and survival to discharge in patients with CPA while in hospital was noted when regular retraining programmes of healthcare providers had been implemented. [7–9] Three South African studies investigated CPR knowledge among doctors in hospitals. In one of these studies at a tertiary hospital, it was

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https://doi.org/10.1016/j.afjem.2022.07.001
Received 11 December 2021; Received in revised form 21 April 2022; Accepted 4 July 2022

found that the majority of participants had not attended CPR training within the preceding two years and obtained an average test score of 35.1% for their knowledge on CPR, which was well below the pass mark of 80%.[10] Another study investigated CPR skills and knowledge among interns during their two-month anaesthesia rotation. No improvement was observed in the pre-rotation and post-rotation scores for the written test, for which none of them scored > 80%, and their practical skills were also a concern as they could not provide good quality CPR. [2]

A study investigating the CPR knowledge of doctors in Limpopo Province, excluding interns, also found that the participants' knowledge of CPR was very poor. In addition, it demonstrated that having experience in performing CPR but with no formal CPR training. was not beneficial. [3] These studies indicated that there is a problem with CPR training and knowledge among doctors in South Africa.

At the Universitas Academic Hospital (UAH) in Bloemfontein, Free State Province, it is unknown how many doctors attend retraining in CPR. It is not an employment requirement in most departments to have an up-to-date CPR course attendance or qualification at any level, such as basic life support (BLS), advanced cardiac life support (ACLS) or paediatric advanced life support (PALS), although it is recommended. The undergraduate medical students at this institution complete the AHA BLS certification in their final year before qualifying and starting their internship. The medical interns complete an in-house CPR practical refresher while rotating through anaesthesia. This CPR training is based on the AHA and the Resuscitation Council of South Africa (RCSA) BLS and ACLS algorithms. Regarding CPR training and retraining of the medical officers, registrars and consultants, there are no formal CPR training opportunities offered to them, this is seen as being their responsibility to obtain recertification privately. Very few departments offer "in-house" CPR retraining despite access to a university clinical simulation training facility. The Departments of Anaesthesia and Family Medicine often make use of the facility to provide informal, in-house CPR practical training.

No published data regarding the outcome of patients with in-hospital cardiopulmonary arrest who received CPR while hospitalised in UAH, are available. The hospital has a resuscitation committee that reviews all reported CPR incidents and statistics are kept by a resuscitation coordinator. However, inconsistent reporting limits the analysis of data. The committee consists of a representative of each clinical department as well as operational managers of wards and theatres.

The aim of this study was to determine if doctors at UAH were adequately trained in CPR and knew how to perform CPR. The study also investigated doctors' attitudes towards CPR training and their perceived self-confidence in performing CPR. A questionnaire was used to obtain information on their CPR knowledge and their past and current CPR training.

Methods

Design

A descriptive observational study using a structured questionnaire, including a CPR knowledge test, was conducted.

Setting

Universitas Academic Hospital (UAH) is a tertiary hospital in the Free State Province and is affiliated with the University of the Free State (UFS) Faculty of Health Sciences, for both undergraduate and postgraduate training in clinical medicine, pathology, nursing, and rehabilitation- and exercise-related health professions. UAH is a tertiary referral institution and therefore does not have an emergency department, but each discipline manages their referred patients in the referral unit.

Participants

All interns, medical officers, registrars and consultants working in clinical departments at UAH were invited to participate in the study during October and November 2019 at their weekly departmental academic meetings.

Participants were excluded if they were not present at the departmental academic meeting on the day the questionnaire was administered, or if they decided not to participate. According to information from the human resources (HR) office, a total of 316 registrars and consultants were employed in all the clinical departments of UAH at the time of the study. The number of medical officers and interns were not included in the information provided by the HR office but was estimated to be approximately 100.

Ethical considerations

Approval of the study protocol was obtained from the Health Sciences Research Ethics Committee (HSREC) (reference UFS-HSD2019/1498/2910), the Free State Province Department of Health (reference FS_201909_011) and the relevant authorities at the University of the Free State.

Questionnaire design and distribution

The questionnaire was developed by the first author for this specific study. It was reviewed and refined by three qualified CPR providers in BLS, ACLS and PALS from the Departments of Family Medicine and Trauma, and the Clinical Simulation and Skills Unit in the Faculty of Health Sciences.

The questionnaire obtained information on demographic variables, CPR training, current exposure, perception regarding retraining and CPR knowledge. The knowledge component consisted of 20 questions divided into basic CPR (6 questions), advanced cardiac CPR (8 questions) and two questions each on paediatric, neonatal and obstetric CPR.

Algorithms from the Resuscitation Council of South Africa (RCSA) [11] and the statement from the AHA on cardiopulmonary arrest during pregnancy [12] were used as guidelines to develop the knowledge component of the questionnaire.

A mark of ≥ 80% for the CPR knowledge component of the questionnaire was interpreted as adequate knowledge of CPR. This standard was in keeping with the stipulations of the AHA BLS, ACLS and PALS courses that requires candidates to achieve a mark of ≥ 84% to receive their qualification.

A pilot study was conducted with the questionnaire being completed by the two medical doctors who were staff members at the Clinical Simulation and Skills Unit. These two participants were general practitioners. The data obtained from the pilot study were not included in the final data analysis and no changes to the questionnaire were necessary following the pilot study.

The questionnaire was distributed to each member of staff of the UAH clinical departments during one of their weekly academic meetings, as arranged in advance with the head of the department. Participation was voluntary and anonymous. The questionnaire was distributed and collected in the same sitting. Voluntary completion of the questionnaire was considered to imply informed consent.

Data analysis

Data were captured into a custom-designed Microsoft Excel spreadsheet and analysed by a biostatistician All questionnaires were included in the data analysis of the first three components of the questionnaire, namely demographic information, CPR training and CPR exposure.

Nine questionnaires were excluded from the analysis of the knowledge component. Of these nine, four had no knowledge questions completed and another five were excluded since the participants had appar-

Table 1
Information of participants with regard to years in practice, position and department.

	n (%)
Years in practice (n=244)	
0–5 years	43 (17.6)
6–10 years	109 (44.7)
11–15 years	39 (16.0)
16–20 years	14 (5.7)
> 20 years	39 (16.0)
Position (n=245)	
Intern	27 (11.0)
Medical officer	13 (5.3)
Registrar	138 (56.3)
Consultant	67 (27.4)
Department (n=245)	
Anaesthesiology	28 (11.4)
Cardiothoracic Surgery	5 (2.0)
Critical Care	1 (0.4)
Dermatology	4 (1.6)
Family Medicine	26 (10.6)
General Surgery	26 (10.6)
Internal Medicine	25 (10.2)
Neurology	3 (1.2)
Neurosurgery	4 (1.6)
Nuclear Medicine	3 (1.2)
Obstetrics and Gynaecology	19 (7.8)
Oncology	9 (3.7)
Ophthalmology	2 (0.8)
Orthopaedics	23 (9.4)
Otorhinolaryngology	7 (2.9)
Paediatric Surgery	3 (1.2)
Paediatrics	17 (6.9)
Plastic Surgery	2 (0.8)
Psychiatry	17 (6.9)
Radiology	12 (4.9)
Urology	9 (3.7)

ently missed an entire page while completing the questionnaire. For the remainder of the incomplete knowledge component of questionnaires, a question which had not been answered was considered as an indication that the participant did not know the answer to that particular question. Missing answers to knowledge questions were only interpreted as the respondent not knowing what the answer was in cases where only here and there an individual question was not answered, and adjacent questions were answered. Respondents frequently wrote “I don’t know” or a question mark on such questions to which they did not respond.

For the knowledge component of the questionnaire, all participants were expected to complete the first six questions on basic CPR. Thereafter, participants were only assessed on the questions applicable to them according to the speciality that they were working in, i.e. adult, paediatric, neonatal and obstetric patients. Based on the questions applicable to each participant, an overall percentage was calculated for questions answered correctly, as well as a percentage of correctly answered questions for each relevant subsection. Numerical variables were summarised by means and standard deviations and categorical variables by frequencies and percentages.

Results

In total, 245 doctors participated in this study, giving an estimated response rate of 58.9% when taking into account all interns, medical officers, registrars and consultants employed at UAH clinical departments.

Table 1 shows that most of the respondents were either registrars or consultants who had been qualified for 6-10 years. When determining the response rate of registrars and consultants only, which were best represented in this sample, the response rate was 64.9%. The distribution of participants according to clinical departments is illustrated in Fig. 1. The departments who had the most participants were the Departments of Anaesthesiology, Surgery and Family Medicine.

Table 2
Previous CPR training of participants and reasons for not being up-to-date with CPR training

	n (%)	Training > 2 years prior to study n (%)
Level/type of training (n=254)		
Undergraduate CPR training	221 (90.2)	–
Basic CPR training	222 (90.6)	144 (64.9)
Advanced CPR training	149 (60.8)	109 (73.2)
Paediatric CPR training	76 (31.0)	51 (67.1)
Neonatal CPR training	36 (14.7)	27 (75.0)
Reason for not being up-to-date with CPR training (n=183)		
Too busy to attend	109 (59.6)	–
Do not see the need to attend	32 (17.5)	–
Financial cost	31 (16.9)	–
Other	11 (6.0)	–

Table 3
Training viewed by participants as essential and frequency of CPR retraining considered necessary.

	Training viewed as essential n (%)
Participants per patient group and level of training	
All patients – basic CPR (n=243)	171 (70.4)
Managing adult patients – advanced CPR (n=223)	161 (72.2)
Managing paediatric patients – paediatric CPR (n=125)	76 (60.8)
Managing neonates – neonatal CPR (n=92)	68 (73.9)
	Frequency considered necessary n (%)
Frequency of CPR training (n=241)	
Bi-annually	7 (2.9)
Annually	39 (16.2)
Every 2 years	146 (60.6)
Every 3 years	25 (10.4)
> Every 3 years	6 (2.5)

CPR training

Regarding training, 23 (9.4%) doctors had never received training in CPR during their undergraduate studies. Although many doctors had received CPR training at undergraduate level and/or attended courses in basic and advanced CPR training, most had not attended retraining within two years (Table 2), with most doctors saying they were too busy to do so (Table 3).

Approximately half of participants (n=121; 49.4%) indicated that their department did not provide in-house CPR training, while some (n=36; 14.7%) were unsure if their department provided CPR training.

Perceptions of need for CPR retraining

Almost all doctors (n=237; 96.7%) felt that keeping up-to-date with current CPR guidelines would improve patient outcomes. Participants’ view on how often CPR retraining was necessary is indicated in Table 4.

Training viewed as essential for doctors to attend, according to the groups of patients the participants were exposed to, is indicated in Table 5. For each category, 30-40% of doctors did not consider CPR training as essential. More than a third of doctors (n=94; 38.4%) acknowledged that their CPR skills were not up-to-date.

Exposure to CPR

When looking at participants’ current exposure in performing CPR, 33 (13.5%) of the participants last performed CPR within the three to six

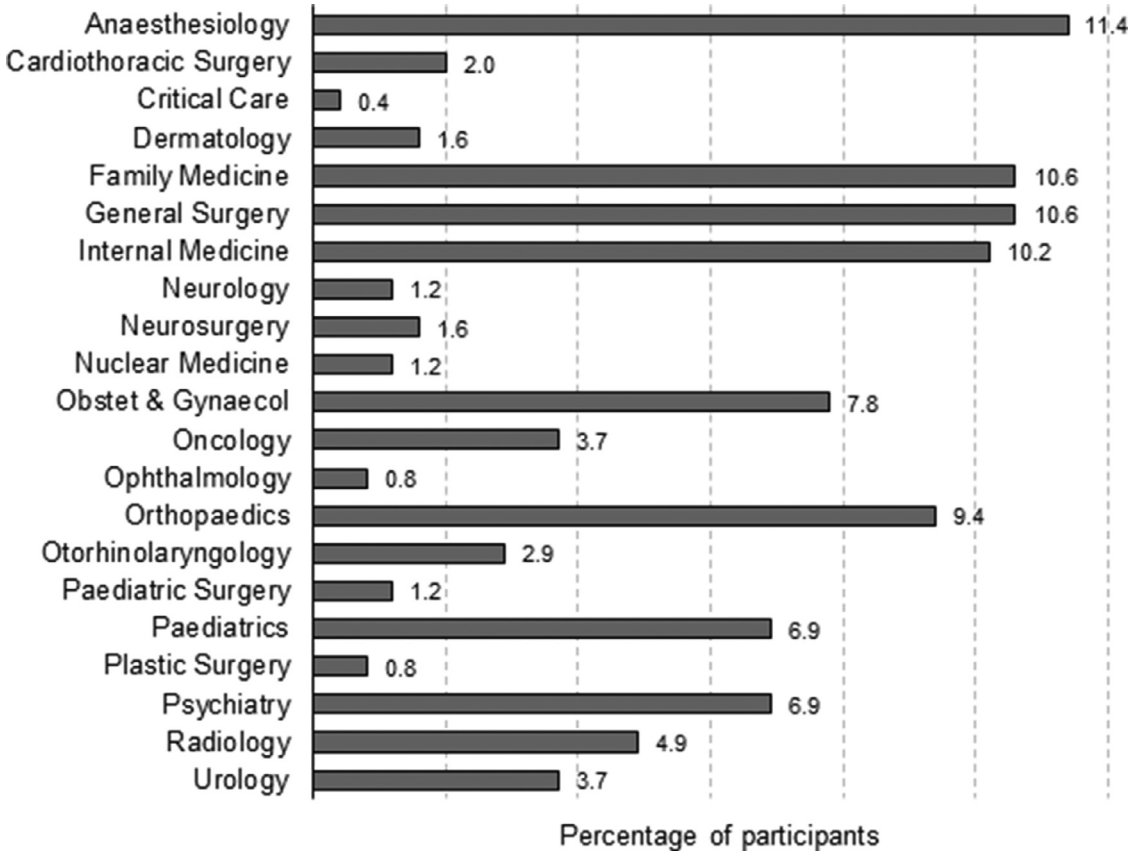

Fig. 1. Participants included in study according to clinical department (%).

Table 4
Results of participants' achievement on the CPR knowledge component of the questionnaire.

	N	Median score (%)	Score		
			< 50% *n* (%)	50–79% *n* (%)	≥ 80% *n* (%)
Overall	236	64.6	56 (23.7)	127 (53.8)	53 (22.5)
Basic CPR (q. 1–6)	239	66.7	46 (19.3)	108 (45.1)	85 (35.6)
Advanced CPR (q. 7–14)	236	75.0	42 (17.8)	120 (50.8)	74 (31.4)
Paediatric CPR (q. 15–16)	121	50.0	33 (27.3)	88 (72.7)	–
Neonatal CPR (q. 17–18)	91	50.0	20 (22.0)	71 (78.0)	–
Obstetric CPR (q. 19–20)	72	50.0	17 (23.6)	55 (76.4)	–

months preceding the study, while 54 (22.0%) participants performed CPR at least twice a year.

Confidence in performing CPR

On questioning if the participant felt confident in performing CPR, registrars were the group with the highest positive result and consultants the least, even less than interns (Fig. 2).

The two most commonly stated reasons for not being confident in performing CPR were 'not doing CPR often enough' (n=86; 35.1%) and 'not enough/no recent training' (n=69; 28.2%). Over 70% of doctors, regardless of seniority, attributed their lack of confidence in CPR to insufficient training (Fig. 3).

A variety of other reasons were given by participants for not being confident in performing CPR. These reasons were grouped into 'skills and knowledge', 'training and supervision' and 'resources', and indicated a deficiency or lack of these particular aspects, as expressed by the participants, that contributed to not being confident in performing CPR.

Knowledge of CPR

Doctors were only assessed on the questions applicable to the groups of patients they had indicated they were in contact with and would therefore be required to perform CPR on, should the need occur. Table 6 indicates the overall score as well as scores achieved for subsections of the questionnaire. Only 55 (22.4%) of the participants achieved an overall score of ≥ 80%.

The paediatric, neonatal and obstetric subsections consisted of only two questions per subsection, so a participant could only achieve a mark of 0%, 50% or 100% per subsection. The majority of participants scored ≥ 50% for the subsections.

The results for each individual question are indicated in Table 7. The questions on which participants performed the best were questions 5, 6,

Table 5
Percentage of participants answering individual CPR knowledge questions correctly.

Category	Question (number of participants)	Correct (%)
Basic CPR	1. When do you change the compressions to ventilations ratio for 30:2 to 15:2? (n=239)	44.8
	2. How frequently should you do a rhythm and pulse check? (You have a timekeeper.) (n=239)	57.3
	3. At what rate should you administer chest compressions to an adult? (n=239	58.2
	4. How frequently can you administer adrenaline if repeat doses are required? (n=239)	58.6
	5. How much adrenaline is in one ampoule at Universitas Academic Hospital? (n=239)	83.7
	6. Which of the following should you do first when you find an unresponsive adult patient? (n=239)	80.8
Advanced cardiac CPR	7. At what rate should you administer rescue breaths to an adult patient? (n=236)	49.2
	8. During which cardiac rhythm is a shock advised? (n=236)	82.2
	9. What is the dose of monophasic defibrillation in an adult patient? (n=236)	37.3
	10. What dose of adrenaline should be administered during cardiopulmonary arrest in an adult? (n=236)	75.4
	11. During which cardiac arrhythmia should adenosine be administered? (n=236)	72.0
	12. During which situation should you administer atropine as the first-line medication? (n=236)	58.5
	13. After a shock is delivered, what is your next step? (n=236)	67.4
	14. With regard to achieving successful patient outcome following a cardiopulmonary arrest, what is the most important time interval? Witnessed arrest to … (n=236)	88.1
Paediatric CPR	15. What dose of adrenaline should be administered during cardiopulmonary arrest in a child? (n-=121)	48.8
	16. When a child is in ventricular fibrillation, what dose of shock should you deliver? (n=121)	60.3
Neonatal CPR	17. What is the rate of compressions to ventilations in neonates during cardiopulmonary resuscitation? (n=91)	52.8
	18. At which heart rate should you start chest compressions in a neonate? (n=91)	65.9
Obstetric CPR	19. During CPR in a pregnant patient, how should you position the patient? (n=72)	26.4
	20. When should a caesarean delivery be done during CPR in a pregnant patient? (n=72)	56.9

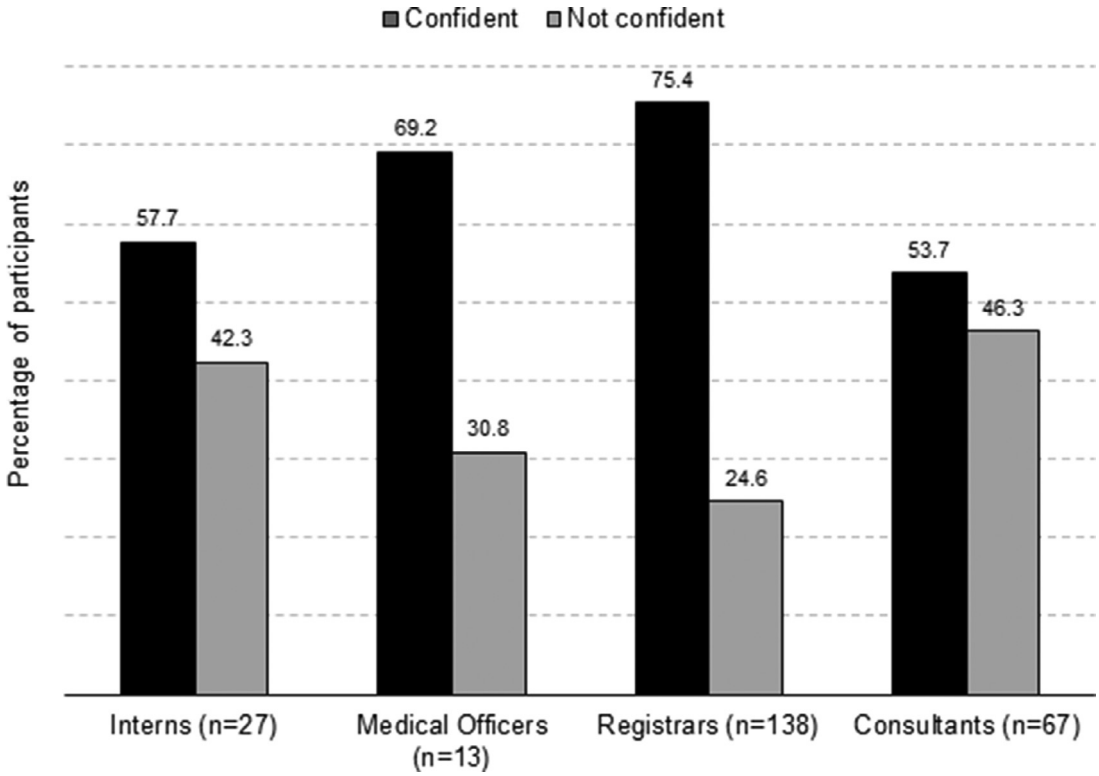

Fig. 2. Participants' confidence in performing CPR (%).

Table 6
CPR knowledge results.

	N	Median score (%)	Score		
			< 50% *n* (%)	50–79% *n* (%)	≥ 80% *n* (%)
Overall	236	64.6	56 (23.7)	127 (53.8)	53 (22.5)
Basic CPR (q. 1–6)	239	66.7	46 (19.3)	108 (45.1)	85 (35.6)
Advanced CPR (q. 7–14)	236	75.0	42 (17.8)	120 (50.8)	74 (31.4)
Paediatric CPR (q. 15–16)	121	50.0	33 (27.3)	88 (72.7)	–
Neonatal CPR (q. 17–18)	91	50.0	20 (22.0)	71 (78.0)	–
Obstetric CPR (q. 19–20)	72	50.0	17 (23.6)	55 (76.4)	–

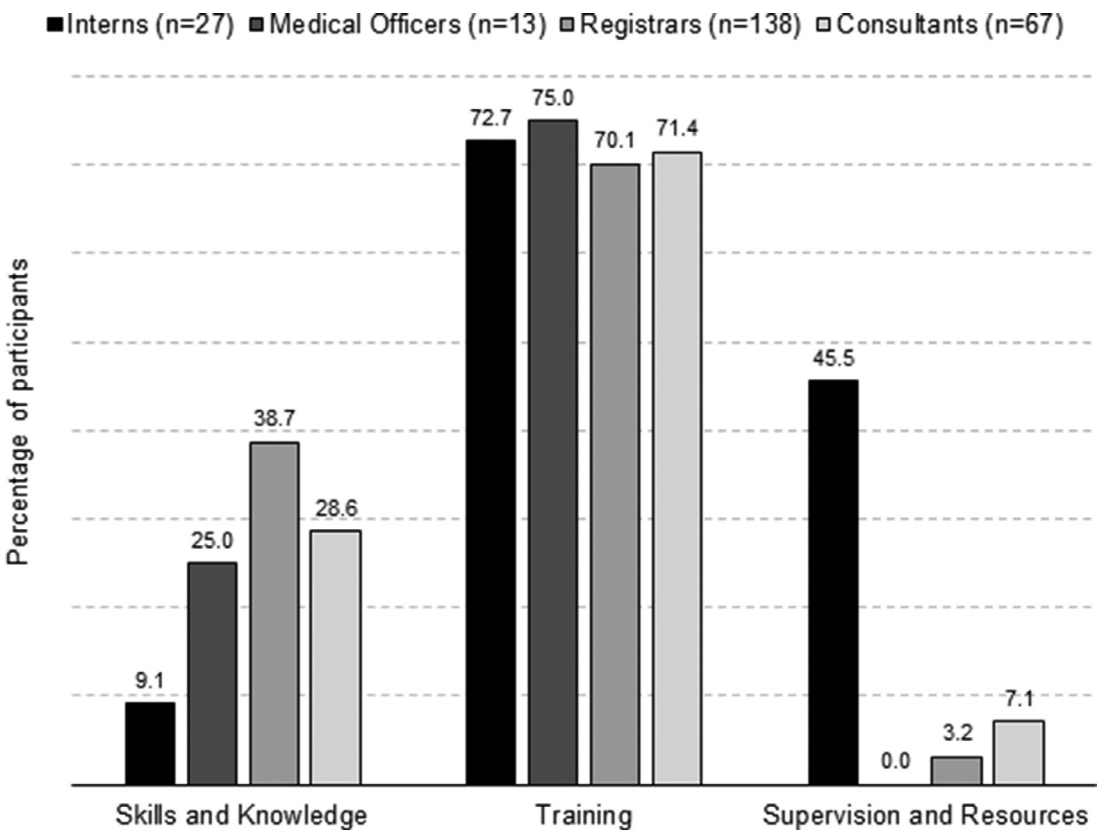

Fig. 3. Reasons stated by participants for not being confident in performing CPR (%).

Table 7
Percentage of participants answering individual CPR knowledge questions correctly.

Category	Question	Correct (%)
Basic CPR	21. When do you change the compressions to ventilations ratio for 30:2 to 15:2?	44.8
	22. How frequently should you do a rhythm and pulse check? (You have a timekeeper.)	57.3
	23. At what rate should you administer chest compressions to an adult?	58.2
	24. How frequently can you administer adrenaline if repeat doses are required?	58.6
	25. How much adrenaline is in one ampoule at Universitas Academic Hospital?	83.7
	26. Which of the following should you do first when you find an unresponsive adult patient?	80.8
Advanced cardiac CPR	27. At what rate should you administer rescue breaths to an adult patient?	49.2
	28. During which cardiac rhythm is a shock advised?	82.2
	29. What is the dose of monophasic defibrillation in an adult patient?	37.3
	30. What dose of adrenaline should be administered during cardiopulmonary arrest in an adult?	75.4
	31. During which cardiac arrhythmia should adenosine be administered?	72.0
	32. During which situation should you administer atropine as the first-line medication?	58.5
	33. After a shock is delivered, what is your next step?	67.4
	34. With regard to achieving successful patient outcome following a cardiopulmonary arrest, what is the most important time interval? Witnessed arrest to …	88.1
Paediatric CPR	35. What dose of adrenaline should be administered during cardiopulmonary arrest in a child?	48.8
	36. When a child is in ventricular fibrillation, what dose of shock should you deliver?	60.3
Neonatal CPR	37. What is the rate of compressions to ventilations in neonates during cardiopulmonary resuscitation?	52.8
	38. At which heart rate should you start chest compressions in a neonate?	65.9
Obstetric CPR	39. During CPR in a pregnant patient, how should you position the patient?	26.4
	40. When should a caesarean delivery be done during CPR in a pregnant patient?	56.9

(BLS) 8 and 14 (ACLS), and the questions on participants performed the worst were questions 1, (BLS) 7, 9, (ACLS) 15 (paediatric CPR) and 19 (obstetric CPR). The breakdown of all the questions and options for answers is shown in the appendix.

Discussion

The results showed that the current competencies of doctors at UAH regarding CPR training and knowledge were inadequate. Their perceptions regarding CPR retraining at regular intervals and the association with patient outcomes did not correlate with their confidence in performing CPR and CPR knowledge. When interpreting the data, it could be viewed in context of each subsection of the questionnaire and then in its entirety.

The majority of participants were registrars, in which was in keeping with the majority of participants that were 6-10 years in practice. Doctors usually enter a registrar program a year or two after completing their internship and community service, and registrar programs are typically of 4-5 years' duration, depending on the discipline.

It is evident from the results that the majority of doctors felt that keeping up-to-date with the latest CPR guidelines would improve patient outcomes. The majority of participants also felt that at least basic CPR

training is essential and that it is necessary to attend CPR retraining every two years. However, despite these sentiments, only a minority of participants had attended retraining and most of these had not attended retraining for over two years.

Although guidelines suggest retraining is required every two years, it has been suggested in the literature that retraining should occur even more frequently, based on evidence that skills and knowledge deteriorate within 3-12 months from initial training. [6] It has also been reported that motor skills deteriorate more rapidly than theoretical knowledge. [13]

These issues are concerning as high-quality CPR has been proven to improve patient outcomes, especially following an in-hospital cardiopulmonary arrest. The motor skills acquired by CPR training are the essence of providing good quality CPR, in addition to early recognition of cardiopulmonary arrest, initiation of CPR, defibrillation where indicated and administration of applicable drugs. [14]

The most common reason stated for not attending retraining was that participants were too busy to attend retraining courses. In addition, many participants mentioned that they were not allowed special leave to attend CPR retraining courses. This should be something for which doctors should not have to take personal leave, and clinical departments should actively encourage attendance of bi-annual CPR retraining or even make it compulsory to attend.

Another common reason stated for not attending courses, was that participants did not see the need to undergo CPR retraining. However, it was not specified whether they held this opinion because they felt that their knowledge was sufficient and retraining was unnecessary, or for other reasons. Regardless of reasons, this point of view expressed by the participants is disconcerting given the poor results obtained the knowledge component of the questionnaire. Most participants who scored poorly on the knowledge tests, did not feel the need to update their CPR knowledge, thereby indicating a falsely elevated self-evaluation of their knowledge and skills.

Financial cost was also given as a reason for not attending retraining. To register and attend the advanced CPR training, a participant first has to obtain the basic CPR qualification and register for the advanced courses within two years, otherwise the basic CPR course will have to be repeated. With this system, significant financial costs are involved. Currently, these courses cost between R 1 000.00 to R 4 000.00 (which was equivalent to approximately US $65-262 at the time of the study). Furthermore, travel and accommodation costs may also be incurred. These costs could be reduced by arranging in-house departmental CPR training courses, probably at a fraction of the cost of formal CPR courses. At UAH, these in-house courses could be presented by suitably qualified staff at the Clinical Simulation and Skills Unit in the adjacent Faculty of Health Sciences. An in-house program will not award the participant with a formal certificate of qualification but will provide regular skills and knowledge refreshers to improve the quality of CPR available to patients when necessary.

The provision of CPR training at UAH was found to be a major problem - most participants did not know whether their departments provided CPR training or indicated that it did not. The departments that did provide CPR training largely incorporated this training in the management of certain emergency situations, such as Essential Steps in the Management of Obstetric Emergencies (ESMOE), Advanced Trauma Life Support (ATLS) and Managing Emergencies in Paediatric Anaesthesia (MEPA). These courses train participants on the management of relevant emergencies, but the focus was not on CPR training. Only a limited number of departments provided basic CPR training.

The majority of participants felt confident in performing CPR, particularly the registrars. Reasons for this could be because registrars are in a training position, which often requires them to be first on-call for emergencies and they may therefore be more involved in the emergency care of patients, including CPR situations, than other groups of doctors. Consultants were least confident, but unfortunately the reasons for this were not explored in the questionnaire. An important concept to mention is also that reported confidence does not equate to competence. In this study, competence and the CPR motor skills were not assessed.

In this study, most doctors performed CPR at least twice a year, with variation between disciplines. Some departments see more acutely ill patients and are confronted with situations requiring CPR more often than other departments.

Although the majority of doctors (64.1%) felt confident in performing CPR, a significant number did not, which is a matter of concern, as every doctor should be competent in at least basic CPR. The results showed that most participants attributed this lack of confidence to training issues. For the doctors such as interns, who were least experienced, problems were also identified with supervision during CPR. Registrars, who were as a group more experienced in terms of years of service, additionally attributed their lack of confidence in CPR to skills and knowledge issues.

The most common individual reasons given for lack of confidence in CPR, included doing CPR infrequently and having had no recent training or practice in CPR. This is consistent the with literature stating that without frequent exposure or retraining, one loses the knowledge and skills required for competent performance of CPR. [13,15] Several participants felt insufficiently confident to administer the required medications during CPR, although it is not known whether they were unsure which medications to use or that they did not know the doses. Others were not confident in using a defibrillator since automated external defibrillators (AEDs) had replaced manual defibrillators in most clinical areas of the hospital and they had only been trained to use the latter. However, this problem could easily have been rectified by the participant requesting AED training as these devices are simple to use and can even be used by non-healthcare practitioners.

Compared to previously published findings, the doctors' tests scores for overall CPR knowledge in this study were higher. In previous studies, most healthcare providers achieved less than 50% for basic and advanced cardiac CPR knowledge. [1-3,10] The participants of this study at UAH achieved an overall median score of 64.6%, which was notably better compared to other studies' mean scores of 35.1% and 44.5%. [1,10] The study populations and the difficulty of the CPR knowledge questions were similar, except for the additional questions on paediatric, neonatal and obstetric CPR, which may have enabled the participants in this study to obtain higher scores.

These speciality-related questions were only assessed according to the groups of patients the participants had self-declared were managed clinically by them. It was deemed that by inference, these would be the types of patients the participants were required to perform CPR on, should the necessity arise. The participants therefore had the best opportunity to score well as these questions were related to the patients they regularly treated. Regardless, an overall CPR knowledge score considered as adequate (≥ 80%) was obtained by less than a quarter of doctors (22.5%). However, in comparison to previous findings, the participants at UAH had better results. In the studies by Niambar et al. [1] and Ragavan et al., [3] only 4.3% and 4.6% of participants, respectively, obtained marks of ≥ 80%. [1,3]

It was disappointing to find that questions regarding adrenaline, the most commonly used medication in CPR, were frequently answered incorrectly. Several (n=40; 16.3%) participants could not say how much adrenaline was in a single ampoule, which could be attributed to the common practice of giving "an ampoule" of a medication without checking its concentration. More than half of the participants (n=125; 51.0%) regularly treating children, did not know the correct dose of adrenaline in μg/kg for a child during a cardiac arrest. Similarly, this is probably because of the practice of drawing up "an ampoule" of adrenaline in a certain volume of diluent, and then giving the adrenaline as mL/kg for a child, without actually knowing how many micrograms were injected. This practice is inherently dangerous as manufacturers potentially can produce ampoules of a different concentration, and different institutions or clinical areas may have different regimes for diluting adrenaline, leading to potentially over- or underdosing, when a clinician is solely

familiar with giving a certain volume of adrenaline per kilogram of a child's weight.

Limitations

Interns and medical officers were poorly represented in this study sample, and therefore the results were not representative of this group of doctors. Most probably, this was because many were not present during the departmental meetings when the questionnaire was completed owing to clinical workload, with registrars given preference to attend departmental meetings.

This study did not evaluate the participants' motor skills required for CPR, while research has shown that CPR skills deteriorate to a greater extent and more rapidly than theoretical knowledge. A future study could incorporate both practical CPR evaluation and theoretical knowledge assessment.

Due to time constraints and the assumption that the participants would be reluctant to complete a lengthy questionnaire, the number and depth of the questions in the knowledge component were limited. Only two questions were included pertaining to paediatric, neonatal and obstetric CPR, respectively, to keep the questionnaire at a reasonable length and encourage its completion. To clarify participants not knowing an answer compared to missing a question, an "I don't know" option could be included for knowledge questions.

This study did not include evaluation of the nursing staff of the hospital. Nursing staff in the wards are usually the first responders to a patient with cardiorespiratory arrest. They initiate basic CPR until the resuscitation team arrives and takes over. In a survey on nurses' basic CPR knowledge and training at UAH, Keenen et al. [16] found that only 11% of nurse participants of all levels of qualifications and seniority, obtained a mark of ≥ 80% for their basic CPR knowledge. This reflected poor CPR knowledge despite the fact that 93.1% of participants reported to have attended CPR courses, of which the majority (60.9%) occurred within one year preceding the study. [16] Although this questionnaire, designed by the first author, was reviewed by qualified CPR providers, it has not been validated in a formal study.

Conclusion

The results of this study demonstrated that the majority of doctors at UAH were not adequately trained in CPR and had inadequate CPR knowledge. Many lacked confidence in performing CPR. Most doctors recognised that it was important to remain up-to-date with CPR training, but had not attended retraining. Doctors at UAH should attend CPR training courses and/or scheduled in-house CPR training, in order to maintain an adequate level of experience with CPR guidelines and re-establish their CPR skills. Creating awareness of the rapid loss of skill and knowledge without retraining could serve as a motivator to create and implement regular CPR training to health care practitioners.

Author contributions

Authors contributed as follows to the study's conception or design; the acquisition, analysis, or data interpretation; and drafting or critical revision for important intellectual content: NdP contributed 50%, GL 35% and GJ 15%. All authors approved the version for publication and agree to be accountable for all aspects of the work.

Dissemination of results

The data communicated in this article represent the findings of the study. Any further information can be obtained from the corresponding author upon reasonable request.

Declaration of Competing Interest

This article was part of the dissertation submitted by Nadia du Plessis in partial fulfilment of the requirements for the degree MMed in Anaesthesiology.

Acknowledgements

The doctors of Universitas Academic Hospital who participated in the study; and Dr. Daleen Struwig, medical writer/editor, Faculty of Health Sciences, UFS, for technical and editorial preparation of the manuscript.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.afjem.2022.07.001.

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