

# Prevalence and Outcomes of Sudden Cardiac Arrest in a University Hospital in the Western Region, Saudi Arabia

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## Abstract

**Background:** Sudden cardiac arrest (SCA) is a major cause of mortality, yet its epidemiological and outcome data in hospitals from Saudi Arabia are limited.

**Objectives:** This study aimed to evaluate the prevalence, risk factors and outcomes of SCA in a teaching hospital in Jeddah, Saudi Arabia.

**Methods:** This retrospective study included all patients aged  $\geq 18$  years with SCA who were resuscitated at King Abdulaziz University Hospital, Jeddah, Saudi Arabia, between January 1 and December 31, 2016. Data were retrieved from the hospital medical records as flow sheets designed in accordance with the Utstein-style recommendations. Factors relating to mortality were analyzed using descriptive analyses and chi-square test.

**Results:** A total of 429 cases of SCA met the inclusion criteria, and its prevalence was 7.76 cases/1000 adult hospital admission. Of these, 61.3% were male, and the mean age was 58.4 years, with 36.6% aged  $>65$  years. Only 3.5% were outside-hospital cardiac arrests. The most common initial rhythm was pulseless electrical activity/asystole (93.2%), while ventricular tachycardia/ventricular fibrillation was documented in only 29 cases (6.8%). The overall rate of return to spontaneous circulation (ROSC) was 56.2%, and 56.8% in cases of in-hospital cardiac arrest (IHCA). Patients with SCA due to sepsis had significantly increased mortality ( $P < 0.000$ ; odds ratio [OR] = 0.24 [0.12–0.47 95% confidence interval [CI]]), while those with SCA due to respiratory causes had significantly better survival outcomes ( $P = 0.001$ ; OR = 2.3 [1.5–3.8 95% CI]). No significant differences in outcomes were found between other risk factors, including cardiac causes.

**Conclusion:** In this population, the prevalence of SCA in adults was higher than reported in many similar studies. Further, sepsis was found to affect the survival rate. Although the rate of ROSC for IHCA patients was favorable compared with other studies, it is relatively poor. This finding signifies the need to identify and control risk factors for SCA to improve survival.

**Keywords:** Cardiopulmonary resuscitation, in-hospital cardiac arrest, Saudi Arabia, sepsis, sudden cardiac arrest, sudden death

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## INTRODUCTION

The Utstein-style guidelines defines sudden cardiac arrest (SCA) as the sudden cessation of cardiac mechanical function as evidenced by the absence of a detectable pulse, absent or gasping breath and/or loss of consciousness.<sup>[1]</sup> In several studies from the United States and China, the incidence of SCA has been found to range from 50 to 100/100,000 individuals in the general population.<sup>[2-4]</sup> SCA can originate from a cardiac or noncardiac insult. The main risk factors for SCA of cardiac etiology are diabetes mellitus, history of cardiovascular disorders and dyslipidemia. For SCA of noncardiac etiology, the main risk factors are hypertension and obesity, while smoking is a risk factor of SCA in general.<sup>[5]</sup>

According to the Utstein-style guidelines, patients are classified as suffering an in-hospital cardiac arrest (IHCA) or an out-of-hospital cardiac arrest (OHCA). The incidence of IHCA is 1–5 events/1000 hospital admissions.<sup>[6]</sup> Further, according to the American Heart Association (AHA), the incidence of IHCA and OHCA in the United States in 2016 was 209,000 and 350,000 annually, respectively.<sup>[7]</sup>

The IHCA survival-to-discharge rate has been reported to be between 20% and 30%, with some outliers.<sup>[8-12]</sup> Two regional studies in the Saudi Arabia and United Arab Emirates have found that the return of spontaneous circulation (ROSC) was 64% and 38%, while the survival rate at discharge was 30% and 8%, respectively.<sup>[9,10]</sup> This indicates that survival rates vary across regions, depending on several key predictors such as setting of the arrest, bystander cardiopulmonary resuscitation (CPR), postresuscitation care, time of initiating basic life support and prompt defibrillation.<sup>[13-15]</sup> Studies from the United States and Thailand have found that patients with IHCA on whom CPR was properly performed have better outcomes compared with OHCA patients.<sup>[13,14]</sup> In addition, although the AHA annual statistics data from 2012 to 2016 report high survival rates among patients with OHCA, reaching 46% if bystander CPR was given, IHCA has higher overall survival rates.<sup>[16]</sup>

Monitoring key predictors of survival such as ventricular fibrillation and ventricular tachycardia are important as they have been found to impact survival rates; however, they are often not monitored, especially in IHCA patients.<sup>[9,10,17-25]</sup> In addition, epidemiological knowledge of key outcomes for SCA can likely improve overall survival rates; however, there is limited such data available from Saudi Arabia. Therefore, the current study aimed to investigate the

prevalence, circumstances and outcomes of patients with SCA who were resuscitated at King Abdulaziz University Hospital (KAUH), Jeddah, Saudi Arabia. Findings from this study would likely add depth into the relation between various etiologies and outcome of SCA, specifically from the Middle Eastern perspective.

## METHODS

### Study design and setting

This retrospective chart review study analyzed all cases of IHCA and OHCA who were resuscitated at KAUH between January 1 and December 31, 2016. The study was approved by the Unit of Biomedical Ethics Research Committee of King Abdulaziz University, Jeddah, Saudi Arabia.

KAUH has an approximate admission rate of 95,000 patients/year. Further, it is located in the middle of a highly crowded residential area of Jeddah, and one of the two largest public hospitals of the city, and thus, this study's population is representative of the area.

During the study period, a total of 626 cardiopulmonary arrests were documented at KAUH. Of these, all patients who met the following criteria were included: age  $\geq 18$  years, cardiac arrests occurring in any department of KAUH and prehospitalization arrests. Studies have shown that pediatrics have a higher probability of surviving until hospital discharge compared with adults.<sup>[8]</sup> In addition, there is significant difference in the initial rhythm of pediatric and adults patients, which can also effect the survival rates after SCA in both age groups.<sup>[8,26]</sup> Therefore, the authors excluded patients aged  $< 18$  years to focus on adults and to control the study variables by eliminating any source of bias or confounders that may distort the results. In addition, patients with a do-not-resuscitate order in place, pregnant and traumatic arrests were also excluded from this study.

At KAUH, for all patients with cardiopulmonary arrest (i.e., absent palpable pulse and respiration), chest compressions are started immediately by the resuscitation team, which comprises physicians (consultants, specialists and residents) and nurses certified in advanced cardiac life support (ACLS). The standard airway intervention is endotracheal intubation; but, occasionally, it may be deferred and a bag-valve mask ventilation or laryngeal mask airways (LMA Classic®; Intersurgical Ltd., Workingham, UK) are placed at the discretion of the treating physician. It should be noted that KAUH does not currently have an "early warning system" in place.

## Data collection

For this study, data were retrieved from all cardiac arrest flow sheets based on the Utstein-style template by a single author. For patients with multiple cardiac arrests, only the first episode was included and analyzed. A standard flow sheet had been completed in real time for all patients requiring chest compressions by a nurse trained in ACLS documentation. The flow sheet contains the date/time of arrest, patient information, type of airway device, time of endotracheal tube placement, name/level of airway operator, initial and subsequent rhythms, medications administered, admitting diagnosis, ROSC, names/position of all team members and additional nurse/physician notes.

In terms of variables, the demographic and clinical characteristics were assessed and their association with mortality was determined. In addition, the association between reversible/nonreversible causes of SCA and mortality were assessed. For this study, “survival” is defined as successful CPR resulting in ROSC.

## Statistical analysis

For analytical purposes, the sample was classified into six groups based on the etiology. The six groups are as follows: medical noncardiac etiologies (comprising metabolic acidosis, electrolyte imbalance, with hypovolemia, liver disease and brain injuries); pulmonary etiologies (comprising hypoxia, respiratory failure, acidosis, pulmonary aspiration, pulmonary embolism, pulmonary edema, respiratory distress and chronic obstructive pulmonary disease); cardiac etiologies (comprising myocardial infarction, cardiogenic shock, heart failure, arrhythmia and cardiomyopathy); sepsis; trauma and surgery; and an “others” group.

Factors relating to mortality were analyzed using descriptive analyses, the Chi-square test and the ANOVA test for multivariate analysis.  $P < 0.05$  was considered as statistically significant. Descriptive statistical measures were used to present the outcomes as frequency and percentage using the SPSS version 22 (IBM Corp., Armonk, NY, USA). The variable risk was demonstrable as odds ratio (OR).

## RESULTS

During the study period, 98,458 patients were admitted to KAUH (aged  $\geq 18$  years: 55,286 patients). Of these, there were 625 cases of SCA among all age groups; however, only 429 patients met the inclusion criteria (i.e., aged  $\geq 18$  years). Accordingly, the prevalence

of SCA in adults was 7.76 cases/1000 hospital admissions.

Table 1 provides details regarding the demographic characteristics, location of SCA occurrence, etiology and initial rhythms. Of note, most patients (96.5%) had IHCA, and the most common etiologies of SCA were noncardiac causes.

The ROSC rate in the current study was 56.2% in IHCA and 40% in OHCA. Table 2 presents the association between

**Table 1: Demographic and clinical characteristics of the sample (n = 429)**

Variables	n (%)
Age (mean $\pm$ SD)	58.43 $\pm$ 18.02
Age group (years)	
<45	98 (22.8)
Between 45 and 65	174 (40.6)
>65	157 (36.6)
Gender	
Male	263 (61.3)
Female	166 (38.3)
Location	
ICU	160 (37.3)
ER	144 (33.6)
Medical ward	93 (21.7)
Surgical ward	15 (3.5)
CCU	13 (3)
Operation room	4 (0.9)
Etiologies to cardiac arrest	
Cardiac	88 (20.5)
Noncardiac	188 (43.8)
Respiratory	102 (23.8)
Sepsis	46 (10.7)
Trauma and surgical	1 (0.2)
Others	4 (0.9)
Initial rhythm	
Shockable	
VF	21 (4.9)
VT	8 (1.9)
Nonshockable	
PEA	245 (57.1)
Asystole	155 (36.1)
Mortality	
Survived	241 (56.2)
Died	188 (43.8)
Settings of the incident	
In-hospital	414 (96.5)
Out-hospital	15 (3.5)
Time of the day	
Morning (8 am-4 pm)	145 (33.8)
Evening (4-11 pm)	133 (31)
Night (11 pm-8 am)	151 (35.2)
The duration of CPR (min)	
<5	70 (16.3)
Between 5	78 (18.2)
Between 10 and 15	110 (25.6)
Between 15 and 20	101 (23.5)
Between 20 and 25	70 (16.3)

Values are presented as mean $\pm$ SD or n (%). CCU – Coronary care unit; PEA – Pulseless electrical activity; SD – Standard deviation; ICU – Intensive care unit; CPR – Cardiopulmonary resuscitation; VF – ventricular fibrillation; VT – Ventricular tachycardia; ER – Emergency room

ROSC and variables evaluated in the study. Bivariate analysis showed that age and gender had no effect on the ROSC rate ( $P = 0.58$  and  $P = 0.08$ , respectively). However, we found a significant difference between the ROSC rates of hospital departments, especially between the intensive care unit (ICU) ( $P = 0.002$ ; OR = 0.5 [0.35–0.8 95% confidence interval [CI]]) and medical ward ( $P = 0.002$ ; OR = 2.25 [1.37–3.7 95% CI]), which significantly indicates that ICU patients have poorer prognosis of SCA, while those in medical wards have a better prognosis. No significant difference in ROSC rates was found between other departments [Table 2].

In terms of etiologies, SCA due to sepsis was significantly associated with increase rate of mortality ( $P < 0.000$ ; OR = 0.24 [0.12–0.47 95% CI]), while SCA due to respiratory morbidities were significantly associated with better outcomes ( $P = 0.001$ ; OR = 2.3 [1.5–3.8 95% CI]) [Figure 1]. No significant difference in outcome was found between other risk factors, including cardiac causes. Nonshockable rhythm was noted in 93% of the cases, while 7% of the cases had a shockable rhythm. After performing the Chi-square test, type of rhythm was found to have no statistically significant effect on the outcome ( $P = 0.39$ ) [Table 2].

Bivariate analysis using the Chi-square test of common etiologies confirmed that patients with sepsis and hypoxia had a significantly different outcome compared with those with other etiologies; sepsis had a negative effect on survival ( $P = 0.00$ , OR = 0.24 [0.12–0.47 CI]), whereas those with hypoxia had better survival rates ( $P < 0.000$ , OR = 3.4 [1.9–6.1 CI], respectively). In addition, disturbances in potassium blood levels were found to be significantly correlated with better survival rates ( $P = 0.006$ , OR = 7.0 [1.6–31 CI]) [Table 3]. This study did not find any significant correlation between ROSC rates and duration of CPR ( $P = 0.858$ ).

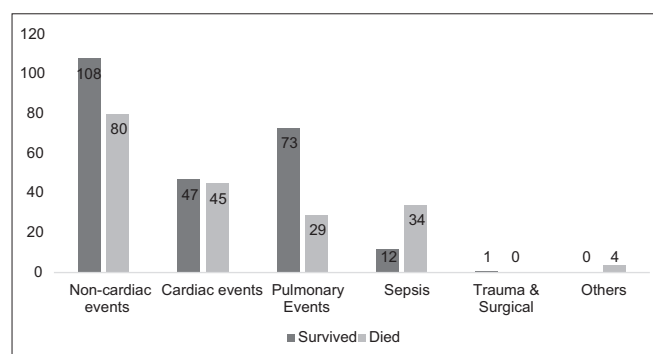
Among the surviving patients, 41 patients (17%) were successfully resuscitated within 5 min, 45 patients (18.7%)

within 5–10 min, 63 patients (26.1%) within 10–15 min, 53 patients (22%) within 15–20 min and 39 patients (16.2%) within 20–25 min. In addition, there was no significant correlation between the CPR duration and gender ( $P = 0.134$ ), age ( $P = 0.4$ ) or initial rhythm ( $P = 0.090$ ).

**Table 2: Association between mortality and other variables (n = 429)**

Variables	Survived (n = 241)	Died (n = 188)	P
Mean age (years)	57.95	59.06	0.53
Age group (years)			
≤65	156 (64.7)	116 (61.7)	0.58
>65	85 (35.3)	72 (38.3)	
Gender			
Male	157 (59.7)	106 (40.3)	0.08
Female	84 (50.6)	82 (49.4)	
Location			0.006
ICU	74 (46.3)	86 (53.8)	0.002
ER	80 (55.6)	64 (44.4)	0.93
Medical ward	66 (71)	27 (29)	0.002
Surgical ward	10 (66.7)	5 (33.3)	0.57
CCU	8 (61.5)	5 (38.5)	0.91
Operation room	3 (75)	1 (25)	0.63
Etiologies of SCA			
Cardiac	47 (51.1)	45 (48.9)	0.321
Noncardiac	108 (57.4)	80 (42.6)	0.71
Respiratory	73 (71.6)	29 (28.4)	0.001
Sepsis	12 (26.1)	34 (73.9)	<0.000
Trauma and surgical	1 (100)	0 (0)	0.999
Others	0 (0)	4 (100)	
Initial rhythm			
Shockable	19 (65.5)	10 (34.5)	0.39
Nonshockable	222 (55.5)	178 (44.5)	
In-hospital SCA			
Yes	235 (56.8)	179 (43.2)	0.19
No	6 (40)	9 (60)	
Time of the day			
Morning	80 (55.2)	65 (44.8)	0.60
Evening	77 (57.9)	56 (42.1)	
Night	84 (55.6)	67 (44.4)	
The duration of CPR (min)			
<5	29 (41.1)	41 (58.6)	0.858
5-10	33 (42.3)	45 (57.7)	
10-15	47 (42.7)	63 (57.3)	
15-20	48 (47.5)	53 (53.5)	
20-25	31 (43.8)	39 (56.2)	

Values are presented as n (%). ICU – Intensive care unit; CCU – Coronary care unit; SCA – Sudden cardiac arrest; CPR – Cardiopulmonary resuscitation; ER – Emergency room



**Figure 1: Etiologies and survival data of sudden cardiac arrest patients**

**Table 3: Association of reversible and nonreversible causes of sudden cardiac arrest with mortality (n = 429)**

Variables	Survived (n = 241)	Died (n = 188)	P
Acidosis	82 (53.6)	71 (46.4)	0.483
Hypothermia	0	0	-
Hyperkalemia or hypokalemia	17 (89.5)	2 (10.5)	0.006
Hypovolemia	15 (62.5)	9 (37.5)	0.667
Hypoxia	61 (78.2)	17 (21.8)	<0.000
Myocardial infarction	31 (49.2)	32 (50.8)	0.285
Pulmonary embolism	6 (37.5)	10 (62.5)	0.201
Trauma	1 (100)	0	0.999
Sepsis	12 (26.1)	34 (73.9)	<0.000
Arrhythmia	7 (70)	3 (30)	0.299
Heart failure	7 (43.8)	9 (56.25)	0.306
Others	2 (50)	2 (50)	-



## DISCUSSION

Survival rates of SCA vary across regions depending on several key predictors. Knowledge of key outcomes for SCA can likely improve overall survival rates; however, there was limited such data available from Saudi Arabia. This study found that the ROSC rate among adult patients at KAUH, Jeddah, Saudi Arabia, was 56.2%. In addition, sepsis and respiratory morbidities significantly affected the ROSC rates along with disturbances in potassium levels; age, gender and duration of CPR had no effect. Further, in IHCA patients, there was significant difference in the ROSC rates between patients from ICU and medical ward.

In the current study, the prevalence of SCA in adults was 7.76 cases/1000 hospital admissions, which was higher than the prevalence of 3.25/1000 admission found by a similar study from Taiwan.<sup>[27]</sup> In an older study from Italy regarding IHCA among all patients aged  $\geq 18$  years, the reported prevalence was 1.25/1000 admissions, which is much lower than of the present study.<sup>[20]</sup> The higher prevalence in our study could be attributed to many reasons; notably, the study from Taiwan included both adult and pediatric patients. As stated earlier, including pediatric patients in the analysis can affect the results of a study. Another reason for the higher prevalence in the current study may be because KAUH is a tertiary healthcare center where patients often present with more complicated and critical conditions. In a similar tertiary care hospital from UAE, the prevalence of IHCA among all age groups was 11.7/1000 admissions, thereby indicating that such hospitals are likely to have higher prevalence.

In the current study, the ROSC rate among patients suffering with IHCA was 56.8%. This rate is considerably higher than that found among patients with IHCA in single-centre studies from Taiwan (40%)<sup>[28]</sup> and UAE (38.7%).<sup>[10]</sup> An important factor that may have caused this variation is the differences in the location of SCA among the three studies. For example, 49% and 46% of the SCA in the latter studies occurred in the ICU,<sup>[10,28]</sup> whereas it was only 37.3% in the current study. This further emphasizes our results regarding poor prognosis of SCA in the ICU. Differences in etiologies, clinical services and management plans offered by each hospital may also have resulted in these variances. In a multicentre study from Italy involving 1539 patients with IHCA, the rate of ROSC rate was 35.7%, which is similar to that of our study. Although this study did not sufficiently analyze the association of etiologies, it did not find that patients with respiratory etiologies had remarkably poor prognosis, which is in contrast with the findings of the current study. However, there are currently no explanations

for these differences, and the authors suggest further studies to determine the respiratory diseases most likely to result in poor prognosis. Nonetheless, comparisons with previous studies highlight the relatively better outcome in our IHCA patients, mainly due to the etiology and department where the SCA occurred. This indicates the need for future studies regarding etiologies and their impact on mortality rates in SCA.

In the current study, having sepsis as an etiology of SCA increased the mortality rate by 4 folds. A recent Norwegian study also showed that septic patients with concomitant SCA had higher mortality rates compared with other arrested patients.<sup>[29]</sup> A population-based study conducted in the United States found that patients with sepsis and concomitant cardiac dysfunction had a 2.3 times higher risk of mortality than patients with severe sepsis and other organ dysfunction; it should be noted that only patients with pulmonary or hepatic dysfunction had higher mortality in that study.<sup>[30]</sup>

Patients with hypoxia in the current study had a 3-fold lower risk of mortality, which is in line with the Norwegian study's finding that patients with this etiology of SCA had a higher survival rate than other etiologies.<sup>[29]</sup> In addition, finding of potassium level disturbances were also similar between the two studies. However, to the best of the authors' understanding, the current study is the first to show an association between potassium imbalance and its effect on the outcome of SCA. Therefore, the authors recommend further studies to investigate the associations between electrolyte imbalances and SCA survival.

The authors recommend development of robust strategies including effective monitoring and continuous assessment to prevent the occurrence of IHCA, especially in patients with sepsis given their poor survival rates. The authors also recommend further studies on the etiologies of SCA and their association with survival outcome. Collective findings from these studies would help in developing screening programs for patients at a high risk of SCA and thus result in its prevention.

Cardiac causes include coronary artery disease (sudden cardiac death is the initial manifestation and accounts for 50% of the cases), arrhythmia, cardiomyopathy and others.<sup>[31]</sup> However, our study did not find a significant correlation between ROSC rates of SCA and cardiac causes, likely because of the small sample size. Another limitation of this study was that the survival rate until discharge and neurological outcome at the time of discharge were not documented and thus could not be assessed.

Other limitations include the unequal number of cases between the departments and that patients did not receive CPR for >25 min.

## CONCLUSION

This study found that at KAUH, the prevalence of SCA in adults is 7.76 cases 1000 hospital, which is higher than most similar studies. Nonetheless, the rate of ROSC for IHCA patients is 56.8%, which is favorable compared with other studies. In addition, sepsis was found to be significantly associated with poor survival. Further research on etiologies and their association would help develop screening programs for identifying and controlling risk factors of SCA and its survival outcome.

## Ethical considerations

The study was approved by the Unit of Biomedical Ethics Research Committee of King Abdulaziz University, Jeddah, Saudi Arabia, on December 30, 2018 (Reference no.: 699-18). Requirement for informed consent was waived by the Committee owing to the study design and use of anonymized data. The study was conducted in accordance with the ethical standards in the Declaration of Helsinki, as revised in 2013.

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## Conflicts of interest

There are no conflicts of interest.

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