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Predictive Factors for Failure of At-scene Cardiopulmonary Resuscitation in Adults with Non-Traumatic Out-of-Hospital Cardiac Arrest

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ABSTRACT

OBJECTIVE: To identify the predictive factors of at-scene cardiopulmonary resuscitation (CPR) failure in out-of-hospital cardiac arrest (OHCA) patients.

METHODS: A retrospective single centre, cross-sectional study methodology was employed, which collected from emergency medical services patient care reports of non-traumatic OHCA patients over 18 years old who underwent CPR for at least 20 minutes from 1 January 2017 to 31 December 2024. Univariate and multivariate analyses were employed, along with multiple logistic regression analysis to identify the predictive factors of at-scene CPR failure. Also the odds ratio (OR) and 95% confidence interval were reported.

RESULTS: During the study period, 455 OHCA patients met the inclusion criteria. Statistically significant predictive factors for CPR failure (after at least 20 minutes of CPR conducted at-scene) included: ACLS in OHCA patients (p-value < 0.05); asystole as initial arrest rhythms (adjusted OR = 4.68, 95%CI: 2.48-8.86, p-value < 0.001); unwitnessed arrest (adjusted OR = 3.51, 95%CI: 2.14-5.76, p-value < 0.001); unresponsive pupils (adjusted OR = 4.22, 95%CI: 1.95-9.10, p-value < 0.001); no prehospital advanced airway management (adjusted OR = 7.34, 95%CI: 2.47-21.82, p-value < 0.001); and no prehospital drug administration during CPR – including no amiodarone (adjusted OR = 2.41, 95%CI: 1.15-5.04, p-value = 0.020), and no atropine (adjusted OR = 9.22, 95%CI: 2.22-38.25, p-value = 0.002).

CONCLUSION: The study found 6 predictive factors for identifying failure after CPR for at least 20 minutes at the scene: asystole as the initial arrest rhythm, unwitnessed arrest, unresponsive pupils, no prehospital advanced airway management, and no prehospital administration of amiodarone and atropine during CPR. CPR team leaders may incorporate these factors when deciding when to terminate resuscitation at the scene.

KEYWORDS: emergency medical service, out of hospital heart arrest, out-of-hospital cardiac arrest, prehospital emergency care, return of spontaneous circulation

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INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is a critical challenge for first-responders and a cause of mortality[1]. It also impacts national public health and the economy. The worldwide average annual incidence in adults is 55 per 100,000 people[2], affecting developed and developing countries alike. For example, the United States of America experiences more than 350,000 cardiac arrest cases per year, with mortality rate of about 90%. Most cases occur in males and in the elderly who have comorbidities[3]. Among these, just 10% survived and were discharged and only 9% had favorable neurological outcomes[2]. In Asia, the annual OHCA incidence rate is 20-21 cases per 100,000 people. However, the mean rate of survival to discharge in Asia is just 8.8% and lower than that of Western countries[4]. The survival rate of OHCA patients in Asia averaged 3%, significantly less than in Australia, Europe, and North America which were 13%, 9%, and 6%, respectively[5]. The standard database of the Pan Asian Resuscitation Outcomes Study (PAROS) reported the rate of survival to discharge of OHCA patients resuscitated by emergency medical services (EMS) in PAROS member countries, as 6% in Thailand, 5.5% in Japan, 3.2% in Singapore, 10.7% in South Korea, 2.5% in Malaysia, and 7.3% in Taiwan[6]. These numbers indicate outcomes differ substantially across various EMS, medical, and public health systems, including hospital management, in each PAROS member nation[7]. Even though currently there has been much progress in EMS and cardiopulmonary resuscitation (CPR) technology, the survival rate at the scene remains low, averaging just 10–12%[8]. It should be noted however that in the studied area which was the Vajra Emergency Medical Services of Navamindradhiraj University in Bangkok, Thailand, the return of spontaneous circulation (ROSC) rate was high at 25.6%[9]. Previous systematic reviews and meta-analyses have reported on the predictive factors of ROSC in OHCA patients – such as witnessed arrest, a shockable rhythm as the initial cardiac rhythm[10] (especially ventricular fibrillation (VF)[9-10]) early epinephrine administration during CPR, and an EMS response time of less than 8 minutes[9]. The predictive factors of favorable neurological outcome included being young and male, initial cardiac rhythm being a shockable rhythm, witnessed arrest, bystander CPR, and shorter time to cannulation[11]. In contrast, patients with comorbidities like old age, initial cardiac rhythm being a non-shockable rhythm, particularly asystole, sepsis or septic shock and acidosis were the factors determining mortality and in-hospital CPR failure [12]. One of the essential factors affecting the outcomes of OHCA patients was the efficiency and outcome of CPR at the scene. EMS teams will perform intense CPR in accordance with the American Heart Association (AHA) global standard guidelines for resuscitation. However, if during CPR, patients remain unresponsive and do not develop ROSC, the AHA advanced life support (ALS) framework recommends CPR termination without hospital delivery if 4 conditions are met: (1) unwitnessed arrest, (2) no bystander CPR, (3) no ROSC after full ALS care in the field, and (4) no automatic external defibrillator (AED) shocks were delivered[13]. Previous meta-analysis found that when the 4 components of ALS were completed, the specificity was 96% for 30-day survival for predicting death[14]. Further, the positive predictive value was 99-100%, with an error of only 1%[15]. The ALS framework cannot provide complete information for the decision in the context of EMS adequately because of incomplete crucial data like, the consideration of patient demographic data, the data of EMS team treatment after fulfilled assistance for OHCA patients. The recommendations of the National Association of EMS Physicians suggest that CPR can be terminated in cardiac arrest patients receiving CPR, in accordance with AHA standard guidelines, after at least 20 minutes of CPR. In addition, EMS can terminate CPR if a patient does not experience ROSC and declare death[16]. Presently, there is a limited and insufficient number of studies regarding the predictive factors of at-scene CPR failure to help support the additional decisions of prehospital emergency medical personnel, especially in the context of developing countries, such as Thailand. The EMS system in Thailand varies significantly across different regions, depending on the local context—such as urban versus rural areas. However, the on-scene management of OHCA patients follows the same principle nationwide, known as the “stay and play” approach. Where the staff at the scene who must make these critical decisions and the CPR commander are not physicians, but paramedics or emergency nurse practitioners (ENP). Thus, if these personnel can identify the predictive factors of at-scene CPR failure, after 20 minutes of CPR, it will benefit ethical clinical decision-making regarding whether to choose the continuation or termination of resuscitation (TOR). Although the current AHA guidelines provide internationally accepted standards for the consideration of TOR in patients with OHCA, these guidelines remain applicable in clinical practice today. However, we argue that there is still a significant knowledge gap regarding the predictive factors associated with unsuccessful CPR, particularly in OHCA patients who have undergone prolonged resuscitation efforts (i.e., after 20 minutes of CPR) without ROSC. This area represents an extension beyond what is currently addressed in the standard AHA guidelines.

The present study aims to identify the predictive factors of at-scene CPR failure, after 20 minutes of CPR, in non-traumatic adult OHCA patients.

METHODS

The retrospective cross-sectional study was conducted within the Vajira Emergency Medical Service (V-EMS) of the Vajira Hospital Faculty of Medicine at Navamindradhiraj University in Bangkok, Thailand. V-EMS is a responsible for EMS zone 1 (of 11 EMS zones in Bangkok) and dispatched from Erawan Center in Bangkok. V-EMS networks with 6 public and private hospitals within EMS zone 1, which covers 50 square kilometers, and serves 500,000 people[1].

For OHCA patients, V-EMS teams are dispatched to each case and include at least 3 members – generally a paramedic or an ENP as team leader, and emergency medical technicians. Paramedic or ENP team leaders would operate under off-line and on-line medical protocols, under emergency physicians’ orders. For cardiac arrest cases in our area, the AHA guidelines (2020)[13] were applied by paramedics or ENPs with all V-EMS staff having earned AHA advanced cardiovascular life support (ACLS) provider certification. The prehospital management of non-traumatic OHCA patients employ the stay and play method for comprehensive life support, while for cases of traumatic OHCA, V-EMS will use scoop and run, which is the standard method for V-EMS operation.

This study was approved by the Institutional Review Board of the Vajira Hospital Faculty of Medicine at Navamindradhiraj University (COA 036/2568) and the Human Research Ethics Committee of the Thammasat University Faculty of Medicine (COA 054/2568). The informed consent requirement was waived because of the retrospective nature of the study and the fact all patient data were anonymized.

Adult OHCA patient data was collected from EMS patient care reports, which were coded with Thailand’s emergency medical triage protocol and criteria based dispatch symptom group 6 (cardiac arrest) that were managed by the V-EMS unit of the Vajira Hospital Faculty of Medicine at Navamindradhiraj University in Bangkok, Thailand from 1 January 2017 to 31 December 2024. Eligibility criteria: Non-traumatic adult OHCA patients (e.g., over 18 years old) who received at least 20 minutes of ACLS in accordance with AHA ACLS guidelines[13], and were assisted by V-EMS. Exclusion Criteria: Adult OHCA patients who acheived ROSC within 20 minutes, and OHCA patients evaluated as dead by a team leader such that no resuscitation should be done; such as livor mortis or rigor mortis, patients having do not attempt resuscitation orders, with cardiac arrest outside the scene, with unknown CPR duration by EMS team or bystander, with re-arrest, with CPR during transfer, and with incomplete data recorded or missing resuscitation data.

OHCA patient data was collected from EMS patient care reports, which contain the record of advanced EMS treatment administered by EMS dispatched by Erawan Center and is the standard form used by Bangkok advanced EMS. This form recorded of data of all EMS patients and all treatments administered by EMS teams, which were recorded by dispatchers, paramedics, or ENPs operating at the scene. The data was a part of remuneration for EMS units. All data were recorded in Microsoft Excel by the principal investigator. The data comprised gender, age, comorbidity, location type, the cause of arrest, the first arrest rhythm, witnessed arrest, pupillary response, bystander CPR, bystander AED use, response time, prehospital defibrillation, prehospital advanced airway management, prehospital drug administration during CPR, and CPR failure. At-scene CPR failure means that patients had no ROSC at the scene or died after CPR (according to AHA ACLS guidelines) 20 minutes from first medical contact.

A descriptive analysis was performed to examine the variable distribution. Continuous variables are presented as mean ± standard deviation or median and interquartile range, and categorical variables are presented as frequencies and proportions. When comparing the two groups, differences were evaluated using independent t-test or Mann–Whitney U test for numeric variables and Chi-square test or Fisher's exact test for categorical variables. We performed for the possible factors predicting at-scene CPR failure for OHCA patients. Univariable and multivariable analyses with multiple logistic regression analysis, odds ratios (ORs), and 95% confidence intervals (CIs), and p-value through backward elimination. The relevant factors identified in univariable analysis as statistically significant ($p < 0.2$) were used in the multivariable analysis.

All statistical tests were considered statistically significant at p-values ≤ 0.05. Stata version 17.0 (StataCorp College Station, TX, USA) was used for all analyses.

RESULTS

During the study period, 455 patients matched the eligibility criteria. Figure 1 shows the flowchart of OHCA patient inclusion. For the analysis of factors associated with at-scene CPR failure using crude analysis, differences between OHCA patients with and without CPR failure were compared and classified by the factors and patient characteristics. EMS time, and EMS treatment were statistically significantly different between OHCA patients with and without at-scene CPR failure (p-value < 0.05), including age, respiratory disease, the cause of arrest, the first arrest rhythm, witnessed arrest, pupillary response, bystander CPR, bystander AED application, response time, prehospital defibrillation, prehospital advanced airway management, and prehospital drugs administered during CPR (adrenaline, amiodarone, and atropine). The mean age of OHCA patients with and without at-scene CPR failure was 65.19 ± 18.41 and 60.90 ± 20.64 4 years, respectively (p-value = 0.027). Those at least 65 years of age represented 56.2% of patients with at-scene CPR failure and 43% of patients without (p-value = 0.009). Respiratory disease was found in 5.4% and 0.7% (p-value = 0.017). The cause of arrest was respiratory in 58.8% and 46.5% (p-value = 0.04). The first arrest rhythm was asystole in 79.9% and 42.3% (p-value < 0.001). Witnessed arrest was 28.4% and 68.3% (p-value < 0.001). Pupillary response was detected in 4.8% and 26.8% (p-value < 0.001). Bystander CPR was done in 40.6% and 61.3% (p-value < 0.001). Bystander AED application was performed in 6.1% and 16.9% (p-value < 0.001). Average response time was 13.21 ± 6.85 and 11.52 ± 5.69 minutes (p-value = 0.006). Prehospital defibrillation was done in

12.1% and 35.2% (p-value < 0.001). Prehospital advanced airway management via endotracheal intubation (ETI) was done in 80.5% and 95.8% (p-value < 0.001). Prehospital drug administration during CPR, including adrenaline (86.3% versus 97.2%, p-value < 0.001), amiodarone (6.7% versus 24.7%, p-value < 0.001), and atropine (1% versus 7.8%, p-value < 0.001) (Table 1).

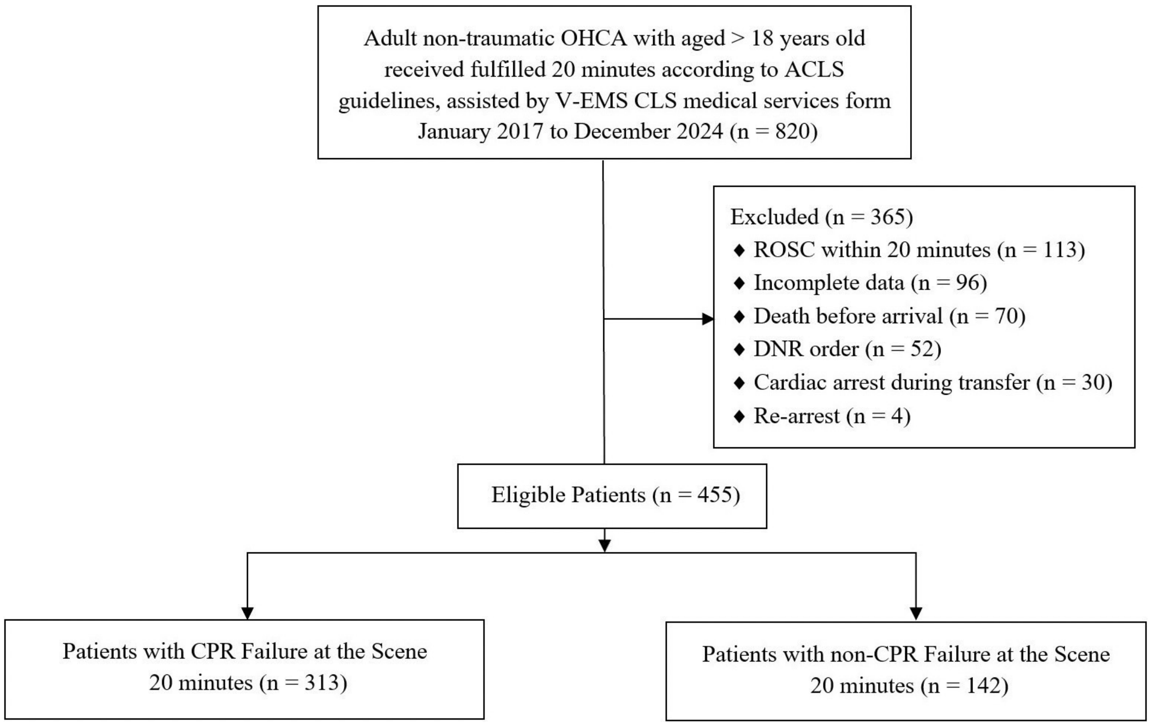

Figure 1 Study flowchart

Table 1 Factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455)

Factors	CPR Failure at the Scene 20 minutes		P-value
	Yes (n = 313)	No (n = 142)	
Gender			
Male	199 (63.6)	97 (68.3)	0.327[δ]
Female	114 (36.4)	45 (31.7)	
Age (years)	65.19 ± 18.41	60.90 ± 20.64	0.027[†]
< 65	137 (43.8)	81 (57.0)	0.009[δ]
≥ 65	176 (56.2)	61 (43.0)	
Co-morbidity	170 (54.3)	89 (62.7)	0.095[δ]
Hypertension	108 (34.5)	57 (40.1)	0.247[δ]
Diabetes mellitus	102 (32.6)	44 (31.0)	0.734[δ]
Coronary heart disease	45 (14.4)	25 (17.6)	0.376[δ]
Dyslipidemia	24 (7.7)	18 (12.7)	0.087[δ]
Renal diseases	22 (7.0)	12 (8.5)	0.593[δ]
Cancer	22 (7.0)	7 (4.9)	0.396[δ]
Respiratory disease	17 (5.4)	1 (0.7)	0.017[δ]
Stroke	4 (1.3)	1 (0.7)	1.000[§]
Other	26 (8.3)	19 (13.4)	0.093[δ]

Table 1 Factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455) (continued)

Factors	CPR Failure at the Scene 20 minutes		P-value
	Yes (n = 313)	No (n = 142)	
Location type			
Non-public	223 (71.2)	94 (66.2)	0.278[δ]
Public	90 (28.8)	48 (33.8)	
Cause of arrest			
Respiratory	184 (58.8)	66 (46.5)	0.040[δ]
Cardiac aetiology	72 (23.0)	46 (32.4)	
Other	57 (18.2)	30 (21.1)	
First arrest rhythm			
Asystole	250 (79.9)	60 (42.3)	< 0.001[δ]
Ventricular fibrillation	35 (11.2)	45 (31.7)	
PEA	28 (8.9)	37 (26.1)	
Witnessed arrest			
No	224 (71.6)	45 (31.7)	< 0.001[δ]
Yes	89 (28.4)	97 (68.3)	
Pupils response			
No	298 (95.2)	104 (73.2)	< 0.001[δ]
Yes	15 (4.8)	38 (26.8)	
Bystander CPR			
No	186 (59.4)	55 (38.7)	< 0.001[δ]
Yes	127 (40.6)	87 (61.3)	
Bystander AED			
No	294 (93.9)	118 (83.1)	< 0.001[δ]
Yes	19 (6.1)	24 (16.9)	
Response time (min)	13.21 ± 6.85	11.52 ± 5.69	0.006[†]
< 8	66 (21.1)	31 (21.8)	0.857[δ]
≥ 8	247 (78.9)	111 (78.2)	
Pre-hospital defibrillation			
No	275 (87.9)	92 (64.8)	< 0.001[δ]
Yes	38 (12.1)	50 (35.2)	
Pre-hospital advanced airway			
No	59 (18.8)	5 (3.5)	< 0.001[§]
ETT	252 (80.5)	136 (95.8)	
LMA	2 (0.6)	1 (0.7)	
Pre-hospital drugs during CPR			
Adrenaline			
No	43 (13.7)	4 (2.8)	< 0.001[δ]
Yes	270 (86.3)	138 (97.2)	
Sodium bicarbonate			
No	234 (74.8)	99 (69.7)	0.261[δ]
Yes	79 (25.2)	43 (30.3)	

Table 1 Factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS. (n = 455) (continued)

Factors	CPR Failure at the Scene 20 minutes		P-value
	Yes (n = 313)	No (n = 142)	
Amiodarone			
No	292 (93.3)	107 (75.4)	< 0.001[δ]
Yes	21 (6.7)	35 (24.7)	
Calcium gluconate			
No	281 (89.8)	122 (85.9)	0.230[δ]
Yes	32 (10.2)	20 (14.1)	
Glucose			
No	292 (93.3)	132 (93.0)	0.896[δ]
Yes	21 (6.7)	10 (7.0)	
Atropine			
No	310 (99.0)	131 (92.3)	< 0.001[§]
Yes	3 (1.0)	11 (7.8)	

Abbreviations: ACLS, advanced cardiovascular life support; AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; ETT, endotracheal tube; LMA, laryngeal mask airway; n, number; PEA, pulseless electrical activity
Data are presented as number (%), mean ± standard deviation or median (interquartile range).
P-value corresponds to [†]Independent samples t-test, [δ]Chi-square test or [§]Fisher's exact test.

For the univariate analysis with simple logistic regression, the statistically significant factors associated with at-scene CPR failure in OHCA patients (p-value < 0.05) were age (≥ 65 years; crude OR = 1.71, 95%CI: 1.14-2.55, p-value = 0.009), respiratory disease (crude OR = 8.1, 95%CI: 1.07-61.46, p-value = 0.043), the cause of arrest (respiratory; crude OR = 1.78, 95%CI: 1.12-2.83, p-value = 0.015), the first arrest rhythm (asystole; crude OR = 5.51, 95%CI: 3.13-9.70, p-value < 0.001), witnessed arrest (crude OR = 5.43, 95%CI: 3.53-8.34, p-value < 0.001), pupillary response (crude OR = 7.26, 95%CI: 3.84-13.74, p-value < 0.001), bystander CPR (crude OR = 2.32, 95%CI: 1.54-3.48, p-value < 0.001), bystander AED application (crude OR = 3.15, 95%CI: 1.66-5.96, p-value < 0.001), prehospital defibrillation (crude OR = 3.93, 95%CI: 2.43 - 6.38, p-value < 0.001), prehospital advanced airway management (crude OR = 6.36, 95%CI: 2.50-16.23, p-value < 0.001), and prehospital drug administration during CPR, namely adrenaline (crude OR = 5.49, 95%CI: 1.93-15.62, p-value = 0.001), amiodarone (crude OR = 4.55, 95%CI: 2.53-8.16, p-value < 0.001), and atropine (crude OR = 8.68, 95%CI: 2.38-31.61, p-value = 0.001) (Table 2).

Table 2 Univariable analyses and multivariable analysis for factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455)

Factors	Univariable analysis			Multivariable analysis		
	Crude OR[1]	(95%CI)	P-value	Adjusted OR[2]	(95%CI)	P-value
Gender						
Male	1.00	Reference				
Female	1.23	(0.81-1.88)	0.327			
Age (years)						
< 65	1.00	Reference				
≥ 65	1.71	(1.14-2.55)	0.009			

Table 2 Univariable analyses and multivariable analysis for factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455) (continued)

Factors	Univariable analysis			Multivariable analysis		
	Crude OR[1]	(95%CI)	P-value	Adjusted OR[2]	(95%CI)	P-value
Co-morbidity						
Hypertension	0.79	(0.52-1.18)	0.247			
Diabetes mellitus	1.08	(0.70-1.65)	0.735			
Coronary heart disease	0.79	(0.46-1.34)	0.377			
Dyslipidemia	0.57	(0.30-1.09)	0.090			
Renal diseases	0.82	(0.39-1.70)	0.594			
Cancer	1.46	(0.61-3.50)	0.398			
Respiratory disease	8.10	(1.07-61.46)	0.043			
Stroke	1.83	(0.20-16.48)	0.592			
Other	0.59	(0.31-1.10)	0.096			
Location type						
Non-public	1.27	(0.83-1.94)	0.278			
Public	1.00	Reference				
Cause of arrest						
Respiratory	1.78	(1.12-2.83)	0.015			
Cardiac aetiology	1.00	Reference				
Other	1.21	(0.68-2.16)	0.510			
First arrest rhythm						
Asystole	5.51	(3.13-9.70)	< 0.001	4.68	(2.48-8.86)	< 0.001
Ventricular fibrillation	1.03	(0.53-1.99)	0.935	2.03	(0.90-4.61)	0.089
PEA	1.00	Reference		1.00	Reference	
Witnessed arrest						
No	5.43	(3.53-8.34)	< 0.001	3.51	(2.14-5.76)	< 0.001
Yes	1.00	Reference		1.00	Reference	
Pupils response						
No	7.26	(3.84-13.74)	< 0.001	4.22	(1.95-9.10)	< 0.001
Yes	1.00	Reference		1.00	Reference	
Bystander CPR						
No	2.32	(1.54-3.48)	< 0.001			
Yes	1.00	Reference				
Bystander AED						
No	3.15	(1.66-5.96)	< 0.001			
Yes	1.00	Reference				
Response time (min)						
< 8	1.00	Reference				
≥ 8	1.05	(0.65-1.69)	0.857			
Pre-hospital defibrillation						
No	3.93	(2.43-6.38)	< 0.001			
Yes	1.00	Reference				
Pre-hospital advanced airway management						
No	6.36	(2.50-16.23)	< 0.001	7.34	(2.47-21.82)	< 0.001
ETT/LMA	1.00	Reference		1.00	Reference	

Table 2 Univariable analyses and multivariable analysis for factors associated with CPR failure at the scene 20 minutes after fulfilled ACLS (n = 455) (continued)

Factors	Univariable analysis			Multivariable analysis		
	Crude OR[1]	(95%CI)	P-value	Adjusted OR[2]	(95%CI)	P-value
Pre-hospital drugs during CPR						
Adrenaline						
No	5.49	(1.93-15.62)	0.001			
Yes	1.00	Reference				
Sodium bicarbonate						
No	1.29	(0.83-2.00)	0.261			
Yes	1.00	Reference				
Amiodarone						
No	4.55	(2.53-8.16)	< 0.001	2.41	(1.15-5.04)	0.020
Yes	1.00	Reference		1.00	Reference	
Calcium gluconate						
No	1.44	(0.79-2.62)	0.232			
Yes	1.00	Reference				
Glucose						
No	1.05	(0.48-2.30)	0.896			
Yes	1.00	Reference				
Atropine						
No	8.68	(2.38-31.61)	0.001	9.22	(2.22-38.25)	0.002
Yes	1.00	Reference		1.00	Reference	

Abbreviations: ACLS, advanced cardiovascular life support; AED, automated external defibrillator; CI, confident interval; CPR, cardiopulmonary resuscitation; ETT, Endotracheal tube; LMA, laryngeal mask airway; OR, odds ratio; PEA, pulseless electrical activity

For the multivariate analysis with multiple logistic regression and backward stepwise selection, statistically significant factors associated with at-scene CPR failure ($p < 0.02$) were selected from the univariate analysis and tested here. Such factors were age, comorbidity, (including dyslipidemia, respiratory disease, and other), the cause of arrest, the initial arrest rhythm, witnessed arrest, pupillary response, bystander CPR, bystander AED use, prehospital defibrillation, prehospital advanced airway management, and prehospital drug administration during CPR, namely adrenaline, amiodarone, and atropine. Statistically significant factors predicting at-scene CPR failure in OHCA patients (p-value < 0.05) were: the initial arrest rhythm (asystole; adjusted OR = 4.68, 95%CI: 2.48-8.86, p-value < 0.001), unwitnessed arrest (adjusted OR = 3.51, 95%CI: 2.14-5.76, p-value < 0.001), lack of pupillary response (adjusted OR = 4.22, 95%CI: 1.95-9.10, p-value < 0.001), no prehospital advanced airway management (adjusted OR = 7.34, 95%CI: 2.47-21.82, p-value < 0.001), and no prehospital drug administration during CPR, including no amiodarone (adjusted OR = 2.41, 95%CI: 1.15-5.04, p-value = 0.020) and no atropine (adjusted OR = 9.22, 95%CI: 2.22-38.25, p-value = 0.002) (Table 2).

DISCUSSION

The present study found 6 predictive factors of at-scene CPR failure 20 minutes after CPR; Firstly, the initial arrest rhythm was asystole. Our study found that OHCA patients with asystole as the initial arrest rhythm had a 4.68-fold greater risk of CPR failure compared to those whose initial rhythm was pulseless electrical activity (PEA). This finding was consistent with previous work reporting that cardiac arrest patients with asystole had a chance of CPR failure 1.63[17], 7.83[12], and 10.31[18] times greater than those with other cardiac rhythms. Therefore, cardiac arrest patients whose initial arrest rhythm was asystole have low survival rates and were associated with significantly greater risk of CPR failure[18]. Asystole is a non-shockable heart rhythm, so AED use is not indicated. This aligns well with AHA recommendations regarding BLS and ALS TOR, which state that the lack of AED shocks having been delivered can be used as one factor in the decision to terminate CPR without hospital delivery[13]. Secondly, the arrest was unwitnessed. The present study found that if OHCA patients who had unwitnessed cardiac arrests underwent CPR for 20 minutes, they would experience CPR failure 3.51 times more than those with a witnessed arrest. This finding was consistent with a retrospective single center-cohort study reporting that OHCA patients who had unwitnessed arrests had 4.91 times fewer ROSCs than those with witnessed arrest. Furthermore, this patient group had significantly increased chances of unfavorable neurological outcomes[18]. Moreover, a large systematic review and meta-analysis reporting that OHCA patients with unwitnessed arrests were associated with decreased survival with favorable functional outcome rates compared to those with a witnessed arrest[11]. Unwitnessed arrest is one of the AHA ALS-TOR factors when deciding for CPR termination without hospital delivery[13]. Thirdly, the absence of a pupillary response. The present study found that if OHCA patients without pupillary response underwent CPR for 20 minutes, they would have a CPR failure rate 4.22 times greater than those with pupillary response. We found that non-reactive pupils were a clinical indicator that could be used to assess central nervous system function in patients resuscitated from cardiac arrest. Many previous studies about the association between non-reactive pupils and CPR outcomes have found that non-reactive pupils during CPR are associated with CPR failure and reduced survival to discharge[19-20]. The European Resuscitation Council and European Society of Intensive Care Medicine guidelines in 2021 recommended that continuously non-reactive pupils during CPR and post-resuscitation might be associated with significantly increased mortality[21]. Fourthly, no prehospital advanced airway management. The present study found that OHCA patients who did not receive prehospital advanced airway management i.e. using only bag valve mask (BVM), together with CPR experienced CPR failure 7.34 times more often than those treated with an ETI. This finding was consistent with systematic reviews and meta-analyses comparing the use of BVM to ETI during CPR for OHCA patients, which reported that BVM performed worse than ETI in terms of ROSC (24% versus 48%; RR = 0.86), the rate of survival to hospital admission (21% versus 27%; RR = 1.037), and the rate of survival to discharge (6% versus 12%; RR = 1.476)[22]. Even though, the finding conflicted with a retrospective study from the large Thailand database of Information Technology of Emergency Medical Service, performed by the National Institute for Emergency Medicine, which reported no significant difference between the use of BVM and ETI in terms of ROSC, with BVM resulting in minimally higher ROSC rate than ETI (19.63% versus 15.56%; p-value = 0.148). The study's authors explained that the OHCA patients treated with BVM had less severe symptoms and most were immediately delivered to hospitals for faster treatment compared to those treated with ETI[23]. However, BVM application in OHCA might not prevent aspiration and the risk of inadequate ventilation[24]. "Fifthly, no prehospital drugs during CPR, including no amiodarone administered. A possible explanation for this findings could be that for amiodarone usage, standard AHA guidelines recommended that antiarrhythmic drug, including amiodarone or lidocaine, be used for sustained VF and pulseless ventricular tachycardia refractory during CPR and defibrillation to help improve ROSC outcomes in cardiac arrest patients[13,25]. OHCA patients who did not receive amiodarone were probably categorized as non-refractory to CPR and defibrillation which might cause increased CPR failure at the scene, compared with those who were refractory to CPR and defibrillation[26]. Systematic review and network meta-analysis found that amiodarone usage increased the chance of prehospital ROSC (OR = 1.402, p = 0.015) but it did not increase survival to discharge (RR = 0.850, p = 0.284) or improve favorable neurological outcomes (OR = 1.114, p = 0.475), compared to placebo[27]. Finally, no prehospital drugs during CPR including no atropine administered. Patients who did not receive atropine were associated with a CPR failure rate 9.22 times greater than those who received atropine, which could be explained by a review of EMS patient care reports. In 3.1% of OHCA cases included in the study, patients received atropine before and during CPR due to either unstable bradycardia or organophosphate poisoning and were administered atropine as an antidote during CPR. In 2010, administering atropine during CPR was part of the standard treatment guidelines for cardiac arrest with asystole and PEA[28]. Presently, the AHA removed atropine from the standard guidelines because of there is no clear evident atropine administration helps improve ROSC outcomes and survival to discharge in most cardiac arrest patients, except those with pre-arrest due to symptomatic bradycardia, or organophosphates or carbamate poisoning[13,28].

The present study has many important limitations. Firstly, it is a retrospective cross-sectional study which employs data from a single center in the Bangkok, Thailand. Therefore, the study results may not be generalizable to other locales. The external validity of the clinical score requires further evaluation. Advancing the field may necessitate additional studies to confirm its applicability, such as those involving multi-center data. Secondly, the data was collected retrospectively from 2017 to 2024. During this period, there were 2 developments and changes to treatment guidelines which were AHA 2015 and 2020. The studied data might be influenced by the different AHA recommendations. Thirdly, the present study is restricted to just one short-term outcome – at-scene CPR failure. Additional studies which might make use of the score to predict long-term OHCA patient outcomes, such as survival to hospital discharge and neurological function outcomes. Fourthly, there might be unmeasured confounding factors associated with the studied outcomes. In the present study, all data collected from the retrospective review of EMS patient care reports. While, we try by all means to maintain neutrality, selection bias may have occurred. Lastly, the EMS patient care reports used for recording OHCA patient data in the studied areas did not comply with the Utstein OHCA standard template.

CONCLUSION

The present study found 6 predictive factors in identifying at-scene CPR failure (after at least 20 minutes of CPR), including the first arrest rhythms being asystole, unwitnessed arrest, unresponsive pupils, no prehospital advanced airway management, and no amiodarone and no atropine administration during CPR. CPR team leaders may incorporate these factors in their consideration of out-of-hospital TOR at the scene.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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DATA AVAILABILITY STATEMENT

The data sets generated and analyzed during the current study are not publicly available due to information, but They are available from the corresponding author on reasonable request answering the survey.

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