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ORIGINAL RESEARCH

Associated Factors of In-hospital Outcomes in Emergency Department's Cardiopulmonary Resuscitation; a Cross-Sectional Study

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Abstract: **Introduction:** Even though the basic principles of cardiopulmonary resuscitation (CPR) are simple, the patients' outcome remains inconsistent. This study aimed to investigate the CPR outcomes and associated factors in the emergency department. **Methods:** This cross-sectional study was conducted on patients who underwent in-hospital CPR following a cardiac arrest in the emergency department for one year. The patient's baseline characteristics and CPR outcomes were recorded from patients' profiles, and the association of patient-related and CPR-related variables with the outcomes was assessed. **Results:** 220 patients with a mean age of 71.5 ± 16.9 (range: 20-100) years were included (60.5% male). 193 cases of cardiac arrests had occurred in the hospital. Presenting cardiac rhythm in 198 cases (90.0 %) was asystole (not requiring defibrillation). The mean duration of conducted CPR was 43.2 ± 15.6 (5-120) minutes. Only 7 patients (3.2%) achieved the return of spontaneous circulation (ROSC) and were discharged from the hospital, with one suffering from neurological impairment due to CPR. There was a significant association between age (p = 0.047), consciousness status at admission (p = 0.003), presenting cardiac rhythm at CPR initiation (p = 0.0001), and establishment of ROSC under 45 minutes (p = 0.043) with patients' outcomes. Presenting cardiac rhythm at CPR initiation (p = 0.001), ROSC under 45 minutes (p = 0.012), and consciousness status at admission (p = 0.027) were independent predictive factors of survival. The area under the ROC curve for presenting cardiac rhythm and ROSC under 45 minutes was 0.817 (95% CI: 0.617-1.000) and 0.805 (95% CI: 0.606-1.000), respectively. **Conclusion:** Based on the present study's findings, the survival rate of patients after CPR in ED was 3.2%. Presenting cardiac rhythm, ROSC under 45 minutes, and consciousness status at admission was among the independent predictors of mortality.

Keywords: cardiopulmonary resuscitation; cardiac arrest; emergency department; survival; associated factors; outcome

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1. Introduction

Immediate initiation of cardiopulmonary resuscitation (CPR) is crucial to attaining favorable outcomes, such that every minute delay diminish the chance of survival to a great extent (1). Generally, two leading causes of cardiac arrest are cardiac disease and respiratory insufficiency (2). Traditionally, sudden cardiac arrest is defined as the failure of the heart to pump blood resulting in loss of circulation (3). For the past 60 years, chest compression generated by hands has been proven a practical intervention to restore blood flow to the vital organs, specifically the brain, as a life-saving intervention in cardiac arrest (4). Although more advanced

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extracorporeal CPR is utilized increasingly in developed countries, conventional CPR remains the primary strategy for cardiac arrest resuscitation in developing countries (5).

Notwithstanding the fact that the basic principles of cardiopulmonary resuscitation are simple, the patients' outcome remains inconsistent. Along with health provider and treatment procedure factors, patients' demographics and underlying clinical state are considered impactful. Studies demonstrated that physicians fail to accurately predict outcomes and overestimate survival in patients undergoing cardiopulmonary resuscitation (6, 7).

Even with achieving the primary goal of return of spontaneous circulation (ROSC), the survival of patients at discharge and 1-year-follow up is poor, with many survivors suffering neurological impairments due to anoxic brain injury (8, 9). International studies proved that survival rates vary between races and ethnicities (10). Fortunately, recent advances in treatment strategies significantly improved the survival rate, while some studies demonstrated non-significant changes in survival rate and outcomes (11, 12). For a better perspective, many authors have conducted studies examining parameters that contributed to CPR outcomes, and the results are not in line (13). Identifying the attributes and elements predicting the outcome has fundamental implications as it would help refine the CPR risk stratification and provide prospective to improve post-resuscitation care. This study aimed to investigate the CPR outcomes and associated factors in the emergency department.

2. Methods

2.1. Study design and setting

This cross-sectional study was designed through a retrospective chart review of patients who underwent in-hospital CPR following a cardiac arrest at Shohadaye Tajrish Hospital, Tehran, Iran, from September 22, 2016, to September 23, 2017 (1-year). Shohadaye Tajrish is a tertiary referral hospital affiliated with Shahid Beheshti University of Medical Sciences. The medical records of all patients admitted to our hospital were registered and documented on an electronic platform basis. For those transferred to the hospital by Emergency Dispatch Services, data regarding the patient's status at the scene and during the transportation to the hospital, along with all the treatments and procedures conducted, were documented as EMS operation records and attached to in-hospital patients' medical records. All the patients' medical chart data are recorded by authorized people, including Emergency physicians, Emergency Nurses, Paramedics, and Emergency Medical Technicians. Based on protocols devised by the hospital emergency department, the CPR procedure is conducted under the direction of Emergency Physicians as the team manager with the on-demand cooperation of Internal medicine Physicians, anesthesiologists, Emergency Room nurses, and surgeons.

2.2. Participants

All the patients who had received in-hospital CPR at Emergency Department (ED) from September 22, 2016, to September 23, 2017 (1-year) were included in the study. The available patients' data were collectively 220 for the study period. Patients who were found deceased by the Emergency Physician at admission and before the initiation of CPR and those with corrupted or incomplete data were excluded. No age restriction was applied to the participants, although most patients admitted to our hospital were adults.

2.3. Data gathering

A comprehensive list of patients who had in-hospital CPR was collected from the Shohadaye Tajrish medical records database. Based on emergency triage protocol, patients who received CPR were assigned routinely and prospectively by a defined code in the hospital registry system. The authors extracted data regarding the variables defined for this study through a case record review of patients who received the defined code for CPR. The variables could be categorized into two domains: patient-related and CPR-related variables. Patients-related variables were age, gender, consciousness status at admission, the location of sudden cardiac arrest, comorbidities (cerebrovascular disease (CVD), hypertension (HTN), Diabetes Mellitus (DM)), habitual history of smoking, alcohol consumption and drug addiction, and lastly, length of hospital stay. CPR-related variables were witnessed arrest, presenting cardiac rhythm, treatments used during CPR, times of conducted CPR during the hospital stay, and CPR duration. Patient notes were reviewed thoroughly by the two authors, and in the cases of discrepancies, a third author (an emergency physician) was consulted.

2.4. Outcome

The study outcomes were Return of Spontaneous Circulation (ROSC), mortality, and neurological impairments in discharge.

2.5. Statistical analysis

Data were analyzed using SPSS version 22. The findings were reported as mean ± standard deviation or frequency (%). The association between CPR and patients' related variable with mortality were evaluated using univariate and multivariate logistic regression analysis. $P < 0.05$ was considered as significant. The area under the receiver operating characteristic (ROC) curve of independent predictors of CPR mortality was calculated and represented with 95% confidence interval.

Table 1: Association of patients and CPR-related variables with in-hospital outcome of patients underwent CPR in emergency department

Variable	Overall	Deceased (213)	Survived (7)	P value
Age (year)				
< 50	28 (12.7)	28 (13.1)	0 (0.0)	
50-70	66 (30.0)	61 (28.6)	5 (71.4)	0.047
> 50	126 (57.3)	124 (58.2)	2 (28.6)	
Gender				
Male	133 (60.5)	128 (60.1)	5 (71.4)	0.606
Female	87 (39.5)	85 (39.5)	2 (28.6)	
comorbidity				
cardiovascular	92 (48.1)	88 (41.3)	4 (57.1)	0.404
Hypertension	118 (53.6)	113 (53.1)	5 (71.4)	0.337
Diabetes Mellitus	56 (25.5)	52 (24.4)	4 (51.7)	0.050
Location of first cardiac arrest				
In hospital	193 (87.7)	187 (87.7)	6 (85.7)	0.869
Out of hospital	27 (12.3)	26 (12.2)	1 (14.3)	
Consciousness status at admission				
Conscious	53 (24.1)	48 (22.5)	2 (28.6)	0.003
Unconscious	167 (75.9)	165 (77.5)	5 (71.4)	
Presenting cardiac rhythm				
Un-shockable*	198 (90.0)	196 (98.0)	2 (28.6)	<0.001
Shockable (VF, VT)	22 (10.0)	17 (8.0)	5 (71.4)	
CPR duration (minutes)				
<45	78 (35.5)	73 (34.3)	5 (71.4)	0.043
≥45	142 (64.5)	140 (65.7)	2 (28.6)	
Witnessed arrest				
Yes	209 (95.0)	203 (95.3)	6 (85.7)	0.252
No	11 (5.0)	10 (4.7)	1 (14.3)	

Data are presented as frequency (%). CPR: cardio-pulmonary resuscitation, VF: ventricular fibrillation, VT: ventricular tachycardia, *: asystole and pulseless electrical activity.

2.6. Ethical considerations

This study was conducted in compliance with the ethical standards of the responsible institution on human subjects as well as with the Helsinki Declaration. Due to the study's retrospective nature, the patients' consent form was waived by the institution's ethical committee. The study protocol was approved by the Ethics committee of Shahid Beheshti University of Medical Sciences (Ethics code: IR.SBMU.RETECH.REC.1400.887).

3. Results

3.1. Demographics

220 patients met the inclusion criteria for this study. The mean age of included patients was 71.5 ± 16.9 (range: 20-100) years (60.5% male). 126 patients (57.3 %) were classified as above 70 years old. 193 cases of cardiac arrests had occurred in the hospital. For the remaining 27 cases where the initial cardiac arrest happened out of the hospital, 16 cases (59.3 %) were witnessed arrest.

Presenting cardiac rhythm in 198 cases (90.0 %) was asystole (not requiring defibrillation). The demographic data of all patients are summarized in table 1.

3.2. Patients' outcomes

The mean duration of conducted CPR was 43.2 ± 15.6 (5-120) minutes. 172 patients (78.2%) underwent CPR only once, 44 patients (20.0%) twice, and lastly, 4 patients (1.8%) thrice. Only 7 patients (3.2%) achieved the return of spontaneous circulation (ROSC) and were discharged from the hospital, with one suffering from neurological impairment due to CPR. The association between underlying patient features and factors is available in table 1. Based on univariate analysis test findings, there was a significant association between age (p = 0.047), consciousness status at admission (p = 0.003), presenting cardiac rhythm at CPR initiation (p = 0.0001), and establishment of ROSC under 45 minutes (p = 0.043) with patients' outcomes. Presenting cardiac rhythm at CPR initiation (p = 0.001), ROSC under 45 minutes (p = 0.012), and consciousness status at admission (p = 0.027) were independent predictive factors of survival based on multivariate logistic regression analysis. The area under the ROC curve (AUC) for presenting cardiac rhythm and ROSC under 45 minutes in the prediction of patients' outcomes was 0.817 (95% CI: 0.617-1.000) and 0.805 (95% CI: 0.606-1.000), respectively (figure 1).

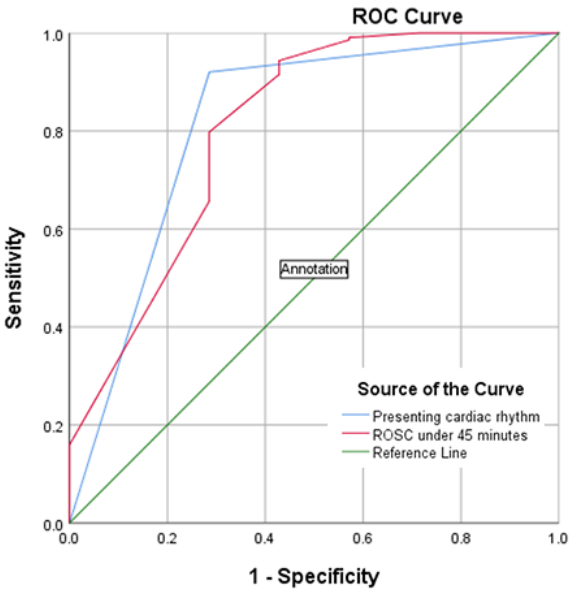

Figure 1: The area under the ROC curve for presenting cardiac rhythm (0.817) and ROSC under 45 minutes (0.805) in predicting the patients' in-hospital outcomes.

4. Discussion

Based on the present study's findings, the survival rate of patients after CPR in ED was 3.2%. Presenting cardiac rhythm, ROSC under 45 minutes, and consciousness status at admission was among the independent predictors of mortality.

It is noteworthy that since our institution is a tertiary referral hospital, most admitted patients suffer from multiple comorbidities and severe illnesses and injuries. However, our findings highlight implementing continuous training programs to enhance the practitioners' knowledge regarding cardiopulmonary resuscitation and ensure sustained delivery of high-quality CPR, which is vital for improving patients' survival (14, 15).

While some studies reported conflicting results regarding the outcome of CPR among genders, we didn't find any difference in our study (16-19). The reason may be the study's sample size, which is not sufficient to draw such a conclusion.

Presenting cardiac rhythm, ROSC under 45 minutes, and consciousness status at admission were among the independent predictors of mortality. Shockable presenting rhythms (VT or VF) due to their immediate response to defibrillation, have a better outcome than un-shockable rhythms in CPR (20-22). Maria Høybye et al., in a large observational study derived from the Danish IHCA registry, reported that pulseless electrical activity has a higher chance of ROSC among un-shockable rhythms than asystole. However, the difference in survival rate after hospital discharge is not sustained (23). On the other hand, despite the significant increase in the survival of all patients, especially with a shockable rhythm, some studies showed that the overall proportion of patients with an initial shockable rhythm has decreased (17, 24-26).

ROSC under 45 minutes was found as an independent associated factor of survival in in-hospital CPR. The inference from previous observational studies among patients suffering from in-hospital cardiac arrest was that survivors had ROSC early on CPR (27, 28).

Goldberg et al. shed light on the interpretation of previous data by emphasizing that deciding to terminate CPR when ROSC does not occur early on may be misleading for practitioners since high-risk patients, especially those with unshockable cardiac rhythm, require longer CPR attempts. This conclusion was based on comparing survival rates of multiple hospitals with a different mean duration of conducted CPR (20). Chung-Ting Chen et al. reported that younger patients seemed to substantially benefit from prolonged CPR attempts when they retrospectively reviewed the survival rate of in-hospital CPR (16). So, based on our study results, a cut-off point beyond which CPR has to be terminated cannot be solely made. Adherence to local institutional guidelines on CPR and optimal bedside individualized clinical judgment is warranted (29, 30).

Our results demonstrated that decreased consciousness status at admission is associated with a poor survival rate. One significant sequela of CPR among survivors is the permanent neurological impairment resulting from neuronal hypoxia and subsequent damage during the resuscitation. In our study, one of seven discharged survivors suffered from neurological impairments. We hypothesize that pre-existing neurological injuries manifesting with altered mental status contribute to poor outcomes after CPR since they are more prone to superimposed neuronal damage during CPR. New advances in post-resuscitation care, such as lowering the metabolism by imposing hypothermia and applying sedative drugs, were promising in preventing neurological disabilities following CPR (31, 32).

However, the disadvantage of such therapies is the decrease in the reliability and validity of neurological examinations after CPR (33, 34). So, we offer to perform a brief but comprehensive neurological examination before and during the CPR to detect those patients who may not benefit from prolonged CPR attempts while selecting those who may exploit prompt and advanced post-resuscitation care to mitigate neurological sequela.

We believe our result would help address the caveats concerning patients' survival during and after CPR. Although the physicians should not only rely on the independent variables of survival prognosis during CPR, our results make them have a better clinical judgment about individual patients. These

would help them to prevent futile therapeutic attempts while providing clues to devise better care strategies during and post-resuscitation.

5. Limitation

This study is a single-center cross-sectional study with a limited sample size conducted before the Covid-19 pandemic, which should be considered when results are interpreted. Due to the lack of pediatric patients in our sample size, the results cannot be generalized to other age groups. We didn't survey the survival of patients after discharge, and further studies should address this issue. Only patients who underwent CPR in the emergency department are investigated in this study. The survival rate and associated factors of patients who underwent CPR in wards and intensive care units may differ from our study results.

6. Conclusion

Based on the present study's findings, the survival rate of patients after CPR in ED was 3.2%. Presenting cardiac rhythm, ROSC under 45 minutes, and consciousness status at admission was among the independent predictors of mortality.

7. Declarations

7.1. Acknowledgments

None.

7.2. Authors' contributions

SS and MMF: Conception and design of the work
SS: Analysis and interpretation of findings
MB: Data gathering and analysis
SRD: Drafting the work and revising it critically for important intellectual content
SS, MMF, MB, and SRD: Read and approved the final version and accountable for all aspects of the work

7.3. Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

7.4. Funding and supports

The study was funded by Proteomix Research Center, Shahid Beheshti University of Medical scinces, who played no role in the study design, data collection, data analysis, or writing the manuscript.

7.5. Conflict of interest

None of the authors has any conflict of interest to declare.

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