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Original Research Article

Enhancing the detection of out-of-hospital cardiac arrest: a study of emergency medical system in Thailand

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ABSTRACT

Background: Globally, survival rates for out-of-hospital cardiac arrest remain low. Implementing a dispatch-assisted cardiopulmonary resuscitation protocol in evolving emergency medical services systems has shown potential for improving OHCA detection and reducing the time to initiate chest compressions.
Methods: In this study, audio recordings of OHCA emergency calls from different regions of Thailand were analyzed from January 2021 to December 2021. The study aimed to assess OHCA detection efficiency and provide CPR recommendations, including OHCA discrimination rates, time from call initiation to OHCA identification, and time to start CPR following dispatcher guidance.
Results: There were 280 OHCA cases, with 170 (60.7%) successfully identified and excluded by dispatchers. OHCA detection took an average of 39 seconds (compared to a benchmark of 60 seconds), while the mean time from notification to chest compression initiation was 298 seconds (compared to a benchmark of 220 seconds). However, OHCA discrimination and phone-based resuscitation advice were highly sensitive (81.18%), accurate (85.72%), and specific (92.73%).
Conclusions: OHCA presents challenges, with the need for faster CPR initiation. Improving reporting processes, enhancing caller understanding, and refining dispatcher skills are crucial to enhance OHCA detection and DA-CPR, ultimately improving survival rates.

Keywords: Out-of-hospital cardiac arrest, Dispatch assisted CPR, Emergency medical dispatcher, OHCA recognition time, Time to start of chest compressions

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) presents a unique challenge as it occurs outside of hospital settings where the availability of personnel and facilities necessary for high-level procedures is limited. The effectiveness of the emergency medical service system in responding to OHCA incidents, starting from telephone calls, has a significant impact on survival rates. The emergency medical dispatchers (EMDs) who receive these calls and provide over-the-phone advice (dispatched assisted CPR: DA-CPR) play a crucial role in determining whether or not a patient is experiencing OHCA. A study from London indicated that there had been a 200% rise in the number of patients accurately identified for OHCAs by using the Advanced Medical Priority Dispatch System.[1] However, emergency call interrogation and DA-CPR vary between dispatch centers and are often performed without evaluation.[2] A systematic review of observational studies found a Return of spontaneous Circulation (ROSC) of only 29%, considerably lower than the rates in European countries, suggesting that emergency patients with OHCA have a lower chance of survival in Asian countries.[3-5] In Thailand, guidelines for providing DA-CPR, so-called 'Criteria based dispatch and prioritizing emergency patient care' were outlined by the National Institute of Emergency Medical Service Thailand in 2013.[6] These guidelines include specific inquiries for all emergency cases, including the symptoms, location, phone number, caller's name, and consciousness of the patient. If a patient is unconscious and not breathing or has agonal breathing, the case will be identified as OHCA and coded 6 red 1, after which CPR instructions are provided over the phone. Comparing international telephone counseling guidelines, a study found that only 46% of the 60 countries surveyed adopted similar guidelines nationally, while 24% did not use any guidelines for providing advice.[7] Furthermore, research supports the notion that accurate identification of OHCA can significantly improve the chances of survival. However, EMDs were found to be able to correctly OHCA detection in only 70.1% related to 7.84 times, indicating a considerable proportion of cases where OHCA conditions were not recognized.[8] Delays in recognizing OHCA were observed in various countries, including France, where the time from receiving a phone call to recognizing an emergency patient as OHCA exceeded the recommended threshold of 60 seconds set by the American heart association (AHA) by 8 seconds.[9] Additionally, a substantial amount of time was wasted during calls to the command control center and communication with the dispatchers.[10] The time from a call to starting chest compressions was also found to be longer than ideal within 220 seconds.

Aim and objectives

This study aimed to determine the duration of OHCA recognition, meaning the time it took for EMDs to start chest compressions after being notified, and the percentage of accuracy for OHCA detection.

METHODS

Study design

This study utilized a cross-sectional analytical design and collected data from the dispatch centers equipped with notification systems in three provinces of Thailand: Mahasarakham Province (northeast), Prachinburi (central), and Songkhla (southern) regions. In these settings, all the CPR steps adhered to the guidelines for providing DA-CPR. The research analyzed retrospective data from audio tapes of incident reports and commands made via the emergency call number "1669" during the period from January to December 2021.

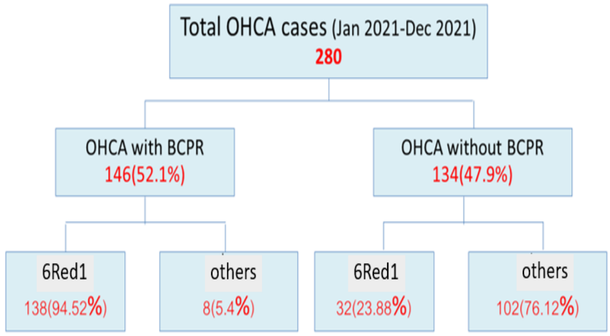

Figure 1: Population flow diagram.

Population

All data for OHCA patients in 2021 treated by bystanders were collected retrospectively. Audio recordings associated with these incidents were reviewed by EMDs using a checklist that included all the necessary variables. Inclusion criteria involved OHCA patients who sought assistance from the dispatch center through a bystander's call and were subsequently transported to the hospital by emergency medical providers. Cardiac arrest cases were excluded if they met any of the following criteria: they occurred in nursing homes, doctors' offices, jails, or unknown locations, with the aim of focusing on how non-healthcare professionals described abnormal breathing; a language barrier hindered the dispatch process; emergency medical providers witnessed the OHCA, or the caller was not present with the patient. For the analysis of the CPR process, we excluded calls in which bystander CPR was initiated before receiving CPR instructions and the audio was incomplete or fragmented. The DA-CPR protocol within the dispatch centers specifies compression-only CPR for adult arrests, and EMDs are expected to provide CPR instructions if the patient is reported as unconscious or apnea or agonal breathing (6 red 1).

Measurements and analysis

The authors considered DA-CPR provided if EMDs initiated CPR instructions resulting in bystanders beginning chest compressions. To investigate whether callers' descriptors influenced DA-CPR process measures, four points were analyzed, which included: OHCA Recognition Rate: This refers to the percentage of calls in which the callers recognized the need for CPR. Bystander CPR Rate: This involves the percentage of calls in which bystanders-initiated chest compressions. OHCA Recognition Duration: This signifies the duration from the moment EMDs received information about patients with unconsciousness, apnea, or agonal breathing until the time CPR was initiated and duration time from the emergency call to the start of chest compressions: This represents the time elapsed from the initial emergency call to the commencement of chest compressions.

Table 1: General characteristics of calls for out-of-hospital cardiac arrest.

Characteristics	All OHCAs (N=280, 100%)	CPR advised (N=204, 72.9%)	Bystander CPR (N=146 ,52.1%)	P value
Male OHCA	197 (70.4)	168 (70)	93 (63.6)	0.011
Age (years)	280 (100)	204 (100)	146 (100)	0.074
<60	107 (38.2)	91 (44.6)	57 (39)	
60-69	57 (20.4)	37 (18.1)	29 (19.8)	
70-79	60 (21.4)	36 (17.6)	24 (16.4)	
≥80	56 (20)	40 (19.6)	36 (24.6)	
Causes of OHCA	280 (100)	204 (100)	146 (100)	-
Non-trauma	255 (91)	199 (94.5)	146 (100)	
Trauma	25 (8.9)	5 (2.4)	-	
Place of OHCA	280 (100)	204 (100)	146 (100)	0.000
Home/residential	231 (82.5)	179 (87.7)	138 (94.5)	
Public	49 (17.5)	25 (12.3)	8 (5.5)	
Witness arrest	252 (100)	204 (100)	126 (100)	0.010
Yes	126 (50)	106 (58.9)	73 (57.9)	
No	122 (48.4)	74 (41.1)	53 (42.1)	
AED used	268 (100)	-	138 (100)	0.282
Yes	12 (4.5)		8 (5.8)	
No	256 (95.5)		130 (94.2)	
Criteria-based dispatch	280 (100)	204 (100)	146 (100)	0.000
6 Red 1 unconscious and apnea	170 (60.7)	158 (77.5)	138 (94.5)	
19 Red 1 unconscious	57 (20.4)	29 (14.2)	4 (2.7)	
5 Red 1 dyspnea	16 (5.7)	8 (3.9)	4 (2.7)	
25 Red 1 traffic injury	25 (8.9)	5 (2.5)	0	
17 Yellow5 fatigue	8 (2.9)	4 (1.9)	0	
16 Red 1 seizure	4 (1.4)	0	0	
Caller relationship with patient	280 (100)	204 (100)	146 (100)	0.000
Bystander	53 (18.9)	37 (18.1)	12 (8.2)	
Parent	203 (72.5)	155 (75.9)	130 (89)	
Health provider	24 (8.5)	12 (5.9)	4 (2.7)	
Training CPR	280 (100)	204 (100)	146 (100)	0.090
Ever	25 (8.9)	16 (7.8)	9 (6.2)	
Never	255 (91)	188 (92.2)	137 (93.8)	
EMS service type	280 (100)	204 (100)	146 (100)	0.372
ALS	170 (60.7)	122 (59.8)	85 (58.2)	
Dual system	110 (39.3)	82 (40.2)	61 (41.8)	
Distance	280 (100)	204 (100)	146 (100)	0.124
≤10 km	137 (48.9)	102 (50)	65 (44.5)	
>10 km	143 (51)	102 (50)	81 (55.5)	

Definitions

OHCA recognition: This denotes the moment when the call dispatcher identified OHCA, either at the time of the initial dispatch or later during the call. Bystander-CPR: This pertains to whether CPR was initiated at any point during the call by the caller or any other bystander present at the scene, as indicated by audible signs. OHCA Recognition Duration: This is the time interval from the receipt of the call until the EMD recognized the need for CPR. Time from Call to Start of Chest Compressions: This represents the duration from the initial emergency call until the bystander performs the first chest compression.

Statistical analysis

In this study, the authors employed the Chi-square test for the following analyses: To examine the association between OHCA recognition and bystander-CPR. To assess the association between the duration of OHCA recognition and the number of OHCA cases. To investigate the association between the time elapsed from the call to the initiation of chest compressions and the number of events involving bystander-CPR. A p value of less than 0.05 was deemed statistically significant. Additionally, the study calculated sensitivity, specificity, and positive predictive values for the recognition of OHCA.

RESULTS

The analysis of 280 emergency medical services cases revealed several key findings (Figure 1). Most cases involved male patients (70.4%) under the age of 60 (38.2%) and were predominantly caused by emergency illnesses (91%). The majority of incidents occurred at home (82.5%). Further, only a small percentage of cases involved the use of automated external defibrillators (AEDs) (4.5%). The OHCA detection and criteria based dispatched were considered, which found that 60.7% of cases met the criteria for cardiac arrest with unconsciousness and agonal breathing or apnea. Significant differences were observed in resuscitation rates among the different criteria-based dispatched categories, including unconsciousness with agonal breathing or apnea, unconsciousness, and dyspnea (Table 1).

Table 2: Review of the timetable for OHCA detection and time from call to start of chest compressions.

Time	Mean (SD)	OHCAs	P value
OHCA recognition duration	39.1 (13.0)	170 (60.7)	0.000
Duration time from call to start of chest compressions	298.0 (375.4)	146 (52.1)	0.000

Table 3: Efficiency of DA-CPR by EMDs and bystander CPR (n=280).

Bystander CPR=146		6 Red 1	Others	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	PPV (%) (95% CI)	NPV (%) (95% CI)	Accuracy (95% CI)
Bystander CPR	Yes	138	8	81.18 (74.48 to 86.75)	92.73 (86.17 to 99.81)	94.52 (89.48 to 97.60)	76.13 (68.00 to 83.07)	85.72% (81.06 to 89.60)
	No	32	102					

Regarding the callers' information, most calls were made by relatives (72.5%). Furthermore, a high percentage (91%) of callers had never received CPR training. When considering the emergency medical service system data, it was found that most were serviced by the advance life support team at 170 cases (60.7%), most of which found that the time from receiving the notification to the scene of the incident was more than 8 minutes in 188 OHCA (67.1%). When concerned with the general characteristics that were significant in cardiopulmonary resuscitation, it was found that certain variables were involved including the crime scene (public or private), witnesses to the event, criteria-based dispatch being identified, and Informant-Patient relationships. It was found that there was a statistically significant difference in performing on-site cardiopulmonary resuscitation by a caller who may be a bystander of CPR. According to the data presented, it was identified that only 146 emergency patients out of the total cases were recognized as experiencing OHCA and received CPR. The average time difference from the moment of notification to the initiation of chest compressions by a bystander was 39 seconds. On the other hand, the average time from notification to the start of chest compressions provided over the phone was 298 seconds. Both of these time differences in OHCA detection and the time provided from receiving a call to initiating chest compressions were found to be statistically significant, indicating variations in bystander CPR among different cases (Table 2). The analysis of the efficiency of OHCA detection and provision of advice over the phone compared to on scene bystander CPR as the gold standard (Table 3). The results show that the EMDs exhibited a relatively high level of efficiency in correctly OHCA recognition cases for DA-CPR. The sensitivity of sorting, indicating the ability to correctly identify OHCA cases, was 81.18%, while the specificity, representing the ability to accurately exclude non-OHCA cases, was 92.73%. The overall accuracy of the separation was 85.72%, indicating a high level of accuracy in providing CPR advice.

DISCUSSION

Among the emergency patients with cardiac arrest, it was found that only 60.7% (170 cases) were correctly classified as such 6 red 1, representing an OHCA detection rate of 70%. However, there were cases where emergency patients received chest compressions despite not being categorized as 6 Red 1, accounting for 5.4%. On the other hand, there were cases where the code 6 Red 1 was given, but chest compressions were not performed, representing 23.88%. These findings suggest that there may be challenges in accurately assessing the signs of cardiac arrest for the informers or difficulties for the EMDs in inquiring about cardiac arrest symptoms. This aligns with a previous study, which revealed that the callers often struggled to determine whether the observed symptoms indicated an out-of-hospital cardiac arrest.[11] It is important to note that this research collected data from representatives of the Thai dispatch centers in the northeast, central, and southern regions, which differed from the information obtained from representatives of the Northern dispatch center. The classification results varied, with 6 Red 1 accounting for 42.6%, followed by loss of consciousness (19 Red 1) at 31.6% and traffic accidents (25 Red 1) at 8.1%.[12] These findings highlight the importance of accurate OHCA detection, as well as effective communication between callers and EMDs in the prehospital setting. The analysis of DA-CPR efficiency in terms of OHCA detection revealed high sensitivity and positive predictive value (81.18%), indicating that there was a strong likelihood that the patients had indeed experienced cardiac arrest when EMDs classified patients as having cardiac arrest outside the hospital. This finding is consistent with previous research conducted in Thailand, which reported a relatively high positive predictive value of 96.7%.[12] Regarding the duration of OHCA detection, the results of this study showed an average time of 39 seconds, with 170 out of 280 cases (60.7%) being assessable as OHCA.[10] This differs from overseas research conducted in 2015, which suggested a 60-second timeframe for OHCA screening and an 84% proportion of emergency cases that could be screened successfully for OHCA. The findings of this research indicate that the ability of EMDs to accurately identify and classify OHCA cases is commendable, as evidenced by the high sensitivity and positive predictive value.

The time from notification to the initiation of chest compressions by a bystander was 298 seconds, with only 146 out of 280 OHCA cases (52.1%) receiving chest compressions. This indicates a delay compared to the time reported in a similar study, where the average time from notification to chest compressions was 220 seconds, and 71% of OHCA cases received chest compressions within that time frame.[10] Furthermore, it is important to note that the proportion of OHCA cases receiving chest compressions after receiving advice should be no less than 75%. In this study, improvements are needed in terms of the quality of the notification system as well as the delivery of advice to ensure reasonable resuscitation practices. This finding aligns with the research conducted by Derkenne et al which highlighted that a significant amount of time was wasted during communication with the EMDs, accounting for 95% of the time.[9] Additionally, there was a lack of variable data on DA-CPR in the database, indicating the need for data collection from real-life observations rather than solely relying on audio tapes.

The development of notification and command systems utilizing artificial intelligence (AI) has been an area of ongoing research. In a recent study, it was found that using an AI-powered machine learning framework could significantly expedite the identification of OHCA conditions compared to traditional approaches.[13] The study demonstrated that the AI system, which analyzed the speech patterns of the informant, was able to reduce the detection time by 28 seconds compared to the conventional OHCA detection query method, which was statistically significant. This timely detection is crucial for initiating life-saving interventions promptly and increasing the chances of positive outcomes for OHCA patients. The integration of AI technologies into notification and command systems holds great promise for improving emergency response capabilities. Further research and development in this field could lead to more efficient and effective systems for identifying and responding to OHCA incidents, ultimately saving more lives.

The analysis of CPR in relation to various characteristics has revealed several significant factors. Among them, several studies conducted in 2018-2019 focused on gender consistently found that female OHCA patients were less likely to receive resuscitation or bystander CPR compared to males.[14-16] This highlights a disparity in CPR provision based on gender. Secondly, research has shown that, in terms of locale, OHCA cases occurring in public areas where bystanders have received CPR training have better survival rates compared to incidents that happen at home, where family members are the witnesses.[17] The presence of trained bystanders in public areas increases the chances of receiving timely CPR, thus improving outcomes. Thirdly, a witness may arrest during a CPR event; if someone witnesses an OHCA incident from the moment the patient starts losing consciousness, it is less likely that the person making the emergency call will decide to provide CPR assistance. This finding suggests that callers may hesitate to initiate CPR if they observe the patient's deterioration in real time.[18] Fourthly, distinguishing characteristics involves the ability of the EMDs to recognize specific symptoms, which plays a crucial role in the initiation of CPR. In particular, the identification of unconsciousness, absence of breathing, or agonal breathing (gasping) is considered significant for promptly classifying cases as OHCA. This aligns with previous research that highlighted the importance of recognizing agonal breathing as a critical symptom.[19] Fifthly, caller-patient relationship, there was a study has found that family members of pediatric OHCA patients, particularly those under 19 years of age, may feel hesitant or fearful when it comes to providing CPR. This indicates that there might be emotional or psychological barriers for family members when performing CPR on relatives, particularly young ones.[20] Understanding these characteristics and their impact on CPR provision is essential for developing targeted interventions and improving the overall quality of emergency response systems. By addressing the identified factors, efforts can be made to bridge the gaps in CPR delivery, enhance training programs, and increase the chances of survival for OHCA patients.

CONCLUSION

There is a need to address the delays that occur in initiating chest compressions and improve the overall quality of the notification system and advice delivery. This can help ensure that a higher proportion of OHCA cases receive timely and appropriate resuscitation, ultimately improving patient outcomes. Collecting data from real situations and considering additional variables related to DA-CPR can further enhance the effectiveness of emergency response protocols.

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