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Adrenaline use as a poor predictor for the return of spontaneous circulation among victims of out-of-hospital cardiac arrest according to a national emergency medical services database

Chaiyaporn Yuksen¹, Phatthranit Phattharapornjaroen¹, Woranee Kreethep¹, Chonnakarn Suwanmano¹, Chestsadakon Jenpanitpong¹, Rawin Nonnongku¹, Yuwares Sittichanbuncha¹, Kittisak Sawanyawisuth^{2*}

¹Department of Emergency Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok,

²Department of Medicine, Faculty of Medicine, Sleep Apnea Research Group, Khon Kaen University, Khon Kaen, Thailand

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ORCID:

0000-0002-4890-7176

0000-0002-4391-2929

0000-0001-5859-3783

0000-0001-8146-3020

0000-0002-2906-7677

0000-0001-6562-5376

0000-0003-1556-4979

0000-0003-3570-8474

Address for
correspondence:

Prof. Kittisak
Sawanyawisuth,
Department of Medicine,
Faculty of Medicine, Khon
Kaen University, 123
Mitraparp Road, Khon
Kaen 40002, Thailand.
E-mail: kittisak@kku.ac.th

Abstract:

OBJECTIVE: This study aimed to determine additional predictors of cardiopulmonary resuscitation success using a national emergency medical services (EMS) database.

METHODS: This retrospective study was conducted by retrieving data from the Information Technology of Emergency Medical Service, a national EMS database. The inclusion criteria were adult patients (18 years old or over) who suffered from out-of-hospital cardiac arrest and received emergency life support. The outcome was a return of spontaneous circulation (ROSC). Predictors for ROSC were determined using multivariate logistic regression analysis.

RESULTS: During the study period, 1070 patients met the study criteria, among whom 199 (18.60%) belonged to the ROSC group. Five factors were eligible for multivariate logistic regression analysis for predicting ROSC. Accordingly, only adrenaline administration was independently and negatively associated with ROSC with an adjusted odds ratio of 0.722 (95% confidence interval: 0.522, 0.997) and a Hosmer–Lemeshow Chi-square of 5.84 ($P = 0.665$).

CONCLUSIONS: Adrenaline use may be a poor predictor for ROSC during out-of-hospital cardiac arrest.

Keywords:

Adrenaline, cardiopulmonary resuscitation, outcomes

Introduction

A report from the American Heart Association (AHA) showed that 347,322 adults in the US suffered from out-of-hospital cardiac arrest in 2018,

a number higher than that in 2011 (295,000 cases).^[1,2] Among the reported cases, approximately 60% were treated by emergency medical services (EMS), 68.5% occurred at home, and 37% were witnessed by a layperson.^[2] While EMS-treated, out-of-hospital cardiac arrests have a

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survival rate of 10.8%, several factors have been associated with survival among such victims.

Early cardiopulmonary resuscitation (CPR) has been the key factor for survival among victims of out-of-hospital cardiac arrest. A previous study found that only 32% of victims suffering from out-of-hospital cardiac arrest received CPR from a layperson, with automated external defibrillators being used in only 2.1% use of the victims.^[3] The median survival rate from ventricular fibrillation was higher than that from other rhythms (21% vs. 7.9%).^[4] In addition, among 10 North American study sites for out-of-hospital cardiac arrest, survival rates varied from 3.0% to 16.3%. These data indicated that several factors are associated with survival among victims of out-of-hospital cardiac arrest. This study therefore aimed to identify predictors of CPR success using a national EMS database.

Methods

This retrospective study was conducted by retrieving data from the Information Technology of Emergency Medical Service (ITEMS), a national EMS database of the National Institute for Emergency Medicine (Thailand). The inclusion criteria were adult patients (18 years old or over) who suffered from both traumatic and nontraumatic out-of-hospital cardiac arrest and received emergency life support and airway management by EMS staff in a prehospital setting. Pregnant women or terminally ill patients with do-not-attempt-resuscitation orders were excluded from the study. The study was conducted from November 2016 to October 2017.

The ITEMS database was searched for eligible patients using the code "cardiac arrest," subsequently enrolling those who met with the inclusion criteria. Clinical baseline characteristics, treatments, and outcome were

recorded. Data were categorized according to either bag-valve-mask ventilation or endotracheal tube intubation. The studied variables included gender, age, response time, on-scene time (min), distance from the scene, defibrillation, fluid therapy, adrenaline administration, and cause of cardiac arrest (internal medicine, surgery, or accident). The studied outcome was a return of spontaneous circulation (ROSC). The ROSC outcome was evaluated at the emergency department of the respective hospitals.

Statistical analyses

Clinical data of eligible patients were analyzed and categorized according to the ROSC. Univariate logistic regression analysis was utilized to calculate the crude odds ratio (OR) of individual variables for ROSC. Factors with $P < 0.20$ during univariate logistic regression were subsequently included in multivariate logistic regression analysis. Analytical results were presented as crude OR, adjusted OR, and 95% confidence intervals (CIs). The goodness of fit of the multivariate logistic regression model was tested using the Hosmer–Lemeshow method. All data analyses were performed using STATA software (StataCorp LP, College Station, TX, USA).

Results

During the study period, 1070 patients met the study criteria, among whom 199 (18.60%) belonged to the ROSC group [Table 1]. Four significant factors were identified between those with and without ROSC, including age and proportion of patients receiving intravenous fluid, adrenaline administration, and medical illness. The ROSC group was younger (50.84 vs. 53.99 years; $P = 0.041$) and had significantly lower proportions of adrenaline administration (43.2% vs. 51.9%) and medical illnesses (54.3% vs. 63.0%) than the no ROSC group ($P = 0.028$ for both the factors).

Table 1: Baseline characteristics and factors of patients suffering from out-of-hospital cardiac arrest registered in the Information Technology of Emergency Medical Service database categorized according to the return of spontaneous circulation

Factors	ROSC (n=199)	No ROSC (n=871)	P
Gender (male), n (%)	141 (70.9)	643 (73.8)	0.393
Age (years), mean +/- SD	50.84±20.79	53.99±19.31	0.041
Response time <8 (min), n (%)	87 (43.7)	363 (41.7)	0.599
On scene time (min), mean +/- SD	2.72±3.65	2.95±3.81	0.444
Distance to the scene (km), mean +/- SD	7.61±7.0	7.34±6.1	0.589
Defibrillation, n (%)	4 (2.0)	9 (1.0)	0.265
Intravenous fluid administration, n (%)	188 (95.4)	820 (94.5)	0.028
Adrenaline administration, n (%)	86 (43.2)	452 (51.9)	0.028
Types of illnesses, n (%)			
Medical	108 (54.3)	549 (63.0)	0.022
Trauma	67 (33.7)	262 (30.1)	0.323
Endotracheal intubation*, n (%)	42 (21.1)	228 (26.2)	0.138

*Others received bag-valve-mask ventilation. SD: Standard deviation, ROSC: Return of spontaneous circulation. Bold values indicate statistically significant difference

Five factors were eligible for multivariate logistic regression analysis to predict the ROSC [Table 2]. However, only adrenaline administration was independently and negatively associated with ROSC, with an adjusted OR of 0.722 (95% CI: 0.522, 0.997) and a Hosmer–Lemeshow Chi-square of 5.84 ($P = 0.665$). As shown in Table 3, seven factors differed significantly between those who did and did not receive adrenaline. Those who received adrenaline were older (55.01 vs. 51.77 years), received more intravenous fluids (98.3% vs. 90.9%), and had higher proportions of medical illnesses (68.0% vs. 54.7%) and endotracheal intubations (33.2% vs. 17.1%) than those who did not receive adrenaline.

Discussion

The ROSC rate reported herein was slightly higher than the survival rate reported by the 2018 report by the AHA. This difference in outcome may be because of the use of CPR for the evaluation of ROSC in the present study, which was higher than the survival rate obtained from hospitals in the AHA report. A study from Korea found that a telephone CPR program increased bystander CPR from 2.9% to 10.3% and the ROSC rate from 1.4% to 4.3%.^[5] However, the ROSC rate in the

aforementioned was much lower than that presented herein because of differences in CPR provider, that is, EMS personnel executed CPR herein, whereas laypersons performed CPR in the Korean study. The ROSC rate in the present study was somewhat higher than that in a previous study, wherein CPR was performed by EMS technicians (5.8%).^[6] The high ROSC rate in the current study could perhaps be attributed to the high response time (almost 50% within 8 min) as shown in Table 1.

Several predictors for good outcomes have been identified among patients with out-of-hospital cardiac arrest, including ventricular fibrillation/tachycardia, serum creatinine, or serum lactate.^[7] The current study found that adrenaline use reduced the likelihood for ROSC by 28% [Table 2]. These data may indicate that most patients may have had unshockable rhythms, resulting in low ROSC rates. One previous study^[7] found that ventricular fibrillation/tachycardia rhythm resulted in more individuals having good than poor outcomes (70% vs. 27%; $P < 0.05$). Another possible reason could be that victims receiving more adrenaline may have had a more severe condition than those who received less adrenaline. As shown in Table 3, those who received adrenaline were older and received delayed treatment as evidenced by the longer travel distance from the scene. The increased number of endotracheal intubations and medical illnesses among those receiving adrenaline may also suggest a more severe condition compared to those not receiving adrenaline. A study from Poland found that young patients suffering from out-of-hospital cardiac arrests had higher rates of ROSC than other age groups (65.81% vs. 58.87%; $P = 0.005$).^[8] Shorter response time has also been another factor associated with ROSC.^[9] One previous study found that among patients suffering from out-of-hospital cardiac arrest, those with ROSC had significantly shorter response time compared to those without ROSC (370 vs. 394 s; $P = 0.015$).

Table 2: Predictors for return of spontaneous circulation in patients suffering from out-of-hospital cardiac arrest registered in the Information Technology of Emergency Medical Service database

Factors	95% CI	
	Unadjusted OR	Adjusted OR
Age	0.992 (0.984-0.999)	0.994 (0.986-1.003)
Intravenous fluid administration	1.222 (0.589-2.536)	1.417 (0.674-2.976)
Adrenaline administration	0.705 (0.517-0.962)	0.722 (0.522-0.997)
Medical illness	0.696 (0.519-1.094)	0.815 (0.578-1.151)
Endotracheal intubation	0.754 (0.519-1.095)	0.810 (0.553-1.186)

CI=Confidence interval, OR=Odds ratio

Table 3: Baseline characteristics and factors of patients suffering from out-of-hospital cardiac arrest registered in the Information Technology of Emergency Medical Service database categorized according to the adrenaline administration

Factors	No adrenaline (n=532)	Adrenaline (n=538)	P
Gender (male), n (%)	392 (73.7)	392 (72.7)	0.783
Age (years), mean +/- SD	51.77±20.26	55.01±18.84	0.013
Response time <8 (min), n (%)	250 (47.0)	200 (37.2)	0.001
On scene time (min), mean +/- SD	2.90±3.90	2.90±3.65	0.974
Distance to the scene (km), mean +/- SD	7.09±6.33	7.68±6.17	0.016
Defibrillation, n (%)	7 (1.3)	6 (1.1)	0.788
Intravenous fluid administration, n (%)	481 (90.9)	527 (98.3)	0.001
Types of illnesses, n (%)			
Medical	291 (54.7)	366 (68.0)	0.022
Trauma	191 (35.9)	138 (25.6)	0.001
Endotracheal intubation*, n (%)	91 (17.1)	179 (33.2)	0.001

*Others received bag-valve-mask ventilation, SD: Standard deviation. Bold values indicate statistically significant difference

Some limitations of the present study are worth noting. First, only information from the ITEMS database had been analyzed. Second, limited data had been available on the type of cardiac arrhythmia or CPR providers. Prehospital CPR teams in our country consist of two types: basic or advanced teams. Accordingly, basic CPR teams may provide limited treatment, excluding adrenaline administration or defibrillation. Second, only endotracheal tubes or bag-valve masks were used herein. Finally, some data, such as intravenous fluid types and amount of fluid therapy or comorbid diseases,^[10-13] might have been missing because of retrospective data collection.

Conclusions

Our findings suggest that adrenaline use may be a poor predictor for ROSC among victims of out-of-hospital cardiac arrest.

Author contribution statement

1. Conceived and designed the experiments: CY, YS, KS. 2. Performed the experiments: CY, PP, WK, CS, CJ, RN, YS. 3. Analyzed and interpreted the data: CY, KS. 4. Contributed reagents, materials, analysis tools or data: CY. 5. Wrote the paper: CY, KS

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None.

Conflicts of interest

The authors declare no conflict of interest.

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