ORIGINAL ARTICLE

Predictors of Mortality in Out-of-hospital Cardiac Arrest (OHCA) Patients: A Retrospective Cross-sectional Study from the Sultanate of Oman

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Abstract

Background: Out-of-hospital cardiac arrest (OHCA) is a significant global health challenge with high incidence and low survival rates; this study aimed to predict mortality in these patients.

Methods: This 5-year retrospective chart review, conducted at the emergency departments (EDs) of two tertiary hospitals, systematically categorized, coded, and analyzed variables to assess mortality risk in OHCA patients.

Results: Of the 822 (36.5%) patients who met the inclusion criteria, the mean age was 60.2 years (SD ± 17.6), with 65.7% being male. Cardiopulmonary resuscitation (CPR) was attempted on 586 patients, with 178 (30.4%) achieving return of spontaneous circulation (ROSC) in the ED. Significant risk factors for mortality included hypertension ($p = 0.01$), diabetes mellitus ($p = 0.05$), respiratory illnesses ($p = 0.04$), and having three or more comorbidities ($p = 0.01$). Manifestations in previous ED visits (<180 days), such as cardiac complaints ($p = 0.05$) and dyspnea due to fluid overload ($p = 0.02$), were significant. Among the cohort, 76.4% visited the ED (<180 days) and had a mortality rate of 95.7%, compared to 78.4% for those who did not visit. Asystole and pulseless electrical activity (PEA) were significant factors for the nonachievement of ROSC ($p < 0.001$ vs $p = 0.032$) and mortality ($p < 0.001$ vs $p = 0.03$). Overall, 49 patients (8.4%) survived to hospital discharge.

Conclusion: Elderly males with hypertension, diabetes, respiratory ailments, and multiple comorbidities constituted a significant risk group. Factors such as prior episodes of chest pain and fluid overload were associated with higher mortality. Patients with asystole and PEA had low survival rates.

Keywords: Cardiopulmonary resuscitation, Out-of-hospital cardiac arrest, Mortality, Survival to hospital discharge.

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Highlights of the Study

This study, conducted in the emergency department (ED) of two tertiary care centers, identified hypertension, diabetes mellitus, respiratory illnesses, and multiple comorbidities as significant predictors of mortality in out-of-hospital cardiac arrest (OHCA). Prior ED visits did not affect outcomes, whereas chest pain, fluid overload, and non-shockable rhythms were predictors of poorer outcomes.

Introduction

Out-of-hospital cardiac arrest is a significant global health challenge, characterized by high incidence rates and low survival outcomes.[1,2] Out-of-hospital cardiac arrest occurs when the heart stops beating outside a hospital setting, and requires immediate and coordinated intervention to improve survival chances.[1,2] The incidence of OHCA is alarmingly high worldwide and varies significantly across different regions. Understanding these variations is crucial for improving emergency response strategies.[2,3]

According to the Sudden Cardiac Arrest Foundation, OHCA is a leading cause of death globally, surpassing fatalities from conditions such as colorectal cancer, breast cancer, prostate cancer, influenza, and pneumonia.[4,5] Based on the American Heart Association Heart and Stroke Statistics—2022 Update, there were over 350,000 cases in the United States of America.[6] In Europe, the incidence of OHCA ranges between 350,000 and 700,000 cases annually, highlighting its extensive impact on public health.[7] The European Registry of Cardiac Arrest recorded 10,682 OHCA events in 1 month across 27 European countries, with 773 cases reported in Italy alone.[7,8] Data

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on OHCA incidence and outcomes in the Middle East are limited but revealing. A retrospective study from Qatar analyzed 4,283 adult nontraumatic OHCA cases, showing a high incidence among males (79.7%).[9] Bystander cardiopulmonary resuscitation (CPR) was provided in 34.2% of cases, with men receiving CPR more frequently than women.[9] Another study from Doha, Qatar, noted that out of 987 OHCA cases, women had a lower survival rate compared to men, although gender was not an independent predictor of mortality.[10] In Saudi Arabia, the incidence and outcomes of OHCA reflect broader regional trends, with survival rates remaining critically low. A study reported that the overall survival rate to hospital discharge was around 2.9%, significantly lower than in many Western countries.[11] The low survival rate highlights the critical need for enhanced public awareness, widespread CPR training, and increased access to automated external defibrillators (AEDs).

Sudden cardiac death is the primary cause of OHCA, accounting for over 75% of cases, predominantly due to acute coronary syndromes.[1,11,12] Other contributing factors include congenital cardiopathies, arrhythmias, and external factors such as trauma or drug overdose. Survival rates for OHCA vary significantly across different regions, reflecting the quality of emergency responses.[1,2,12] On a global scale, the average survival rate to hospital discharge after emergency medical services (EMS)-treated OHCA is approximately 8.8%.[13] Some regions, however, demonstrate better outcomes. For instance, Europe has a higher survival rate of around 11.7%, whereas in the Middle East, the rates range from 1.3 to 2.4%, highlighting considerable potential for improvement in emergency care.[3,9–11,13]

Research on OHCA in the Sultanate of Oman is limited, and this study focuses on predictors of mortality after OHCA that would provide valuable additions to the global literature on the subject.

Methodology

Study Design

This was a retrospective cross-sectional chart review study.

Setting

The study included patient data from the emergency departments (EDs) of two prominent tertiary care centers in Muscat, Sultanate of Oman: Sultan Qaboos University Hospital and the Royal Hospital. Both EDs, recognized at the platinum level, are integral parts of these hospitals and each serves over 40,000 adult patients annually, covering both medical and surgical cases.

Objectives

The rationale for this study stems from the recognition of consistently low survival rates to hospital discharge following OHCA incidents. The primary aim was to identify the clinical characteristics of patients with OHCA and explore their patterns of ED visits at the two mentioned hospitals in the period leading up to the cardiac arrest. Our objectives were to identify the most prevalent complaints and diagnoses reported during these visits, analyze the demographics and comorbidities of OHCA patients, and determine the association between the initial electrocardiogram (ECG) rhythm, return of spontaneous circulation (ROSC), and outcomes.

Participants

Adult patients aged 18 years or older who presented at the EDs of the mentioned institutes with OHCA were included in the study. Patients who arrived at the ED as "brought dead" without CPR were also included, unless they met any of the following exclusion criteria: receiving palliative care, having do-not-resuscitate (DNR) orders, experiencing trauma-related deaths, or lacking a registered national identity document (ID) number. We excluded individuals without a registered national ID number, as this prevented us from retrieving their original hospital files or records from each hospital's facilities. Many of these patients were listed as unknown, with no available age, comorbidities, or other data, making their inclusion in the analysis unfeasible. To maintain the study's primary objective, we excluded patients with pre-existing DNR orders or those whose OHCA resulted from trauma. Charts with duplicated data and in-hospital cardiac arrests were excluded.

Study Period

We conducted a thorough 5-year review of patient medical records from January 1, 2016, to December 31, 2020, based on the specified criteria.

Variables

Following the approval of each institute's research committee, requests were sent to the respective hospital medical record systems for data on patients diagnosed with cardiac arrest (ICD: I46), cardiac arrest due to an underlying cardiac condition (ICD: I462), cardiac arrest due to other underlying conditions (ICD: I468), respiratory arrest (ICD: R092), personal history of sudden cardiac arrest (ICD: Z8674), and cardiac arrest of unspecified cause (ICD: I469). The relevant variables were then extracted from each hospital's electronic data sheets. The data sheets contained a wide range of variables, including demographics such as age and gender, comorbidities, ED visit-related information, initial ECG at presentation, achievable ROSC in the ED, and survival to hospital discharge.

Data Source and Statistical Analysis

Clinical data from hospital electronic records were documented using Microsoft® Excel for Mac, Version 16.85.2. Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software, version 25.0.0.0, developed by SPSS Inc. in Armonk, New York, United States of America (USA). Quantitative variables were summarized using mean and standard deviation (SD), while qualitative variables such as gender and demographics were summarized using frequency and percentage. The time difference between the OHCA date and the ED visit date was calculated, and cases with a difference of more than 180 days were excluded. The Chi-square test assessed associations between demographics, clinical complaints at ED visits, CPR outcomes, and the initial ECG rhythm, with significance set at $p \leq 0.05$. Where applicable, multivariate logistic regression was employed for variables that showed significance in the bivariate analysis.

Ethical Considerations

Prior to commencing the research, ethical clearance was obtained from the Medical Research Committee at the College of Medicine and Health Sciences (CoMHS), Sultan Qaboos University (MREC#2151), and the Ministry of Health (MoH) (SRC#81/2020). Measures were taken to comply with ethical standards and protect patient privacy.

Results

During the study period, 2,251 cases of cardiac arrest were identified across both institutes, of which only 822 (36.5%) met the inclusion

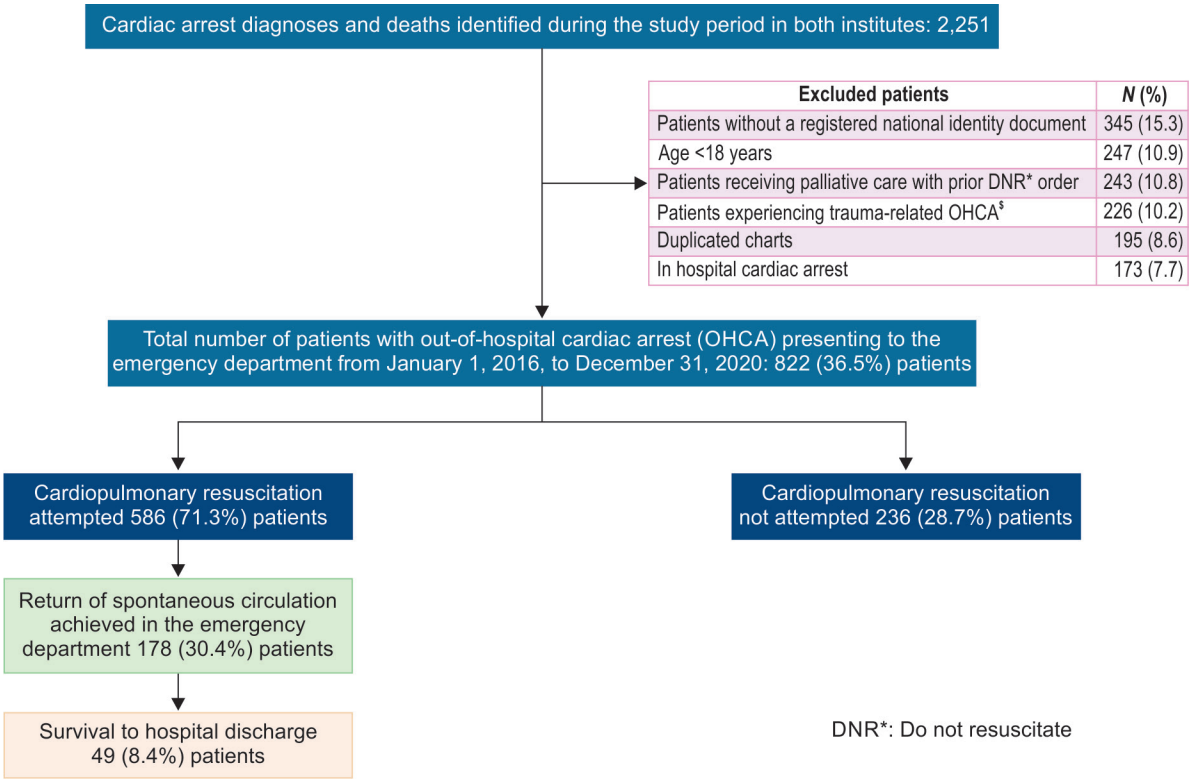

Fig. 1: STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) diagram

criteria (Fig. 1). Cardiopulmonary resuscitation was attempted on 586 patients, among whom 178 (30.4%) achieved ROSC in the ED. The mean age of the cohort was 60.2 years (SD ± 17.6), with males comprising 65.7% (540). Patients aged 50 years and above constituted 72.9% (599) of the cohort.

Table 1 illustrates the relationship between various comorbidities and mortality risk. Hypertension ($p = 0.01$, OR: 2.03, 95% CI: 1.19–3.43) and diabetes mellitus ($p = 0.05$, OR: 1.65, 95% CI: 1.01–2.72) showed statistically significant associations with mortality. Respiratory illnesses and having three or more comorbidities were also significant risk factors ($p = 0.04$ and $p = 0.01$, respectively). Other comorbidities did not show a statistically significant risk for mortality.

Table 2 presents the relationship between past ED-presenting complaints (within 180 days) and mortality risk after OHCA. Cardiac complaints such as left-sided chest pain and palpitations were significant risk factors ($p = 0.05$, OR: 4.78, 95% CI: 1.15–19.94). Dyspnea secondary to fluid overload from cardiac or kidney disease was also significant ($p = 0.02$, OR: 3.54, 95% CI: 0.33–0.88). Statistically nonsignificant presenting complaints during ED visits included various symptoms such as shortness of breath, fever, and others.

Table 3 outlines the relationship between ED visits within 180 days of OHCA, CPR attempts, and outcomes. Among 822 patients, 76.4% visited the ED, correlating with a mortality rate of 95.7%, compared to 78.4% mortality among those who did not visit the ED. Cardiopulmonary resuscitation influenced outcomes, with ROSC achieved in 28.1% of cases with an ED visit and 36.2% without an ED visit ($p < 0.01$, OR 2.12, 95% CI: 1.48–3.03 and $p < 0.01$, OR 0.47, 95% CI: 0.33–0.68, respectively).

Table 4 provides insights into the initial recorded ECG rhythm and its prediction for mortality. Asystole was prevalent in 72.2% of cases, significantly correlating with nonachievement of ROSC ($p < 0.001$) and mortality (unadjusted OR 4.99, adjusted OR 5.92, $p < 0.001$). Pulseless electrical activity (PEA) was noted in 22.9% of cases, with significant mortality rates ($p = 0.032$, unadjusted OR 2.06, adjusted OR 2.48, $p = 0.03$).

Overall, 49 patients (8.4%) survived to hospital discharge (Fig. 1).

Discussion

This study represents a pioneering effort in identifying predictors of mortality among OHCA patients from this country. Our cohort, averaging 60.2 years in age with a male predominance and 72.9% aged 50 years and older, aligns with global findings emphasizing the vulnerability of older adults to OHCA.[9,10,14] Older individuals are predisposed to OHCA due to a higher prevalence of comorbidities such as hypertension, diabetes mellitus, coronary artery disease, and heart failure, which independently predict mortality as observed in our study and consistent with previous literature.[15–18] Søholm et al. and Hirlekar et al. similarly identified preexisting heart disease and renal dysfunction as significant predictors of mortality.[19,20]

Structural and functional changes in the aging heart, including cardiomyopathies and altered electrical conduction coupled with a heavier burden of ischemic heart disease in older age-groups, elevate the risk of arrhythmias, acute coronary events, and ultimately, sudden cardiac arrest.[21–23] Aging diminishes cardiac reserve, impairs stress response mechanisms, and reduces organ function contributing to poorer outcomes compared to younger individuals.[21,22] Delayed recognition of atypical symptoms and

Table 1: Relationship between comorbidities and the risk of mortality after an out-of-hospital cardiac arrest

				Multivariate logistic regression analysis		
Variables	*Frequency 822 (%)*	*Mortality 753 (%)*	*Univariate analysis p-value*	*Unadjusted odds ratio (95%CI*)*	*Adjusted odds ratio (95%CI*)*	*Adjusted p-value*
Hypertension	389 (47.3)	342 (45.4)	0.01	2.03 (1.19–3.43)	0.68 (0.34–1.34)	0.27
Diabetes mellitus	322 (39.1)	284 (37.7)	0.05	1.65 (1.01–2.72)	0.97 (0.52–1.83)	0.92
Dyslipidemia	97 (11.8)	85 (11.3)	0.26	1.47 (0.76–2.86)	–	–
Ischemic heart disease	158 (19.2)	140 (18.6)	0.36	1.30 (0.74–2.30)	–	–
Arrhythmias	54 (6.6)	51 (6.8)	0.30	0.539 (0.16–.78)	–	–
Heart failure	103 (12.5)	92 (12.2)	0.67	1.16 (0.58–2.29)	–	–
Cerebrovascular disorders	84 (10.2)	79 (10.5)	0.24	0.572 (0.22–1.46)	–	–
Respiratory illnesses	92 (11.2)	78 (10.4)	0.04	1.89 (1.01–3.56)	0.82 (0.40 –1.67)	0.58
Renal diseases	154 (18.7)	135 (17.9)	0.18	1.47 (0.84–2.58)	–	–
Gastrointestinal diseases	13 (1.6)	11 (1.5)	0.46	1.78 (0.39–8.19)	–	–
Thyroid disorders	27 (3.3)	27 (3.6)	0.09	0.96 (0.95–0.98)	–	–
Malignancies (solid tumor)	39 (4.7)	37 (4.9)	0.34	0.50 (0.12–2.13)	–	
Hematological disorders	21 (2.6)	20 (2.7)	0.45	0.47 (0.06–3.55)	–	–
Peripheral vascular diseases	17 (2.1)	15 (2.0)	0.75	1.28 (0.29–5.69)	–	–
Two comorbidities	144 (17.5)	132 (17.5)	0.66	0.86 (0.45–1.65)	–	–
Three or more comorbidities	230 (27.9)	198 (26.3)	0.01	2.11 (1.28–3.49)	0.63 (0.32–1.26)	0.19

Here, the denominator was 822 patients, selected based on known comorbidities for calculation and subsequent statistical analysis. The Chi-square test was utilized to assess associations between comorbidities and risk of OHCA, with a *p*-value ≤ 0.05 considered significant. Multivariate logistic regression analyses were conducted for variables showing significance in the univariate analysis. CI*, confidence interval

Table 2: Relationship between past presenting complaints to ED (<180 days) and the risk of mortality after an OHCA

			Bivariate analysis	
Variables	*ED$^{\$}$ visit 628 (%)*	*Mortality 601 (%)*	*p-value*	*Unadjusted odds ratio (95% CI*)*
Cardiac complaints such as left-sided chest pain and/or palpitations and/or syncope and/or presyncope	66 (10.5)	64 (10.6)	*0.05*	4.78 (1.15–19.94)
Dyspnea secondary to fluid overload either due to underlying cardiac disease or kidney disease	195 (31.1)	189 (31.4)	*0.02*	3.54 (0.33–0.88)
Shortness of breath secondary to infective pathology and/or related to reactive airway disease and/or undetermined	176 (28.1)	171 (28.4)	0.85	0.95 (0.58–1.57)
Fever and/or other symptoms of sepsis	70 (11.1)	67 (11.2)	0.14	1.18 (0.87–6.91)
Gastrointestinal manifestations like abdominal pain and/or nausea/vomiting and/or epigastric pain	52 (8.3)	47 (7.8)	0.73	0.86 (0.37–1.98)
Fatigue, generalized body pain, and weakness	28 (4.5)	27 (4.5)	0.24	0.86 (0.52–28.80)
Other complaints such as back pain, injury-related issues, unilateral weakness of the body, or decreased urine output, etc.	41 (6.5)	36 (6.0)	0.49	0.53 (0.77–1.73)

Please note that these variables were documented in the medical charts and chosen for analysis, focusing on the predominant symptoms. Here, the denominator was set at 628 patients who had prior visits to the ED (<180 days) before an OHCA, forming the basis of our calculations and statistical analysis. The Chi-square test was utilized to evaluate associations between ED visits (<180 days) and the risk of mortality after OHCA, with a significance level at *p*-value ≤ 0.05. CI*, confidence interval

Table 3: Relationship between ED (<180 days) visits, resuscitation, and outcome after an OHCA

			Bivariate analysis	
Variables	*Patients n (%)*	*Mortality n (%)*	*p-value*	*Unadjusted odds ratio (95% CI*)*
Emergency department visit (<180 days)	628 (76.4)	601 (95.7)	0.01	0.40 (0.19–0.85)
No emergency department visit at our center	194 (23.6)	152 (78.4)	0.01	2.50 (1.18–5.32)
Cardiopulmonary resuscitation attempted was 586 patients	178 (30.4)	408 (69.9)	<0.01	74.76 (23.10–241.94)
Return of spontaneous circulation vs ED visit ($n = 423$; 67.4%)	119 (28.1)	304 (71.9)	<0.01	2.12 (1.48–3.03)
Return of spontaneous circulation vs no ED visit ($n = 163$; 84.1)	59 (36.2)	104 (63.8)	<0.01	0.47 (0.33–0.68)

The Chi-square test was used to evaluate associations between ED (<180 days) visits, resuscitation, and outcome after an OHCA, with a statistical significance set at a p-value ≤ 0.05. CI*, confidence interval

Table 4: Initial ECG rhythm at presentation to the emergency department and predictors of mortality

				Multivariate logistic regression analysis		
			Univariate analysis	*Unadjusted odds*	*Adjusted odds ratio*	*Adjusted*
Variables	*Frequencies n (%)*	*Mortality n (%)*	*p-value*	*ratio (95%CI*)*	*(95%CI*)*	*p-value*
Initial ECG rhythm and prediction of nonreturn of spontaneous circulation ($n = 408$; 69.6%)						
Asystole	423 (72.2)	329 (56.2)	<0.01	1.99 (1.39–2.84)	0.43 (0.29–0.62)	<0.01
PEA pulse	134 (22.9)	66 (11.3)	0.04	2.17 (1.02–4.58)	0.28 (0.13-0.61)	0.01
VT/VF^	29 (4.9)	13 (2.2)	0.48	1.22 (0.71–2.12)	–	–
Initial ECG rhythm and prediction of nonsurvival to hospital discharge ($n = 537$; 91.6%)						
Asystole	423 (72.2)	401 (68.4)	<0.001	4.99 (2.19–11.31)	5.92 (2.32–15.08)	<0.001
PEA pulse	134 (22.9)	129 (22.1)	0.032	2.06 (1.05–4.01)	2.48 (1.10–5.56)	0.03
VT/VF^	29 (4.9)	7 (2.2)	0.073	0.64 (0.39–1.05)	1.08 (0.57–2.02)	0.82

Initial ECG rhythms were recorded for patients for whom CPR was attempted. The Chi-square test was used to evaluate associations between initial ECG rhythm and predictors of mortality after OHCA, with a statistical significance set at a p-value ≤ 0.05. CI*, confidence interval; VT/VF^, ventricular tachycardia/ventricular fibrillation, PEA#, pulseless electrical activity

lower baseline health status further hinder timely intervention and survival postcardiac arrest.

Regarding presenting complaints at ED visits within 180 days preceding OHCA, our study identified cardiac symptoms such as left-sided chest pain, palpitations, and dyspnea secondary to fluid overload as significant predictors of mortality. These findings underscore the critical role of recognizing cardiovascular symptoms as indicators of poor outcomes postOHCA. Perry et al. and Reyaz et al. support these observations, highlighting the prognostic value of such symptoms in predicting mortality before cardiac arrest.[24,25] While our findings align with recent studies indicating challenges in predicting outcomes for elderly patient groups, it is noteworthy that our study also revealed a higher percentage of patients in the ED visit group achieving ROSC. Therefore, establishing rigorous outpatient follow-up or local health center protocols with clear red flags communicated to family members could significantly benefit in preventing such incidents through timely intervention and management.

The outcomes of shockable and non-shockable rhythms in achieving ROSC and survival to hospital discharge vary significantly. Shockable rhythms, such as ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT), are generally associated with higher rates of ROSC and survival compared to non-shockable rhythms like PEA or asystole.[26,27] Studies consistently show that prompt defibrillation and early intervention in shockable rhythms significantly improve outcomes, with ROSC rates often exceeding 50% and survival to hospital discharge rates ranging from 20 to 40%. In contrast, non-shockable rhythms present greater challenges, with lower ROSC rates and survival rates generally below 10–20%.[28,29] Asystole and PEA were identified as significant risk factors for failure to achieve ROSC and increased mortality, whereas VF and VT showed more favorable outcomes. It is important to note that our study did not account for variables such as the number of defibrillation attempts, medications used, airway protection, and other adjuncts, which could influence outcomes.

The American Heart Association (AHA) provides comprehensive guidelines aimed at improving survival rates from OHCA.[30] Factors influencing survival to hospital discharge include timely recognition of cardiac arrest, prompt initiation of CPR emphasizing quality (bystander/EMS), early defibrillation in shockable rhythms during OHCA.[30] After achieving ROSC, survival outcomes significantly depend on the patient's physiological state, quality of postcardiac arrest care, and various inpatient factors. Our study revealed a hospital discharge survival rate of 8.4%, consistent with rates observed in other developed nations.

Limitations of the Study

Being a retrospective study, there may be some missing data, which is a limitation of our research. We were unable to determine the quality of CPR, whether administered by bystanders or EMS, as it varied. The initial rhythm at the time of arrest could not be determined in some cases. Additionally, details regarding the number of shocks delivered to each patient in cases of VT/VF were unavailable. Our study included only patients who visited the two EDs; therefore, it is possible that some patients visited other health facilities. Some patients might have received epinephrine injections outside the hospital when resuscitated by expert EMS and may have been intubated. All these factors could have influenced the final

outcomes. However, despite these limitations, we do not believe that the study's overall results were significantly affected.

Strength of the Study

This study is one of the first from this country to predict the factors influencing the outcomes of OHCA. It aims to assist both EMS systems and physicians in better understanding and improving patient outcomes. Although retrospective, it draws on a substantial dataset from the EDs of two large hospitals, lending robustness and reliability to the findings. By excluding patients treated post-COVID pandemic, the study avoids potential biases related to the virus and its impact on OHCA scenarios. Furthermore, the study's credibility is enhanced by the direct supervision of the CPR chairperson of the institute, adding an extra layer of oversight and expertise.

Conclusion

Our study provides valuable insights into the predictors of mortality among OHCA patients, focusing particularly on older adults with significant comorbidities. Analyzing presenting complaints preceding OHCA, such as cardiac symptoms and dyspnea secondary to fluid overload, underscores the prognostic importance of symptom recognition. The distinction between shockable and non-shockable rhythms in achieving ROSC and survival highlights the critical role of timely defibrillation and advanced life support measures, aligning with guidelines provided by the AHA. Addressing these predictors could significantly enhance interventions to improve outcomes and save lives.

Research Quality and Ethics Statement

The Institutional Review Board/Ethics Committee at the College of Medicine and Health Sciences (CoMHS), Sultan Qaboos University (MREC#2151, dated 7th July 2020), and the Ministry of Health (MoH) (SRC#81/2020, dated 22nd September 2020) approved this study. The authors followed the applicable Enhancing the QUAlity and Transparency Of health Research (EQUATOR) Network guidelines, specifically the STROBE guidelines, during the conduct of this research project. We confirm the originality of this submission and conducted a plagiarism check.

Contribution of the Authors

Contribution of the authors is as tabularized below.

	Tasnim	*Amal/Darpanarayan/ Naima*	*Mohammed/ Abdul Majeed*	*Khalid/Thekra/ Maimoona*	*Mohammed Al Hsani*
Concepts	Yes	Yes	Yes	Yes	No
Design	Yes	No	Yes	Yes	No
Definition of intellectual content	Yes	Yes	No	No	Yes
Literature search	Yes	Yes	No	Yes	No
Clinical studies	Yes	Yes	No	Yes	No
Experimental studies	Yes	Yes	No	No	No
Data acquisition	Yes	Yes	Yes	Yes	Yes
Data analysis	Yes	Yes	Yes	No	No
Statistical analysis	Yes	Yes	No	No	No
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