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# 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 OHCA cases 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 OHCA cases, 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

#### 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

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.

## 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

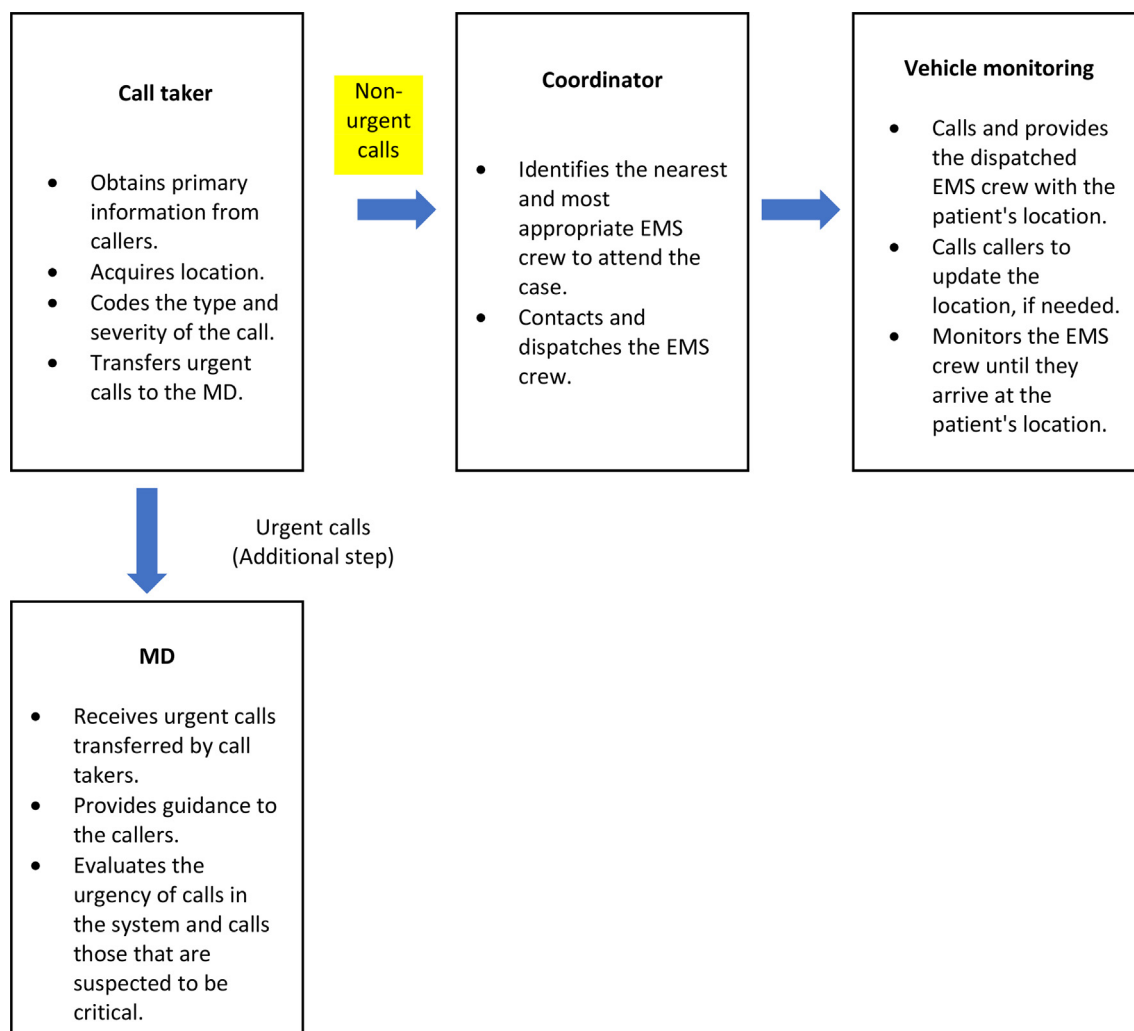


Fig. 1. A flow diagram of the three stages representing the call process at the SRCA and the MD's role.

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  $\geq 18$  years of age and reporting on an adult OHCA patient ( $\geq 18$

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 quadruple 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



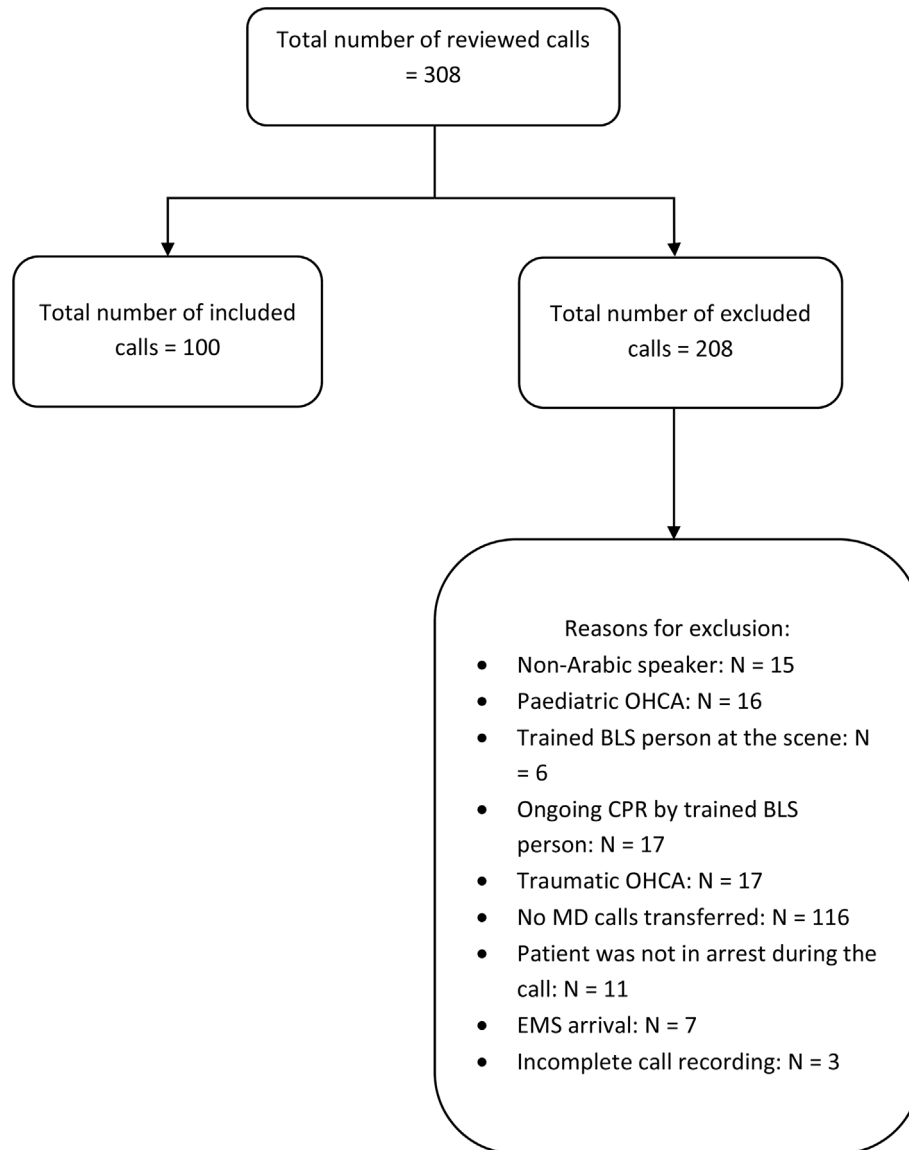


Fig. 2. A flow diagram detailing the included and excluded OHCA calls.

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.

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

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%)	

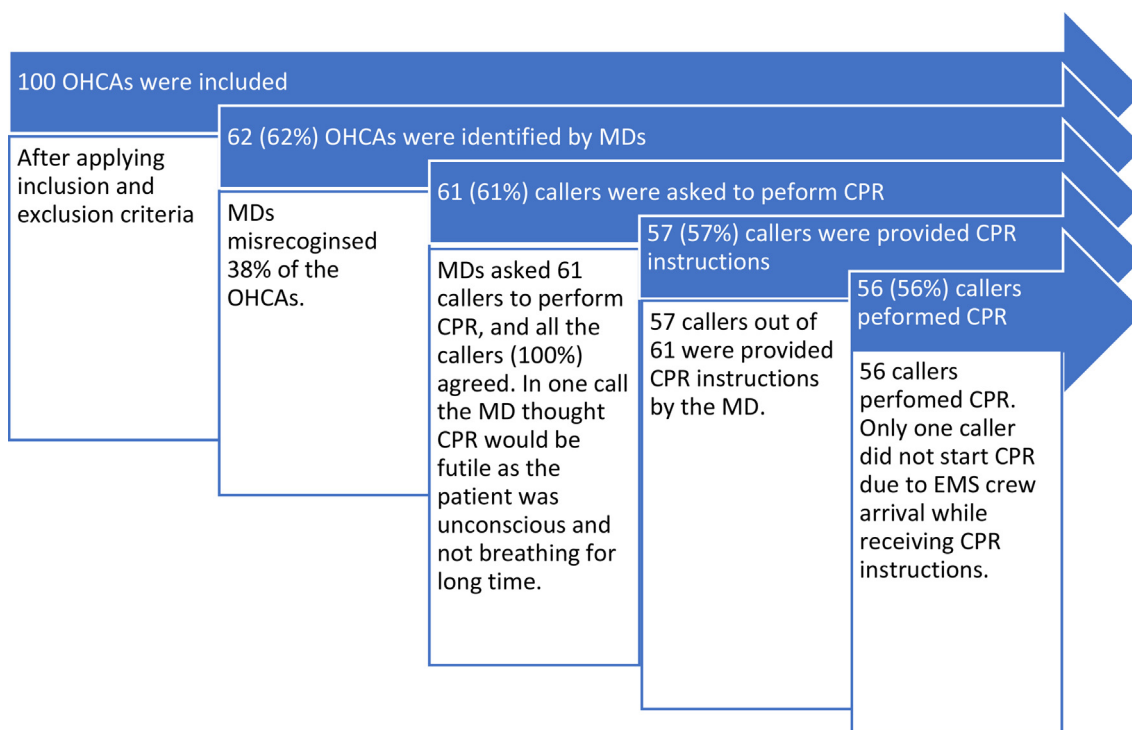


Fig. 3. Illustrations of OHCA calls and CPR rate.

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 OHCA calls 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 OHCA calls were correctly identified [20]. These data highlight the difficulty in identifying OHCA calls 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

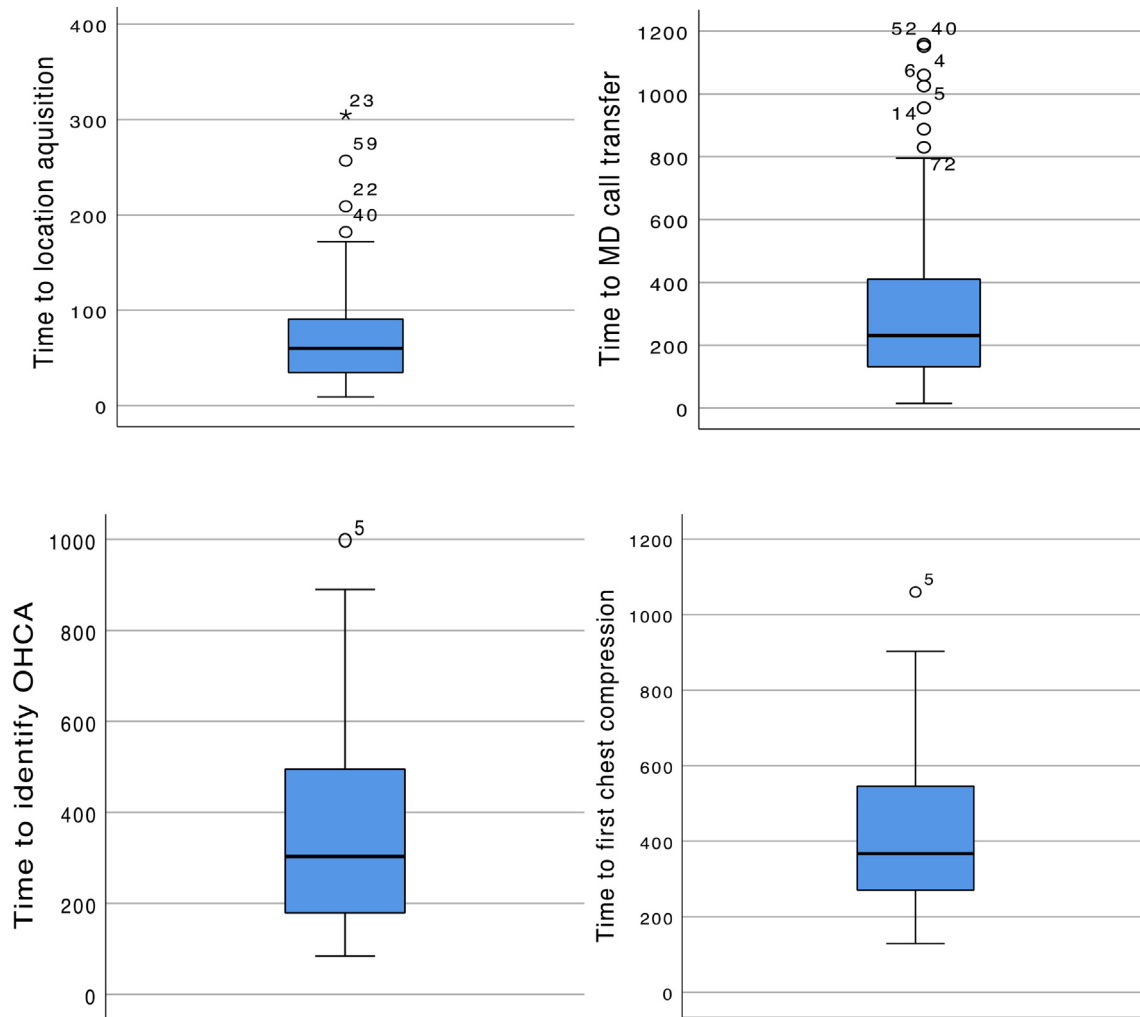


Fig. 4. A Box Whisker plot of the time in seconds from call receipt to events.

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 <sup>a</sup>	60	34–91	21 (21.2%)	21 (21.2%)

<sup>a</sup> 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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