Success Rate and Predictors of Adult Cardiopulmonary Resuscitation at the Emergency Room in a University Hospital

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Objective: To determine the success rates of adult cardiopulmonary resuscitation (CPR) and identify the predictors of successful CPR at the emergency room (ER) at a university-based hospital.

Materials and Methods: Adult patients that experienced cardiac arrest and received CPR at the ER were prospectively observed. The primary outcomes were the rates of return of spontaneous circulation (ROSC), survival to hospital admission, survival to hospital discharge, and discharge with good neurological outcome. The secondary outcome was to determine the predictors of ROSC.

Results: One hundred twenty-nine adult patients were enrolled in the study. The success rates of CPR were ROSC 41.9%, survived to hospital admission 34.1%, survived to hospital discharge 8.5%, and discharged with a good neurologic outcome 3.9%. From multiple logistic regression, the predicting factors for ROSC were cardiac arrest at the ER (odds ratio [OR] 4.89, 95% CI 1.90 to 12.55; p<0.001) and cardiac arrest during morning shift (OR 2.40, 95% CI 1.08 to 5.34; p=0.031).

Conclusion: The success rates of the CPR outcomes were good. Cardiac arrest at the ER and arrest during the daytime were predicting factors for ROSC.

Keywords: Adult cardiopulmonary resuscitation, Cardiac arrest, Emergency room

Cardiac arrest is an emergency situation that requires immediate cardiopulmonary resuscitation (CPR). The goals of CPR are to preserve life, restore health, relieve suffering, and limit disability while respecting the decisions of the individual[1]. CPR outcomes vary among studies because of differences in the circumstances of cardiac arrest, availability of equipment, and performance of the CPR team. The influencing factors of CPR outcome at the emergency room (ER) are patient characteristics, early detection, immediate CPR, initial shockable rhythm, duration of CPR of less than 10 minutes, and advanced cardiac life support[2-11]. Successful CPR was reported as return of spontaneous circulation (ROSC) that ranged from 30.2 to 59.1%[8,12,13] and survival to hospital discharge that ranged from 5 to 22%[8,14-17].

Songklanagarind Hospital is an 850-bed university based hospital in southern Thailand. The ER at Songklanagarind Hospital has approximately 50,000 to 53,000 visits per year and CPR was performed on average, 160 times per year, which is the highest rate in the hospital[15]. The CPR procedure followed the updated American Heart Association standard guideline but the results of CPR were unclear. The authors aimed to determine the CPR outcomes and predictors of ROSC.

Materials and Methods
Study design
A prospective observational study was performed

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between January 2010 and March 2011 at the ER of Songklanagarind Hospital. When cardiac arrest patients presented at the ER, the emergency physician (EP) and team prompt CPR, and immediately activated the CPR team. The adult CPR team consisted of an EP, internist, surgeon, and anesthesiologist, who were qualified (have passed CPR training). The CPR team resuscitated and managed post cardiac arrest care closely. Approval for the study was obtained from the Institutional Ethics Committee Board of the Faculty of Medicine at Prince of Songkla University.

Study population

The inclusion criteria were patients older than 15 years who experienced cardiac arrest and received CPR at the ER of Songklanagarind Hospital. The exclusion criteria were 1) do not attempt resuscitation order, 2) signs of irreversible death such as rigor mortis, and 3) in-hospital patients who received CPR by a team apart from the ER such as the intensive care unit.

Data collection

The data were collected from the medical records and modified CPR record forms based on the Utstein template[18,19]. The data consisted of baseline characteristics, causes of cardiac arrest, location of cardiac arrest, witness arrest, initial rhythm, CPR team arrival, duration of CPR time, and CPR outcomes. The patients were categorized by initial CPR outcome into two groups, the ROSC or the non-ROSC group. ROSC was defined as a brief restoration of spontaneous circulation that provided evidence of more than an occasional gasp, occasional fleeting palpable pulse, or arterial waveform of more than 30 seconds[19]. Neurologic outcome in the surviving patients was categorized according to the Cerebral Performance Category score (CPC) when patients were discharged. Good neurological outcome was defined as a CPC score of 1 or 2[19].

Outcome measurement

The primary outcomes were success rates of CPR defined by the ROSC rate, survival to hospital admission rate, survival to hospital discharge rate, and discharged with good neurological outcome. The secondary outcomes were predictors of ROSC.

Statistical analysis

The statistical analysis was conducted using R software, version 3.2.2. The mean and median were used to describe continuous variables. Discrete variables are reported as number and percentage. Comparison of the data between the ROSC group and the non-ROSC group used the chi-square test, Fisher's exact test for categorical data and the unpaired t-test, Mann-Whitney U test for continuous data in analysis. Multiple logistic regression was performed for the predictors of ROSC. A p-value of less than 0.05 was considered statistically significant. A two-tailed p-value of less than 0.05 was selected as the level of statistical significance.

Results

One hundred forty-seven patients experienced cardiac arrests at the ER. Eighteen patients were excluded because of a do not resuscitate order (11 patients), signs of irreversible death (3 patients), and incomplete data (4 patients). One hundred twenty-nine patients met the inclusion criteria. The baseline characteristics are shown in Table 1.

Fifty-four patients achieved ROSC, 44 patients survived to hospital admission, 11 patients survived to hospital discharge, and 5 patients were discharged with good neurological outcome (Table 2).

The statistically significant factors predicting ROSC from multivariate logistic regression analysis were cardiac arrest at the ER (odds ratio [OR] 4.89, 95% CI 1.90 to 12.55; p<0.001) and cardiac arrest during morning shift (OR 2.40, 95% CI 1.08 to 5.34; p=0.031).

The out-of-hospital cardiac arrest (OHCA) subgroup was the largest group to receive CPR at the ER. The percentage of non-traumatic patients who achieved ROSC was higher (80.0%) than the trauma patients (20.0%). The percentage of ROSC patients who were transported to the ER by an advanced life support (ALS) ambulance was 11.4% (Table 3). The CPR outcomes of OHCA were 34.3% achieved ROSC, 26.5% survived to hospital admission, 5.9% survived to hospital discharge, and 2.0% of hospital discharged patients had good neurological outcome (Table 2).

The three most common causes of cardiac arrest at the ER were trauma, heart disease, and respiratory disease. The ROSC rates were 26.3%, 21.1%, and 26.3%, respectively. The mean duration of ER arrival to cardiac arrest in the ROSC group was 37 minutes, which was shorter than the non-ROSC group (73 minutes) (Table 4).

Discussion

The CPR outcomes of the present study, i.e., ROSC (41.9%), survived to hospital admission

Table 1. Baseline characteristics of all adult cardiac arrest patients who received cardiopulmonary resuscitation at the emergency room

Characteristics	Overall (n=129); n (%)		p-value
	ROSC group (n=54)	Non-ROSC group (n=75)	
Sex			0.136
Male	37 (68.5)	60 (80.0)	
Female	17 (31.5)	15 (20.0)	
Age (year); mean±SD	55±19	52±18	0.301
Cause of cardiac arrest			0.196
Non-trauma cause	41 (75.9)	49 (65.3)	
Trauma cause	13 (24.1)	26 (34.7)	
Location of cardiac arrest			0.001
OHCA	35 (64.8)	67 (89.3)	
Cardiac arrest at the ER	19 (35.2)	8 (10.7)	
Transport to ER by ALS ambulance	12 (22.2)	5 (6.7)	0.010
Comorbidity			
Diabetes	10 (18.5)	7 (9.3)	0.128
Hypertension	14 (25.9)	14 (18.7)	0.324
Hyperlipidemia	4 (7.4)	6 (8.0)	1.000
Heart diseases	13 (24.1)	10 (13.3)	0.116
Cerebrovascular diseases	2 (3.7)	3 (4.0)	1.000
Malignancy	6 (11.1)	6 (8.0)	0.548
Witnessed arrest	40 (74.1)	49 (65.3)	0.290
Initial rhythm			1.000
Shockable rhythm	4 (7.5)	5 (6.8)	
Non-shockable rhythm	49 (92.5)	68 (93.2)	
Duration of CPR team arrival after activation (minute); median (IQR)	3 (2 to 5.5)	5 (2 to 7)	0.094
Administration of first dose of adrenaline (minute); median (IQR)	1 (1 to 2)	2 (1 to 2.3)	<0.001
Duration of CPR time			<0.001
≤10 minutes	27 (50.0)	0 (0.0)	
>10 minutes	27 (50.0)	75 (100)	
Morning shift (08:00-16:00)	22 (40.7)	18 (24.0)	0.043

ROSC=return of spontaneous circulation; OHCA=out-of-hospital cardiac arrest; ER=emergency room; ALS=advanced life support; CPR=cardiopulmonary resuscitation; SD=standard deviation; IQR=interquartile range

Table 2. Successful cardiopulmonary resuscitation

Success	Overall (n=129) n (%)	OHCA (n=102) n (%)	Cardiac arrest at the ER (n=27) n (%)
ROSC	54 (41.9)	35 (34.3)	19 (70.4)
Survived to hospital admission	44 (34.1)	27 (26.5)	17 (63.0)
Survived to hospital discharge	11 (8.5)	6 (5.9)	5 (18.5)
Hospital discharged with good neurological outcome[a]	5 (3.9)	2 (2.0)	3 (11.1)

OHCA=out-of-hospital cardiac arrest; ER=emergency room; ROSC=return of spontaneous circulation

[a] Good neurological outcome=the Cerebral Performance Category score 1 or 2

Table 3. Baseline characteristics of out-of-hospital cardiac arrest

Characteristics	OHCA (n=102); n (%)		p-value
	ROSC group (n=35)	Non-ROSC group (n=67)	
Male	26 (74.3)	52 (77.6)	0.707
Age (year); mean±SD	52±19	52±18	0.853
Cause of cardiac arrest			0.074
Non-trauma cause	28 (80.0)	42 (62.7)	
Trauma	7 (20.0)	25 (37.3)	
Location of cardiac arrest			0.242
At home	25 (71.4)	40 (59.7)	
Public area	10 (28.6)	27 (40.3)	
Witness arrest	21 (60.0)	41 (61.2)	0.907
Transport to ER by ALS ambulance	4 (11.4)	3 (4.5)	0.228
Collapse to the ER arrival time (minute); median (IQR)	16 (11 to 30)	25 (15 to 33)	0.067
Initial rhythm			0.228
Shockable rhythm	4 (11.4)	3 (4.5)	
Non-shockable rhythm	31 (88.6)	64 (95.5)	
Duration of CPR time			<0.001
≤10 minutes	17 (48.6)	0 (0.0)	
>10 minutes	18 (51.4)	67 (100)	
Morning shift (08:00-16:00)	14 (40.0)	18 (26.9)	0.175

OHCA=out-of-hospital cardiac arrest; ROSC=return of spontaneous circulation; ER=emergency room; ALS=advanced life support; CPR=cardio-pulmonary resuscitation; SD=standard deviation; IQR=interquartile range

Table 4. Baseline characteristics of cardiac arrest at the emergency room

Characteristics	Cardiac arrest at ER (n=27); n (%)		p-value
	ROSC group (n=19)	Non-ROSC group (n=8)	
Male	11 (57.9)	8 (100)	0.061
Age (year); mean±SD	61±18	56±18	0.459
Non-trauma cause of cardiac arrest	13 (68.4)	7 (87.5)	0.389
Transport to the ER by ALS ambulance	8 (42.1)	2 (25.0)	0.666
Problems/conditions leading to the ER visit			
Trauma	5 (26.3)	1 (12.5)	0.633
Heart diseases	4 (21.1)	4 (50.0)	0.183
Respiratory diseases	5 (26.3)	1 (12.5)	0.633
Infection	2 (10.5)	2 (25.0)	0.558
Metabolic disease	2 (10.5)	2 (25.0)	0.558
Gastrointestinal diseases	2 (10.5)	0 (0.0)	0.567
Vascular diseases	0 (0.0)	1 (12.5)	0.296
ER arrival to cardiac arrest time (minute); median (IQR)	37 (12 to 131)	73 (9 to 269)	0.690
Initial rhythm			0.054
Shockable rhythm	0 (0.0)	2 (33.3)	
Non shockable rhythm	18 (100.0)	4 (66.7)	
Duration of CPR time			0.025
≤10 minutes	10 (52.6)	0 (0.0)	
>10 minutes	9 (47.4)	8 (100)	
Morning shift (08:00-16:00)	8 (42.1)	0 (0.0)	0.061

ROSC=return of spontaneous circulation; ER=emergency room; ALS=advanced life support; CPR=cardiopulmonary resuscitation; SD=standard deviation; IQR=interquartile range

(34.1%), survived to hospital discharge (8.5%), and survived to hospital discharge with good neurological outcome (3.9%), were similar to the previous studies[8,12,13]. In general, cardiac arrest at the ER, transport to the ER by ALS ambulance, first dose of adrenaline administered within one minute, duration of CPR of 10 minutes or less, and cardiac arrest during the morning shift had higher rates of ROSC with statistical significance, consistent with other studies[8,9,11,13,14,20].

The present study emphasized the cornerstone of adrenaline on the success of CPR, i.e., the sooner adrenaline is administered, the better the outcome. Surprisingly, the CPR team arrival time did not affect the ROSC rate. The cause of the present study result probably was from the implementation of the standard CPR guideline throughout the hospital to achieve an organizational CPR standard competency.

The predicting factors of ROSC were cardiac arrest at the ER (OR 4.89, 95% CI 1.90 to 12.55; p<0.001). This result was the same as the Sittichanbuncha et al study (adjusted OR 8.55, 95% CI 2.41 to 30.30)[21]. Cardiac arrest during the morning shift was also a predicting factor of ROSC (OR 2.40, 95% CI 1.08 to 5.34; p=0.031), which agreed with the previous studies[11,14].

When patients were categorized in the present study into OHCA and cardiac arrest at the ER, the CPR outcomes of cardiac arrest at the ER were superior to OHCA, which agreed with the study by Chew et al[12]. The ROSC rate of OHCA cases was 34.3%, which was similar with the previous studies (31% to 41%)[22,23], while survival to hospital discharge rate was 5.9%, which was close to the results of the other studies (7.1% to 10%)[22-25]. In the group of OHCA, cardiac arrest in a public area had better CPR outcomes than cardiac arrest at home, according to the study by Gräsner et al who reported that the rates of ROSC were 53.8% in arrest at a public area and 40.5% in arrest at home[26]. A study by Murakami et al reported that the rates of CPR outcome in the admitted alive and discharged alive groups were 49.7% and 31%, respectively, in cardiac arrests in a public area, which were higher than those occurring at home[27]. On the other hand, cardiac arrest in a public area in the OHCA group in the present study had a lower ROSC rate (28.6%) than cardiac arrest at home (71.4%). The authors' study results found that witnessed arrest achieved ROSC (60.0%) that was almost equal to non-ROSC (61.2%) (p=0.907) different from the other studies which found that witnessed arrest had better CPR outcomes[27-29].

There was possibly a difference in the competency of laypersons in the general public doing CPR.

Only seven of 102 patients arrived at the ER in an ALS ambulance. This result illustrated an important gap in OHCA care, which is composed of early detection, immediate high-quality basic life support, and access to the emergency system. A public campaign to teach basic life support and provide access to the emergency care system along with training in high quality CPR for basic life support personnel should be emphasized to improve OHCA outcome.

The length of stay of cardiac arrest patients at the ER was associated with ROSC. A long stay in the ER before having cardiac arrest was associated with an unfavorable outcome, which was similar to other studies[30-32]. The risks in critical patients, such as clinical deterioration or cardiac arrest, need to be identified using intensive monitoring for early detection or prevention of adverse events. Immediate response or timely appropriate treatment is necessary when clinical conditions worsen. However, overcrowding in the ER also affects the monitoring and other care processes for patients who are at risk for deterioration[33]. The specific concerns of patient safety are challenges for the ER personnel to improve the service and decrease the length of stay in the ER, especially in an overcrowded situation.

Conclusion

The success rates of CPR outcomes, i.e., ROSC, survival to hospital admission, survival to hospital discharge, and discharge with good neurological outcome, in the ER at Songklanagarind Hospital compared well with other studies. Predicting factors that related to ROSC at the ER were cardiac arrest at the ER and during the morning shift.

What is already known on this topic?

The results of successful CPR at the ER are superior to OHCA.

What this study adds?

The predicting factors for successful CPR, in cardiac arrest patients, at the ER.

Acknowledgement

Conflicts of interest

The authors declare no conflict of interest.

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