Original Article

Factors Associated with Successful Resuscitation during Out-of-Hospital Cardiac Arrest Performed By Surgico Medical Ambulance and Rescue Team (S.M.A.R.T), Division of Emergency Medical Service and Disaster, Faculty of Medicine Vajira Hospital, Navamindradhiraj University

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Objective: To explore factors associated with successful on-scene cardiac resuscitation and to identify the number of patients with return of spontaneous circulation (ROSC).

Materials and Methods: The present study was a retrospective descriptive study. Data were collected from the Surgico Medical Ambulance and Rescue Team at the Emergency Medicine Service and Disaster Division, Navamindradhiraj University. Data were recorded by using the overall operation reports of the Bangkok Emergency Medical Service Centre (Erawan Centre) about advanced life support. The reports used the code followed by the Emergency Medical Triage Protocol and Criteria Based Dispatch (CBD), CBD6 Red1, or followed by Response Code (RC) RC6 Red1, between May 2019 and April 2020.

Results: Two hundred seventy-three patients with out-of-hospital cardiac arrest (OHCA) were included in the present study. Seventy (25.6%) patients were successfully on-scene resuscitated, of which, 65.7% were male patients with an average age of 57.87 (standard deviation [SD] 21.6) years. However, 203 (74.4%) patients that received appropriated advanced resuscitation (non-ROSC) died on scene. Among patients in the successful resuscitation group and those in the deceased group, 65.7% and 61.6% were male, respectively (p=0.537). The mean age was 57.87 (SD 21.6) years and 65.8 (SD 20.21) years, respectively (p=0.006). In the multivariate analysis controlled for confounders, a significant association (p<0.05) was found between successful pre-hospital cardiac resuscitation on scene with the following four factors, traumatic cardiac arrest (adjusted odds ratio [OR] 4.18, 95% confidence interval [CI] 1.60 to 10.93, p=0.004), response time within eight minutes (adjusted OR 2.07, 95% CI 1.03 to 4.14, p=0.041), initial electrocardiogram with ventricular fibrillation (adjusted OR 2.63, 95% CI 1.13 to 6.12, p=0.025, and pulseless electrical activity (adjusted OR 2.89, 95% CI 1.26 to 6.64, p=0.012), and administration of resuscitation drug with epinephrine (adjusted OR 13.62, 95% CI 4.72 to 39.31, p<0.001).

Conclusion: In the present study, four factors were found to have a significant association with successful prehospital cardiac resuscitation on scene. Based on the knowledge discovered, these factors will develop on-scene CPR guidelines for the care of patients with OHCA for the authors' emergency medical service personals.

Keywords: Success; Resuscitation; Prehospital cardiac arrest

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Out-of-hospital cardiac arrest (OHCA) occurs in 20 to 140 patients per 100,000, with a survival rate of 2% to 11%[1,2]. Rapid response times for cardiopulmonary resuscitation (CPR), automated external defibrillator (AED) use, and advanced life support (ALS) are necessary in the pre-hospital cardiac resuscitation on scene[3]. OHCA is fatal and thus should be resuscitated urgently because time is associated with the survival rate of the patients. The American Heart Association has specified a chain of survival in the guideline for patients with cardiac arrest from the scene to the final step[4], and suggested that effective resuscitation started with laying the patient

supine on a hard surface[5] and then high-quality CPR, which were highly associated with survival rate[6,7]. The Surgico Medical Ambulance and Rescue Team (S.M.A.R.T), Division of Emergency Medical Service and Disaster, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, has provided services since 1995, including emergency medical service (EMS), aquatic life support, disaster relief, interfacility patient transfer, and patient transport. The team is the leader of the Zone 1 Bangkok EMS area, in which the Bangkok EMS Centre (Erawan Centre) is the dispatch center[8]. When reviewing both Thai and international literatures, many publications have focused on factors associated with successful pre-hospital cardiac resuscitation on scene, especially from provincial hospitals whose dispatch centers are stationed at the hospitals, under the supervision of Narenthorn Centre. However, no study has been conducted in Bangkok, particularly in a university hospital. Thus, the present study intended to explore factors associated with successful pre-hospital cardiac resuscitation on scene to improve the institute and related practice.

Objective

The primary objective was to explore factors associated with successful pre-hospital cardiac resuscitation on scene of S.M.A.R.T, Division of Emergency Medical Service and Disaster, Faculty of Medicine Vajira Hospital, Navamindradhiraj University. The secondary objective was to identify the number of patients with return of spontaneous circulation (ROSC).

Materials and Methods

The present study was approved by the Institutional Review Board (COA 122/2563). Given the retrospective descriptive design, no consent was required. All data from the sample were classified. The results would be presented anonymously, without any effect to the patients or the team members.

The present study was a retrospective descriptive design. Overall operation reports of the Bangkok EMS Centre (Erawan Centre) concerning ALS were reviewed, using the code followed by the Thailand Emergency Medical Triage Protocol and Criteria Based Dispatch (CBD) version 2, 2013, CBD6 Red1, or Response Code (RC), RC6 Red1, between May 1, 2019, and April 30, 2020, for a period of one year. Two hundred seventy-three patients had OHCA. The inclusion criteria were 1) dispatched to S.M.A.R.T at the Emergency Medicine Service and Disaster Division, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, and 2) at least 18 years old. The exclusion criteria were 1) incomplete data or no record of related resuscitation, 2) evaluated as deceased and does not need resuscitation by the team leader, 3) with do-not-resuscitate order, 4) not OHCA on scene, 5) OHCA during transfer, 6) termination of resuscitation on scene, 7) other ALS teams had performed CPR before S.M.A.R.T. arrived at the scene. Collected data consisted of patient factors, including gender, age, underlying disease, scene, cause of cardiac arrest, witnessed arrest, bystander CPR, AED use on scene, and treatment factors for the S.M.A.R.T, Vajira Hospital including operating period, response time, initial cardiac rhythm, defibrillation, intubation, medication during CPR, and total resuscitation period. The definition of successful resuscitation is ROSC at the scene. While the definition of AED on scene is bystander's AED usage before ambulance arriving the scene, observed by team leader.

Statistics analysis

The statistical analysis was conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). The mean and standard deviation (SD) were used to describe parametric and non-parametric continuous data, and number and percentages to describe categorical data. Univariable analysis was performed for the possible factors associated with successful cardiac resuscitation. Variables in the univariable analysis with p-value less than 0.050 were included in the multivariable model. The results of logistic regression analysis were displayed as Odds ratio (OR), 95% confidence interval (CI) and p value. A p-value of less than 0.05 was considered significant.

Sample size calculation

The present study aimed to explore factors associated with successful pre-hospital cardiac resuscitation on scene by S.M.A.R.T, utilizing multiple logistic regression analysis. Sample size was calculated with G-power version 3.1.9.4 for multiple logistic regression analysis, with significance level (α) as 0.05, and power of test as 0.80. With reference to the study by Saengpanit[9], the significant factors associated with successful pre-hospital cardiac resuscitation on scene by EMS, Uttaradit Hospital ($p<0.05$) were bystander CPR (OR 24.188; 95% CI 6.827 to 85.698) and witnessed arrest (OR 19.529; 95% CI 6.339 to 60.168). Traumatic cardiac arrest

was associated with worse outcome (OR 0.085; 95% CI 0.023 to 0.316)[9]. The authors used the traumatic cardiac arrest data from that study for sample size calculation because it had the largest sample size. The rates of traumatic and non-traumatic cardiac arrests were 34.2% and 59.4%, respectively. The calculated OR was 0.355. The sample size for the multiple logistic regression analysis was at least 198. However, owing to the retrospective design, additional samples were considered. To account for 20% of incomplete data, the calculated sample size was 248, in accordance with the equation nnew = 198 / (1–0.2)[10]. Therefore, the final sample size was 250. Simple random sampling by a computer program was used.

Results

Patient characteristics

Between May 1, 2019 and April 30, 2020, 273 patients with OHCA on scene were treated by S.M.A.R.T, 70 (25.6%) achieved ROSC, while 203 (74.4%) did not. The study flow is demonstrated in Figure 1. Moreover, 65.7% and 61.6% of the patients in the ROSC and non-ROSC groups were male, respectively (p=0.537). The mean age in these groups were 57.87±21.6 years and 65.8±20.1 years, respectively (p=0.006), and most of the patients were at least 60 years old (51.4% and 63.1%, respectively, p=0.100). The most common scene of both groups was home (74.3% and 84.7%, respectively, p=0.050). Of the patients in the ROSC and non-ROSC groups, 35.7% and 23.6% had underlying disease (p=0.049) and 20.0% and 9.4% had traumatic cardiac arrest, respectively (p=0.019). Witnessed arrest occurred in 94.3% and 79.8% of the patients in the ROSC and non-ROSC groups, respectively (p<0.001). Moreover, 87.1% in the ROSC group and 64.0% in the non-ROSC group received bystander CPR (p<0.001). AED was used on scene in 17.1% and 3.9% of the patients in the ROSC and non-ROSC groups, respectively (p<0.001) (Table 1).

Treatment characteristics by S.M.A.R.T, Vajira Hospital

Treatments were most often initiated between 8 a.m. and 4 p.m., which accounted for 44.3% and 36.9% in the ROSC and non-ROSC groups, respectively (p=0.517). The mean duration from team activation to scene arrival was 11.97±7.82 minutes and 13.18±7.10 minutes, respectively (p=0.234), whereas treatment duration within eight minutes was initiated in 34.3% and 21.2% of the patients,

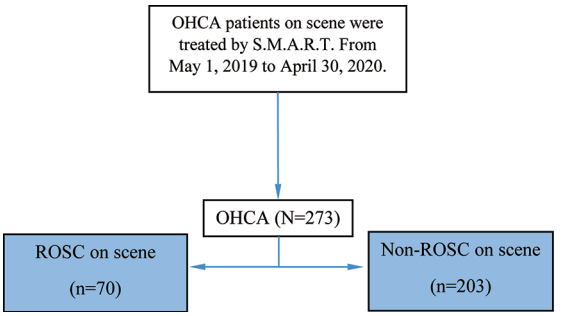

Figure 1. Study population flow.

respectively (p=0.028). Initial cardiac rhythm was ventricular fibrillation (VF) in 22.9% and 6.4% (p<0.001), ventricular tachycardia (VT) in 2.9% and 1.0% (p=0.272), asystole in 64.3% and 81.8% (p=0.003), as well as pulseless electrical activity (PEA) in 22.9% and 10.8%, (p=0.012) of the patients in the ROSC and non-ROSC groups, respectively. As regards to intubation, endotracheal tubes were used in 80.0% and 44.3% (p<0.001), laryngeal mask airway (LMA) was used in 2.9% and 0.5% (p=0.162), and bag mask ventilation was used in 58.6% and 43.8% (p=0.033) of the patients in the ROSC and non-ROSC groups, respectively. With regard to medications administered during CPR, epinephrine was used in 92.9% and 54.7% (p<0.001), amiodarone was given in 12.9% and 2.5% (p=0.002), bicarbonate was utilized in 35.7% and 19.7% (p=0.007), glucose was injected in 2.9% and 7.4% (p=0.254), calcium gluconate was applied in 20.0% and 7.4% (p=0.003), and atropine was administered in 5.7% and 0.0% (p=0.004) of the patients in the ROSC and non-ROSC groups, respectively. The mean total resuscitation period was 21.10 (SD 12.84) minutes in the ROSC group and 15.62 (SD 13.62) minutes in the non-ROSC group (p=0.003), in addition, 60.0% of the patients achieved ROSC in 11 to 30-minutes, whereas non-ROSC was observed in 48.8% of the patients within 0 to 10 minutes (p<0.001) (Table 2).

Factors associated with successful cardiac resuscitation

Gender, age, scene, underlying disease, cause of cardiac arrest, witnessed arrest, bystander CPR, AED use at the scene, treatment period, response time, initial cardiac rhythm with VF, pulseless VT (pVT), asystole, and PEA, intubation with endotracheal tube, LMA, and bag mask ventilation, medications during CPR, and total resuscitation period were factors analyzed.

Table 1. Patient characteristics (n=273)

Variables	Total (n=273); n (%)	ROSC (n=70); n (%)	Non-ROSC (n=203); n (%)	p-value*
Sex				0.537
Male	171 (62.6)	46 (65.7)	125 (61.6)	
Female	102 (37.4)	24 (34.3)	78 (38.4)	
Age (years); mean±SD	63.77±20.83	57.87±21.6	65.8±20.21	0.006
Less than 40	36 (13.2)	14 (20.0)	22 (10.8)	0.100
40 to 59	73 (26.7)	20 (28.6)	53 (26.1)	
At least 60	164 (60.1)	36 (51.4)	128 (63.1)	
Scene				0.050
Home	224 (82.1)	52 (74.3)	172 (84.7)	
Public place	49 (17.9)	18 (25.7)	31 (15.3)	
Underlying disease	73 (26.7)	25 (35.7)	48 (23.6)	0.049
Heart disease	24 (8.8)	10 (14.3)	14 (6.9)	0.060
Diabetes mellitus	37 (13.6)	13 (18.6)	24 (11.8)	0.155
Hypertension	45 (16.5)	13 (18.6)	32 (15.8)	0.585
Hyperlipidemia	9 (3.3)	3 (4.3)	6 (3.0)	0.698
Renal disease	6 (2.2)	1 (1.4)	5 (2.5)	1.000
Stroke	1 (0.4)	0 (0.0)	1 (0.5)	1.000
Human immunodeficiency virus infection	0 (0.0)	0 (0.0)	0 (0.0)	NA
Cancer	2 (0.7)	1 (1.4)	1 (0.5)	0.448
Others	27 (9.9)	10 (14.3)	17 (8.4)	0.153
Cause of cardiac arrest				0.019
Trauma	33 (12.1)	14 (20.0)	19 (9.4)	
Non-trauma	240 (87.9)	56 (80.0)	184 (90.6)	
Witnessed arrest				<0.001
Yes	228 (83.5)	66 (94.3)	162 (79.8)	
No	45 (16.5)	4 (5.7)	41 (20.2)	
Bystander CPR				<0.001
Yes	191 (70.0)	61 (87.1)	130 (64.0)	
No	82 (30.0)	9 (12.9)	73 (36.0)	
AED use at the scene				<0.001
Yes	20 (7.3)	12 (17.1)	8 (3.9)	
No	253 (92.7)	58 (82.9)	195 (96.1)	

AED=automated external defibrillator; CPR=cardiopulmonary resuscitation; ROSC=return of spontaneous circulation; SD=standard deviation

* p-value corresponds to Student's t-test, chi-square test, or Fisher's exact test

Univariable analysis: Gender, age, scene, underlying disease, cause of cardiac arrest, witnessed arrest, bystander CPR, AED use at the scene, treatment period, response time, initial cardiac rhythm with VF, pVT, asystole, and PEA, intubation with endotracheal tube, LMA, and bag mask ventilation, medications during CPR, and total resuscitation period were factors analyzed in the univariable analysis, using simple logistic regression analysis. Significant factors ($p<0.05$) were age at younger than 40 years (OR 2.26, 95% CI 1.05 to 4.86, p=0.037), traumatic cardiac arrest (OR 2.42, 95% CI 1.14 to 5.14, p=0.021), witnessed arrest (OR 4.18, 95% CI 1.44 to 12.12, p=0.009), bystander CPR (OR 3.81, 95% CI 1.79 to 8.11, p=0.001), AED use at the scene (OR 5.04, 95% CI 1.97 to 12.93, p=0.001), response time less than eight minutes (OR 1.94, 95% CI 1.07 to 3.53, p=0.030), initial cardiac rhythm with VF (OR 4.33, 95% CI 1.96 to 9.56, $p<0.001$), asystole (OR 0.40, 95% CI 0.22 to 0.74, p=0.003), or PEA (OR 2.44, 95% CI 1.20 to 4.97, p=0.014), intubation with endotracheal tube (OR 5.02, 95% CI 2.63 to 9.60,

Table 2. Characteristics of treatment provided by S.M.A.R.T, Vajira Hospital (n=273)

Variables	Total (n=273); n (%)	ROSC (n=70); n (%)	Non-ROSC (n=203); n (%)	p-value*
Treatment period				0.517
8 a.m. to 4 p.m.	106 (38.8)	31 (44.3)	75 (36.9)	
4 p.m. to 12 p.m.	94 (34.5)	23 (32.9)	71 (35.0)	
12 p.m. to 8 a.m.	73 (26.7)	16 (22.9)	57 (28.1)	
Response time (minutes); mean±SD	12.87±7.30	11.97±7.82	13.18±7.10	0.234
Less than 8	67 (24.5)	24 (34.3)	43 (21.2)	0.028
At least 8	206 (75.5)	46 (65.7)	160 (78.8)	
Initial cardiac rhythm				
VF	29 (10.6)	16 (22.9)	13 (6.4)	<0.001
VT	4 (1.5)	2 (2.9)	2 (1.0)	0.272
Asystole	211 (77.3)	45 (64.3)	166 (81.8)	0.003
PEA	38 (13.9)	16 (22.9)	22 (10.8)	0.012
Intubation				
Endotracheal tube	3 (1.1)	2 (2.9)	1 (0.5)	0.162
LMA	130 (47.6)	41 (58.6)	89 (43.8)	0.033
Bag mask ventilation	146 (53.5)	56 (80.0)	90 (44.3)	<0.001
Medication during CPR				
Epinephrine	176 (64.5)	65 (92.9)	111 (54.7)	<0.001
Amiodarone	14 (5.1)	9 (12.9)	5 (2.5)	0.002
Bicarbonate	65 (23.8)	25 (35.7)	40 (19.7)	0.007
Glucose	17 (6.2)	2 (2.9)	15 (7.4)	0.254
Calcium gluconate	29 (10.6)	14 (20.0)	15 (7.4)	0.003
Atropine	4 (1.5)	4 (5.7)	0 (0.0)	0.004
Total resuscitation period (minutes); mean±SD	17.03±13.62	21.10±12.84	15.62±13.62	0.003
0 to 10	115 (42.1)	16 (22.9)	99 (48.8)	<0.001
11 to 30	132 (48.4)	42 (60.0)	90 (44.3)	
31 to 60	26 (9.5)	12 (17.1)	14 (6.9)	

CPR=cardiopulmonary resuscitation; LMA=laryngeal mask airway; PEA=pulseless electrical activity; ROSC=return of spontaneous circulation; SD=standard deviation; VF=ventricular fibrillation; VT=ventricular tachycardia

* p-value corresponds to Student's t-test, chi-square test, or Fisher's exact test

p<0.001) or bag mask ventilation (OR 1.81, 95% CI 1.04 to 3.14, p=0.034), medication during CPR with epinephrine (OR 10.78, 95% CI 4.16 to 27.88, p<0.001), amiodarone (OR 5.84, 95% CI 1.89 to 18.09, p=0.002), bicarbonate (OR 2.26, 95% CI 1.24 to 4.12, p=0.007), or calcium gluconate (OR 3.13, 95% CI 1.43 to 6.88, p=0.004), and total resuscitation period of 11 to 30-minutes (OR 2.89, 95% CI 1.52 to 5.49, p=0.001) or 31 to 60-minutes (OR 5.30, 95% CI 2.08 to 13.50, p<0.001) (Table 3).

Multivariable analysis: Multiple logistic regression analysis was performed with forward stepwise selection method, using the following significant factors (p<0.05) in the univariable analysis: age, cause of cardiac arrest, witnessed arrest, bystander CPR, AED use at the scene, response time, initial cardiac rhythm with VF, asystole, or PEA, intubation with endotracheal tube and bag mask ventilation, medication during CPR, and total resuscitation period. In the multivariable analysis controlled for confounding, significant factors (p<0.05) were traumatic cardiac arrest (adjusted OR 4.18, 95% CI 1.60 to 10.93, p=0.004), response time less than eight minutes (adjusted OR 2.07, 95% CI 1.03 to 4.14, p=0.041), initial cardiac rhythm with VF (adjusted OR 2.63, 95% CI 1.13 to 6.12, p=0.025) or PEA (adjusted OR 2.89, 95% CI 1.26 to 6.64, p=0.012), and medication during CPR with epinephrine (adjusted OR 13.62, 95% CI 4.72 to 39.31, p<0.001) (Table 4).

Table 3. Univariate analysis

Variables	ROSC (n=70); n (%)	Non-ROSC (n=203); n (%)	OR	95% CI	p-value
Sex					
Male	46 (65.7)	125 (61.6)	1.20	0.68 to 2.11	0.537
Female	24 (34.3)	78 (38.4)	1.00	Reference	
Age (years)					
Less than 40	14 (20.0)	22 (10.8)	2.26	1.05 to 4.86	0.037
40 to 59	20 (28.6)	53 (26.1)	1.34	0.71 to 2.53	0.363
At least 60	36 (51.4)	128 (63.1)	1.00	Reference	
Scene					
Home	18 (25.7)	31 (15.3)	1.92	0.99 to 3.71	0.052
Public place	52 (74.3)	172 (84.7)	1.00	Reference	
Underlying disease	25 (35.7)	48 (23.6)	1.79	1.01 to 3.23	0.051
Heart disease	10 (14.3)	14 (6.9)	2.25	0.95 to 5.33	0.065
Diabetes mellitus	13 (18.6)	24 (11.8)	1.70	0.81 to 3.56	0.158
Hypertension	13 (18.6)	32 (15.8)	1.22	0.60 to 2.48	0.585
Hyperlipidemia	3 (4.3)	6 (3.0)	1.47	0.36 to 6.04	0.593
Renal disease	1 (1.4)	5 (2.5)	0.57	0.07 to 5.00	0.615
Stroke	0 (0.0)	1 (0.5)	-	-	NA
HIV infection	0 (0.0)	0 (0.0)	-	-	NA
Cancer	1 (1.4)	1 (0.5)	2.93	0.18 to 47.44	0.450
Other	10 (14.3)	17 (8.4)	1.82	0.79 to 4.20	0.158
Cause of cardiac arrest					
Trauma	14 (20.0)	19 (9.4)	2.42	1.14 to 5.14	0.021
Non-trauma	56 (80.0)	184 (90.6)	1.00	Reference	
Witnessed arrest					
Yes	66 (94.3)	162 (79.8)	4.18	1.44 to 12.12	0.009
No	4 (5.7)	41 (20.2)	1.00	Reference	
Bystander CPR					
Yes	61 (87.1)	130 (64.0)	3.81	1.79 to 8.11	0.001
No	9 (12.9)	73 (36.0)	1.00	Reference	
AED use at the scene					
Yes	12 (17.1)	8 (3.9)	5.04	1.97 to 12.93	0.001
No	58 (82.9)	195 (96.1)	1.00	Reference	
Treatment period					
8 a.m. to 4 p.m.	31 (44.2)	75 (36.9)	1.47	0.74 to 2.95	0.275
4 p.m. to 12 p.m.	23 (32.9)	71 (35.0)	1.15	0.56 to 2.39	0.699
12 p.m. to 8 a.m.	16 (22.9)	57 (28.1)	1.00	Reference	
Response time (minutes)					
Less than 8	24 (34.3)	43 (21.2)	1.94	1.07 to 3.53	0.030
At least 8	46 (65.7)	160 (78.8)	1.00	Reference	
Initial cardiac rhythm					
VF	16 (22.9)	13 (6.4)	4.33	1.96 to 9.56	<0.001
VT	2 (2.9)	2 (1.0)	2.96	0.41 to 21.39	0.283
Asystole	45 (64.3)	166 (81.8)	0.40	0.22 to 0.74	0.003
PEA	16 (22.9)	22 (10.8)	2.44	1.20 to 4.97	0.014
Intubation					
Endotracheal tube	56 (80.0)	90 (44.3)	5.02	2.63 to 9.60	<0.001
LMA	2 (2.9)	1 (0.5)	5.94	0.53 to 66.56	0.148
Bag mask ventilation	41 (58.6)	89 (43.8)	1.81	1.04 to 3.14	0.034
Medication during CPR					
Epinephrine	65 (92.9)	111 (54.7)	10.78	4.16 to 27.88	<0.001
Amiodarone	9 (12.9)	5 (2.5)	5.84	1.89 to 18.09	0.002
Bicarbonate	25 (35.7)	40 (19.7)	2.26	1.24 to 4.12	0.007
Glucose	2 (2.9)	15 (7.4)	0.37	0.08 to 1.65	0.193
Calcium gluconate	14 (20.0)	15 (7.4)	3.13	1.43 to 6.88	0.004
Atropine	4 (5.7)	0 (0.0)	-	-	NA
Total resuscitation period (minutes)	1.00				
0 to 10	42 (60.0)	90 (44.3)	2.89	1.52 to 5.49	0.001
11 to 30	12 (17.1)	14 (6.9)	5.30	2.08 to 13.50	<0.001
31 to 60	16 (22.9)	99 (48.8)	1.00	Reference	

CI=confidence interval; CPR=cardiopulmonary resuscitation; HIV=human immunodeficiency virus; LMA=laryngeal mask airway; NA=not available; OR=odds ratio; PEA=pulseless electrical activity; ROSC=return of spontaneous circulation; VF=ventricular fibrillation; VT=ventricular tachycardia

Table 4. Multivariate analysis

Variables	Univariable analysis			Multivariable analysis		
	OR[1]	95% CI	p-value	OR_{adj}[2]	95% CI	p-value
Age (years)						
Less than 40	2.26	1.05 to 4.86	0.037			
40 to 59	1.34	0.71 to 2.53	0.363			
At least 60	1.00	Reference				
Cause of cardiac arrest						
Trauma	2.42	1.14 to 5.14	0.021	4.18	1.6 to 10.93	0.004
Non-trauma	1.00	Reference		1.00	Reference	
Witnessed arrest						
Yes	4.18	1.44 to 12.12	0.009			
No	1.00	Reference				
Bystander CPR						
Yes	3.81	1.79 to 8.11	0.001			
No	1.00	Reference				
AED use at scene						
Yes	5.04	1.97 to 12.93	0.001			
No	1.00	Reference				
Response time (minutes)						
Less than 8	1.94	1.07 to 3.53	0.030	2.07	1.03 to 4.14	0.041
At least 8	1.00	Reference		1.00	Reference	
Initial cardiac rhythm						
VF	4.33	1.96 to 9.56	<0.001	2.63	1.13 to 6.12	0.025
Asystole	0.40	0.22 to 0.74	0.003			
PEA	2.44	1.20 to 4.97	0.014	2.89	1.26 to 6.64	0.012
Intubation						
Endotracheal tube	5.02	2.63 to 9.60	<0.001			
Bag mask ventilation	1.81	1.04 to 3.14	0.034			
Medication during CPR						
Epinephrine	10.78	4.16 to 27.88	<0.001	13.62	4.72 to 39.31	<0.001
Amiodarone	5.84	1.89 to 18.09	0.002			
Bicarbonate	2.26	1.24 to 4.12	0.007			
Calcium gluconate	3.13	1.43 to 6.88	0.004			
Total resuscitation period (minutes)						
0 to 10	1.00	Reference				
11 to 30	2.89	1.52 to 5.49	0.001			
31 to 60	5.30	2.08 to 13.50	<0.001			

OR_{adj}=adjusted odds ratio; CI=confidence interval; CPR=cardiopulmonary resuscitation; OR=odds ratio; PEA=pulseless electrical activity; VF=ventricular fibrillation

Variables in the univariable analysis with p<0.050 were included in the multivariable model

[1] Crude odds ratio estimated by binary logistic regression, [2] Adjusted odds ratio estimated by multiple logistic regression (backward stepwise selection method)

Discussion

In the present study, the analyses of 273 patients with OHCA, traumatic cardiac arrest, response time less than eight minutes, initial VF, PEA, and epinephrine administration during CPR were the factors associated with successful pre-hospital cardiac resuscitation on scene provided by S.M.A.R.T, Division of Emergency Medical Service

and Disaster, Faculty of Medicine Vajira Hospital, Navamindradhiraj University. The operation team from S.M.A.R.T. included paramedics, emergency medical technicians (EMTs), emergency nurse practitioner (ENPs), and emergency physicians (EPs). However, in the night shift, there were only paramedics and EMTs under on-line medical director of the team.

Similar to Limesuriyakan's study, evaluating factors associated with the outcome of OHCA at the emergency department of Phra Nakhon Si Ayutthaya Hospital found that witnessed arrest, bystander chest compression, and bystander's AED usage were not associated with ROSC[11]. The present study contradicted the systematic review and meta-analysis that found that bystander AED improved ROSC and clinical outcomes[12]. The study of Lai et al found that cardiac rhythm on admission was a strong factor associated with survival at discharge of VF versus non-VF (adjusted OR 3.51; 95% CI 3.06 to 4.01)[13]. Adrenaline administration during CPR was associated with survival according to Chanchayanon et al[14].

In the present study, response time less than eight minutes was significantly related with success in pre-hospital cardiac resuscitation by S.M.A.R.T, Vajira Hospital, consistent with the previous knowledge, which is that the faster the CPR was performed after cardiac arrest, especially within four minutes, the higher the survival rate. Therefore, emergency medicine has identified response time of eight minutes as an EMS quality indicator. For this reason, S.M.A.R.T, Vajira Hospital, has realized the importance of readiness for providing emergency services to patients with OHCA in Zone 1, Faculty of Medicine Vajira Hospital, Navamindradhiraj University. To avoid traffic congestion in Bangkok, the S.M.A.R.T team contacted the police officers by radio communication to manage the traffic. Furthermore, the motorlance was assigned to lead the ambulance to achieve response time of less than eight minutes.

The present study had certain limitations. First, with the retrospective descriptive design using codes followed by the Emergency Medical Triage Protocol and CBD, CBD6 Red1 or RC, RC6 Red1, for one year, in overall operation reports related to ALS by the Bangkok EMS Centre (Erawan Centre), many instances were not recorded. Second, only pre-hospital cardiac resuscitation data were examined, so data during transport and concerning treatment in the emergency room were not evaluated. Third, regarding the initial cardiac rhythm data in Table 2, the number of asystole and VF cases were repeated in operation reports of the Bangkok EMS Centre by paramedics. Finally, data were solely analyzed from S.M.A.R.T, Division of Emergency Medical Service and Disaster, Faculty of Medicine Vajira Hospital, Navamindradhiraj University; hence, the results cannot be generalized.

Conclusion

In the present study, there was 273 patients with OHCA, of which 70 (25.6%) achieved ROSC, while 203 (74.4%) did not. The factors associated with successful pre-hospital cardiac resuscitation on scene were traumatic cardiac arrest, response time of less than eight minutes, initial VF, PEA, and epinephrine administration during CPR. Based on this knowledge, these factors will be used to develop on-scene CPR guidelines for the care of patients with OHCA for the authors' EMS personals.

What is already known on this topic?

There has been a guideline for OHCA patients from the arrival to the scene to the final step. Rapid response time for CPR, AED use, and ALS are associated with survival rate.

What this study adds?

This study explored and identified factors associated with successful pre-hospital cardiac resuscitation on the scene to improve service quality as well as the pre-hospital cardiac resuscitation guidelines of S.M.A.R.T, Vajira Hospital.

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Conflicts of interest

No conflicts of interest are to be declared.

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