Trauma Mon. 2016 February; 21(1): e31796. doi: 10.5812/traumamon.31796

Published online 2016 February 6. **Research Article**

A Prospective Study of Survival After In-Hospital Cardiopulmonary Resuscitation and its Related Factors

Sedigheh Miranzadeh,[1] Mohsen Adib-Hajbaghery,[1,*] and Nadimeh Hosseinpour[1]

[1]Trauma Nursing Research Center, Kashan University of Medical Sciences, Kashan, IR Iran

*Corresponding author: Mohsen Adib-Hajbaghery, Trauma Nursing Research Center, Kashan University of Medical Sciences, Kashan, IR Iran. Tel: +98-3155540021, Fax: +98-3155546633, E-mail: adib1344@yahoo.com

Received 2015 July 25; **Revised** 2015 September 30; **Accepted** 2015 November 17.

Abstract

Background: Despite several studies, there is no agreement on factors that affect survival after in-hospital cardiopulmonary resuscitation (CPR).

Objectives: This study aimed to evaluate the survival rate of in-hospital CPR and its related factors at Shahid Beheshti hospital in Kashan, Iran, in 2014.

Patients and Methods: A descriptive study was conducted on all cases of CPR performed in Kashan Shahid Beheshti hospital during a 6-month period in 2014. Through a consecutive sampling method, 250 cases of CPR were studied. A three-part researcher-made instrument was used. The outcome of CPR was documented as either survival to hospital discharge or unsuccessful (death of the patient). Chi-square test, t test, and logistic regression analysis were used to analyze the data.

Results: Of all CPR cases, 238 (95.2%) were unsuccessful and 12 (4.8%) survived to hospital discharge. Only 2.6% of patients who were resuscitated in medical units survived to hospital discharge, whereas this rate was 11.4% in the emergency department. Only 45 (18%) patients were defibrillated during resuscitation; in 11 patients, defibrillation was performed between 15 to 45 minutes after the initiation of CPR. The mean time from initiation of CPR to the first DC shock was 13.93 ± 8.88 minutes. Moreover, the mean duration of CPR was 35.11 ± 11.42 minutes. The survival rate was higher in the morning shift and lower during the time of shift change (9.4% vs. 0). The duration of CPR and speed of arrival of the CPR team were identified as factors that predicted the outcome of CPR.

Conclusions: The survival rate after in-hospital CPR was very low. The duration of CPR and the time of initiating CPR effects patients' outcomes. These findings highlight the crucial role of an organized, skilled, well-established and timely CPR team.

Keywords: Cardiopulmonary Resuscitation (CPR), Survival Rate, Iran

1. Background

As a basic skill, cardiopulmonary resuscitation (CPR) is one of the greatest innovations in the history of medicine. It is a quick intervention for preventing or postponing death in patients who suffer sudden cardiac arrest (1).

Each year, 200,000 cases of in-hospital cardiac arrest (2, 3) and approximately 370,000 to 750,000 cases of in-hospital CPR are recorded in the United States (US) (4). According to the American heart association (AHA), the survival rate would be up by 50% if advanced life support is delivered within 3 to 5 minutes of cardiac arrest from ventricular fibrillation. However, the chance of recovery decreases by 7% - 10% for each minute delay in providing defibrillation (1).

Since 1960 when Kouwenhoven introduced external cardiac compression, there have been many advances in resuscitation techniques, drugs, and skills of medical teams (1, 2). However, the rate of survival has not changed significantly over the past 40 years (5). Reports of survival after in-hospital resuscitation range from 7% to 26% (5, 6). The survival rates even vary across departments of an institution (7). Although studies on the rate of survival after in-hospital resuscitation are not directly comparable across countries and surveys because of differences in research methods and the definitions used, the overall survival rate seems to be low (1, 2). For instance, one US study reported a survival rate of 14.7%, whereas a United kingdom (UK) study mentioned a 16.7% survival (8). However, in another British study, Simon Cooper et al. reported that although the immediate success rate of in-hospital CPR was 38.6%, the rate decreased to 24.7%, 15.9%, and 11.3% after 24 hours, survival to hospital discharge, and survival after 12 months, respectively (9). In another study in Turkey, Pembeci et al. reported an immediate success rate of 49.3%, and a subsequent decrease to 28.5% and 13.4% after 24 hours and to hospital discharge, respectively (7). The survival rate was 17% in the largest resuscitation study that investigated 14,720 cases of in-hospital CPR (10). In 2005, Adib-Hajbaghery et al. studied survival after in-hospital CPR in Kashan, Iran, and reported that although patients' short-term survival was 19.9%, only 5.3% survived to hospital discharge (11).

A number of factors affect the outcome of CPR (1). Studies showed that patients' underlying diseases, age and gender, time since the onset of cardiac arrest, duration of CPR, existence of trained staff, needed supplies, and an efficient communication system, quality of resuscitation interventions, and an effective organization and leadership affect the outcome of CPR. A shortcoming in any of these factors can affect the outcome of resuscitation (9, 12-16). In 2010, the European Resuscitation Association guidelines emphasized the importance of immediate basic life support and early defibrillation (17). In a 10-year study in England, Cooper et al. reported that patients' cardiac rhythm immediately before cardiac arrest is an important predictive variable for CPR success. According to Cooper et al., the survival rate had an inverse relationship with increased age and duration of CPR. The chance of CPR success was lower during night shifts however, patients' gender and rapid starting of basic life support (BLS) were associated with the outcome of CPR (9).

Rakic et al. also confirmed that the rate of survival after in-hospital CPR was higher among younger patients, those who were hospitalized in coronary care units, those who had a witnessed arrest, those who were resuscitated during morning shifts, and patients with a ventricular fibrillation (VF) or pulse less ventricular tachycardia (VT) immediately before cardiac arrest (5). Pembeci et al. also studied 134 CPR cases in a Turkish university hospital and reported that prompt starting of resuscitation and presence of an experienced CPR team and necessary equipment can positively affect the survival to discharge following a cardiac standstill (7). Adib-Hajbaghery et al. reported that the duration of CPR, time of cardiac arrest, time from cardiac arrest to initiation of CPR, and defibrillation within the first few minutes of cardiac arrest were the key predictors of survival to hospital discharge after in-hospital resuscitation (11).

2. Objectives

Despite various studies, there is no agreement on the factors that affect survival after in-hospital resuscitation. This study aimed to evaluate the rate of survival after in-hospital CPR and its related factors at Shahid Beheshti hospital in Kashan, Iran.

3. Patients and Methods

A prospective descriptive study was conducted on all cases of CPR performed at Kashan Shahid Beheshti hospital from July to December 2014. Through a consecutive sampling method, 250 cases of in-hospital CPRs performed in patients 18 years or older were assessed.

A three-part researcher-made instrument was used. The first part included seven questions on demographics (i.e., patient's code, date of admission, age, gender, ward, medical diagnosis, and history of other co-morbidities). The second part consisted of seven questions about the resuscitation (i.e., date and time of arrest, time from arrest to announcing a CPR code, time of arrival of the resuscitation team, airway access time, duration of intubation, the time the first direct current (DC) shock was delivered, and duration of CPR). The third part of the instrument consisted of questions on interventions applied during CPR, the outcome of CPR, availability of resuscitation supplies, and condition before the restoration.

Content validity of the instrument was confirmed by a panel of 10 experts in Kashan's faculty of nursing and midwifery. Reliability of the instrument was assessed using the inter-observers method. The third author and a trained co-researcher were present during 10 cases of CPR and completed the instrument for these 10 patients simultaneously. The observers' agreement coefficient was found to be 99.5%.

The third author and three other trained co-researchers collected data for this study. Each observer was present at a fixed shift. Whenever a CPR code (code 99) was announced at the hospital, the observer who was present at the hospital immediately presented at the scene (bedside), observed the activity of the CPR team, and documented all the needed information. A revival of the code was considered a new case. The outcome of CPR was documented as successful or unsuccessful (death of the patient). Thereafter, each case of successful CPR was followed and the outcome was documented as death or survival to hospital discharge.

A successful CPR was defined as restoration of the heart rhythm observable on the monitoring system or return of a palpable pulse.

3.1. Ethical Considerations

The study protocol was approved by the research council and the research ethics committee at the Kashan University of Medical Sciences (No. 9367).

3.2. Statistical Analysis

Statistical analysis was performed using SPSS version 13. Chi-square test was used to evaluate the effects of qualitative variables (i.e., gender, having a co-morbidity, ward, presence of an airway before cardiac arrest occurred, and work shift) and the outcome of CPR. A t test was used to examine the effect of quantitative variables (age, time from arrest to announcing a CPR code, time spent for intubation, time of arrival of the resuscitation team, time of the first DC shock, and duration of resuscitation) on the outcome of CPR. Logistic regression was used to identify significant predictors of survival. A P value of < 0.05 was considered statistically significant.

4. Results

During the study period, 250 CPRs were performed for 223 patients. Among the 223 patients, 124 (55.6%) were males. The mean age of patients was 69.53 ± 14.16 years (Table 1). We found no significant association between either age or gender and survival rate (Table 2).

Table 1. Demographics of the Study Population

Variable	Values[a]
Age	69.53 ± 14.16
Gender	
Male	124 (55.6)
Female	99 (44.4)
Having other co-morbidities	
Yes	185 (83)
No	38 (17)
Medical diagnosis	
Neurological	28 (12.6)
Cardiac	43 (19.3)
Pulmonary	32 (14.35)
Renal	29 (13)
Cancer	34 (15.25)
Trauma	19 (8.5)
Other	38 (17)
Ward	
Medical	100 (44.8)
Surgical	12 (5.4)
Intensive care unit	68 (30.5)
Emergency department and para-clinic	43 (19.3)

[a]Data are presented as No. (%) or mean ± SD.

Of all cases of CPR, 238 (95.2%) were unsuccessful and 12 (4.8%) survived to hospital discharge. A majority of resuscitation attempts (19.3%) were performed for patients with cardiac diseases. Furthermore, 44.8% of the CPRs were performed in medical units. Only 2.6% of patients who were resuscitated in medical units survived to hospital discharge, whereas this rate was 11.4% in the emergency department (ED).

The mean time from cardiac arrest to announcing a CPR code was 1.21 ± 1.80 minutes. Moreover, the mean time from cardiac arrest to arrival of the CPR team (response time) was 2.29 ± 2.40 minutes (range, 0 - 15 minutes). In 93.6% of cases, the CPR team presented at the patient's bedside in 0 - 5 minutes, whereas in 16 cases, it took the team more than 5 minutes to arrive. In 178 (71.2%) patients, there was an artificial airway before the occurrence of cardiac arrest. In the 50 patients without an airway, a tracheal tube was inserted in less than 5 minutes after cardiac arrest; however, in nine cases, it took more than 5 minutes for tube insertion. The mean time spent for tracheal intubation was 11.21 ± 6.88 seconds (range, 2 - 30 seconds). Results of the t test showed no significant difference in the time of announcing a code (P = 0.283) or in the time spent for tracheal intubation (P = 0.097) between patients who survived to discharge and those with an unsuccessful CPR (Table 2). However, the time of arrival of the resuscitation team was significantly different between patients who survived to discharge and those with an unsuccessful CPR (P = 0.002; Table 2).

Table 2. Relationship Between Related Factors and Outcome of CPR[a,b]

Variables Resuscitation	Outcome		P Value
	Survival to discharge	Unsuccessful	
Gender			.798
Male	6 (4.5)	128 (95.5)	
Female	6 (5.2)	110 (94.8)	
Shift			.189
Morning	6 (9.4)	58 (90/6)	
Evening	3 (4.7)	61 (95.3)	
Night	3 (3)	96 (97)	
Between shifts	0	23 (9.7)	
Ward			.107
Medical	3 (2.6)	111 (97.4)	
Surgical	0	15 (100)	
ICU, CCU, Dialysis	4 (5.2)	73 (94.8)	
Emergency department And Para-clinical	5 (11/4)	39 (88.6)	
Airway present before CPR			.003
Yes	4 (2.2)	174 (97.8)	
No	8 (88.9)	64 (11.1)	
Time of the first DC shock			.62
No shock	11 (5.4)	194 (94.6)	
15 min	1 (2.9)	33 (97.1)	
15 - 45 min	0	11 (100)	
CPR history			.081
Yes	3 (2.4)	121(97.6)	
No	9 (7.1)	117 (92.9)	
Having other co-morbidity			.00
Yes	5 (2.5)	199 (97.5)	
No	7 (15.2)	39 (84.8)	
Age, y	64.92 ± 11.82	69.72 ± 14.41	.258
Time from arrest to announcing a CPR code, min	0.67 ± 1.61	1.24 ± 1.80	.283
Time spent for intubation, s	7.38 ± 2.92	11.62 ± 7.05	.097
Time of arrival of the resuscitation team, min	1.08 ± 1.08	2.35 ± 2.43	.002
Time of the first DC shock, min	5 ± 0	14.14 ± 8.88	.315
Duration of resuscitation, min	25 ± 9.77	35.62 ± 11.27	.003

Abbreviations: CCU, Coronary care unit; ICU, Intensive Care Unit.
[a]The level of significance was tested using Chi-square test or t test.
[b]Data are presented as No. (%) or mean ± SD.

Table 3. Predictors of Survival to Hospital Discharge

Parameter	B	SE	95% Confidence Interval		Exp B	P Value
			Lower	Upper		
CPR duration	0.121	.037	1.049	1.214	1.129	.001
Response time	0.557	.268	1.032	2.955	1.746	.038
History of previous CPR	−2.033	.820	0.026	0.654	0.131	.013
Having other co-morbidities	−2.311	.718	0.024	0.405	0.099	.001
Constant	4.994	NA	NA	NA	NA	.004

Abbreviations: Exp B, Exponentiation of the B coefficient; NA, not available; SE, Standard Error.

Only 45 patients (18%) received DC shocks during resuscitation; 34 received the DC shock in less than 15 minutes, whereas 11 received it between 15 and 45 minutes after the initiation of CPR. The mean time from initiation of CPR to the first DC shock was 13.93 ± 8.88 minutes. Moreover, the mean duration of CPR was 35.11 ± 11.42 minutes. Time of receiving the first DC shock was not significantly different between patients who survived to discharge and those with an unsuccessful CPR (P = 0.315); however, the duration of CPR was significantly different between patients who survived to discharge and those with an unsuccessful CPR (P = 0.003; Table 2).

Furthermore, 25.6% of all CPRs were performed during the morning shift, 25.6% during the evening shift, 39.6% during the night shift, and 9.2% during the time of shift change (Table 2). However, the survival rate was higher in the morning shift and lower for the time of shift change (9.4% vs. 0).

Logistic regression analysis showed that duration of CPR and the speed of arrival of the CPR team can positively predict the outcome of CPR (Table 3).

5. Discussion

The rate of survival to hospital discharge was 4.8% in the present study. This rate is lower when compared with rates reported in previous studies. The rate of survival to discharge after in-hospital CPR has not changed significantly in the past 40 years (18), with values ranging from 7% to 26% (6). In a large study, which included 14,720 cases of CPR, 17% of patients who underwent in-hospital CPR were survived to discharge (10). Ehlenbach et al. also studied 433,985 cases of in-hospital CPR performed for older adults; the rate of survival to discharge was 3.18% and did not change over 13 years (6). A study in Kashan has reported a survival rate of about 5.3% (11). The differences in survival rates across different studies might be related to several factors such as differences in the definitions of survival and differences in the populations and the settings. However, it seems that the survival rate in our setting has decreased to some extent over the past decade. Such a decrease might be attributed to the vast changes not only in the management of the hospital, but also to the rapid and extensive turnover among the nursing and medical staff, and the higher ages of patients in the present study.

In this study, although no significant relationship was found between shift work and the survival rate, the survival to discharge was obviously higher in the morning shift. Consistent with the present study, Kaernested et al. (19), Herlitz et al. (14), and Boyde et al. (20) also reported that survival after in-hospital resuscitation was higher in the day and morning hours. Rakic et al. also reported that the survival rate was relatively lower in the night shift (5). However, Peters et al. in Australia studied the same issue and reported that the survival rate was higher in the evening shift (21). Perhaps, factors such as early detection of cardiac arrest due to the existence of more nurses and physicians, as well as quick access to physicians and experienced staff in morning, may be a reason for this difference. On the other hand, as the study revealed, no patients survived to hospital discharge when the cardiac arrest occurred around shift change. Perhaps, the delay to diagnosis of cardiac arrest and the delay in CPR interventions are responsible for the poor prognosis of CPR at this time slot. Therefore, special policies should be established to prevent the delay in CPR at the time of shift change.

In this study, the survival rate was not associated with either the time of using DC shock or the time from arrest to announcing a CPR code. New resuscitation guidelines emphasize on early CPR and early defibrillation (17). The negative aftermath of delayed defibrillation has been reported in several studies (15, 17, 19, 22). However, consistent with our results, some of the studies have emphasized on the positive effect of early presence of an expert or an experienced CPR team on the time of defibrillation (23). Therefore, it can be concluded that rapid arrival of a skilled and organized CPR team is a crucial factor in the success of CPR. An experienced CPR team can diagnose shock-able arrhythmias and can use the DC shock on time and appropriately. Although most patients in the present study had a cardiac problem, a majority of them had additional co-morbidities, and this might have negatively affected the effectiveness of DC shocks.

In the present study, a significant relationship was found between the survival rate and the duration of CPR. This finding was consistent with the results of some previous studies (8, 9). Adib-Hajbaghery et al. reported that no patients survived to discharge with CPR lasting more

than 60 minutes (11). Perhaps, as Adib-Hajbaghery et al. reported, the duration of CPR might reflect the severity of disease, the response time of the CPR team, the quality of CPR, and the progressive decline in the cerebral blood flow (11).

In the present study, although no statistical relationship was found between the patients' survival and the ward in which the CPR was performed, a higher survival rate was observed in patients resuscitated in the ED. This finding was consistent with results of Kayser et al. (24), and might be a reflection of the effect of the underlying disease on the outcome of CPR. Patients in EDs are usually acute cases, whereas those in medical units usually have sub-acute or chronic disorders. Many of patients in medical units are aged and have several co-morbidities that can decrease the prognosis of CPR. On the other hand, EDs are usually better equipped and have more skilled staff, and cardiac arrest is also diagnosed earlier in these units. All these variables might contribute to the better outcome of CPR in EDs.

Logistic regression analysis showed that the duration of CPR and the speed of arrival of the CPR team could positively predict the outcome of CPR. At the same time, having a history of being resuscitated during present hospitalization and having additional co-morbidities had negative effects on the outcome of CPR.

In conclusion, this study showed that the survival rate after in-hospital CPR was relatively low.

Acknowledgments

The authors thank the Research Deputy of the Kashan University of Medical Sciences for providing the grant. The authors are indebted to the authorities at the Kashan Faculty of Nursing and Shahid Beheshti Medical Center who cooperated in the study.

Footnotes

Authors' Contribution: Study concept and design: Mohsen Adib-Hajbaghery, Nadimeh Hosseinpour, and Sedigheh Miranzadeh; data collection and preparing the first draft of the manuscript: Nadimeh Hosseinpour, Mohsen Adib-Hajbaghery; data analysis and critical revisions of the paper for important intellectual content, and supervision the study: Mohsen Adib-Hajbaghery.

Funding/Support: Research Deputy of the Kashan University of Medical Sciences supported this study (grant number: 9367).

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