Outcomes of Cardiopulmonary Resuscitation and Its Predictors in Hospitalized Patients

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1. Background

Cardiopulmonary resuscitation (CPR) has been a frequently performed medical intervention that increases the chance of survival of a person suffering from cardiac arrest, and there is an excellent value of diversity in the rate of successful rehabilitation in societies.

According to the American Heart Association, nearly 95% of the sudden cardiac death cases, die before they reach the hospital and if after cardiac arrest, CPR did not provide, for every one minute delay in starting the CPR, 7 - 10 percent increases in the risk of death (5). Today, cardiopulmonary resuscitation can be done in two components of CPR including basic life support (BLS) and advanced life support (ALS) (6). With the above explanations, one of the greatest challenges in performing CPR is the time to start, so that even a minute delay at resuscitation reduces the likelihood of success. The importance of time is such that, when CPR begins with a delay of 10 minutes, brain death will occur despite the success of heart.
resuscitation (7). Any major issue in prognosis and outcomes in cardiac arrest is the location of the patient at the time of CPR, time of starting CPR, underlying disease, initial electrocardiogram (EKG) rhythm, proper defibrillation and most importantly the quality of CPR (8).

Though performing CPR has made substantial progress in recent years, there are limited data on the outcomes of CPR from low and middle-income countries (8-11). Thus, various settings and resources in low and middle-income countries have the potential to affect the eventual outcome of CPR (12).

2. Objectives

This study aims to determine the possible success rate of CPR in patients who had a cardiac arrest at a referral hospital in Southwestern Iran, as well as providing a conceptual framework based on CPR outcomes.

3. Methods

Study design and population: This retrospective study analyzed the medical records of all in-hospital and out-hospital cardiac arrest patients who underwent CPR during two years between January 2017 and June 2018, using forms designed by the Ministry of Health for recording CPR data (checklist 1). The Ethical Committee of National Ahvaz Jundishapur University of Medical Sciences approved this study of. Successful CPR defined by patients that have a return of spontaneous circulation (ROSC) after CPR, subjects alive for more than 24 hours, and those who had survived to discharge (13).

3.1. Setting

This trauma and cardiovascular center hospital was a 660-bed facility with an Emergency Department (ED) comprising of 50 monitored beds and two resuscitation beds. During the study period, more than 80,000 patients underwent either emergency department visits or were admitted to the hospital, of which 578 patients either present with cardiac arrest or go into arrest during a hospital stay.

3.2. Inclusion Criteria

Young adult, middle age and old patients (age >10 years) who had sustained either an in- or out-of-hospital cardiac arrest and were brought to the ED for treatment, or those who underwent CPR between January 2017 and June 2018 anywhere in the hospital.

3.3. Exclusion Criteria

Patients who were reported dead on hospital arrival, those with an advanced directive of no CPR (NCPR), or those with missing records or incomplete data were excluded.

3.4. Data Collection

The information including demographic information, the ward which CPR was performed, hospitalization, the delay before the onset of CPR, time of the day, were obtained. According to the American Heart Association, successful resuscitation or ROSC is defined for all rhythms as the restoration of an impressive spontaneous rhythm that results in more than an occasional gasp, short palpated pulse, or arterial wave form. Indeed when CPR causes the patient’s heart rate to return spontaneously, it is called a successful CPR.

3.5. Statistical Analysis

To compare the difference of the seasons, we compared the number of patients and the success rates of CPR in different seasons of the year. The mean and standard deviations were used to describe qualitative variables from frequency and percentage. For data analysis, simple logistic regression was used. The data were analyzed using SPSS version 21.0 (IBM SPSS Statistics for Windows, version 21.0. Armonk, NY: IBM Corp), and P < 0.05 was considered significant.

4. Results

The first set of analyses examined the number of people who were receiving CPR based on gender. Overall, 587 CPR operations were carried out on 361 men (61%), 231 women (39%), of which 152 (25.89%) were successful and 435 other operations (74.1%) were unsuccessful. There was no significant difference (P = 0.271) in the success rate of CPR between men and women (Table 1, Figure 1). The mean age of patients who underwent CPR was 59 ± 22 years, of which 31 cases (5.5%) were 10 to 14 (young adult classification), and 264 (46.6%) were over the age of 14 to 64 (middle age classification), and 271 (47.9%) were above 64 years old (old classification). There was a significant difference between CPR in three age groups 10 to 14 years old, 14 to 64, and older than 64 (P = 0.003). The comparison of age groups revealed a significant difference only between the success rate of CPR in the age group of 14 - 64 with the group above 64 (P = 0.002).

The results indicated 186 (31.7%) CPR were performed in the spring with 30.3% success rate, in the summer in
Table 1. Population and Event Characteristics

| Characteristic | Successful, No. (%) | Unsuccessful, No. (%) | Total, No. (%) | P Value |
|---------------|---------------------|-----------------------|----------------|---------|
| Gender        |                     |                       |                |         |
| Male          | 87 (57.2)           | 271 (62.3)            | 358 (60)       | 0.271   |
| Female        | 65 (42.8)           | 164 (37.7)            | 229 (39)       |         |
| Total         | 152                 | 435                   | 587            |         |
| Age           |                     |                       |                |         |
| 10 - 14       | 7 (4.8)             | 24 (5.7)              | 31 (5.5)       | 0.002   |
| 14 - 64       | 85 (57.8)           | 179 (42.7)            | 264 (46.6)     |         |
| ≥ 64          | 55 (37.4)           | 218 (31.6)            | 273 (47.9)     |         |
| Season        |                     |                       |                |         |
| Spring        | 46 (30.1)           | 140 (92.4)            | 186 (31.7)     | 0.495   |
| Summer        | 25 (16.4)           | 51 (17.7)             | 76 (12.9)      |         |
| Autumn        | 21 (13.8)           | 69 (15.9)             | 90 (15.3)      |         |
| Winter        | 60 (39.5)           | 175 (40.2)            | 235 (40)       |         |
| Total         | 152                 | 435                   | 587            |         |
| Location      |                     |                       |                |         |
| Inside the hospital | 137 (92.6)     | 409 (94.2)            | 546 (93.8)     | 0.466   |
| Out of hospital | 11 (7.4)        | 25 (5.8)              | 36 (6.2)       |         |
| Total         | 148                 | 434                   | 582            |         |
| Shift         |                     |                       |                |         |
| Morning       | 51 (33.6)           | 100 (23)              | 151 (25.7)     | 0.037   |
| Afternoon     | 32 (21.3)           | 108 (24.8)            | 140 (23.9)     |         |
| Night         | 69 (45.4)           | 227 (52.2)            | 296 (50.4)     |         |
| Total         | 152                 | 435                   | 587            |         |
| Ward          |                     |                       |                |         |
| Emergency ward | 57 (38.5)         | 212 (49)              | 269 (46.3)     | 0.041   |
| General ward  | 71 (48)             | 185 (42.7)            | 256 (44.1)     |         |
| Intensive care unit | 36 (8.3)      | 20 (13.5)             | 56 (9.6)       |         |
| Total         | 148                 | 433                   | 581            |         |
| Witness       |                     |                       |                | 0.9     |
| Present       | 36 (87.8)           | 115 (85.8)            | 151 (86.3)     |         |
| Not present   | 5 (12.2)            | 19 (14.2)             | 24 (13.7)      |         |
| Total         | 41                  | 134                   | 175            |         |

76 (12.8%) cases with a 16.4% success rate, in the autumn in 90 (15.2%) case with 13.8% success rate and finally in the winter in 235 (40%) cases with a 39.5% success rate. According to the results, most of the patients were in winter, and the highest percentage of success was in the same season; however, data analysis revealed no significant difference between CPR success rate in various seasons. Since the climatic conditions of the study area are tropical and there are practically no distinct four seasons, another analysis was performed comparing the first six months of the year (hot months) with the second six months of the year (colder months). The second analysis shows no significant differences.

Following this, the results of the site of CPR showed that 94.2% of cardiac arrests happened in the hospital, albeit there were no significant differences between CPR success rates between outside and inside the hospital (Table 1). Investigating the occurrence of cardiac arrest and its success rate at hospital shifts showed a significant difference in the CPR success rate in three different shifts (P = 0.037). Using the LSD follow-up test, we compared shifts, which showed a significant difference between the success rate of CPR in the morning shift with the evening shift (P = 0.034) and night (P = 0.017). Also, there was no significant difference between the success rates of CPR operation in the evening shift with night shifts.
Investigating the CPR in different sites of the hospital revealed that of the 581 operations carried out, 269 operations (46.3%) were carried out in the emergency department, 256 other operations (44%) in the general wards and 56 cases (9%) in intensive care units, and in six cases, the site that the CPR was taking place was not reported. The analysis results showed a significant difference in the rate of CPR success rate on different sites ($P = 0.041$). The dual comparison revealed a significant difference in the success rate of CPR only between the emergency department and intensive care units ($P = 0.023$).

The presence of a witness (therapist) at the moment of the cardiac arrest showed that of 175 cases, the witness in the 152 cases was at the patient’s bedside, and about 24 cases, there were no witnesses. Data analysis revealed that was no significant difference between the success rates of CPR operation in the presence of the witness and the absence of the witness ($P = 0.09$).

It is necessary to mention that several recording forms of recovery have not been filled, and we have lost some data. In the age variable, 20 forms, in the witness 412 forms, in ward six and the location 5 forms were incomplete.

In summary, these results show that in the current study, the difference in age, wards, and shift were significant.

5. Discussion

The present study was designed to determine the effect of different practical factors on the CPR success rate, which showed that resuscitation was not significantly different between men and women. The results of this study are compatible with the findings of previous work in Iran, China, and America, which reported that the CPR success rate is not affected by the gender of the patients (10, 14-16). Another important finding was that the success rate of CPR in the age group of 14 - 64 was higher than that of the group above 64 years. This finding confirms the association between aging and the success rate of CPR, reported in previous studies (17, 18). In contrast, another study on the association between the age and survival after cardiac arrest at the outside of the hospital reported that although age is related to the survival of people after cardiac arrest, however, age alone does not predict the outcome of CPR and is,
in fact, a poor indicator of survival (19).

Interestingly, a group of researchers examined the relationship between high and low air temperatures and outside hospital cardiac arrest with a heart attack cause. The results of the study indicated that the occurrence of cardiac arrest outside the hospital is associated with low air temperature. Also, cardiac arrest in people aged 80 years or older was associated with high air temperatures (20). Contrary to expectations, this study did not find a significant difference between CPR success rates at distinct seasons.

The prevalence of outside the hospital cardiac arrest is more than 300,000 people in the United States per year and is the third leading cause of death, and an evaluated 290,000 in-hospital cardiac arrests happen each year in the United States (21, 22). Moreover, the in-hospital mortality rate after cardiac arrest was reported at the level of 81.6% in Great Britain (23), 77.7% in the United States (24), 74% in Poland, 95% in Italy (25) and 70% in Sweden. In the present study, in-hospital and out-hospital mortality rates after cardiac arrest were 74.9 and 69.4%, respectively. Further, it can be said that we have similar results with the articles mentioned above.

Although the shortage of human resources and fatigue of therapists in the night shift affects the delivery of optimal services and have been addressed previously, no data was found on the association between working shift and the success of CPR and the quality of services (26, 27). Contrary to expectations, the current study finds a significant difference between CPR success rate and work shifts although, some studies have reported a relationship between long working hours and reverse outcomes in health care (28, 29).

As shown in Figure 2, the peak of cardiac arrest occurred at 3 a.m. and 4 p.m. Several studies on the circadian clock revealed a link between the pathogenesis of heart disease in response to adverse stress, such as ischemia/reperfusion and cardiomyocytes circadian clock (30, 31).

Further statistical tests revealed that there is a significant difference in the success rate of CPR only between the emergency department and intensive care units in the current experiment. Although it was not possible to investigate the significant relationships of different wards on the success rate of CPR, several issues were identified that the percentage of survival after CPR in ICUs is higher than in emergencies (32). However, various studies have acknowledged that advanced life support is provided by the cardiac arrest team, and the appropriate and correct use of a defibrillator is an essential factor in patients’ survival (33, 34).

However, there have been no sufficient controlled studies that compare differences in the effects of the presence or absence of witnesses at the moment of cardiac arrest. The results of this study did not show any significant increase in CPR success rate in the presence of witnesses. It is explained by the fact that there is not a complete record of the presence or absence of witnesses at the moment of cardiac arrest in the majority of CPR forms and need to be further explored in the future. Although information about the effects of the presence of a witness in the moment of cardiac arrest is limited, a study in 2013 reported that in-hospital cardiac arrest had a higher chance of survival after discharge in the presence of the witness, comparable ones with monitoring and revealed that monitored cases had a lower rate of survival to hospital discharge (35).

5.1. Limitations

The time interval for CPR announcement to start operations in all registries reported as zero. Of course, this claim is a matter of debate, and we report it as a limitation of the current study.

5.2. Conclusions

The current study is the first epidemiological study of cardiac arrest at this center. The results of this study did not show any significant increase in the success rate of CPR in the presence of witnesses, location of cardiac arrest, season, and gender. Despite the differences in cases and diagnosis of the disease and the reason for hospitalization, the main factors contributing to the success rate of CPR were age, work shift, and hospital wards. However, we need to explain the probable background diseases, past medical history, and, most importantly, the quality of CPR factors that influence CPR success in future reviews.

Supplementary Material

Supplementary material(s) is available here [To read supplementary materials, please refer to the journal website and open PDF/HTML].

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Figure 2. Prevalence of arrest by the hour of occurrence.

Footnotes

Authors’ Contribution: Encouraged to investigate and supervised the findings of this work: Meysam Moezzi; helped supervise the project: Fakher Rahim; developed the theory, wrote the manuscript: Golshan Afshari; help in analytic calculations: Meysam Alavian; entry of information in Excel: Maryam Banitorfi and Nasrin Fatemi; analyzed the data: Saeed Hesam.

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13. APPENDIX 1 - Color Key to ACC/AHA Management Guidelines: Estimate Multidisc Cardio Annal. 2021; 12(1):e104654. 7

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