Original Article

Factors Associated with the Short-Term Survival from Cardiopulmonary Resuscitation (CPR) among Older Patients in a Middle-Income Country

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Objective: The present study was aimed to explore factors associated with short-term survival from CPR among older patients in a middle-income country.

Materials and Methods: The author retrospectively reviewed data of all patients aged 60 years and older who presented to our emergency department (ED) after out-of-hospital cardiac arrest (OHCA) during 2010 to 2017. Data collection was done using Utstein-Style Guidelines for uniform reporting of data by trained research assistants.

The primary outcome was to determine the success rate of CPR and factors associated with 7-days survival in OHCA among older patients. Data was calculated using appropriate statistical analysis. Overall survival from each factor were presented by median survival time, which analyzed in to hazard ratio.

Results: We had 308 patients in the present study. One hundred and sixty-five patients (53.6%) were female, with a mean age of 74.78±9.50 years. An average CPR time was 26.75±16.64 minutes and average time to return of spontaneous circulation (ROSC) was 17.56±12.95 minutes. A total of 163 (52.9%) achieved ROSC and 88 (28.6%) patients survived to hospital admission. Overall median survival time was 7 days.

In multivariable analysis model, patients with first recorded ECG as asystole (HRadj 1.53 95% CI 1.18 to 1.98) and those required time to ROSC more than 12 minutes (HRadj 3.21 95% CI 2.98 to 4.74) decreased a chance of survival.

Conclusion: Half of the older patients had ROSC and almost one-third survived to hospital admission. Asystole and time to ROSC >12 minutes decreased a chance of 7 days survival among older adults. The present study may give some idea in crucial decision-making for out of hospital cardiac arrest among older adults.

Keywords: Short-term survival, Cardiopulmonary resuscitation, Elderly patients

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Cardiopulmonary resuscitation (CPR) is the main treatment process in patients with cardiac arrest. In 2016, the American Heart Association (AHA) announced the rate of successful CPR resulting in return of spontaneous circulation (ROSC) was 25% for both in and out of hospital settings[1].

When focusing on elderly populations, the ROSC rate decreased drastically from 8.1% in the 60-69 years age group and continued to diminish as low as 3% in patients aged more than 80 years[2]. One study in the USA reported half the elderly survivors survived until hospital discharge, and half the discharged patients lived on for more than 24 months[3]. Although advanced age is one of the most important factors affecting the CPR process, there are other factors that should be taken into consideration[4]. Chang et al[5] and Cooper et al[6]. found that decline in physiological reserve, initial cardiac rhythm, bystander involvement, and the specific causes of arrest might be important factors to consider in resuscitating the elderly. One German registry study examined the impact of emergency medical services (EMS) on the whole CPR process[7].

Thailand is considered a middle-income country. According to the national statistical office report[8], Thailand is now an aging society with an increase of 6 million (14.9%) in the geriatric population in the last 20 years. Several studies[9,10] have collected and analyzed out-of-hospital cardiac arrest (OHCA) data in this area. The recent largest study was the PAROS study[11], which included data from 9 Asia-Pacific countries and 9 provinces in Thailand. None of them focused on geriatric populations and factors associated with short-term outcomes in OHCA.

The present study aimed to explore the success rate of CPR with factors from various perspectives in

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treating elderly patients in a middle-income country, which may greatly benefit the decision-making during CPR session.

Materials and Methods

This was a retrospective cohort study. The authors reviewed data of all patients aged 60 and older who experienced OHCA between 1 January 2010 and 31 December 2017 and eventually received treatment at one emergency department (ED) of a university hospital in Bangkok, Thailand. Our hospital has approximately 70,000 ED visits per year and 30% of them are aged over 60 years. Patients with cardiac arrest were identified initially by searching the hospital's electronic database using ICD10 code I46.0 (cardiac arrest with successful resuscitation) and I46.9 (cardiac arrest, unspecified). Researchers reviewed the ED visit card to confirm that the patients had OHCA during the ED visited. Exclusion criteria were patients with do not resuscitate orders and incomplete CPR data recorded in ED.

Data collection process

The data collection was done by two research assistants (RAs), a bachelor of Medical and Public Health, and a secretary. The RAs were blinded to the study hypothesis.

Research assistants training process

RAs were trained to collect data under supervision of the principle investigator (PI). This included eight hours' training for data collection and identifying medical terms. RAs met the principle investigator twice a month to clarify terms and data that were not clear. Furthermore, they could contact PI directly if they had problems with the terms or were unsure about data abstractions. The PI randomly selected 5% of medical records to test for interrater reliability between RAs.

Data collection was done using 2015 Revised Utstein-Style Recommended Guidelines for uniform reporting of data[12]. The collected data consisted of age, gender, underlying diseases, Charlson co-morbidity index, activities of daily living (ADL), pre-hospital bystander, witnessed or non-witnessed arrest, time to first defibrillation, initial rhythm of cardiac arrest, drug administration and time to first drug administration. Furthermore, route of drug administration, type of drug administration, endotracheal tube intubation, ST-segment myocardial infarction (STEMI) and reperfusion attempts, overall CPR duration and time to last ROSC achieved, blood samples sent during CPR, such as serum glucose level, serum potassium level, serum lactate level and pH from blood gas were collected. Patients who survived ED were further followed-up for 7 days to evaluate short-term survival by using in-hospital database.

The primary outcome of the present study was to determine factors associated with the short-term survival from CPR among OHCA elderly patients.

Patients' informed consent was waived by the ethics committee of our hospital, since approval is not considered necessary for analyzing anonymous data for quality management. The present study was approved by the hospital's institutional review board.

Statistical analysis

In the present study, the authors incorporated all cases that corresponded to the inclusion and exclusion criteria of the study design in the study period.

Quantitative values such as age, Charlson comorbidity index score, and various time values in the CPR process were presented using mean and standard deviation (SD) or median and interquartile range (IQR) where appropriate. The relationship between factors was determined by using student's t-test or Mann Whitney u-test. The calculation was statistically significant when *p*-value was less than 0.5. Qualitative values such as gender, cause of cardiac arrest, and the first cardiac rhythm recorded were presented using percentages. Chi-square was used to test a relationship between factors, with *p*-value less than 0.5 being statistically significant.

Overall survival from each factor was presented as median survival time, which was analyzed into hazard ratio (HR) and underwent univariable and multivariable analysis. The *p*-value less than 0.5 was considered statistically significant. All statistical calculations found in the present study were calculated by STATA software version 15.1.

Results

During the study period, an electronic database search showed 471 elderly patients with compatible ICD-10 code. Further chart review identified 308 elderly patients with OHCA and a complete CPR record form in ED. The trend shows an increase in the number of cardiac arrest patients every year since 2010, as in Figure 1.

Overall 77 patients (25%) arrived by ambulance. One hundred and sixty-five patients (53.6%) were female, with an average age of 74.78±9.50 years. Ninety patients (29.2%) were dependent with ADLs. Only 34 (11.2%) patients had a bystander who responded (Table 1). Asystole was the most common initially recorded cardiac rhythm [171 (55.5%) patients]. Most causes of OHCA among elderly patients were from internal medical problems (94.8%). Ninety-seven (31.5%) patients were defibrillated at some point during the CPR process and mean time to defibrillation was 32.1±25.1 minutes. Most of the elderly patients received [299 (97.1%) patients] epinephrine during CPR with an average dose of 8.9±5.5 ampules of 1 ml of 1: 1,000

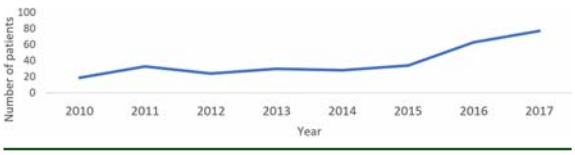

Figure 1. Number of OHCA elderly patients from 2010 to 2017.

Table 1. General characteristics of study patients

Variables	n (%)
Age (years)	74.8±9.5
Gender, female	165 (53.6)
Underlying diseases	267 (86.7)
Myocardial infarction (MI)	80 (26.0)
Congestive heart failure (CHF)	17 (5.5)
Peripheral vascular disease	5 (1.6)
Cerebrovascular disease	47 (15.3)
Dementia	8 (2.6)
Peptic ulcer disease	14 (4.5)
Chronic pulmonary disease	19 (6.2)
Mild Liver disease	2 (0.6)
Diabetic mellitus (DM) without complication	80 (26.0)
Hemiplegia	6 (1.9)
Diabetic mellitus (DM) with complication	25 (8.1)
Chronic kidney disease	61 (19.8)
Any malignancy	13 (4.2)
Metastatic solid malignancy	20 (6.5)
Moderate or severe liver disease	6 (1.9)
Acquired immune deficiency syndrome (AIDS)	1 (0.3)
Charlson comorbidity index, mean±SD	4.9±2.3
ADL (Dependency)	90 (29.2)
Bathing	61 (19.8)
Dressing	62 (20.1)
Movement	88 (28.6)
Toilet hygiene	61 (19.8)
Continence	14 (4.5)
Eating	15 (4.9)
Witnessed arrest	
Emergency medical services (EMS)	16 (5.2)
Bystanders	248 (80.5)
Doctor or Nurse	43 (14.0)
N/A	1 (0.3)
Bystanders response	
Have done	34 (11.1)
No	272 (88.3)
N/A	2 (0.6)

Table 2. Clinical characteristics of study patients

Variables	n (%)
First rhythm records	
Ventricular Fibrillation (VF)	20 (6.5)
Pulseless electrical activity (PEA)	96 (31.2)
Pulseless ventricular tachycardia (pVT)	8 (2.6)
Asystole	171 (55.5)
Cause of cardiac arrest	
Internal Medicine	292 (94.8)
Accidental injury	9 (2.9)
Respiratory obstruction	2 (0.6)
STEMI	
Find	21 (6.8)
Not found	287 (93.2)
First defibrillation	
Number of patients	97 (31.5)
Defibrillation time	32.12±25.11
Drug administration	300 (97.4)
Epinephrine	299 (97.1)
Dose (amp)	8.95±5.50
Antiarrhythmic	57 (18.5)
Amiodarone	52 (16.9)
Amiodarone and Lidocaine	5 (1.6)
Dose (amp)	1.77±0.76
Calcium gluconate	93 (30.2)
Sodium bicarbonate	84 (27.3)
50% glucose	51 (16.6)
pH (n = 89)	7.15±0.18
Lactate (mmol/L) (n = 96)	10.65±4.85
K (mmol/L) (n = 233)	5.19±1.92
Glucose (mg%) (n = 286)	181.07±129.72
Survival to admission	88 (28.6)
CPR time (min), mean ± SD	26.75±16.64
Time to ROSC (min), mean ± SD	17.56±12.95

Factors associated with survival

epinephrine. Fifty-seven (18.5%) patients received an antiarrhythmic drug during CPR with 52 (16.9%) patients receiving only amiodarone and 5 (1.6%) patients receiving both amiodarone and lidocaine. An average CPR time was 26.8±16.6 minutes and average time to ROSC was 17.6±12.9. Half of elderly patients [163 (52.9%) patients] had ROSC and 88 (28.6%) patients survived to hospital admission (Table 2).

Patient characteristics (Table 3)

In univariate analyses, the present study showed that witnessed arrest by doctor and nurse significantly improved survival outcome (HR 0.62, 95% confidence interval (CI) 0.42 to 0.93) $p = 0.019$. While advanced age using cut-off point at age 75 (HR 1.42, 95% CI 1.10 to 1.82) $p<0.006$, impairment in bathing (HR 1.38, 95% CI 1.02 to 1.86), toilet hygiene (HR 1.36, 95% CI 1.01 to 1.83), and continence (HR 1.8, 95% CI 1.03 to 3.15) had a negative effect on the CPR process. In multivariate analysis there was no statistical significance for each outcomes.

First recorded cardiac rhythm (Table 4)

In univariate analyses, asystole (HR 1.68, 95% CI 1.30 to 2.17) decreased survival outcome Ventricular fibrillation (VF) and pulseless ventricular tachycardia (pVT) had no significant effect in survival outcome. In multivariate analysis, asystole was associated with decreased survival outcome (HRadj 1.53, 95% CI 1.18 to 1.98).

CPR process (Table 4)

Univariate analyses showed that patients with an initial rhythm of non-VF and who had a defibrillation time ≥30 minutes during CPR process had worse survival outcomes (HR 2.74, 95% CI 1.26 to 5.96). Patients who received amiodarone during CPR improved their survival outcomes (HR 0.30, 95% CI 0.09 to 0.93). CPR time >30 minutes was associated with worse outcome (HR 2.74, 95% CI 2.09 to 3.60). Time to ROSC >12 minutes decreased the chance of survival (HR 3.44, 95% CI 2.29 to 5.16). In multivariate analysis, time to ROSC >12 minutes resulted in decreased

Table 3. Overall survival (general characteristic)

Variables	n	Median survival time (hrs)	95% CI	Univariable analysis			Multivariable analysis		
				HR	95% CI	*p*-value	HR_{adj}	95% CI	*p*-value
Age (years)									
≤75	159	1.17	(0.98 to 1.87)	1.00	Reference		1.00	Reference	
>75	149	1.03	(0.77 to 1.53)	1.42	(1.10 to 1.82)	0.006	1.16	(0.90 to 1.50)	0.245
Gender									
Female	165	1.03	(0.82 to 1.53)	1.12	(0.87 to 1.44)	0.374			
Charlson comorbidity index score									
<5	149	1.00	(0.82 to 1.32)	1.00	Reference				
≥5	159	1.27	(1.03 to 2.03)	0.84	(0.66 to 1.08)	0.181			
ADL (dependency)									
Any	90	0.93	(0.67 to 1.55)	1.27	(0.97 to 1.66)	0.081			
Bathing	61	0.92	(0.55 to 1.55)	1.38	(1.02 to 1.86)	0.036			
Dressing	62	0.92	(0.55 to 1.73)	1.25	(0.92 to 1.69)	0.146			
Movement	88	0.92	(0.67 to 1.55)	1.27	(0.97 to 1.67)	0.079			
Toilet hygiene	61	1.02	(0.63 to 1.55)	1.36	(1.01 to 1.83)	0.047			
Continence	14	0.63	(0.50 to 1.18)	1.80	(1.03 to 3.15)	0.040			
Eating	15	0.92	(0.50 to 1.73)	1.51	(0.88 to 2.6)	0.135			
Witnessed arrest									
Bystanders	249	1.10	(0.85 to 1.48)	1.00	Reference				
EMS	16	0.72	(0.53 to 1.32)	1.37	(0.79 to 2.35)	0.259			
Doctor or nurse	43	3.27	(0.95 to 13.52)	0.62	(0.42 to 0.93)	0.019			
Bystanders response									
Have done CPR	34	0.92	(0.72 to 3.43)	0.83	(0.55 to 1.27)	0.394			

Table 4. Overall survival (clinical characteristic)

Variables	n	Median survival time (hrs)	95% CI	Univariable analysis			Multivariable analysis		
				HR	95% CI	*p*-value	HR_{adj}	95% CI	*p*-value
Initial cardiac rhythm									
Asystole	171	0.83	(0.72 to 1.03)	1.68	(1.30 to 2.17)	<0.001	1.53	(1.18 to 1.98)	0.001
PEA	96	1.57	(1.12 to 6.08)	0.66	(0.50 to 0.88)	0.004			
VF	20	1.72	(0.57 to NA)	0.75	(0.44 to 1.29)	0.304			
Pulseless VT	8	1.27	(0.48 to 5.72)	1.30	(0.64 to 2.63)	0.466			
STEMI									
Not found	287	1.10	(0.87 to 1.32)	1.00	Reference				
Found	21	1.93	-	0.59	(0.34 to 1.03)	0.065			
Defibrillation time									
Defibrillation time <30 mins	57	1.72	-	1.00	Reference		1.00	Reference	
Defibrillation time ≥30 mins	40	0.67	(0.83 to 1.90)	2.01	(1.42 to 2.86)	<0.001	1.25	(0.87 to 1.78)	0.217
Drug administration									
Epinephrine									
Yes	299	1.10	(0.92 to 1.32)	2.06	(0.91 to 4.63)	0.081			
Anti-arrhythmic drugs									
Amiodarone	52	0.90	(0.63 to 1.27)	1.54	(1.13 to 2.14)	0.008			
Amiodarone & Lidocaine	5	0.72	-	1.23	(0.46 to 3.32)	0.680			
Potassium									
Normal (3.6 to 5.2 mmol/L)	111	2.77	(1.48 to 8.18)	1.00	Reference				
Abnormal	122	1.30	(1.02 to 2.08)	1.44	(1.07 to 1.94)	0.017			
Unknown	75	0.53	(0.48 to 0.72)	3.58	(2.58 to 4.98)	<0.001			
Glucose									
Normal (70 to 250 mg/dL)	182	1.23	(1.02 to 1.60)	1.00	Reference				
Hypoglycemia	41	0.57	(0.48 to 0.77)	1.60	(1.11 to 2.31)	0.012			
Hyperglycemia	63	1.58	(0.98 to 2.47)	0.99	(0.72 to 1.36)	0.956			
Unknown	22	1.10	(0.50 to 11.9)	0.94	(0.56 to 1.58)	0.819			
CPR time									
≥30 mins	148	0.82	(0.72 to 0.95)	2.74	(2.09 to 3.60)	<0.001	0.80	(0.91 to 1.50)	0.245
Time to ROSC									
≥12 mins	89	1.93	(1.27 to 2.72)	3.44	(2.29 to 5.16)	<0.001	3.21	(2.98 to 4.74)	<0.001
Unknown	139	0.53	(0.50 to 0.62)	12.76	(8.54 to 19.07)	<0.001			

survival outcome (HRadj 3.21, 95% CI 2.98 to 4.74).

Laboratory values (Table 4)

Univariate analyses showed that abnormal serum potassium (HR 1.44, 95% CI 1.07 to 1.94) and hypoglycemia (HR 1.60, 95% CI 1.11 to 2.31) were having negative effects in survival outcomes. In multivariate analysis there was no statistical significance for any outcome.

Discussion

Thailand is slowly becoming an aged society[13], in parallel with the trend of almost every country in the world. This phenomenon explains the surge of elderly ED visits and OHCA being in line with the yearly CPR trend we have seen in the present study[13].

The present study showed that the initial rhythm as asystole was a significant negative predictor. This is by far the most prominent factor across elderly OHCA studies[4,14-17], indicating that the irreversible cause of cardiac arrest in conjunction with poor functional reserve results in poor outcome in CPR for elderly OHCA. Considering asystole as major cause of non-shockable rhythm, our result aligned with both all age group studies from Xue et al[17]. which defined the survival to discharge outcomes between shockable vs. non-shockable rhythm (31% vs. 17%, $p<0.001$). The result also aligned with the large elderly study from Funada el al[9] which showed odd ratio for 1-month survival from initial shockable rhythm at 1.93.

Time to ROSC >12 minutes was a significant negative predictive factor. The result was inconsistent with a study focused on all age groups, which showed 90% of patients achieved ROSC within 20 minutes of CPR and patients requiring more time had a lower chance of survival and good neurological outcome[18]. The result may contribute to the optimum resuscitation time for OHCA in elderly patients.

EMS personnel witnessing arrest had no significant value in our study; this was contradicted by a large multivariate study of elderly OHCA in Japan, which showed EMS witnessing arrest was a predictor of good CPR outcome after multivariate analysis. The reason for the conflicting result is due to a much lower EMS exposure of elderly OHCA at the time of the study. Also, initial shockable rhythm didn't contribute to any statistical significance in the present study. This may be explained by the same EMS issue when compared with other healthcare systems such as the implementation of EMS-based early defibrillation program in 6 cities in the United States significantly improved survival after OHCA[19]. A newly organized EMS system in Thailand with increased accessibility, including paramedic training initiated in 2015, may prove beneficial. Future studies may reveal the significance of these OHCA aspects.

In terms of age and gender, our results align with the majority of the previous studies[4,14,17,20,21]. Advanced age was associated with poorer outcomes following OHCA, while gender differences generally did not contribute to survival. The decline in physical reserve in the elderly population was important[5]. A recent study focused on the effect of the age-adjusted Charlson comorbidity index score with survival from OHCA from all age groups and found that a Charlson comorbidity index score greater than 5 decreased survival rate significantly[16]. This contradicts our results and may stem from the effect of elderly populations or from the nature of our study population which had index score of 4.94 ± 2.26, thus the majority of cases had an index score very near to the cut-off point of five.

The present study was a single-center study and the results may not be generalizable. This was a retrospective study with incomplete data. Furthermore, the authors could not evaluate the quality of CPR, such as pushing too hard, pushing too fast, among other factors, which may affect survival outcomes. In relation to ACLS guidelines for post-resuscitation hypothemia, our hospital did not routinely perform it due to the limitation of resources at the time. These may affect the survival outcome. The lower rate of EMS utilization may have contributed to the significance of results in the analysis.

Conclusion

Half of the older patients had ROSC and almost one-third survived to hospital admission. Initial rhythm as asystole and those requiring more than 12 minutes for ROSC had poor outcomes. The present study may provide some ideas in crucial decision-making for out of hospital cardiac arrest among older adults.

What is already known on this topic?

Cardiopulmonary resuscitation (CPR) is the main treatment process in patients with cardiac arrest. In 2016, the American Heart Association (AHA) announced the rate of successful CPR resulting in return of spontaneous circulation (ROSC) was 25% for both in and out of hospital setting.

There is limited research in middle income countries on factors associated with short term survival from CPR among older patients.

What this study adds?

Half of the older patients had ROSC and almost one-third survived to hospital admission. Administration of both amiodarone and lidocaine predicted the success rate of CPR among older adults. In contrast, those requiring more than12 minutes for ROSC had poor outcomes. The present study may provide some ideas in crucial decision-making for out of hospital cardiac arrest among older adults.

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Potential conflicts of interest

The authors declare no conflict of interests.

References

1. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, et al. Heart disease and stroke statistics—2013 update: a report from the American Heart Association. Circulation 2013;127:e6-245.
2. Tresch DD, Thakur RK, Hoffmann RG, Olson D, Brooks HL. Should the elderly be resuscitated following out-of-hospital cardiac arrest? Am J Med 1989;86:145-50.
3. Swor RA, Jackson RE, Tintinalli JE, Pirrallo RG. Does advanced age matter in outcomes after out-of-hospital cardiac arrest in community-dwelling adults? Acad Emerg Med 2000;7:762-8.
4. Sauter TC, Iten N, Schwab PR, Hautz WE, Ricklin ME, Exadaktylos AK. Out-of-hospital cardiac arrests in Switzerland: Predictors for emergency department mortality in patients with ROSC or on-going CPR on admission to the emergency department. PLoS One 2017;12:e0188180.
5. Chang WH, Huang CH, Chien DK, Su YJ, Lin PC, Tsai CH. Factors Analysis of Cardiopulmonary Resuscitation Outcomes in the Elderly in Taiwan. Int J Gerontol 2009;3:16-25.
6. Cooper S, Evans C. Resuscitation Predictor Scoring Scale for inhospital cardiac arrests. Emerg Med J 2003;20:6-9.
7. Neukamm J, Grasner JT, Schewe JC, Breil M, Bahr J, Heister U, et al. The impact of response time reliability on CPR incidence and resuscitation success: a benchmark study from the German Resuscitation Registry. Crit Care 2011;15:R282.
8. Statistical Forecasting Bureau National Statistical Office, Thailand. The 2014 survey of older persons in Thailand [Internet]. 2014 [cited 2017 Jan 27]. Available from: http://service.nso.go.th/nso/nsopublish/themes/files/elderlyworkFullReport57-1.pdf.
9. Funada A, Goto Y, Maeda T, Tada H, Teramoto R, Tanaka Y, et al. Prehospital predictors of neurological outcomes in out-of-hospital cardiac arrest patients aged 95 years and older: A nationwide population-based observational study. J Cardiol 2017;69:340-4.
10. Azlan N, Nidzwani S. Factors predicting outcome of cardiopulmonary resuscitation among elderly Malaysians: a retrospective study. Med J Malaysia 2012;67:278-83.
11. Ong ME, Shin SD, De Souza NN, Tanaka H, Nishiuchi T, Song KJ, et al. Outcomes for out-of-hospital cardiac arrests across 7 countries in Asia: The Pan Asian Resuscitation Outcomes Study (PAROS). Resuscitation 2015;96:100-8.
12. Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation. Circulation 2015;132:1286-300.
13. Department of Economic and Social Affairs United Nations, World population ageing 2017: highlights [Internet]. New York: United Nations; 2017 [cited 2018 Dec 21]. Available from: https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf.
14. Hiemstra B, Bergman R, Absalom AR, van der Naalt J, van der Harst P, de Vos R, et al. Long-term outcome of elderly out-of-hospital cardiac arrest survivors as compared with their younger counterparts and the general population. Ther Adv Cardiovasc Dis 2018;12:341-9.
15. van de Glind EM, van Munster BC, van de Wetering FT, van Delden JJ, Scholten RJ, Hooft L. Pre-arrest predictors of survival after resuscitation from out-of-hospital cardiac arrest in the elderly a systematic review. BMC Geriatr 2013;13:68.
16. Huang W, Teo GKW, Tan JW, Ahmad NS, Koh HH, Ong MEH. Influence of comorbidities and clinical prediction model on neurological prognostication post out-of-hospital cardiac arrest. Heart Asia 2018;10:e011016.
17. Xue JK, Leng QY, Gao YZ, Chen SQ, Li ZP, Li HP, et al. Factors influencing outcomes after cardiopulmonary resuscitation in emergency department. World J Emerg Med 2013;4:183-9.
18. Reynolds JC, Grunau BE, Rittenberger JC, Sawyer KN, Kurz MC, Callaway CW. Association between duration of resuscitation and favorable outcome after out-of-hospital cardiac arrest: implications for prolonging or terminating resuscitation. Circulation 2016;134:2084-94.
19. Bunch TJ, Hammill SC, White RD. Outcomes after ventricular fibrillation out-of-hospital cardiac arrest: expanding the chain of survival. Mayo Clin Proc 2005;80:774-82.
20. Ehlenbach WJ, Barnato AE, Curtis JR, Kreuter W, Koepsell TD, Deyo RA, et al. Epidemiologic study of in-hospital cardiopulmonary resuscitation in the elderly. N Engl J Med 2009;361:22-31.
21. Zoch TW, Desbiens NA, DeStefano F, Stueland DT, Layde PM. Short- and long-term survival after cardiopulmonary resuscitation. Arch Intern Med 2000;160:1969-73.