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ORIGINAL ARTICLE

Evaluation of Telephone Cardiopulmonary Resuscitation Performance in Current Practice in Saudi Arabia

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Abstract

Objectives: **Out-of-hospital cardiac arrest (OHCA) is a global health problem with a low survival rate. Telephone cardiopulmonary resuscitation (T-CPR) guidance by emergency medical services (EMS) dispatchers can improve CPR performance and, consequently, survival rates. Accordingly, the American Heart Association (AHA) has released performance standards for T-CPR in current practice to improve its quality. However, no study has examined T-CPR performance in Saudi Arabia. Therefore, this study aims to evaluate T-CPR performance in the Saudi Arabian EMS system.**

Methods: **A retrospective observation of OHCA calls in current practice was conducted in Riyadh, Saudi Arabia. OHCA calls were reviewed to identify those that met the selection criteria. Variables collected included return of spontaneous circulation (ROSC), OHCA recognition rate, time from EMS call receipt to location acquisition, to OHCA recognition and to commencement of CPR.**

Results: **A total of 308 OHCA cases were reviewed, and 100 calls were included. ROSC was identified in 10% of the included calls. OHCA was correctly recognized in 62% of the calls. The time to OHCA identification and CPR performance from EMS call receipt were found to be 303 s and 367 s, respectively.**

Conclusion: **T-CPR performance in Saudi Arabia is below AHA standards. However, this is similar to what has been reported in the literature. Avoiding any unnecessary call transfer during OHCA calls and prompt identification of callers' locations could improve T-CPR performance.**

Keywords: Dispatcher assisted cardiopulmonary resuscitation, Telephone cardiopulmonary resuscitation, Dispatch, Cardiac arrest, Protocol

1. Introduction

Out of hospital cardiac arrest (OHCA) is a global health problem with a survival rate of only 7–10% [1,2]. Early initiation of cardiopulmonary resuscitation (CPR) can double or quadruple the survival rate [3]. For each minute without CPR and the use of electrical defibrillation, the chance of survival decreases between 7 and 10% [4]. Furthermore, high-quality bystander CPR can increase the survival rate by more than three times as compared to low-quality CPR [5]. However, a systematic review reported that only 32% of bystanders were willing to perform CPR, although the rate varied

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between communities [1]. Hesitancy was attributed to factors such as a lack of CPR knowledge or confidence or a fear of performing it incorrectly [6].

Guidance by emergency medical service (EMS) dispatchers following telephone CPR (T-CPR) instructions has been shown to improve bystander CPR rates, time and quality of bystander CPR performance, and subsequent patient outcomes [3]. Furthermore, a systematic review and meta-analysis measuring the impact of T-CPR found that providing T-CPR instructions improved the return of spontaneous circulation (ROSC), neurologic outcomes, and survival rates in OHCA calls [7]. Thus, the international liaison committee on resuscitation (ILCOR) recommends that EMS dispatchers provide CPR instructions to untrained callers [8]. However, despite the potential benefits of T-CPR, 26% of OHCAs are misrecognized, and the time taken to identify OHCA and start the first compression range from 60 to 170 s and 140–328 s, respectively, with no minimum standards of performance published in the literature [9,10].

In 2020, the American Heart Association (AHA) introduced performance standards for T-CPR that aim to improve survival rates [11]. Targets include 1) recognition of OHCA in less than 90 s and delivery of the first chest compression in less than 150 s from EMS call receipt, 2) identification of 75% of OHCA cases and 95% of all identifiable OHCAs, and 3) guiding callers to perform CPR in 75% of cases where OHCA is correctly recognized. Although some OHCA calls could be transferred to EMS by another agency such as police department, AHA acknowledges this potential additional time [11], and, therefore, highlights the importance to achieve these standards which are measured since EMS call are received by dispatchers. It is important for an EMS provider to periodically audit its performance against these standards. While EMS performance is well reported in the literature internationally, no studies from Saudi Arabia have been published to date, despite EMS providers, such as the Saudi Red Crescent Authority (SRCA), implementing a T-CPR system.

As is the case with many EMS systems, the SRCA calls are triaged using an algorithm in a computer-aided dispatching system to dispatch an appropriate ambulance crew [12]. However, for more urgent calls, such as cases of suspected OHCA, the call taker transfers the call to a doctor of medicine (MD), who instructs the caller on how to proceed. This approach differs from that taken in other dispatch systems, such as the medical priority dispatch system and criteria-based dispatch, where the dispatcher is responsible for both receiving calls and providing pre-arrival instruction. The transfer of a call to an MD requires time and potentially introduces avoidable delays. Thus, subsequent to this study, the SRCA implemented more conventional dispatcher-provided instruction, thereby negating the need for call transfer [13]. This study aimed to evaluate T-CPR performance in Saudi Arabia prior to the adoption of the new process.

Abbreviations

OHCA	Out of hospital cardiac arrest
CPR	Cardiopulmonary resuscitation
EMS	Emergency medical service
T-CPR	Telephone CPR
ROSC	Return of spontaneous circulation
ILCOR	International liaison committee on resuscitation
AHA	American Heart Association
SRCA	Saudi Red Crescent Authority
MD	Doctor of medicine
IQR	Interquartile ranges
IRB	Institutional review board

2. Materials and methods

2.1. Setting

Data were collected from a single center, the SRCA main center in Riyadh. It is the dispatching department of SRCA, and includes call takers and all MDs, that handle EMS calls in Riyadh. The SRCA responds to all types of pre-hospital healthcare issues, ranging from minor to life-threatening illnesses, such as cardiac arrest. SRCA call takers receive all calls made by the public to a specific emergency phone number '997'. All calls received by the SRCA are triaged using algorithms and guidelines in a computer-aided dispatching system [12]. Based on the urgency of the call, the appropriate ambulance crew is dispatched to the patient, and pre-arrival instructions are provided. The call process from call receipt until ambulance arrival for patients is achieved through three main stages with the assistance of an MD, where calls are suspected to be of a critical nature (urgent calls) (see Fig. 1).

Call takers routinely transfer urgent calls, including suspected OHCA calls, to MDs who are available in the SRCA dispatch department. The SRCA uses a T-CPR protocol that was developed in late 2016 by MDs at the SRCA and was derived from ILCOR recommendations. The protocol starts with primary questions to establish basic information (e.g., patient's age and scene safety) before asking about consciousness and breathing quality to check if CPR instructions are recommended. The MD then delivers CPR instructions or other suitable

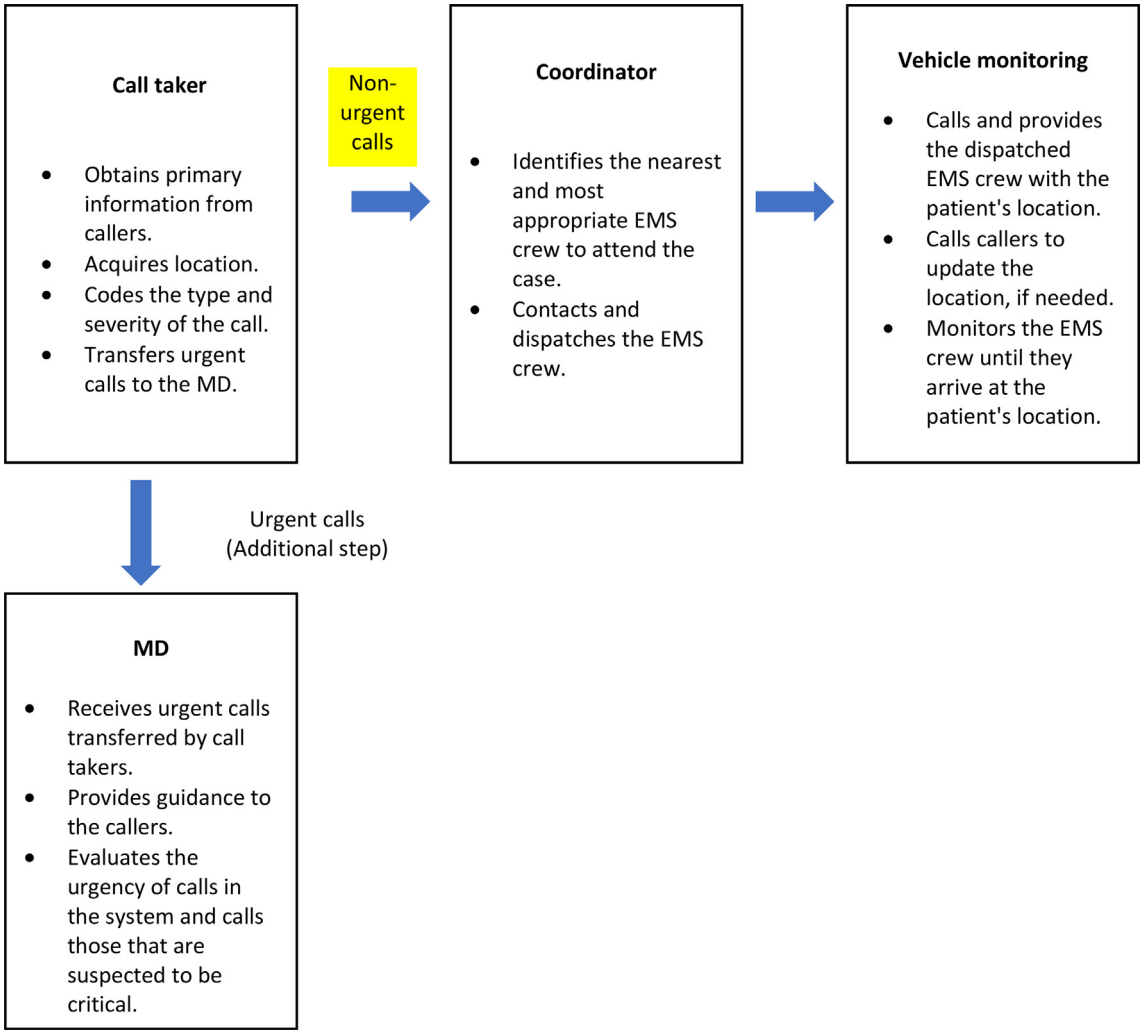

Fig. 1. A flow diagram of the three stages representing the call process at the SRCA and the MD's role.

instructions according to the patient's situation. This assessment and delivery of care by an MD is therefore an additional step for urgent calls.

2.2. Study design and data collection

The study is a retrospective observation of current practice based on a quantitative analysis of OHCA calls. Call recordings were collected from the SRCA in Riyadh. Confirmed OHCA cases (established from EMS crew reports) between January 2017 and July 2018 were reviewed by the primary investigator (MBH) to identify and include 100 consecutive OHCA calls that matched the selection criteria. This is the first exploratory study of OHCA calls in Saudi Arabia, and the sample size was chosen to reflect similar studies reported in the literature [14–19].

The call was included if the caller was ≥18 years of age and reporting on an adult OHCA patient (≥18 years old) who spoke Arabic fluently. Calls were excluded if they met the following criteria: traumatic OHCA, presence of CPR-trained bystander on scene, CPR in progress prior to the call, arrival of EMS crew before OHCA identification by MD, and non-Arabic-speaking callers. The call was also excluded if it could not be analyzed due to a missing or corrupted recording.

Variables in the dataset included the demographics of the callers and patients (e.g., gender and relationship) and event times, including time to location acquisition, time to MD transfer, time to OHCA identification, and time to start first chest compression. The data also included the proportion of MDs that recognized OHCA, MDs' provision of CPR instructions and caller CPR rates, and the ROSC outcome. Call recordings were reviewed by the primary investigator (MBH) in a quiet office using proprietary software at the SRCA, which

stores calls digitally. Event times were measured using a stopwatch.

2.3. Data analysis

Data were analyzed using IBM® SPSS® software version 27. Variables were tested for normality and presented as medians and interquartile ranges (IQR). Categorical data were presented as counts and percentages. Comparisons between the data sets were examined for significance using a Mann–Whitney U test.

2.4. Ethical consideration

Permission to conduct the study was gained from an institutional review board (IRB) at the Ministry of Health in Saudi Arabia. Access to the SRCA system was granted following IRB approval from the Ministry of Health.

3. Results

A total of 308 OHCA cases were reviewed to identify 100 calls that met the selection criteria (see Fig. 2). More calls were made by men (76%), and male patients accounted for 60% of the sample (see Table 1). ROSC was identified in 10% of cases.

Of the 100 OHCA cases, only 62 were correctly identified by the MD as being in cardiac arrest at the time of the call. Fifty-six of these (90.3%) went on to receive bystander CPR (see Fig. 3).

The median time to identify OHCA was 303 s (IQR 177.8–496.3), exceeding the AHA target (90 s) by 213 s. Time from call receipt to starting chest compressions was consequently also delayed at 367 s (IQR 266.8–550.5), exceeding the AHA standard (150 s) by 217 s, respectively (see Fig. 4). Female callers started chest compressions significantly faster than male callers ($p = .002$), with median times for each gender of 280 and 480.5 s, respectively, but both males and females still exceeded the performance standard. The delayed time to the first chest compression could have been influenced by how the call was processed. Specifically, the MD call transfer took a median of 231.5 s, measured from the EMS initial call receipt until the MD answered the call (see Fig. 4). The median time from call receipt to identifying the location was 60 s (see Fig. 4). The findings are summarized in Table 2.

4. Discussion

The findings of this observational study indicated that only 10% of OHCA patients had ROSC prior to their hospital arrival. This rate is less than half that reported in a systematic review which revealed that 23.8% of OHCA patients overall survived to hospital admission [1]. However, when comparing Saudi Arabia with other Gulf countries, the rate was similar or better. Kuwait and the Emirates showed 1.6–6% and 9.2% pre-hospital ROSC, respectively [20,21], while Qatar had a 13% ROSC rate at hospital admission [22]. The low ROSC rates in Saudi Arabia and other Gulf countries need urgent intervention to determine the possible reasons and how improvements can be made. Such an investigation could subsequently increase the survival rate by improving the quality of T-CPR performance.

The time to first chest compression (median 367 s) was prolonged and fell well below the AHA recommendations, which is likely to detrimentally impact ROSC. This time interval exceeded the AHA standards by 217 s. In this context, the time to starting CPR is crucial to OHCA patients' survival, as early initiation can double or quadrable the survival rate [3]. Two studies in the literature reported meeting AHA standards, with times from EMS call receipt to first chest compression at 145 and 148 s, respectively [23,24]. However, there is no clear explanation for why these studies achieved the AHA standard, and the majority of studies in the literature show a delayed time to first chest compression, ranging from 140 to 328 s [10].

When the time to identifying OHCA is delayed, the time to first compression is also subsequently delayed. The MDs identified OHCA in 303 s from EMS call receipt, which is 213 s short of what the AHA recommends. This delay in OHCA recognition is consistent with findings from other studies [15,17,19,25]. Research has identified factors associated with delayed time to OHCA recognition and CPR initiation. These include how dispatchers give instructions (e.g., asking "unnecessary questions"), work pressures caused by high call volume, emotional distress experienced by callers, the presence of agonal breathing, and physical barriers (e.g., callers are away from patients or need to reposition patients for CPR) [16,17,26,27]. However, this study found that the way in which calls are processed by EMS can also contribute to delays. The SRCA differs from EMS providers in that OHCA calls are transferred to an MD to assess and advise the caller. There was a median of 231.5 s between the call receipt and the MD answering the call. More specifically, 171.5 s was spent waiting for the call to be transferred to the MD (measured as starting from the identification of the location by the call taker until the MD answered the call). This additional step of transferring some types of calls is not present in

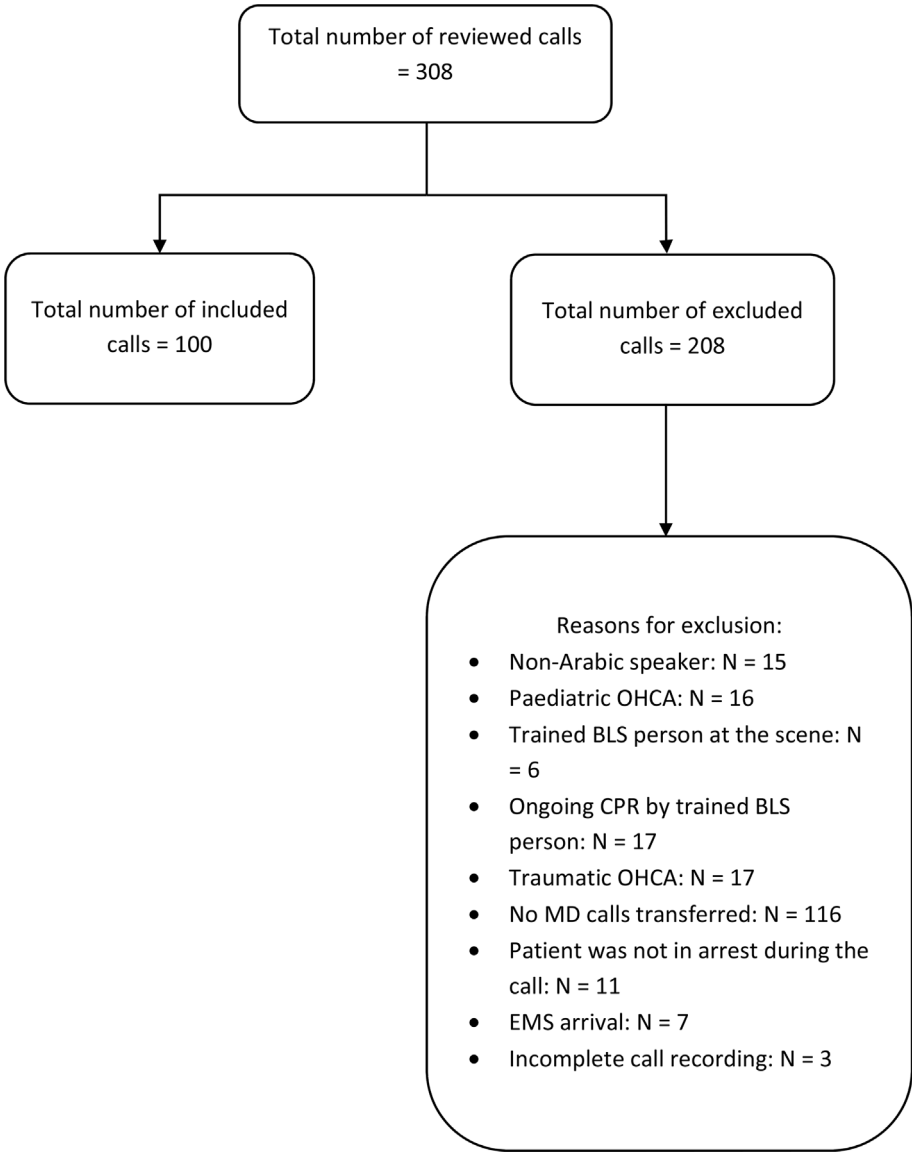

Fig. 2. A flow diagram detailing the included and excluded OHCA calls.

other commonly used EMS dispatching systems [28,29]. Thus, avoiding unnecessary transfers in calls would improve the time to first chest compression. Recently, the SRCA established an emergency medical dispatch program that graduates dispatchers to receive calls and subsequently provide pre-arrival instructions with no need for MD call transfer [13]. The new program has already been implemented under the aim of improving T-CPR performance, and further study is needed to confirm that T-CPR performance improves as expected.

Table 1. Demographic characteristics of the OHCA callers and patients.

Demographic characteristics	Caller N (%)	Patient N (%)
Gender:		
Male	76 (76%)	60 (60%)
Female	24 (24%)	40 (40%)
Caller relationship:		
Relative	72 (72%)	
Non-relative	26 (26%)	
Unknown	2 (2%)	

Time to first compression was also influenced by the time spent identifying the callers' locations. The median time taken to identify the location was 60 s from call receipt, which is double that of the AHA recommendation [11]. The T-CPR protocol in SRCA requires asking callers to describe their locations when call-tracking systems do not automatically identify call locations. Furthermore, postal codes in Saudi Arabia are not used to identify locations, as they are in some other countries, making it more difficult for callers to describe their locations. Issues

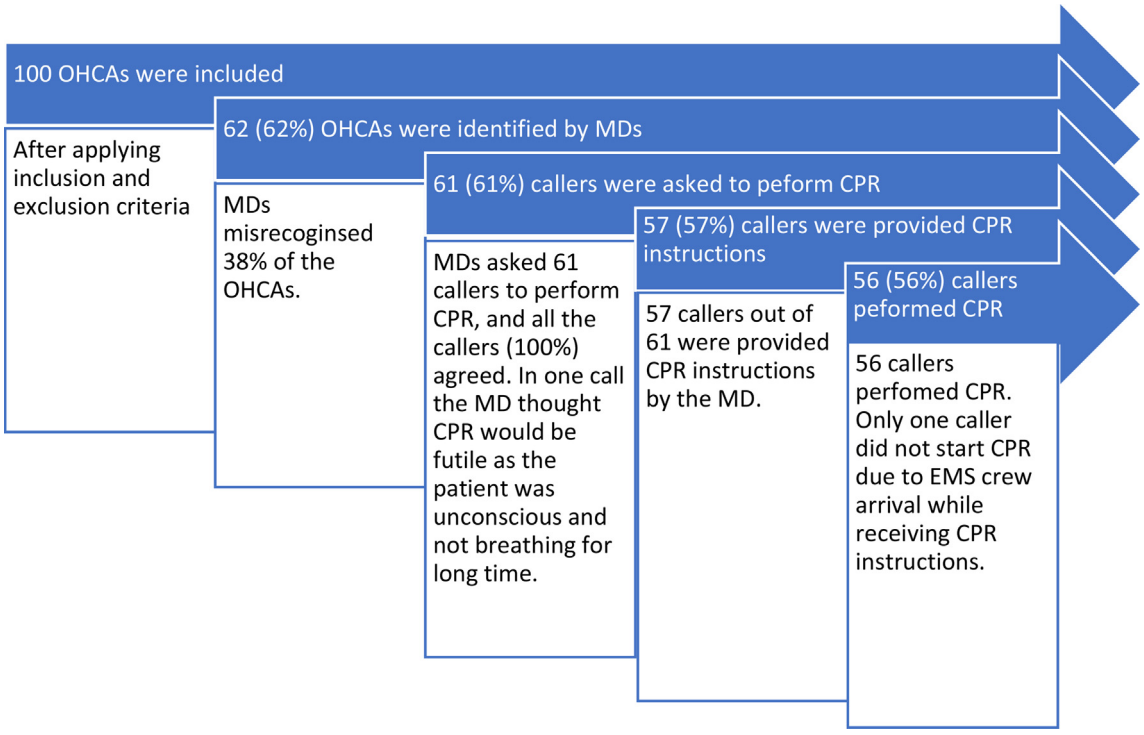

Fig. 3. Illustrations of OHCA calls and CPR rate.

with location acquisition have been reported in the literature. O'Neill and Deakin [30] found that, after call receipt, 73 s was spent establishing the location, although no clarification was provided as to why the location was difficult to identify. Thus, a well-designed call-tracking system could reduce unnecessary delays in starting chest compressions. The SRCA has developed a system for cases in which a caller cannot describe their location, whereby a text message is sent to the caller with a link to share the location. Another recent method is to use the national address details. Each resident (e.g., flat and house) has a specific national address (that contains several digits and a street name), which the SRCA can use to identify their location. These methods have the potential to improve the time to acquire callers' locations.

In addition to prompt commencement of CPR, it is critical for dispatchers to be able to identify the cardiac arrest and to subsequently convince callers to perform CPR. This study found that 62% of OHCAs were correctly identified, which is 13% below the AHA standard. However, OHCA recognition is a problem worldwide [9]. A systematic literature review, which included 16 studies, showed the average of OHCA recognition with 73.9% (ranging from 14.1 to 96.9%), which is below AHA standards [9]. Although Saudi Arabia is below this average, it showed better performance compared to other countries in the region, such as Kuwait, which reported that only 12.9% of OHCAs were correctly identified [20]. These data highlight the difficulty in identifying OHCAs over telephone. Presence of agonal breathing, which is inaccurately described by callers to dispatchers, is the main factor affecting the recognition [31–33]. Other factors include callers, where emotionally distressed are unable to cooperate with dispatchers, and where callers are not in the same location as the patient, and are therefore unable to provide sufficient information to dispatchers to identify the cardiac arrest [14,31,34–41]. No callers in this Saudi Arabian study refused to perform CPR when asked, which is significantly different from what has been reported in other studies. The literature shows variations in caller T-CPR rates ranging from 9 to 85%, with the majority falling short of the AHA recommendation (75%) [15,17,18,26,30,42–49]. Although the reasons for high compliance with requests to perform CPR in Saudi Arabia are not clear, this could be due to cultural considerations, where people feel the responsibility to save the patient. It should also be noted that in this study, most callers (72%) had family relationships with the patients.

Dispatching systems used worldwide are varied across countries; in some, different systems are used in different regions within a country [50,51]. Also, there is not internationally standardized method to

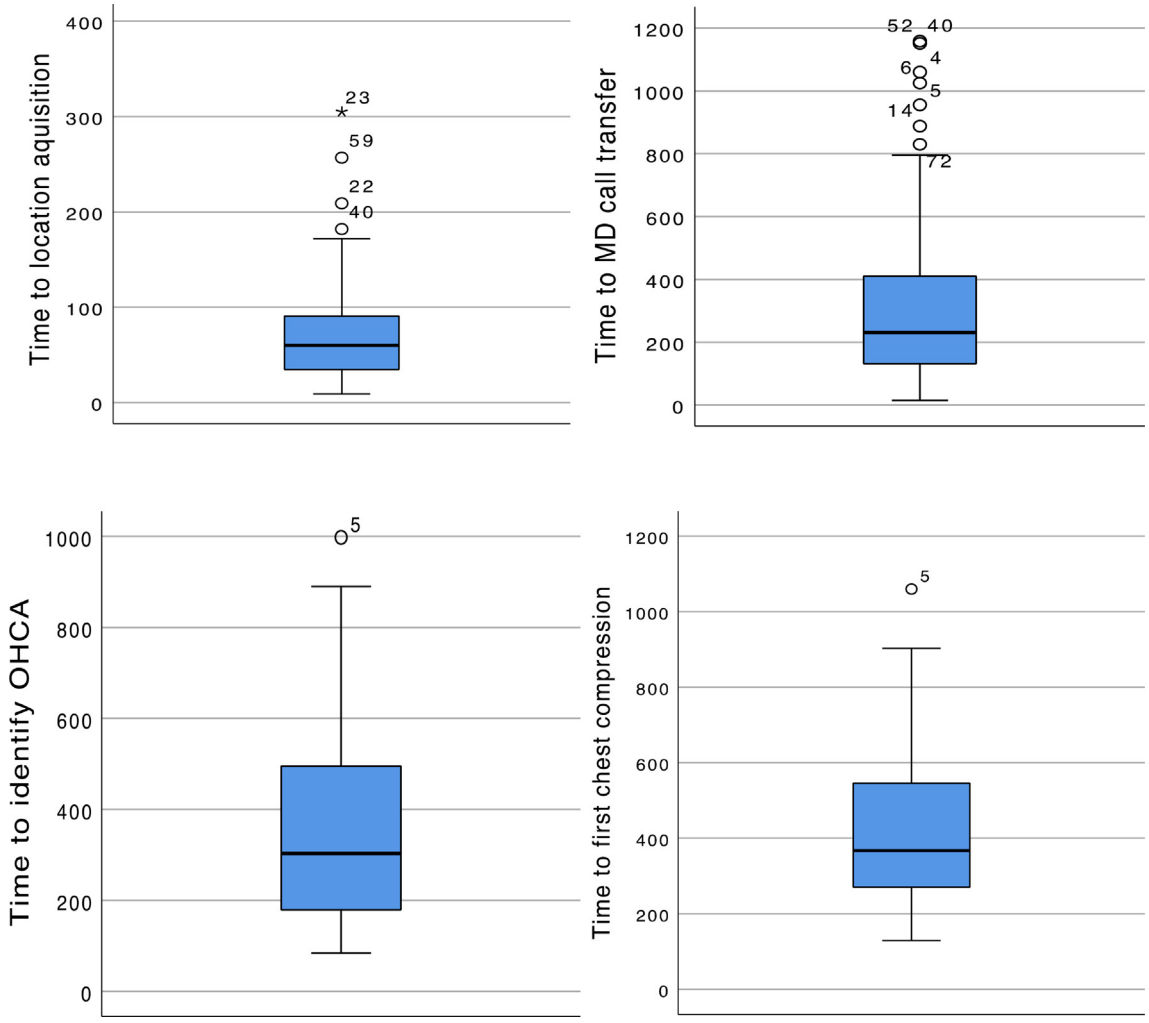

Fig. 4. A Box Whisker plot of the time in seconds from call receipt to events.

deliver T-CPR instructions to callers, therefore, methods of delivering the instructions differ between EMS systems. This is likely due to the lack of consensus on the effectiveness of the dispatching systems currently used in providing pre-arrival instructions [28]. The findings in this study, especially the unnecessary call transfer and location acquisition process, can inform designing the dispatching systems worldwide aiming for improvement. Despite this, achieving AHA standards is challenging [11]. Thus, it is also recommended that a quality improvement program be established in each EMS system. This can include providing training to dispatchers and reviewing OHCA calls for quality assessment [11]. Improving the T-CPR performance of each EMS has the potential to improve the overall survival rate of such cases.

Although SRCA has now made several changes to the dispatching system, the findings of this study are still important. The findings of T-CPR performance in this study are the first in Saudi Arabia and can be used to monitor the progress of dispatching

Table 2. Time intervals in the OHCA call process.

	N	Median	IQR	Compliance with high AHA standards N (%)	Compliance with minimum acceptable AHA standards N (%)
Time to first chest compression (s)	56	367	266.8–550.5	0 (0%)	2 (3.6%)
Time to OHCA identification (s)	62	303	177.8–496.3	0 (0%)	1 (1.6%)
Time to MD call (s)	100	231.5	131.5–413	N/A	N/A
Time to location acquisition (s)	99[a]	60	34–91	21 (21.2%)	21 (21.2%)

[a] Time to location acquisition in one call was not found in the EMS calls system, and the reasons for this are unknown.

system in Saudi Arabia for quality improvement. Dispatching systems worldwide are varied due to lack of evidence [28,50,51], and, therefore, monitoring the progress of changes made to dispatching systems have the potential to develop a well-designed dispatching system.

This study has a limitation, in that the data extracted were based on audio recordings. Thus, the reported event times might be slightly inaccurate (i.e., have a few seconds of difference from the actual times). For example, the time to OHCA identification was considered complete once the MD confirmed it or started to provide CPR instructions. However, as the MDs did not always provide verbal confirmation of OHCA identification, a precise time point was difficult to identify. Nevertheless, this difference is unlikely to influence the findings, as the time to identify OHCA was found to be below the AHA recommendation by 213 s.

5. Conclusion

The T-CPR performance reported in this study, conducted in a Saudi Arabian setting, falls below the AHA standards. However, this is similar to what has been reported in the literature. Avoiding any unnecessary call transfer during OHCA calls and prompt identification of callers' locations could improve the time to first compression. Accordingly, establishing a quality improvement program for dispatching centers is recommended for any EMS worldwide to improve T-CPR performance and subsequently OHCA survival rates.

Author contribution

Conception and design of Study: MB, JT, GP, NA. Literature review: MB, JT, GP. Acquisition of data: MB, JT, GP, MA. Analysis and interpretation of data: MB, JT, GP. Research investigation and analysis: MB, NA, MA. Data collection: MB, NA, MA. Drafting of manuscript: MB, JT, GP. Revising and editing the manuscript critically for important intellectual contents: NA, MA. Data preparation and presentation: MB, JT, GP. Supervision of the research: NA, MA. Research coordination and management: MB.

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Conflict of interest

None declared.

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References

[1] Sasson C, Rogers MA, Dahl J, Kellermann AL. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes 2010;3(1):63–81. https://doi.org/10.1161/circoutcomes.109.889576.

[2] Dyson K, Brown SP, May S, Smith K, Koster RW, Beesems SG, et al. International variation in survival after out-of-hospital cardiac arrest: a validation study of the Utstein template. Resuscitation 2019;138:168–81. https://doi.org/10.1016/j.resuscitation.2019.03.018.

[3] Monsieurs KG, Nolan JP, Bossaert LL, Greif R, Maconochie IK, Nikolaou NI, et al. European resuscitation council guidelines for resuscitation 2015: section 1. Executive summary. Resuscitation 2015;95:1–80. https://doi.org/10.1016/j.resuscitation.2015.07.038.

[4] Larsen MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: a graphic model. Ann Emerg Med 1993;22(11):1652–8. https://doi.org/10.1016/s0196-0644(05)81302-2.

[5] Kleinman ME, Brennan EE, Goldberger ZD, Swor RA, Terry M, Bobrow BJ, et al. Part 5: adult basic life support and cardiopulmonary resuscitation quality: 2015 American Heart association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2015;132(18 Suppl 2):S414–35. https://doi.org/10.1161/cir.0000000000000259.

[6] Moon S, Ryoo HW, Ahn JY, Park JB, Lee DE, Kim JH, et al. A 5-year change of knowledge and willingness by sampled respondents to perform bystander cardiopulmonary resuscitation in a metropolitan city. PLoS One 2019;14(2):e0211804. https://doi.org/10.1371/journal.pone.0211804.

[7] Nikolaou N, Dainty KN, Couper K, Morley P, Tijssen J, Vaillancourt C, et al. A systematic review and meta-analysis of the effect of dispatcher-assisted CPR on outcomes from sudden cardiac arrest in adults and children. Resuscitation 2019;138:82–105. https://doi.org/10.1016/j.resuscitation.2019.02.035.

[8] Soar J, Maconochie I, Wyckoff MH, Olasveengen TM, Singletary EM, Greif R, et al. International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations: summary from the basic life support; advanced life support; pediatric life support; neonatal life support; education, implementation, and teams; and first aid task forces. Circulation 2019;140(24):e826–80. https://doi.org/10.1161/cir.0000000000000734.

[9] Viereck S, Møller TP, Rothman JP, Folke F, Lippert FK. Recognition of out-of-hospital cardiac arrest during emergency calls—a systematic review of observational studies. Scand J Trauma Resuscitation Emerg Med 2017;25:1–12.

[10] Maier M, Luger M, Baubin M. Telephone-assisted CPR: a literature review. Notf Rett Med 2016;19(6):468–72. https://doi.org/10.1007/s10049-016-0210-5.

[11] Kurz MC, Bobrow BJ, Buckingham J, Cabanas JG, Eisenberg M, Fromm P, et al. Telecommunicator cardiopulmonary resuscitation: a policy statement from the American Heart association. Circulation 2020;141(12):e686–700. https://doi.org/10.1161/cir.0000000000000744.

[12] Moafa HN, van Kuijk SMJ, Alqahtani DM, Moukhyer ME, Haak HR. Disparities between rural and urban areas of the central region of Saudi Arabia in the utilization and time-centeredness of emergency medical services. Int J Environ Res Publ Health 2020;17(21):7944. https://doi.org/10.3390/ijerph17217944.

[13] Alsofayan Y, Almakhalas K, Alabdali A, Arafat M, Aljerian N, Cluntun A, et al. An innovative curriculum development experience: emergency medical dispatch role

in the healthcare transformation vision of Saudi Arabia. 2021. https://doi.org/10.21203/rs.3.rs-1111612/v1.
[14] Alfsen D, Moller TP, Egerod I, Lippert FK. Barriers to recognition of out-of-hospital cardiac arrest during emergency medical calls: a qualitative inductive thematic analysis. Scand J Trauma Resuscitation Emerg Med 2015;23:70. https://doi.org/10.1186/s13049-015-0149-4.
[15] Clegg GR, Lyon RM, James S, Branigan HP, Bard EG, Egan GJ. Dispatch-assisted CPR: where are the hold-ups during calls to emergency dispatchers? A preliminary analysis of caller-dispatcher interactions during out-of-hospital cardiac arrest using a novel call transcription technique. Resuscitation 2014;85(1):49–52. https://doi.org/10.1016/j.resuscitation.2013.08.018.
[16] Case R, Cartledge S, Siedenburg J, Smith K, Straney L, Barger B, et al. Identifying barriers to the provision of bystander cardiopulmonary resuscitation (CPR) in high-risk regions: a qualitative review of emergency calls. Resuscitation 2018;129:43–7. https://doi.org/10.1016/j.resuscitation.2018.06.001.
[17] Michiels C, Clinckaert C, Wauters L, Dewolf P. Phone CPR and barriers affecting life-saving seconds. Acta Clin Belg 2021;76(6):427–32. https://doi.org/10.1080/17843286.2020.1752454.
[18] Heward A, Donohoe R, Whitbread M. Retrospective study into the delivery of telephone cardiopulmonary resuscitation to "999" callers. Emerg Med J 2004;21(2):233–4. https://doi.org/10.1136/emj.2003.006965.
[19] Travers S, Jost D, Gillard Y, Lanoe V, Bignand M, Domanski L, et al. Out-of-hospital cardiac arrest phone detection: those who most need chest compressions are the most difficult to recognize. Resuscitation 2014;85(12):1720–5. https://doi.org/10.1016/j.resuscitation.2014.09.020.
[20] Al Hasan D, Drennan J, Monger E, Al Mahmid S, Ahmad H, Ameen M, et al. Dispatcher assisted cardiopulmonary resuscitation implementation in Kuwait: a before and after study examining the impact on outcomes of out of hospital cardiac arrest victims. Medicine 2019;98(44).
[21] Alqahtani SE, Alhajeri AS, Ahmed AA, Mashal SY. Characteristics of out of hospital cardiac arrest in the United Arab Emirates. Heart Views 2019;20(4):146–51. https://doi.org/10.4103/heartviews.heartviews_80_19.
[22] Irfan FB, Bhutta ZA, Castren M, Straney L, Djarv T, Tariq T, et al. Epidemiology and outcomes of out-of-hospital cardiac arrest in Qatar: a nationwide observational study. Int J Cardiol 2016;223:1007–13. https://doi.org/10.1016/j.ijcard.2016.08.299.
[23] Plodr M, Truhlar A, Krencikova J, Praunova M, Svaba V, Masek J, et al. Effect of introduction of a standardized protocol in dispatcher-assisted cardiopulmonary resuscitation. Resuscitation 2016;106:18–23. https://doi.org/10.1016/j.resuscitation.2016.05.031.
[24] Gram KH, Praest M, Laulund O, Mikkelsen S. Assessment of a quality improvement programme to improve telephone dispatchers' accuracy in identifying out-of-hospital cardiac arrest. Resusc Plus 2021;6:100096. https://doi.org/10.1016/j.resplu.2021.100096.
[25] Shah M, Bartram C, Irwin K, Vellano K, McNally B, Gallagher T, et al. Evaluating dispatch-assisted CPR using the CARES registry. Prehosp Emerg Care 2018;22(2):222–8. https://doi.org/10.1080/10903127.2017.1376133.
[26] Chien CY, Chien WC, Tsai LH, Tsai SL, Chen CB, Seak CJ, et al. Impact of the caller's emotional state and cooperation on out-of-hospital cardiac arrest recognition and dispatcher-assisted cardiopulmonary resuscitation. Emerg Med J 2019;36(10):595–600. https://doi.org/10.1136/emermed-2018-208353.
[27] Kim TH, Sohn Y, Hong W, Song KJ, Shin SD. Association between hourly call volume in the emergency medical dispatch center and dispatcher-assisted cardiopulmonary resuscitation instruction time in out-of-hospital cardiac arrest. Resuscitation 2020;153:136–42. https://doi.org/10.1016/j.resuscitation.2020.05.036.
[28] Bohm K, Kurland L. The accuracy of medical dispatch - a systematic review. Scand J Trauma Resuscitation Emerg Med 2018;26(1):94. https://doi.org/10.1186/s13049-018-0528-8.
[29] Baabdullah M, Faden H, Alsubhi R, Almalki A, Masri B, Alharbi A. The efficiency of the medical priority dispatch system in improving patient outcomes. Saudi Journal of Emergency Medicine 2020;1(2):110–20. https://doi.org/10.24911/SJEMed/72-1586163179.
[30] O'Neill JF, Deakin CD. Evaluation of telephone CPR advice for adult cardiac arrest patients. Resuscitation 2007;74(1):63–7. https://doi.org/10.1016/j.resuscitation.2006.11.007.
[31] Vaillancourt C, Verma A, Trickett J, Crete D, Beaudoin T, Nesbitt L, et al. Evaluating the effectiveness of dispatch-assisted cardiopulmonary resuscitation instructions. Acad Emerg Med 2007;14(10):877–83. https://doi.org/10.1197/j.aem.2007.06.021.
[32] Lewis M, Stubbs BA, Eisenberg MS. Dispatcher-assisted CPR: time to identify cardiac arrest and deliver chest compression instructions. CIRCULATIONAHA Circulation 2013;113:002627.
[33] Bang A, Herlitz J, Martinell S. Interaction between emergency medical dispatcher and caller in suspected out-of-hospital cardiac arrest calls with focus on agonal breathing. A review of 100 tape recordings of true cardiac arrest cases. Resuscitation 2003;56:25–34.
[34] Eisenberg MS, Carter W, Hallstrom A, Cummins R, Litwin P, Hearne T. Identification of cardiac arrest by emergency dispatchers. Am J Emerg Med 1986;4(4):299–301.
[35] Weslien M, Nilstun T, Lundqvist A, Fridlund B. When the unreal becomes real: family members' experiences of cardiac arrest. Nurs Crit Care 2005;10(1):15–22.
[36] Swor R, Khan I, Domeier R, Honeycutt L, Chu K, Compton S. CPR training and CPR performance: do CPR-trained bystanders perform CPR? Acad Emerg Med 2006;13(6):596–601. https://doi.org/10.1197/j.aem.2005.12.021.
[37] Viereck S, Møller TP, Ersbøll AK, Bækgaard JS, Claesson A, Hollenberg J, et al. Recognising out-of-hospital cardiac arrest during emergency calls increases bystander cardiopulmonary resuscitation and survival. Resuscitation 2017;115:141–7.
[38] Hauff SR, Rea TD, Culley LL, Kerry F, Becker L, Eisenberg MS. Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation. Ann Emerg Med 2003;42(6):731–7.
[39] Culley LL, Clark JJ, Eisenberg MS, Larsen MP. Dispatcher-assisted telephone CPR: common delays and time standards for delivery. Ann Emerg Med 1991;20(4):362–6.
[40] Kuisma M, Määttä T. Out-of-hospital cardiac arrests in Helsinki: Utstein style reporting. Heart 1996;76(1):18–23.
[41] Bång A, Ortgren P-O, Herlitz J, Währborg P. Dispatcher-assisted telephone CPR: a qualitative study exploring how dispatchers perceive their experiences. Resuscitation 2002;53(2):135–51.
[42] Dameff C, Vadeboncoeur T, Tully J, Panczyk M, Dunham A, Murphy R, et al. A standardized template for measuring and reporting telephone pre-arrival cardiopulmonary resuscitation instructions. Resuscitation 2014;85(7):869–73. https://doi.org/10.1016/j.resuscitation.2014.02.023.
[43] Kim TH, Lee YJ, Lee EJ, Ro YS, Lee K, Lee H, et al. Comparison of cardiopulmonary resuscitation quality between standard versus telephone-basic life support training program in middle-aged and elderly housewives: a randomized simulation study. Simulation in Healthcare-J Society for Simulation in Healthcare 2018;13(1):27–32. https://doi.org/10.1097/sih.0000000000000286.
[44] Huang CH, Fan HJ, Chien CY, Seak CJ, Kuo CW, Ng CJ, et al. Validation of a dispatch protocol with continuous quality control for cardiac arrest: a before-and-after study at a city fire department-based dispatch center. J Emerg Med 2017;53(5):697–707. https://doi.org/10.1016/j.jemermed.2017.06.028.
[45] Syvaoja S, Salo A, Uusaro A, Jantti H, Kuisma M. Witnessed out-of-hospital cardiac arrest- effects of emergency dispatch recognition. Acta Anaesthesiol Scand 2018;62(4):558–67. https://doi.org/10.1111/aas.13051.
[46] Lerner EB, Farrell BM, Colella MR, Sternig KJ, Westrich C, Cady CE, et al. A centralized system for providing dispatcher assisted CPR instructions to 9-1-1 callers at multiple municipal public safety answering points. Resuscitation 2019;142:46–9. https://doi.org/10.1016/j.resuscitation.2019.07.010.

[47] Zhang L, Luo M, Myklebust H, Pan C, Wang L, Zhou Z, et al. When dispatcher assistance is not saving lives: assessment of process compliance, barriers and outcomes in out-of-hospital cardiac arrest in a metropolitan City in China. Emerg Med J 2021;38(4):252–7. https://doi.org/10.1136/emermed-2019-209291.

[48] Riou M, Ball S, Whiteside A, Bray J, Perkins GD, Smith K, et al. 'We're going to do CPR': a linguistic study of the words used to initiate dispatcher-assisted CPR and their association with caller agreement. Resuscitation 2018;133:95–100. https://doi.org/10.1016/j.resuscitation.2018.10.011.

[49] Fujie K, Nakata Y, Yasuda S, Mizutani T, Hashimoto K. Do dispatcher instructions facilitate bystander-initiated cardiopulmonary resuscitation and improve outcomes in patients with out-of-hospital cardiac arrest? A comparison of family and non-family bystanders. Resuscitation 2014; 85(3):315–9. https://doi.org/10.1016/j.resuscitation.2013.11.013.

[50] Pozner CN, Zane R, Nelson SJ, Levine M. International EMS systems: the United States: past, present, and future. Resuscitation 2004;60(3):239–44. https://doi.org/10.1016/j.resuscitation.2003.11.004.

[51] Langhelle A, Lossius HM, Silfvast T, Bjornsson HM, Lippert FK, Ersson A, et al. International EMS systems: the nordic countries. Resuscitation 2004;61(1):9–21. https://doi.org/10.1016/j.resuscitation.2003.12.008.