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ORIGINAL ARTICLE

The understandability and quality of telephone-guided bystander cardiopulmonary resuscitation in the Western Cape province of South Africa: A manikin-based study

Leonel P De Caires, Katya Evans, Willem Stassen *

Division of Emergency Medicine, Faculty of Health Science, University of Cape Town, Observatory, Cape Town, South Africa

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ABSTRACT

Background: The incidence of cardiovascular disease is on the increase in Africa and with it, an increase in the incidence of out-of-hospital cardiac arrest (OHCA). OHCA carries a high mortality, especially in low-resource settings. Interventions to treat OHCA, such as mass cardiopulmonary resuscitation (CPR) training campaigns are costly. One cost-effective and scalable intervention is telephone-guided bystander CPR (tCPR). Little data exists regarding the quality of tCPR. This study aimed to determine quality of tCPR in untrained members of the public. Participants were also asked to provide their views on the understandability of the tCPR instructions.

Methods: This study followed a prospective, simulation-based observational study design. Adult laypeople who have not had previous CPR training were recruited at public CPR training events and asked to perform CPR on a manikin. Quality was assessed in terms of hand placement, compression rate, compression depth, chest recoil, and chest exposure. tCPR instructions were provided by a trained medical provider, via loudspeaker. Participants were also asked to complete a short questionnaire afterwards, detailing the understandability of the tCPR instructions. Data were analysed descriptively and compared to recommended quality guidance.

Results: Fifty participants were enrolled. Hand placement was accurate in 74 % ($n = 37$) of participants, while compression depth and chest recoil only had compliance in 20 % ($n = 10$) and 24 % ($n = 12$) of participants, respectively. The mean compression rate was within guidelines in just under half (48 %, $n = 24$) of all participants. Only 20 (40 %) participants exposed the manikin's chest. Only 46 % ($n = 23$) of participants felt that the overall descriptions offered during the tCPR guidance were understandable, while 80 % ($n = 40$) and 36 % ($n = 18$) felt that the instructions on hand placement and compression rate were understandable, respectively. Lastly, 94 % ($n = 47$) of participants agreed that they would be more likely to perform bystander CPR if they were provided with tCPR.

Conclusion: The quality of CPR performed by laypersons is generally suboptimal and this may affect patient outcomes. There is an urgent need to develop more understandable tCPR algorithms that may encourage bystanders to start CPR and optimise its quality.

Introduction

The incidence of cardiovascular diseases on the African continent was expected to double in the three decades from 1990 to 2020 [1]. In the absence of robust representative epidemiological data on out-of-hospital cardiac arrest (OHCA) from the African continent [2,3], and considering that the leading cause of OHCA is cardiovascular disease [4,5], it may be argued that similar trends in the incidence of OHCA might be expected.

Outcomes following OHCA are poor in low-resource settings, with some reporting as little as 0 % survival rates [2]. Even in high income countries with established mechanisms to manage OHCA, most countries report long-term survival rates ranging from 5.8 %−9.5 % [6]. In order to maximise survival, the International Liaison Committee on Resuscitation (ILCOR) and several national and regional organisations recommend early bystander cardiopulmonary resuscitation (CPR) [7,8]. To equip bystanders to perform CPR, mass public CPR training programmes have been suggested, but these haven't been found to be cost effective [9,10], especially for low resource settings with underdeveloped emergency care systems and a limited public fiscus. Yet, the

* Corresponding author.
E-mail address: willem.stassen@uct.ac.za (W. Stassen).

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chances of survival from OHCA decreases by 7–10 % for every minute's delay in initiating CPR [11]. Considering then that the median response time to OHCAs in the City of Cape Town, South Africa was 26 min [12], it becomes clear that waiting for the arrival of emergency medical services (EMS) before treatment commences, is not feasible.

One solution to overcome this, is for the emergency despatch centre staff (or call-takers) to identify OHCA at the initial call for emergency assistance, and to encourage bystander CPR through telephone-guided instructions, so-called tCPR [13,14]. The implementation of tCPR programmes have correlated with a doubling of bystander CPR rates [15] and improved survival [16–19]. In one study, 30-day survival increased from 7.1 % to 13 % when tCPR was administered [20]. Similarly, a study from the United States found a 56 % (aOR 1.56; 95 % CI 1.06–2.31) increase in the odds of favourable functional outcome at discharge when tCPR was provided [21]. However, multiple barriers including poor communication and lack of confidence have been demonstrated to prevent successful initiation of bystander CPR by the caller [22–24]. To overcome this, it is essential that OHCA recognition and tCPR algorithms are easy to use, and makes use of clear and concise, contextually relevant language [25].

After tCPR has been initiated successfully, it is essential for the bystander CPR to be optimised to improve quality through an adequate compression rate and depth, allowing for complete chest recoil and minimising interruptions [7]. Good quality CPR has been linked to improved functionally intact survival [7].

To our knowledge, there is currently no published literature available on the uptake of tCPR in South Africa, nor on the quality of bystander CPR that is achieved when tCPR is successfully implemented. The current study therefore sought to determine the quality of bystander CPR when given tCPR instructions in a simulated environment. A secondary aim was to determine the understandability of the tCPR instructions. In this way we seek to provide preliminary, exploratory data that can assist in the development and implementation of tCPR guidelines within the Western Cape and South African contexts.

Methods

Study design

This study followed a prospective, simulation-based observational study design. Ethical approval was obtained from the Human Research and Ethics Committee of the University of Cape Town (Ref: 066/2019). Where items are applicable, this study is reported according to the Simulation-Based Research Extensions for the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement [26].

Study setting

The Western Cape province of South Africa has a population of approximately 6.3 million people, with around 11 % of the South African population living within this province. In this province, ischaemic heart disease, a common cause of OHCA [5], ranks amongst the top three causes of death [27]. In the Western Cape, approximately 26 % of the population subscribe to a medical insurance scheme [28], allowing them access to high resourced private healthcare. The majority of people living within the province speak Afrikaans (46.6 %) as their first language, followed by isiXhosa (31.1 %) and English (19.6 %) [29]. The prevalence of OHCA in the City of Cape Town (the province's most populous city) is estimated at 23.2 per 100 000 [12]. For those patients in whom resuscitation is attempted, the return of spontaneous circulation rate is 1.3 % [12]. There is no OHCA registry in this province or city.

This study was performed at a series of hands-only CPR training events run in and around the city of Cape Town. Data collection occurred at community halls or venues of non-governmental organisations in three suburbs (Muizenburg, Cape Town City Bowl, and Woodstock). Such events were organised on an ad hoc basis by the University of Cape Town's Division of Emergency Medicine's residency group.

Participants

At these training events, members of the public may arrive at their own convenience and receive one-on-one instructor-led hands-only CPR training. Potential participants were approached in-person at these events by the first author (LDC). Eligibility to participate required that the potential participants be 18 years or older, had no prior CPR training and had no physical or psychological characteristics that would impact on their ability to perform CPR. This was ascertained verbally and self-reported by the participants. Participation in the study was entirely voluntary and written, informed consent was obtained prior to enrolment. Members of the public were still trained in hands-only CPR even if they were not eligible or willing to participate in the research. No data were recorded on members of the public that did not consent for the research.

Simulation and equipment

After obtaining informed consent, participants were taken into a private room, where a high-fidelity resuscitation manikin was set up (Resusci Anne QCPR, Laerdal Medical, Stavanger, Norway). A standardised smartphone (Apple iPhone XR, Apple Inc., California, United States of America) was placed on loudspeaker, as per the algorithm, and handed to participants to call an allocated EMS call-taker. They were told that the manikin was a "person" who had collapsed and they would be required to phone an emergency phone number and start with the line of *"Please help, someone has collapsed."*

A healthcare provider (medical doctor) was trained on the Western Cape Provincial Emergency Medical Services (EMS) hands-only tCPR guide cards and assigned the role of the EMS call-taker throughout the study to ensure consistency. The call-taker did not deviate from the allocated script used on the algorithm and was not present in the room at any point. No language other than English was used to explain CPR, regardless of participants' home language, as the EMS Guidecards are only available in English.

Once the call-taker was phoned, tCPR instructions were provided to participants and hands-only CPR was performed on the manikin. The principal investigator (LDC) remained in the room to set up the manikin, but did not assist the participant in any way. The participant could stop the simulation at any time should they feel uncomfortable or fatigued.

Variables and data measurements

CPR quality was independently analysed using the manikin. The manikin was linked to the SkillsReporter software (Laerdal Medical, Stavanger, Norway). The SkillsReporter software records and reports CPR quality in terms of: (1) hand placement, measured as proportion (%) of compressions in the centre of the chest, overlying the lower third of the sternum; (2) mean compression rate, with a quality requirement of 100–120 compressions per minute; (3) mean compression depth, with a quality recommendation of at least 5–6 cm; and 4) complete chest recoil, measured as proportion (%) of compressions with adequate recoil. All of the quality endpoints were in accordance with the 2017 recommendations as set out by ILCOR, at the time of the study [30]. Additionally, the investigator (LDC, an emergency medicine resident and qualified CPR instructor) observed for 5) exposure of the manikin's chest in real time. The software also reports No Flow time, i.e. interruptions.

The second part of the study was to elicit the self-reported comfort and understanding of performing CPR after being guided via the telephone. A questionnaire, based on literature and created by the primary investigator, was answered using a Likert scale and recorded anonymously on a paper-based questionnaire applied by the primary investigator. Whilst the questionnaire was not piloted, it was validated for content prior to data collection. The questionnaire aimed to collect basic demographic data (gender and home language) and consisted of a set of questions regarding the participants understanding and clarity of the CPR instructions given to them. The willingness of the participants to initiate tCPR was also determined.

Data analysis

For the primary outcomes (CPR quality), data were analysed descriptively. For each of the five quality domains (hand placement, compression rate, compression depth, chest recoil, and chest exposure) results were converted into a binary dataset, comply with guidelines: Yes/No. We report compliance as a proportion of participants with each of the quality criteria. We report no flow time descriptively.

We further sought associations between CPR quality (mean depth, mean rate, hand placement, chest recoil) and self-identified gender and home language using an unpaired *t*-test or one-way analysis of variance (ANOVA) - significance was set at $p = 0.05$. To compare categorical variables (chest exposure association between gender and language), a Chi-square test was performed and significance was set at $p = 0.05$. All analyses were performed using SPSSS (v. 25, IBM Corporation, New York, United States of America).

For the secondary outcomes, demographic and survey results were analysed descriptively. We also sought associations between self-reported comfort and understandability with CPR quality, using ANOVA or Chi-square tests as appropriate. Significance was set at $p = 0.05$.

Results

Fifty participants ($n = 50$) were recruited over a series of five hands-only CPR training events in the greater Cape Town metropole (Muizenburg, Cape Town City Bowl and Woodstock) between July and December 2019. Two events were hosted at non-profit organisations that seek to provide unemployed adults with skills to enter the job market, and the other two events were organised at two separate markets. The majority of the participants identified as female ($n = 32$, 64 %), and just under half ($n = 20$, 40 %) reported English as their first language.

Fig. 1 outlines the quality of bystander CPR with tCPR instructions across the sample, expressed as a percentage of participants that comply with current recommendations. Hand placement was accurate in 74 % ($n = 37$) of participants, while compression depth and chest recoil only had compliance in 20 % ($n = 10$) and 24 % ($n = 12$) of participants, respectively. The mean compression depth across the sample was 33.0 mm. Of all the individual chest compressions, only 17.7 % of them were between recommended depth ranges of 50–60 mm. The mean compression rate across the sample was 92 compressions per minute, while the mean compression rate was within guidelines in just under half (48 %, $n = 24$) of all participants. Only 20 (40 %) of participants exposed the manikin's chest, despite being instructed to do so.

Home language was statistically significantly associated with correct hand placement ($p = 0.01$) and chest exposure ($p < 0.01$). Mean compression depth was associated with self-identified gender (male 41 mm vs. female 29 mm; $p < 0.01$). No other associations were demonstrated.

Fig. 2 shows the responses to the post-tCPR questionnaire. Only 46 % ($n = 23$) of participants felt that the overall descriptions offered during the tCPR guidance were understandable, while 80 % ($n = 40$) and 36 % ($n = 18$) felt that the instructions on hand placement and compression rate were understandable, respectively. Almost all participants (94 %, $n = 47$) felt that instructions should be made available in someone's home language, while 92 % ($n = 46$) felt that compression rate would have been improved if an auditory queue or metronome was offered. Only 42 % ($n = 21$) of participants agreed that they would perform mouth-to-mouth on a stranger, while 90 % ($n = 45$) agreed that they would do so for a family member. Lastly, 94 % ($n = 47$) of participants agreed that they would be more likely to perform bystander CPR if they were

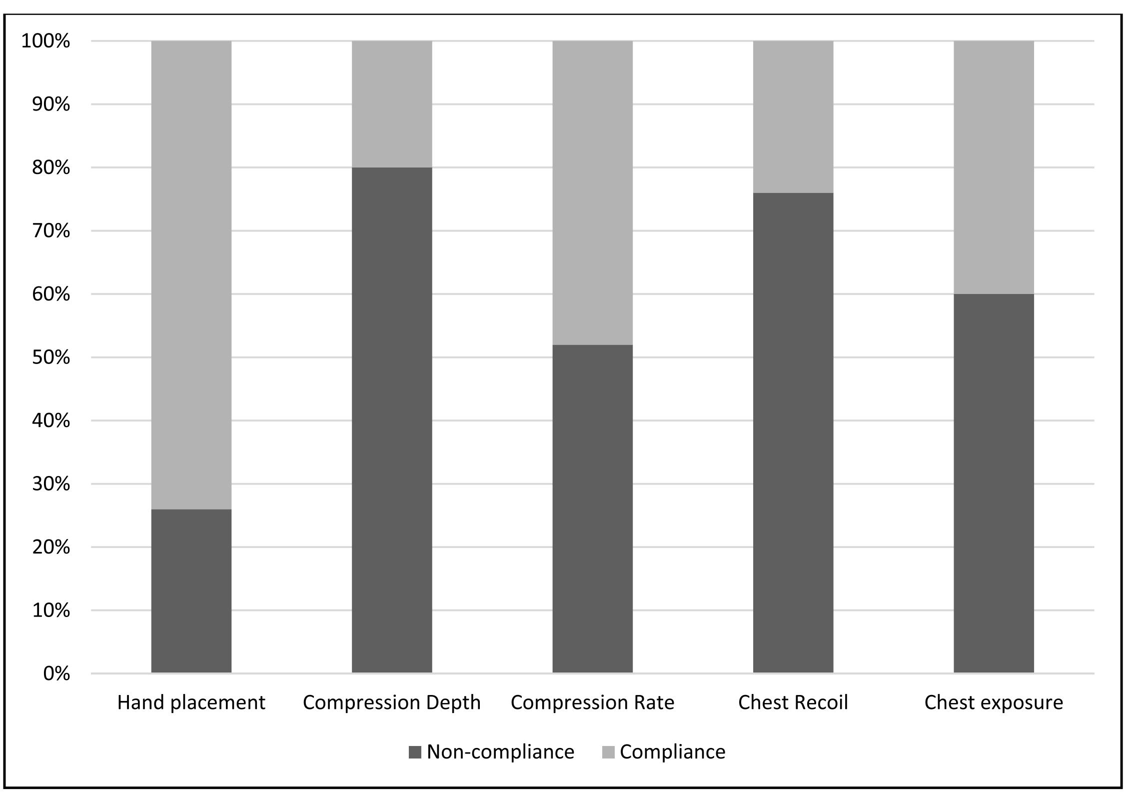

Fig. 1. Compliance rates across the five quality criteria [30].

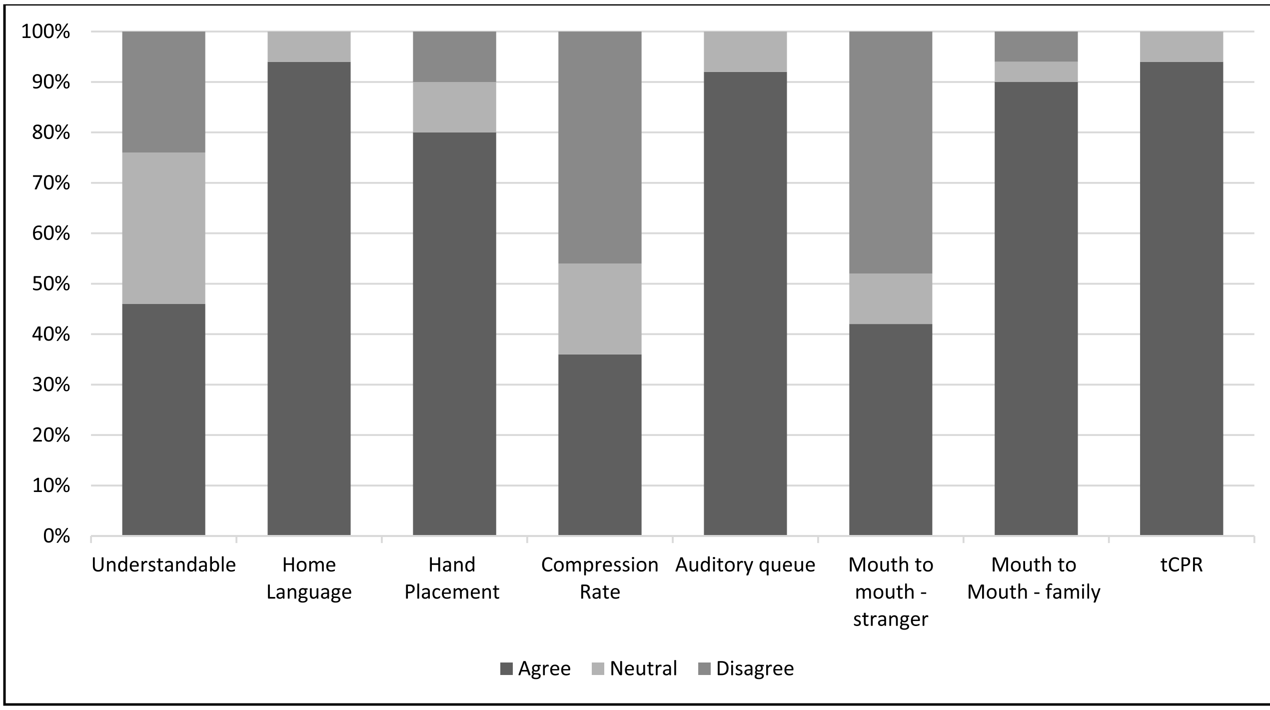

Fig. 2. Understandability and views of the tCPR instructions.

provided telephonic guidance on how to do so. CPR quality was not associated with understandability of the tCPR instructions or with self-reported comfort with performing CPR ($p>0.05$).

Some observations made during the CPR scenario merit a comment even though they were not part of the formal data points to be collected. The scenario proved confusing for some individuals as media and television often depict CPR with both chest compressions and ventilations. This occasionally caused some participants to stop CPR and make comment on the lack of instructions thereof. Another observation that may hold some clinical impact was that a large proportion of participants would cease chest compressions every time the call-taker spoke or said "Keep going, you're doing great" as they tended to think another instruction was being delivered to them. The mean no flow time across the sample was 4.48 (SD: 6.58) seconds.

Discussion

The aim of this study was to determine the quality of bystander CPR when laypersons were given tCPR instructions. Quality was assessed in terms of five domains: (1) hand placement, (2) compression rate, (3) compression depth, (4) chest recoil, and (5) chest exposure. Compared to CPR quality recommendations [30], untrained laypeople in the Western Cape performed sub-optimally in all quality domains. Telephone-guided bystander CPR, given by a qualified and trained call-taker or dispatcher, using a well-defined and standardised algorithm, has the potential to increase both the quality and the likelihood of bystanders performing CPR [16,21,31]. To the authors' knowledge, this is the first study to describe the quality of bystander CPR when given tCPR instructions in an African population.

Quality CPR with proper compression rate and depth is essential to improve survival in OHCA [30]. Our study found poor performance in these domains. When compared to another South African study on OHCA performance by EMS personnel, similar results are seen [32]. This points to a need for additional training and upskilling not only for laypersons, but also for EMS personnel who are expected to respond to incidents of OHCA. Regarding training, mass public CPR campaigns may not be cost-effective for many LMICs, however tCPR may present to be a cost-effective alternative. Recent studies have shown that continuous telephonic encouragement and coaching by a call-taker or dispatcher over the phone may result in improved compression rates [33], depth and overall CPR quality [34]. Considering this, it would be important to include continuous coaching in the training and implementation of OHCA telephonic recognition and tCPR guidelines. Continuous telephonic support for tCPR should be balanced against limited operator resources and call waiting and handling times, especially in contexts with poor OHCA outcomes and prolonged EMS response times.

It was encouraging to note that the overwhelming majority of respondents would be more likely to initiate bystander CPR when provided with tCPR guidance. tCPR may therefore be an important and cost-effective approach of overcoming barriers to starting CPR, especially to allay fears of causing harm [35,36], litigation [35] or lack of knowledge and confidence [36]. To optimise the impact of tCPR programmes however, it is essential that recognition is quick and accurate, and that instructions are understandable [16].

A secondary aim was therefore to determine the understandability of the tCPR instructions. Generally, participants felt that understandability of the instructions was low, except for hand placement which was also the best performing quality domain. There is currently no universally adopted algorithm for the recognition of OHCA in South Africa, nor is there a standard script for tCPR. While it was previously demonstrated that the keywords and phrases that people use when describing OHCA does not differ much between languages [37], language appeared to be important in this study. Instructions were given in English, and first language English speakers performed statistically better in instruction-dense domains such as hand placement and chest exposure. Similarly, almost all participants felt that tCPR instruction should be provided in the caller's home language. This is supported in the literature from other settings, that shows improved CPR quality during home-language instruction [38].

Irrespective of language, there may be other ways to improve understandability of tCPR instructions. Previously literature have investigated the effect of replacing terms in tCPR scripts [39,40], the use of metronomes [39], and excluding any redundant words in the scripting [39]. Ultimately, it has been demonstrated that the simplification of tCPR scripts result in improvements of uptake and performance [39]. It is important that these lessons are implemented in the development of OHCA recognition and tCPR initiatives within the African context. It is also important to keep in mind that language, instruction, willingness to act and the acceptability of interventions have a sociocultural and sociolinguistic context from which it cannot be divorced. It is for this reason that we recommend that any interventions for OHCA be developed with this context in mind and through participatory approaches that are inclusive of extensive community engagement.

Another facet of context that cannot be ignored is the extent to which the chain of survival is developed in a given setting and the resources available to expend for OHCA care, versus other health priorities. The reality for LMICs is that the funding of one health intervention necessarily means the defunding of another. As such, OHCA may not be the top health priority for every setting and tCPR may not be an appropriate intervention for every setting. Therefore, before any of these recommendations (or tCPR) is implemented or developed, a deliberate priority-setting process should be undertaken. These processes and any subsequent interventions that are being planned should be underpinned by the latest evidence and appropriate engagement with healthcare providers, policy- makers and community members. Even in LMICs where OHCA and tCPR is considered a priority, implementation should follow clear guidelines that are culturally acceptable and sensitive to resource constraints.

Study limitations

This study is not without limitations. Firstly, it was necessary to perform a manikin-based study in order to answer the research questions. The assessment was therefore devoid of distractions and a heightened stress response that could be expected in a real incident of OHCA. This could have affected the CPR quality. In this simulation study, the call-taker was a trained healthcare provider and it is unclear if this would affect the instructions given over the phone however, there was no deviation from the scripted instructions. A convenience, unpowered sample was recruited for this study. While the aim is not to generalise these results to the an entire population, this does represent a potential for self-selection or sampling bias. Given these limitations, results may not be externally valid to other settings.

Conclusion

In this manikin-based tCPR study, it was found that the quality of CPR performed by laypersons is generally suboptimal and this may affect patient outcomes. Participants also generally found instructions to not be understandable, which might have affected the results. Notwithstanding, participants agreed that tCPR instructions provided in their home language would encourage them to start bystander CPR. There is therefore an urgent need to develop more understandable tCPR algorithms that may encourage bystanders to start CPR and optimise its quality. The implementation of interventions for OHCA should always be underpinned by the resources available in a particular setting and weighed against other health priorities and community wishes.

Dissemenation of results

The results of this study were shared with the Western Cape Emergency Medical Services. Results are also published in a Masters thesis on an open repository.

Author contribution

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: LD contributed 60 %, WS 30 % and KE 10 %. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of Competing Interest

At the time of peer review, Dr Willem Stassen was an editor of the African Journal for Emergency Medicine. Dr Stassen did not participate in this manuscript's editorial process. The journal applies a double blinded process for all manuscript peer review. The authors declared no further conflicts of interest.

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