

Impact of Cardiopulmonary Resuscitation Duration on Survival of Out-of-Hospital Cardiac Arrest

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Abstract

Background: Patients experiencing cardiac arrest outside medical facilities are at greater risk of death and might have negative outcomes. Cardiopulmonary resuscitation duration affects survival of such patients, which suggests that duration of CPR may be vital to patient outcomes.

Objectives: The study aims to evaluate the impact of cardiopulmonary resuscitation duration on survival of patients who have suffered out-of-hospital cardiac arrest.

Methods: Data were collected from emergency cases handled by a secondary hospital in industrial Jubail, Saudi Arabia, between 2015 and 2020. There were 257 out-of-hospital cardiac arrest cases, 236 of which resulted in death.

Results: Bivariate analysis showed no significant association between duration of CPR, gender, and cause of death whereas there is statistically significant between duration of CPR and age ($p = 0.014$). Hence, the results revealed that death was more likely in elderly patients. The mean and standard deviation for the duration of emergency CPR procedures specifically in surviving patients were 26.5 ± 7.20 min, whereas in patients who died after the procedure, the mean and standard deviation for the duration of CPR were 29.6 ± 9.15 min. The mean age and standard deviation in surviving patients were found to be 38 ± 18.59 years, and 49.4 ± 23.39 years for those who died.

Conclusion: Cardiopulmonary Resuscitation Duration out-of-hospital cardiac arrest does not significantly influence the patient survival in the current study hospital. Other variables may have a more significant effect.

Introduction

Out-of-hospital cardiac arrest (OHCA) is among the leading causes of death and is a vital public health issue globally. OHCA is a worldwide problem affecting about 55 of every 100,000 people (Rhee et al., 2020). Lai et al. (2018) defined cardiac arrest as the “sudden cessation of heartbeat and the abrupt loss of cardiac mechanical activity in a person who may or may not have been diagnosed with heart disease, confirmed by the absence of a detectable pulse and unresponsiveness of apnea” (p. or para. #). Reynolds et al. (2016) found that over 356,000 people experience a sudden OHCA annually in the united states. Survival is related to different OHCA factors, including CPR duration, age, gender, and whether one is a medical or trauma patient.

The implementation of CPR guidelines appears to have improved patients' survival rates after an OHCA. According to Larribau et al. (2018), CPR guidelines are updated every 5 years, with the gradual improvement in treatment leading to the doubling of survival rates for shockable and non-shockable OHCA's over the past 3 decades. Prompt intervention and CPR are critical for survival and minimizing neurological damage in patients experiencing OHCA's (Mathiesen, et al., 2018). Thus, CPR is vital for increased chances of survival.

Research about the optimal CPR duration for patients with OHCA has presented different results concerning survival. Nehme et al. (2016) stated that resuscitation guidelines recommend continuous CPR efforts to hospitals for OHCA witnessed by EMS personnel. The study explored the impact of CPR duration on the survival of paramedic-observed OHCA. The authors determined that the median CPR duration was 12 min overall but the duration was higher in nonsurvivors than in survivors (24 min versus 2 min; Nehme et al., 2016). Therefore, Nehme et al. concluded that resuscitation efforts exceeding 32 min resulted in a less than 1% survival rate for EMS-witnessed OHCA. A similar study by Matsuyama et al. (2017) determined the median CPR duration was 25 min and concluded that the survival rate and the number of patients with desirable results were reduced with increasing CPR durations. However, the researchers determined that some OHCA patients could benefit from prolonged CPR of less than 30 min.

Other studies have also examined the link between promising results and the resuscitation period. For instance, Reynolds et al. (2016) explored the association between resuscitation duration and favorable outcomes after OHCA. They found that for a CPR duration up to 37 min, 99% of patients achieved a return of spontaneous circulation (ROSC). The authors concluded that a shorter CPR duration is related to the higher likelihood of desirable outcomes at hospital discharge. However, patients with favorable health traits were more likely to survive prolonged CPR up to 47 min. Hara et al. (2015) indicated that OHCA results differed based on the period between initial CPR and first recorded rhythm. Thus, shortening the time to initial CPR is critical for improving OHCA outcomes.

Gender also significantly affects the survival rate. Rhee et al. (2020) determined that the survival rate in male patients was 13.7% higher than in females. Age affects survival rates significantly, and Rhee et al. indicated that the survival rate for patients aged 7–18 years is highest at 30.7% and declines with age. Huang et al. (2021) explored the impact of age on survival by observing two age groups, below and above 75 years, and found a significant difference between survival to hospital discharge by age ($p = 0.006$ and $p < 0.001$, respectively). Huang et al. explained that old age is a poor prognosticator of OHCA outcomes and indicated that the odds ratio for poor outcomes is 1.97 for individuals aged 60–80 years and 8.97 for those over 80 years.

Furthermore, the odds ratio for a 1-year survival rate following OHCA is 0.96 for every additional year. Consequently, Huang et al. (2021) postulated that different comorbidities of medical OHCA patients, such as hypertension, diabetes, liver disease, stroke, renal disease, and respiratory disease, affect the survival rate. Fukuda et al. (2016) determined that stroke-related OHCA patients have better chances of prehospital ROSC than OHCA patients with a presumed cardiac etiology but a reduced chance of 1-month survival or desirable results. The authors also affirmed that having a younger age and shockable initial documented rhythm were related to an improved survival rate and that men have a more favorable survival rate and better outcomes than women.

The discussion above has shown the effects of CPR duration, age, gender, and medical or trauma status on survival rates. The studies presented similar findings concerning age, medical status, and gender, but the results regarding the optimal number of minutes of CPR duration differed between studies. However,

the investigations affirmed that shortening the time to initial CPR is critical for improving OHCA outcomes and that younger male individuals with no underlying issues have higher survival rates than their female counterparts. Finally, the available studies demonstrated mixed findings and the biggest challenge for a physician is deciding when to terminate CPR in OHCA. No study has been performed in Industrial Jubail, Saudi Arabia, to determine the impact of CPR duration and the demographic factors on OHCA survival rates. Moreover, this study aimed to investigate and determine the influence of gender, age, CPR duration, and medical status on survival rates at a secondary hospital in Industrial Jubail.

Research Methodology

Research Design

This research utilized a quantitative cross-sectional design to evaluate the impact of CPR duration on survival or death after OHCA. The primary endpoint was survival to hospital discharge.

Study Setting

This research was carried out in Jubail, Saudi Arabia, at a secondary hospital with an approximately 200-bed capacity. The institution has eight ambulances and offers care for various groups of patients who are critically ill and require comprehensive stabilization. About two to three prehospital cardiac arrest incidents occur each month; the attending EMS will request assistance and initiate efforts aimed at resuscitating a patient in collaboration with other members of the team. According to American Heart Association guidelines, when providing CPR, the EMS in charge is required to fill out a CPR form and ensure that it is duly completed after the event.

Study Participants

This study included only the patients' OHCA data. Both pediatric and adult patients of both genders were included.

Variables

The dependent variables assessed in this study included patient outcomes such as death or OHCA survival. The independent variables assessed in this study included patients' demographic data, such as gender and age, and the duration of CPR measured in minutes until the ROSC was achieved in prehospital settings or after hospital admission.

Data Collection

The hospital's electronic medical database was retrospectively utilized to collect the participating patients' data; this was important because it provided easy access to important demographic data and patient outcome information. The cardiac arrest cases sampled in this study were reported between 2015 and 2020.

Procedure and Timeline

The assessment of patient outcomes—death or survival—was done at hospital discharge. Data were gathered during a 2-month period between January and February 2021.

Ethics and Limitations

Ethical approval was obtained by from the Institutional Review Board at Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia (IRB-PGS-2021-03-048) and the Institutional Review Board at Royal Commission Hospital, Industrial Jubail, Saudi Arabia (IRB-RCH-013). The medical chart research was carried out confidentially without the exposure of any of the participants' personal information.

Analysis

To determine and illustrate a descriptive summary of the findings, such as means, frequencies, and standard deviations, a univariate analysis was performed. Additionally, a bivariate analysis was carried out to evaluate the association between CPR duration and the rate of survival or death using the χ^2 test. This test was preferred because the outcome variable was categorized as either survival or death, whereas the independent variables included gender, the duration of CPR measured in minutes, and the participant's age. IBM SPSS Statistics (Version 25) (IBM Corp, 2017) was utilized to carry out the analysis.

Results

A total of 257 patients were shortlisted for this study, 184 (71.6%) were males, and the remaining 73 (28.4%) were females. The mean and standard deviation of the patients' age was years (age range was 7 to 94 years). The overall mean and standard deviation of the duration of cardiopulmonary Resuscitation (CPR) was found to be minutes (with an actual range from 9 to 60 minutes). The majority of the patient's OHCA were caused by medical causes ($n= 144, 56\%$); In contrast, the remaining OHCA incidents were attributed to traumatic causes ($n= 113, 44\%$). The characteristics of the patients are summarized in **Table 1**.

Table.2 shows that the majority of the CPR procedure resulted in the patient's death ($n= 236, 91.8\%$), and only 21 (8.2%) of the patients survived. There is a very large and negative difference between death and survival outcome associated with CPR procedure in the study setting.

Analyzing the general outcome of the CPR procedure, it is clear that a very small proportion of females survived the medical procedure ($n= 4, 5.5\%$ of all females with OHCA), compared to a vast majority of females who died while CPR was being administered ($n= 69, 94.5\%$). The results for males in terms of proportionality were figuratively better than those of females but not statistically significant, with a P-value of 0.321 (alpha of 0.05). The results showed 9.2% (17) of males survived, but 90.8% (177) of all males died even with the administration of CPR. Although the gender of the patient is not statistically

significant to their survivor status, the odds of survival for males is 1.756 higher than females (95% CI= 0.570-5.407) (**Table.2**).

Similarly, when comparing the proportion of survivals of OHCA caused by medical conditions and traumatic conditions, it was clear that CPR was less likely to be effective when the patient's OCHA was caused by natural medical conditions ($n= 9$, 6.3% of all OCHA caused by medical conditions). Although, the difference in the proportion of survivability was not statistically significant given the p-value for the assessment was greater than the alpha of 5%. However, the odds ratio show that CPR procedure is almost twice as effective in patients with OHCA caused by trauma compared to patients with OHCA caused by a medical condition (OR= 1.782, 95% CI=0.723-4.392) (**Table.2**).

The mean and standard deviation for the duration of CPR emergency procedure specifically in survived patients were minutes; while in patients who died after the procedure the mean and standard deviation for the duration of CPR were minutes. The mean age and standard deviation in survived patients were found to be years, and for those who died, years old. An independent samples t-test was run to determine whether the differences between the two means of CPR duration for patients who survived and died were statistically significant. The results indicate no statistically significant difference given , but there was a statistically significant difference ($P = 0.014$) between the mean age of survivors and those who died. Hence, the results revealed that death was more likely in elderly patients (**Table 2**).

Discussion

Because cardiac arrest continues to cause a significant number of deaths in Saudi Arabia, it is important to investigate the effectiveness of CPR procedures in saving the lives of affected individuals. To achieve that goal, this study on the effects of CPR on survival rates outcomes, together with the existing literature, offers insights concerning the termination of the medical procedure. The study aimed to investigate the impact of CPR duration on survival or death to demonstrate the survival rate for cardiac arrest patients. This was achieved through the utilization of a qualitative cross-sectional design to assess the impact of CPR duration on survival outcomes.

The dependent variables assessed in this study included cardiac patients' outcomes such as death or survival after OHCA. This study found that a majority of the CPR procedures resulted in the patients dying, 236 (91.8%), versus surviving, 21 (8.2%). The results revealed a high likelihood of death among elderly patients after the administration of CPR. This study also found that the mean age and standard deviation of patients who survived were 38 ± 18.59 years, whereas those who died were older, 49.4 ± 23.39 years old. The majority of patient deaths, 144 (56%), were associated with medical causes; in contrast, the remaining 113 (44%) deaths were attributed to traumatic causes. The results revealed a significant negative difference between outcomes of death and survival associated with the CPR procedure.

Similarities in research findings revealed low survival rates among elderly patients with preexisting medical conditions expose patients to adverse cardiac events that impact the duration of survival.

Conditions that may affect survival results irrespective of CPR duration include sepsis, hypotension, hepatic dysfunction, pneumonia, and malignancy. Al-Mulhim et al. (2019) agreed that preexisting medical conditions substantially impact health outcomes among cardiac arrest patients. Trauma patients showed the worst results after a minute of compressions as the CPR duration increased. However, Matos et al. (2013) found that children and adults in cardiac intensive care units have higher survival rates compared to those in noncardiac units. Cardiac patients can survive hypoxic conditions and low-flow associated with an arrest.

The independent variable analyzed during the study was the duration of CPR measured in minutes until achieving a ROSC. The overall mean and standard deviation of CPR ranged from 9 to 60 min. The standard deviation of CPR duration was 26.5 ± 7.20 min for surviving patients and 29.3 ± 9 min for patients who died. The research findings revealed that health care institutions that incorporate resuscitation for a short duration reported higher survival rates among OHCA patients.

Similarities in results indicate that a shorter CPR duration increases patient survival rates. Scott et al. (2015) found that children with respiratory-induced arrest had a higher chance of survival when exposed to a shorter CPR duration. Matos et al. (2013) indicated 15 min as the accepted cutting point. Cheema et al. (2019) found that on average, CPR lasted 19.68 min. Consequently, CPR duration is a vital survival determinant among cardiac arrest patients. Xue et al. (2013) added that patients who survived had lower CPR durations than patients who died before discharge. Welbourn and Efstathiou (2018) alluded that outcomes are good in patients who achieve a ROSC after shorter periods. Patients who show early signs of a ROSC exhibited higher survival rates compared to their counterparts who exhibited later signs. Shorter CPR durations were reported as leading to favorable outcomes among in-hospital cardiac arrest patients.

Differences in results revealed that prolonged CPR resulted in worse survival outcomes among patients. Welbourn and Efstathiou (2018) noted that OHCA patients facing longer periods before CPR commencement experienced extreme hypoxia and severe brain injury from reperfusion. Cheema et al. (2019) agreed that longer CPR durations worsen patient outcomes by reducing survival rates. According to Matos et al. (2013), a longer CPR duration affects survival due to prolonged inhibited blood flow to the brain. Matos et al. further reported that extended CPR increases shallow compressions to the chest and excess leaning force, causing profound brain and heart perfusion. Trauma patients showed the worst results as CPR durations increased. Xue et al. (2013) added that patients who survived were exposed to shorter CPR durations compared to patients who did not survive until discharge. Consequently, CPR epistemology generally points to neurological damages and reduced survival rates.

Conclusion

The administration of CPR on cardiac patients is critical for enhancing their survival. However, continuous chest compressions among out-of-hospital patients during emergency cases results in adverse patient outcomes.

This project's objective is to explore the overall effects of CPR duration on survival rates and outcomes after OHCA. I sought to answer the following research question: What are the survival rates and outcomes for cardiac arrest patients given CPR outside of a hospital? The research analysis indicates that shorter CPR durations invariably lead to greater chances of survival. Significantly, survival is also affected by the existence of preexisting conditions. This study's results also noted that longer CPR durations contribute to lower survival rates and additional adverse neurological outcomes in cardiac arrest patients.

Abbreviation

CPR	Cardiopulmonary Resuscitation
ROSC	Return Spontaneous of Circulation
OHCA	Out of Hospital Cardiac Arrest

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the college and hospital "attached". As the information used in this study does not include any identifying information from the patients; thus, a written consent from the patients was not required.

Consent for publication

I Hissah Albinali, hereby declare that I participated in the development of manuscript (**Impact of Cardiopulmonary Resuscitation Duration on Survival of Out-of-Hospital Cardiac Arrest**) and give my consent for the article to be published in the journal.

Availability of data and material

Attached.

Competing interests

The authors declare that there is no conflict of interest relevant to this work.

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Authors' contributions

Hissah Albinal , Arwa Alumran and Saja Alrayes contributed and reviewed this manuscript.

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Tables

Table 1: Demographic Characteristic of the study participants (n=257)

Variable	Frequency (%) / Mean ± SD
Gender	
Male	184 (72)
Female	73 (28)
Cause of Out of Hospital Cardiac Arrest	
Medical	144 (56)
Trauma	113 (44)
Age (years)	48.4 ± 23.2 (Range from 7 to 94)
Duration of CPR (minutes)	29.3 ± 9 (Range from 9 to 60)

Table 2: Association between Demographic Factors, Causes of Death, Duration of CPR, and Outcome

Variable	Outcome		Test statistic (P-value)	OR	95% CI
	Survive <i>n</i> = 21	Death <i>n</i> = 236			
Gender				1.756	0.570-5.407
Female	<i>n</i> = 4 (5.5%)	<i>n</i> = 69 (94.5%)	$\chi^2 = .985$ (0.321)		
Male	<i>n</i> = 17 (9.2%)	<i>n</i> = 167 (90.8%)			
Cause of death				1.782	0.723-4.392
Medical	<i>n</i> = 9 (6.3%)	<i>n</i> = 135 (93.8%)	$\chi^2 = 1.611$ (0.204)		
Trauma	<i>n</i> = 12 (10.6%)	<i>n</i> = 101 (89.4%)			
Duration of CPR (minutes)	Mean: 26.5±7.20	Mean: 29.6±9.15	<i>t</i> = 1.483 (0.139)	-	
Age (years)	Mean: 38±18.59	Mean: 49.4±23.39	<i>t</i> = 2.624 (0.014)	-	