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Original Article

Comparison of Prehospital Management between Older and Younger Out-of-Hospital Cardiac Arrest Patients: A Single-Centre Study in Bangkok

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SUMMARY

Backgrounds: There was limited data specific to bystander cardiopulmonary resuscitation (CPR) in older out-of-hospital cardiac arrest (OHCA) patients in Thailand. Accordingly, the aim of this study was to determine the rate of bystander CPR and other types of prehospital management compared between older and younger OHCA patients in Thailand.
Methods: This cross-sectional study was conducted using data from the cardiac arrest registry of a university hospital in Thailand from 1 January 2014 to 31 December 2019. All non-traumatic OHCA patients were eligible for inclusion except for EMS-witnessed OHCA and those pronounced dead at the scene. Included OHCA were categorized into the older (> 65 years) or younger (18–65 years) age groups.
Results: The final analysis included 575 patients, and 328 (57.0%) of those were in the older age group. The shockable rhythm was significantly less in the older group than in the young group (OR: 0.4, 95% CI: 0.2–0.6). We found no significant difference between the older and younger groups for bystander cardiopulmonary resuscitation (CPR) rate (OR: 1.0, 95% CI: 0.7–1.5), public automated external defibrillator (AED) use (OR: 0.3, 95% CI: 0.1–1.1), emergency medical service (EMS) use (OR: 0.9, 95% CI: 0.6–1.3). Factors associated with bystander CPR in our cohort were OHCA witnessed by healthcare provider (adjusted OR (aOR): 21.7, 95% CI: 4.3–111.1) and EMS utilization (aOR: 8.4, 95% CI: 4.6–15.3).
Conclusion: The citywide data suggests no significant difference in bystander CPR rate or other types of administered prehospital management between older and younger OHCA patients.

1. Introduction

Out-of-hospital cardiac arrest (OHCA) is a critical medical emergency that is associated with remarkably high morbidity and mortality rates.[1] The Pan Asian Resuscitation Outcomes Study (PAROS), which collected data from several Asian countries, reported a survival rate of OHCA patients that ranged from 0.5–8.5%.[2] Previous studies reported witnessed arrest,[3] bystander cardiopulmonary resuscitation (CPR),[3–6] and public automated external defibrillator (AED) use[6,7] to be factors that increase the survival rate among OHCA patients.

Many countries are currently transitioning to aging or aged societies.[8] The number of people with medical conditions continues to increase despite the implementation of numerous health literacy programmes. Limitations that make it more difficult for older patients to access healthcare services include physical inability, lack of a caregiver, financial problems, and a perception that they are being a burden on their family. Recent studies revealed lower rate of bystander CPR among elderly OHCA patients in France and Denmark when compared with younger population.[9,10] Although Thai OHCA patients were mostly in aging population,[11] there were limited data describing characteristics of Thai elderly OHCA patients. We, therefore, hypothesized that older Thai patients may have more limited access to emergency life support, such as bystander CPR, emergency medical services (EMS), and other types of prehospital management, than their younger counterparts. Accordingly, the aim of this study was to determine the rate of bystander CPR and other types of prehospital management compared between older and younger OHCA patients in Thailand.

2. Methods

2.1. Study design and setting

This cross-sectional study included adult (aged 18 years or older) non-traumatic OHCA patients who presented to the Department of Emergency Medicine of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand during the 1 January 2014 to 31 December 2019. We excluded all trauma cases, EMS-witnessed arrests, and patients who were pronounced dead at the scene. Eligible patients were categorized into the younger age (age 18–65 years) or older age (age > 65 years) groups.[9,10] An OHCA patient was specifically defined in this study as a person who went into

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cardiac arrest outside of Siriraj Hospital. The protocol for this study was approved by the Siriraj Institutional Review Board (COA no. Si 307/2019), and written informed consent was not obtained because all patient data was retrospectively collected.

Siriraj Hospital, which is a 2,200-bed super-tertiary referral centre, is located in Northwest Bangkok, which is the capital city of Thailand. The emergency department (ED) is responsible for treating all non-traumatic emergency cases. Our ED has approximately 200,000 visits annually, and most of those patients come from the west of Bangkok. The majority of the area is a semi-urban community that consists of old households and new condominiums. An estimated 1,000,000 people reside in the coverage area, which accounts for 10% of the population in Bangkok, and 1.4% of the overall Thai population. Regarding OHCA cases, there are three ways that a patient can be transported to the hospital. First, a bystander can call 1669, which is the medical emergency number for the Thai EMS system. The dispatcher will send an advanced level ambulance that provides advanced life support (ALS) administered by emergency nurses or paramedics. Most advanced level ambulances are based at a hospital. Before ambulance arrival, the dispatcher advises dispatcher-assisted CPR (DACPR) as standard protocol. In Bangkok, the DACPR has been implemented since 2013 which covered the study period. If available, the dispatcher will also send a basic level ambulance to support the advanced team as the first responder. Basic level ambulances, which are commonly staffed by volunteers, provide only chest compression, basic airway management, and AED use. Detailed information about the Thai EMS system is comprehensively described in a previous report.[12] Second, a bystander can call a private hospital or volunteer-based ambulance that is not part of the 1669 system. Third and last, a bystander can transport the OHCA patient to the hospital by him/herself in a private vehicle.

2.2. Data sources and data collection

Our OHCA registry was developed using variables and definitions from the PAROS database registry.[13] Patient characteristics; location where the collapse occurred; prehospital data, such as bystander CPR, public AED use, initial rhythm, and prehospital advanced airway and drug administration; initial rhythm at the ED, and patient outcome data, were collected and recorded. Regarding the location where OHCA occurred, there are 9 predefined locations in our registry, as follows: home residence, healthcare facility, public/commercial building, nursing home, street/highway, industrial place, transport centre, place of recreation, or in EMS/private ambulance. We include OHCA that occurred during private transport in the street/highway category. The type of person who contacted with the patient prior to arrival at the ED were categorised in our registry as (1) layperson, (2) bystander family, (3) bystander healthcare provider, (4) ambulance crew. Bystander healthcare provider is defined as a healthcare provider who is not dispatched by the EMS system for that OHCA case. The ambulance crew are defined as EMS providers who are dispatched by the emergency call centre, including both basic and advanced level ambulances. Patient characteristics, prehospital interventions, and ED interventions, including bystander CPR and AED use, are input into EMS records and ED medical records after OHCA resuscitation by EMS and ED providers, respectively. The presumed cause of cardiac arrest is decided and recorded by ED providers based on evidence from patient history and physical examination. Data from the OHCA registry, from EMS records, and from ED medical records were collected by researchers and research assistants. Patient outcome data was collected from the patient's hospital record. Concerning registry quality assurance, the OHCA registry at our centre is audited monthly by Department of Emergency Medicine administrators to ensure the entry of consistently complete and accurate data entry. A flow diagram of the patient enrolment process is shown in Figure 1.

2.3. Outcome measures

The primary outcome was comparison of the bystander CPR rate between the younger age and older age groups. Secondary outcome measures included prehospital management, such as bystander AED use, EMS use, prehospital advanced airway use (endotracheal tube and laryngeal mask airway), and prehospital drug administration. Lastly, patient outcomes at the ED were compared between groups.

2.4. Statistical analysis

We performed descriptive analysis of patient demographic data, clinical characteristics, prehospital resuscitation information, and patient outcomes. We grouped OHCA location into (1) home residence; (2) healthcare facility, including nursing home; (3) public/commercial building, including place of recreation, transportation

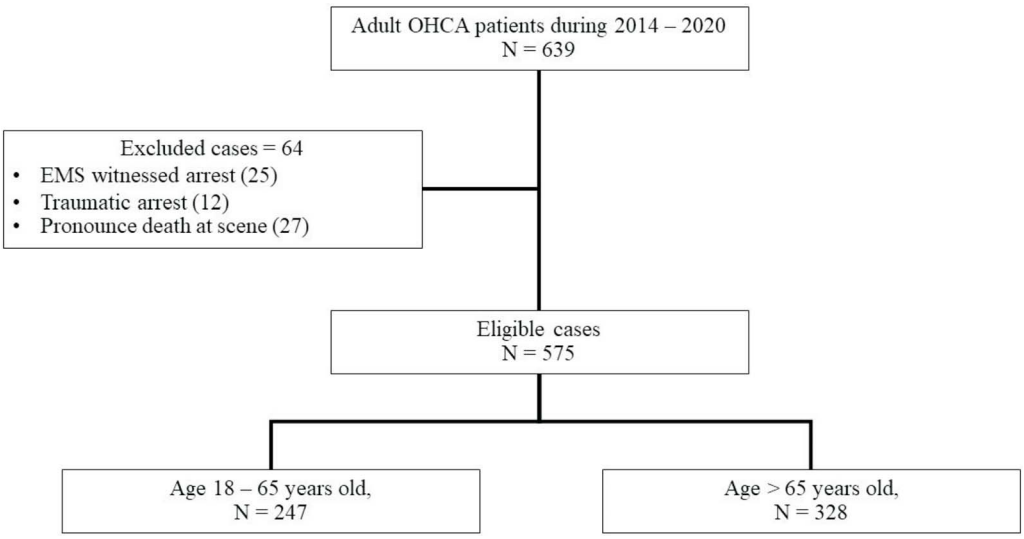

Figure 1. Flow diagram of the patient enrolment process. Abbreviations: OHCA, out-of-hospital cardiac arrest; EMS, emergency medical service.

centre, or industrial area; or, (4) street/highway, including OHCA during private transport. All categorical variables were compared between groups using chi-square test or Fisher's exact test, and those results are shown as number and percentage. We also identified the chance of the older group related with each factor compared with the younger group and presented odd ratios and their 95% confidence intervals to indicate the uncertainty. The study reports prehospital time intervals including (1) response time which was defined as the time from calling the emergency number to the ambulance arrived at the scene, (2) scene time which was defined as the time between the ambulance arrival at the scene and the ambulance departure from the scene, (3) transport time which was defined as the time between the ambulance departure from the scene and the ambulance arrival at ED. All time intervals were compared median using the Mann-Whitney U test.

We also conducted the multiple logistic regression analysis to identify the association between the age group and other factors with bystander CPR in our cohort. The study used the location of arrest, the type of person who witnessed the arrest, and the mode of transportation to ED as co-factors in the analysis.

The results of that analysis are presented as odds ratio (OR) and 95% confidence interval (CI). Two-tailed *p*-values of < 0.05 were considered statistically significant. SPSS statistical package version 18 was used for all statistical analyses.

3. Results

A total of 639 adult OHCA patients were identified during the January 2014 to December 2019 study period. After excluding 64 cases that were EMS-witnessed arrest, traumatic cases, or patients who were pronounced dead at the scene, the remaining 575 patients were included in our analysis. Of those, 328 (57.0%) patients were aged > 65 years (older age group patients), and the remaining 247 (43.0%) patients were aged 18–65 years (younger age group patients) (Figure 1).

3.1. OHCA characteristics and demographic data

The clinical characteristics and demographic data of included patients are shown in Table 1. Descriptive analysis revealed significant differences between older and younger OHCA victims. The older group was more likely to be female (odds ratio [OR]: 2.40, 95% confidence interval [CI]: 1.70–3.39), to have heart disease (OR: 2.10, 95% CI: 1.36–3.22), to have the initial rhythm as asystole (OR: 1.94, 95% CI: 1.39–2.72), and to have respiratory aetiology as the cause of OHCA (OR: 1.53, 95% CI: 1.02–2.29).

3.2. Comparison of prehospital resuscitation between the older and younger groups

Regarding our primary outcome, no significant difference was observed between the older and younger patients who received CPR from a bystander (OR: 0.99, 95% CI: 0.65–1.52) or for public AED use (OR: 0.27, 95% CI: 0.07–1.05) (Table 2). Concerning other types of prehospital management, there was also no significant difference between groups relative to receiving prehospital advanced airway (OR: 0.81, 95% CI: 0.48–13.77), prehospital drug administration (OR: 0.89, 95% CI: 0.47–1.67), or mechanical CPR (OR: 0.85, 95% CI: 0.41–1.76). Lastly, no significant differences were observed between the older and younger groups relative to the method of transportation

Table 1
Patient demographic and clinical characteristics compared between OHCA groups.

Characteristics	Younger group (age 18–65 yrs) (n = 247) n (%)	Older group (age > 65 years) (n = 328) n (%)	Odds ratio (95% CI)	*p*
Female gender	79 (32.0%)	174 (53.0%)	2.4 (1.7–3.4)	***< 0.001***
Heart disease (n = 491)	38 (19.4%)	99 (33.6%)	2.1 (1.4–3.2)	***< 0.001***
Respiratory disease (n = 491)	23 (11.7%)	41 (13.9%)	1.2 (0.7–2.1)	0.486
Location of event				***0.003***
Home residence	160 (64.8%)	230 (70.3%)	1.3 (0.9–1.8)	0.158
Healthcare facility	4 (1.6%)	14 (4.3%)	2.7 (0.9–8.4)	0.081
Public/commercial building	31 (12.6%)	16 (4.9%)	0.4 (0.2–0.7)	***< 0.001***
Street/highway	52 (21.1%)	67 (20.5%)	1.0 (0.6–1.5)	0.605
Cardiac arrest witnessed by				
Bystander family	173 (70.0%)	248 (75.6%)	1.3 (0.9–1.9)	0.136
Bystander healthcare provider	5 (2.0%)	11 (3.4%)	1.7 (0.57–4.89)	0.342
Bystander layperson	35 (14.2%)	22 (6.7%)	0.4 (0.2–0.8)	***0.004***
Not witnessed	34 (13.8%)	47 (14.3%)	1.0 (0.7–1.7)	0.847
Initial rhythm at ED				
Ventricular fibrillation	62 (25.1%)	36 (11.0%)	0.4 (0.2–0.6)	***< 0.001***
Ventricular tachycardia	2 (0.8%)	2 (0.6%)	0.8 (0.1–5.4)	0.752
Pulseless electrical activity	69 (27.9%)	78 (23.8%)	0.8 (0.6–1.2)	0.259
Asystole	103 (41.7%)	191 (58.2%)	1.9 (1.4–2.7)	***< 0.001***
Sinus/other perfusing rhythms	11 (4.5%)	21 (6.4%)	1.5 (0.7–3.1)	0.315
Presumed cause of cardiac arrest				
Presumed cardiac aetiology	142 (57.5%)	168 (51.2%)	0.8 (0.6–1.1)	0.776
Respiratory aetiology	47 (19.0%)	87 (26.5%)	1.5 (1.0–2.3)	***0.036***
Others	58 (23.5%)	73 (22.3%)	0.9 (0.6–1.4)	0.729
ROSC at ED	88 (35.9%)	95 (29.1%)	0.7 (0.5–1.0)	0.086
Survival to admission (n = 571)	25 (10.4%)	24 (7.4%)	0.7 (0.4–1.2)	0.216
Survival to discharge (n = 563)	10 (4.0%)	5 (1.5%)	0.4 (0.1–1.1)	0.070

A *p*-value < 0.05 indicates statistical significance.
Abbreviations: CI, confidence interval; ED, emergency department; EMS, emergency medical service; OHCA, out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation.

used to transport the patient to the ED, including EMS (OR: 0.93, 95% CI: 0.64–1.34), private ambulance (OR: 0.75, 95% CI: 0.44–1.26), or private transport (OR: 1.19, 95% CI: 0.85–1.67) (Table 2).

3.3. Factors associated with rate of receiving bystander CPR

Multivariable logistic regression analysis was performed to identify association between the older age group and the rate of receiving bystander CPR (Table 3). The results of that analysis revealed the older age group not to be independently associated with the rate of receiving bystander CPR (adjusted [aOR]: 1.13, 95% CI: 0.68–1.88). When compared with the non-witnessed cardiac arrest group, OHCA witnessed by a bystander healthcare provider or a layperson was independently associated with the rate of receiving bystander CPR (aOR: 21.73, 95% CI: 4.25–111.13, and aOR: 5.15, 95% CI: 2.05–

Table 2
Prehospital resuscitation factors compared between the younger and older OHCA groups.

Resuscitation factors	Younger group (age 18–65 yrs) (n = 247) n (%)	Older group (age > 65 years) (n = 328) n (%)	Odd ratio (95% CI)	*p*
Bystander CPR	46 (18.6%)	61 (18.6%)	1.0 (0.7–1.5)	0.994
Public AED usage	8 (3.2%)	3 (0.9%)	0.3 (0.1–1.1)	0.059
Initial rhythm at scene (n = 225)				
Ventricular fibrillation	19 (18.8%)	7 (5.6%)	0.3 (0.1–0.6)	***0.004***
Ventricular tachycardia	1 (1.0%)	1 (0.8%)	0.8 (0.5–13.2)	0.884
Pulseless electrical activity	12 (11.9%)	13 (10.5%)	0.9 (0.4–2.0)	0.740
Asystole	45 (44.6%)	73 (58.9%)	1.8 (1.0–3.0)	***0.033***
Unknown shockable rhythm	2 (2.0%)	1 (0.8%)	0.4 (0.0–4.5)	0.460
Unknown non-shockable rhythm	1 (1.0%)	4 (3.2%)	3.3 (0.4–30.3)	0.285
Unknown	21 (20.8%)	25 (20.2%)	1.0 (0.5–1.8)	0.907
First CPR before arrival at ED by (n = 569)				
Ambulance crew	57 (23.3%)	66 (20.4%)	0.8 (0.6–1.3)	0.406
Bystander family	21 (8.6%)	34 (10.5%)	1.3 (0.7–2.2)	0.443
Bystander healthcare provider	13 (5.3%)	13 (4.0%)	0.7 (0.3–1.6)	0.466
Layperson	11 (4.5%)	13 (4.0%)	0.9 (0.4–2.0)	0.779
No CPR initiated	143 (58.4%)	198 (61.6%)	1.1 (0.8–1.6)	0.508
Prehospital advanced airway (n = 225)	55 (53.9%)	60 (48.8%)	0.8 (0.5–13.8)	0.443
Mechanical CPR (n = 225)	17 (16.7%)	18 (14.6%)	0.9 (0.4–1.8)	0.676
Prehospital drug (n = 225)	80 (78.4%)	94 (76.4%)	0.9 (0.5–1.7)	0.720
Transportation to hospital by				
Private vehicle	143 (57.9%)	204 (62.2%)	1.19 (0.85–1.67)	0.297
Private ambulance	32 (13.0%)	33 (10.1%)	0.8 (0.4–1.3)	0.279
EMS	72 (29.1%)	91 (27.7%)	0.9 (0.6–1.3)	0.711
Response time (n = 137) median [IQR]	10 [8–15]	11 [8–14.5]		0.865
Scene time (n = 135) median [IQR]	18 [11.75–25.5]	20 [15–27]		0.266
Transport time (n = 136) median [IQR]	9 [5.75–11.25]	8 [5.75–11]		0.646

A *p*-value < 0.05 indicates statistical significance.
Abbreviations: AED, automated external defibrillator; CI, confidence interval; CPR, cardiopulmonary resuscitation; ED, emergency department; EMS, emergency medical service; OHCA, out-of-hospital cardiac arrest.

Table 3
Univariable and multivariable analysis for factors associated with OHCA receiving BCPR.

Factors	BCPR		Univariable analysis		Multivariable analysis	
	Non-BCPR (n = 468) n (%)	BCPR (n = 107) n (%)	Crude OR (95% CI)	*p*	Adjusted OR (95% CI)	*p*
Older age group*	267 (57.1%)	61 (57.0%)	1.0 (0.7–1.5)	0.994	1.1 (0.7–1.9)	0.624
Location of arrest						
Home residence	332 (68.8%)	68 (64.2%)	ref		ref	
Healthcare facility	8 (1.7%)	10 (9.4%)	5.9 (2.2–15.5)	***< 0.001***	0.9 (0.2–3.7)	0.828
Public/commercial building	31 (6.6%)	16 (15.1%)	2.4 (1.3–4.7)	***0.008***	0.8 (0.3–2.1)	0.672
Street/highway	107 (22.9%)	12 (11.3%)	0.5 (0.3–1.0)	0.057	0.6 (0.3–1.4)	0.235
Arrest witnessed by						
No	66 (14.1%)	15 (14.0%)	ref		ref	
Family	370 (79.1%)	51 (47.7%)	0.6 (0.3–1.1)	0.121	1.2 (0.6–2.4)	0.596
Healthcare provider	4 (0.9%)	12 (11.2%)	13.2 (3.7–46.7)	***< 0.001***	21.7 (4.3–111.1)	***< 0.001***
Layperson	28 (6.0%)	29 (27.1%)	4.6 (2.1–9.8)	***< 0.001***	5.2 (2.1–13.0)	***0.001***
Mode of transportation						
Private vehicle	326 (69.7%)	21 (19.6%)	ref		ref	
Private ambulance	47 (10.0%)	18 (16.8%)	5.9 (3.0–12.0)	***< 0.001***	4.1 (1.9–8.9)	***< 0.001***
EMS	95 (20.3%)	68 (63.6%)	11.1 (6.5–19.1)	***< 0.001***	8.4 (4.6–15.3)	***< 0.001***

A *p*-value < 0.05 indicates statistical significance.
* Older age group (age > 65 years).
Abbreviations: BCPR, bystander cardiopulmonary resuscitation; CI, confidence interval; EMS, emergency medical service; OHCA, out-of-hospital cardiac arrest; OR, odds ratio.

12.97, respectively). EMS and private ambulance use were also factors independently associated with the rate of bystander CPR when compared with the OHCA patients transported by private vehicle (aOR: 8.39, 95% CI: 4.60–15.29, and aOR: 4.11, 95% CI: 1.91–8.85, respectively).

4. Discussion

This study found no significant difference in the outcomes of OHCA, or in the rate of bystander CPR or other types of prehospital resuscitation, including bystander AED use, prehospital advanced airway use, prehospital drug administration, and EMS use, between older and younger OHCA patients.

We initially postulated that the bystander CPR rate would be lower in the older group since they are thought to have more difficulty gaining access to healthcare services; however, the results of this study showed no significant differences in the bystander CPR rate between the older and younger groups. One reason that may explain the observed lack of difference between groups may be the generally low level of basic life support and CPR knowledge among Thai population. Basic life support training has not yet been included in the curriculum of the Thai educational system, and there is limited access to community-based CPR training in Thailand. Therefore, many Thai people do not know what they should do if someone collapses in front of them, or they do not have enough confidence to perform CPR – even if they know how to do it. This problem is further complicated by the fact that other interventions, such as bystander AED use, are even more complex to administer.

Studies conducted in developed countries, such as France and Denmark, and England, found a higher bystander CPR rate than we found in Thailand;[9,10,14] however, some of those studies found a decrease in the bystander CPR rate with increasing age of the arrest victim.[9,10] The reported decreasing rate of bystander CPR as the age of the arrest victim increases could be due to fear of performing it incorrectly and/or causing further injury to the arrest victim.[15,16] Fear of potential lawsuit was another reported reason since some older patients may have a living will that contains a 'do not resuscitate' (DNR) provision.[17]

Regarding EMS use, our data revealed no significant difference in its use and between older and younger OHCA patients. It might be due to an overall low rate of EMS use among OHCA patients when compared with other countries. A recent study in Thailand[18] found that many people did not activate EMS because they did not know that this service is available, and they also didn't know the 1669 call number. Lastly, prehospital management was not significantly different between groups since these interventions were provided by trained EMS teams and they followed standardized OHCA protocol regardless ages of victims. In contrast, a study from Japan found that prehospital advanced airway and prehospital drug administration all decreased with increasing patient age.[19] The rate of prehospital advanced airway use and drug administration was found to decrease with advancing patient age in France.[20] The different prehospital intervention among age groups might be due to poor prognosis in older patients.[21]

Although there was no association between either age group and the bystander CPR rate and other types of prehospital management, the results of this study highlight the need for widespread CPR and basic life support training among the general population in Thailand. The authors have3 recommendations to improve bystander CPR rate in our community. First, we recommend active community CPR training since the majority of OHCA cases occurred at home. And our evidence also found a higher rate of being witnessed by family members but a lower chance of CPR being performed by family members. Second, we recommend providing public education about EMS use. Third and last, we recommend improvement of the dispatcher-assisted CPR system since our results revealed strong independent association between EMS use and the rate of bystander CPR. Adoption and implementation of these 3 recommendations would vastly improve the bystander CPR rate, which would improve the likelihood of survival among OHCA victims in Thailand.

5. Limitations

This study has some mentionable limitations. First, our data was collected from a single centre, which means that this data may not reflect OHCA in other areas or across Thailand. Second, the study had a potential selection bias since the investigators included only the OHCA patients who were transported to ED. Some elderly patients might not be activated EMS system or not be transported to hospital by their family. Our EMS and ED medical record OHCA data were input after resuscitation, which means that there could have been some recall bias. Furthermore, the fact that we retrospectively collected data from EMS and ED medical records means that some data could have been missing or incomplete. Lastly, our centre's OHCA registry did not evaluate bystander decision-making relative to why CPR was or was not given. Further study should be conducted to assess the reasons for and against bystander CPR in both age groups. The results of that type of investigation would help us better understand bystander decision-making and improve our public education in the future.

6. Conclusion

Data from a Thai city population presents no significant difference in the bystander CPR rate or in other types of administered prehospital management between older and younger OHCA patients. There was also no significant difference in the outcomes of OHCA between the older and younger groups. However, there were low rate of bystander CPR and EMS use regardless age groups. We recommended more public education about basic life support in Thailand. Further study should investigate barriers of bystander CPR especially in elderly patients. It might help improve first aid education in aging or aged societies.

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Conflict of interest declaration

All authors declare no personal or professional conflicts of interest relating to any aspect of this study.

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