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Clinical paper

Temporal trends in the incidence and outcomes of cardiopulmonary arrest events treated in the emergency department at a tertiary hospital in Jordan

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Abstract

Objective: This study aimed to estimate the incidence and outcomes of cardiac arrest treated in the emergency department (ED), and identify factors associated with survival to hospital discharge.

Methods: This was a single-center observational study of all adult cardiac arrest patients treated in the ED between 2015 and 2022. Patients were categorized into out-of-hospital cardiac arrest (OHCA) and in-ED events based on whether the patients arrived at the ED in cardiac arrest or developed during the ED visit. Annual incidence rates were calculated per 10,000 ED visits. Changes in the temporal trend for incidence were assessed using Poisson regression and factors associated with survival to hospital discharge among admitted patients were identified using logistic regression models.

Results: A total of 613 patients received cardiopulmonary resuscitation in the ED, resulting in an incidence rate of 9.3 per 10,000 visits with an annual incidence decreasing by 3.9% (95% CI: 0.7%—7.1%). Compared to OHCA events (n = 373), in-ED events (n = 240) had a lower and decreasing incidence rate (6.1 vs. 3.2 per 10,000 visits) and had higher rates of return of spontaneous circulation (19.3% vs. 47.1%), survived to hospital admission (17.2% vs. 37.5%), and survived to hospital discharge (1.9% vs. 7.9%). Among admitted patients, predictors of survival to hospital discharge included in-ED event, younger age, cardiac etiology, receiving defibrillation, and fewer epinephrine doses.

Conclusions: Clinical outcomes following OHCA and in-ED cardiac arrests were poor in Jordan. Efforts should be directed toward improving the performance of community and healthcare practitioners with significant emphasis on prehospital emergency care.

Keywords: Cardiac arrest, Emergency department, Out-of-hospital, Survival, Jordan

Introduction

Cardiac arrest stands as one of the most lethal manifestations of cardiovascular disease worldwide, significantly affecting morbidity and mortality rates. Variations in its incidence and survival are influenced by many factors such as regional healthcare infrastructure, promptness of emergency responses, public awareness, and differences in patient and clinical characteristics.[1–4] The emergency department (ED) is important in managing out-of-hospital cardiac arrest (OHCA) and in-ED cardiac arrest,[5,6] with generally higher survival rates observed for patients receiving cardiopulmonary resuscitation (CPR) in the ED compared to those in other hospital departments or those experiencing OHCA.[7] Nonetheless, recent studies suggest a continuing need to monitor ED resuscitation performance and survival, regardless of the origin of sudden cardiac arrest.[5,6] The differences in incidence, resuscitation efforts, and clinical outcomes between patients who arrive at the ED with a cardiac arrest and

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those who experience a cardiac arrest after arriving at the ED needs further evaluation.[8]

In developed countries, factors such as the capability for percutaneous coronary interventions, overall patient volume, and the teaching status of the hospital are associated with higher survival rates to hospital discharge among ED treated cardiac arrest patients.[6] However, most cardiac arrest research derives from these developed regions, with a notable scarcity of data from developing countries.[9] The global understanding of cardiac arrest patterns is important for benchmarking and creating effective public health strategies and emergency training programs for regions with fewer resources.[10] In Jordan, for example, the clinical and epidemiological features of OHCA and in-hospital cardiac arrest (IHCA) are poorly documented, with a single study indicating mortality rates (3.0% for OHCA and 14.9% for IHCA)[11] significantly lower than global averages (8.8% for OHCA and 17.6% for IHCA).[12,13]

The healthcare system in Jordan presents unique challenges and opportunities for cardiac arrest management. It comprises public, private, and international donor-supported facilities striving toward universal health coverage.[14] Hospitals, both public and private, deliver emergency care under the Ministry of Health regulations, which mandate that life-saving treatments be accessible to everyone irrespective of insurance status.[14,15] However, cardiac arrest management often receives less attention than other conditions, particularly in the public sector. Although most hospitals and the national emergency medical services (EMS) follow American Heart Association (AHA) guidelines for cardiac arrest care and advanced cardiovascular life support (ACLS) training, resource variability and high patient volumes can hinder rapid recognition and immediate intervention. Moreover, the lack of national data registries and policies such the absence of clear do-not-resuscitate or termination-of-resuscitation present significant barriers to effective cardiac arrest care.

This may highlight a substantial local data quality and availability challenge, emphasizing the need for more extensive and contemporary research to comprehend the cardiac arrest burden fully and formulate evidence-based public health policies. This study aims to estimate the overall and annual incidence rates of ED cardiac arrests and resuscitation efforts in Jordan over an eight-year period, comparing the characteristics and the clinical outcomes of patients who arrived at the ED with a cardiac arrest and those who had a cardiac arrest after arriving at the ED. It also seeks to identify factors associated with survival to hospital discharge after surviving ED and being admitted to the hospital.

Methods

Study design

This observational study retrospectively investigated a cohort of all adult patients (18 years or older) who had an event of cardiac arrest and received resuscitation in the ED of King Abdullah University Hospital (KAUH) between January 2015 and December 2022. This study received approval from the Institutional Review Board of Jordan University of Science and Technology (Ref#: 86/148/2022).

Study setting

KAUH, a 642-bed hospital, is the main tertiary referral hospital in northern Jordan and is an AHA accredited center. Most physicians and nurses are at least certified as basic life support (BLS) responders, and many hold ACLS certification. The Jordanian Civil Defence is the sole provider of EMS in Jordan. Ambulances are equipped with paramedics trained in ACLS according to the AHA guidelines and with the necessary devices and tools. However, ACLS medications were not available in all ambulances during the study period. In Jordan, paramedics are not eligible to terminate resuscitation once initiated, while OHCA patients are transported to the nearest hospital.

Study sample

The study population included all adult patients who experienced an event of ED cardiac arrest as defined by the need for CPR. These events were divided into two categories based on the timing of the cardiac arrest: OHCA events and in-ED events. OHCA events were defined as cases where patients arrived at the ED in a cardiac arrest and immediately underwent resuscitation by the CPR team upon arrival to ED. In-ED events referred to patients who experienced cardiac arrest and received resuscitation after arrival and registration at the ED. Those patients who were declared dead on arrival without any resuscitation attempt and those who had achieved sustained return of spontaneous circulation (ROSC) prior to ED arrival without rearrest in the ED were not included in this study. Similarly, individuals who were near arrest at triage but did not progress to full cardiac arrest (i.e., did not receive CPR) were also excluded.

Data collection

Data was collected retrospectively from the electronic medical records of patients who had a CPR note. Clinical information was obtained manually by screening relevant reports from electronic medical records such as medical history, CPR notes, and discharge notes. We collected data for OHCA and in-ED events in accordance with Utstein-Style Templates for OHCA and IHCA, respectively,[6,7] as available, including patient variables, event variables, and outcome variables. However, prehospital data (i.e., witnessed status, bystander CPR, transportation mode, and EMS treatment) were not available at the time of data collection.

Patient variables included date of birth, sex, time and date of ED registration, hospital admission and hospital discharge, past medical history, and the total number of previous ED visits. For the event variables, we reviewed all CPR notes and extracted data on time and date when resuscitation was initiated and terminated, initial rhythm in ED, number of CPR cycles, and treatment provided such as epinephrine doses and defibrillation. The etiology of cardiac arrest was identified by a medical doctor after reviewing the patient's electronic medical file including history, progress, and/or discharge notes. This identification was guided by a previous study.[8] For outcome variables, we collected discharge status and date and time of death, ROSC, hospital admission, and hospital discharge.

Study outcomes

We estimated the overall and annual incidence rates per 10,000 ED visits. The incidence rate was calculated as the number of ED cardiac arrest events that occurred during the study period divided by the number of all adult ED visits during that period, as described in a previous study.[9] Three clinical outcomes were described in this study for all events: ROSC, survival to hospital admission, and survival to hospital discharge. We also identified predictors of survival to hospital discharge after admission to the hospital.

Statistical analysis

Baseline characteristics were summarized using descriptive statistics. Missing data were reported and excluded from the analyses.

Continuous variables were reported as mean and standard deviations (SD) or median and interquartile ranges (IQR). Categorical variables were reported as counts and percentages. Differences in the characteristics and outcomes between study groups were assessed using *t*-test, Wilcoxon rank-sum test, and chi-square test as appropriate.

Incidence rates were estimated as the number of events per 10,000 ED visits along with their 95% confidence intervals (CIs) assuming Poisson distribution. Given indications of overdispersion in the data, negative binomial regression models were subsequently employed to estimate temporal trends and annual percentage changes in the incidence rates. This approach allowed for additional dispersion parameters and provided robust estimates of incidence rate ratios (IRRs) with corresponding 95% CIs for each study group across the observed period. For the rates of the clinical outcome, the 95% CIs were estimated using exact binomial interval method.

To assess factors associated with survival to hospital discharge, our analysis was limited to patients who were admitted to hospital because of the large percentage of missing data among unadmitted patients who died in the ED. We employed both univariable and multivariable logistic regression models to estimate unadjusted and adjusted odds ratios (aOR), along with their 95% CI. For the multivariable logistic regression, we applied a backward selection method including all patients and event characteristics, including only those variables with a p-value less than 0.2. Collinearity was evaluated using the Variance Inflation Factor, and model performance was assessed based on the Bayesian Information Criterion and Akaike Information Criterion. A two-tailed p value of <0.05 was considered statistically significant. All statistical analyses were performed on STATA statistical software version 16.0 (Statacorp, College Station, Texas, USA).

Results

Incidence rates

During the 8-year study period, a total of 613 adults experienced cardiac arrest and received resuscitation by the CPR team at KAUH ED. The total number of adults who visited the ED during the study period was 662,269 patients, giving an incidence rate of 9.3 per 10,000 ED visits (95% CI: 8.6, 10.0). The annual incidence rate was highest in 2017 (12.4; 95% CI: 10.1, 15.3) and lowest in 2021 (6.1, 95% CI: 4.8, 7.9). The annual incidence rate likely declined by an average of 4.0% (IRR = 0.960; 95% CI: 0.916–1.003, $p = 0.068$). The annual absolute number of ED cardiac arrest events did not change significantly over the study period ($p = 0.826$ for trend). However, the annual absolute number of overall ED visits increased by an average of 4% (95% CI: 3.9, 4.1; $p < 0.001$ for trend). Fig. 1 shows annual changes in the incidence rates per 10,000 ED visits.

About two thirds of the of the study sample (60.9%, $n = 373$) were OHCA events and received resuscitation immediately upon arrival to the ED, while 39.1% ($n = 240$) were in-ED events. The incidence rate of OHCA events per 10,000 ED visits was 5.6 (95% CI: 5.1, 6.2), without showing a significant change in the annual incidence rate (IRR 0.988; 95% CI 0.919, 1.063; $p = 0.753$). Whereas the incidence rate of in-ED events was 3.6 (95% CI: 3.2, 4.1) cases per 10,000 ED visits, decreasing by an average of 8.4% per year (IRR = 0.916; 95% CI: 0.861, 0.975; $p = 0.006$).

Baseline characteristics and differences between the study groups

Table 1 presents the distribution of the study variables among all events and across OHCA and in-ED event groups. Compared to in-ED events, patients with OHCA events were younger, had a

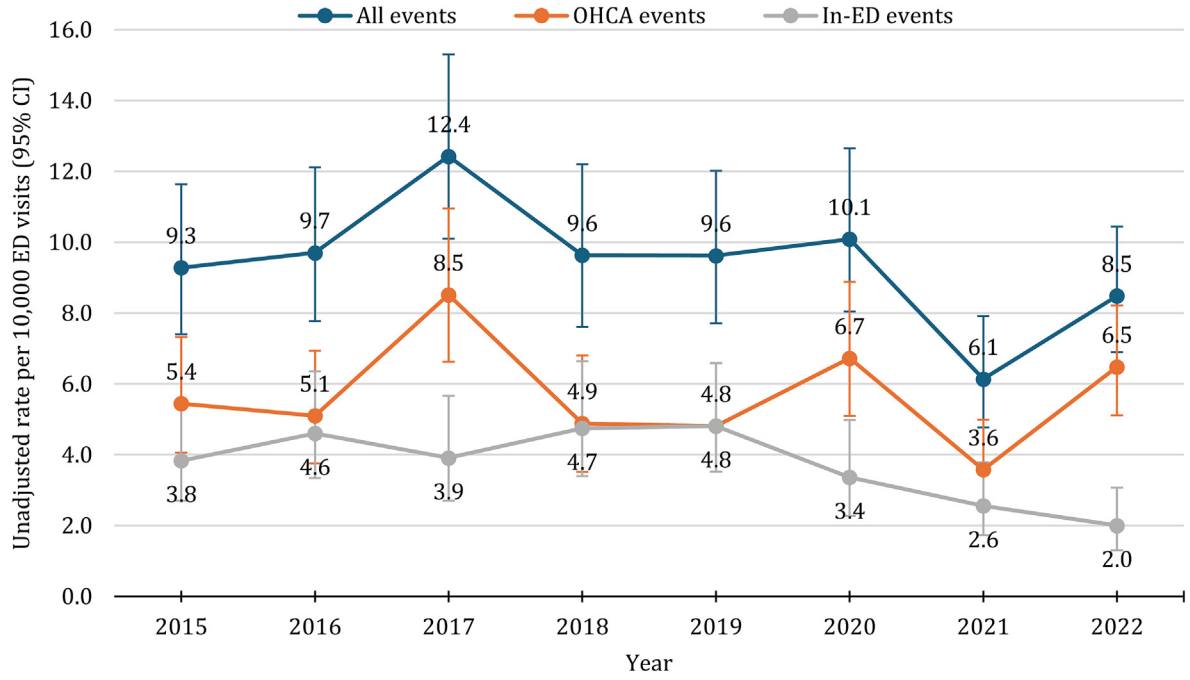


Fig. 1 – Annual changes in the incidence rates of ED treated cardiac arrests per 10,000 ED visits for overall and for ED cardiac arrest and OHCA.

Table 1 – Baseline and event characteristics for All ED treated cardiac arrest patients and their distribution between OHCA and in-ED events.

	All events n = 613	OHCA events n = 373 (60.8%)	In-ED events n = 240 (39.2%)	P value
Age, median (IQR)	64 (49–76)	62 (46–75)	65 (53–79)	0.045
Male sex, n (%)	376 (61.3)	242 (64.9)	134 (55.8)	0.025
Comorbidity, n (%)				
Diabetes	169 (27.6)	89 (23.9)	80 (33.3)	0.010
Hypertension	203 (33.1)	108 (29.0)	95 (39.6)	0.006
Respiratory diseases	51 (8.3)	23 (6.2)	28 (11.7)	0.016
Ischemic heart diseases	90 (14.7)	40 (10.7)	50 (20.8)	0.001
Cancer	69 (11.3)	30 (8.0)	39 (16.3)	0.002
Stroke	43 (7.0)	23 (6.2)	20 (8.3)	0.305
Renal diseases	32 (5.2)	19 (5.1)	13 (5.4)	0.861
Missing	265 (43.2)	195 (52.3)	70 (29.2)	<0.001
Number of previous ED visits, median (IQR)	2 (0–9)	2 (0–7)	3 (1–13)	<0.001
Precipitating cause, n (%)				
Cardiac	78 (12.7)	36 (9.7)	42 (17.5)	0.004
Medical non-cardiac	116 (18.9)	52 (13.9)	64 (26.7)	<0.001
Trauma	37 (6.0)	27 (7.2)	10 (4.2)	0.119
Missing	382 (62.3)	258 (69.2)	124 (51.7)	<0.001
Initial Rhythm, n (%)				
Asystole	571 (93.2)	359 (96.3)	212 (88.3)	<0.001
PEA	28 (4.6)	9 (2.4)	19 (7.9)	0.001
VF/VT	14 (2.3)	5 (1.3)	9 (3.8)	0.051
Defibrillated during resuscitation, n (%)	68 (11.1)	3 9 (10.5)	29 (12.1)	0.531
Epinephrine doses, median (IQR)	4 (3–5)	4 (3–5)	3 (2–5)	<0.001
Duration of resuscitation in minutes, median (IQR)	15 (11–20)	15 (11–20)	13 (9–17)	<0.001
Daytime events 6AM-5PM, n (%)	345 (56.3)	222 (59.5)	123 (51.3)	0.044
Weekend events, n (%)	192 (31.3)	118 (31.6)	74 (30.8)	0.834
Clinical outcomes, n (%)				
ROSC	185 (30.2)	72 (19.3)	133 (47.1)	<0.001
Survived to hospital admission	154 (25.1)	64 (17.2)	90 (37.5)	<0.001
Survived to hospital discharge	26 (4.2)	7 (1.9)	19 (7.9)	<0.001

All results presented as frequency and percentage, unless otherwise indicated.

ED, Emergency department; PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia; ROSC, return of spontaneous circulation

higher proportion of males, and had a lower median number of previous visits to the ED. OHCA events had a larger proportion of missing data on both medical history and etiology of arrest than in-ED events (Table 1).

In-ED events had a higher proportion of cardiac etiology (17.5% vs 9.7%, $p = 0.004$) and medical non-cardiac etiology (26.7% vs 13.9&, $p < 0.001$, respectively), compared to OHCA events. Only 2.3% ($n = 14$) had an initial shockable rhythm, 11.1% received defibrillation during resuscitation, and the median number of epinephrine doses was 4 (IQR: 3–5). OHCA events had a higher proportion of initial asystolic arrests, a higher median number of epinephrine doses, and a longer median duration of resuscitation when compared to in-ED events (Table 1).

Study outcomes

Rates and trends for clinical outcomes

Among the study sample, a total of 185 patients (30.2%) achieved ROSC in the ED, 154 patients (25.1%) survived to hospital admission, and 26 patients (4.2%) survived to hospital discharge, without significant changes in the trend over the study period (p value for trend was > 0.05) (Fig. 2).

Compared to OHCA events, in-ED events had significantly higher rates ($p < 0.001$) of ROSC (19.3%; 95% CI: 15.6%–23.6% vs 47.1%; 95% CI: 40.8%–53.4%, respectively), survival to hospital admission (17.2%; 95% CI: 13.7%–21.3% vs 37.5%; 95% CI: 31.6%–43.8%, respectively), and survival to hospital discharge (1.9%; 95% CI: 0.9%–3.9% vs 7.9%; 95% CI: 5.1%–12.1%, respectively). The annual rates of hospital admission and survival to hospital discharge were consistently higher among in-ED events compared to OHCA events (Fig. 3). However, there was no significant change in trend for all clinical outcomes for both OHCA and in-ED events.

Difference between study characteristics and clinical outcomes

Table 2 describes patient-related and event-related characteristics of ED cardiac arrest patients who survived to hospital admission and hospital discharge. Age and sex did not differ significantly between survivors and non-survivors at either hospital admission or discharge. There was a large proportion of missing data (>50%) on comorbidities and etiology among non-survivors.

Compared to non-survivors, the initial shockable rhythm was more common among those who survived to hospital admission (1.7% vs 4.6%; $p = 0.051$, respectively) and hospital discharge (1.9% vs 15.4%; $p < 0.001$, respectively). Survivors were also more likely to be defibrillated ($p < 0.05$) and received fewer epinephrine doses with shorter resuscitation ($p < 0.001$). Those who survived to hospital discharged had more weekend arrests (53.9% vs

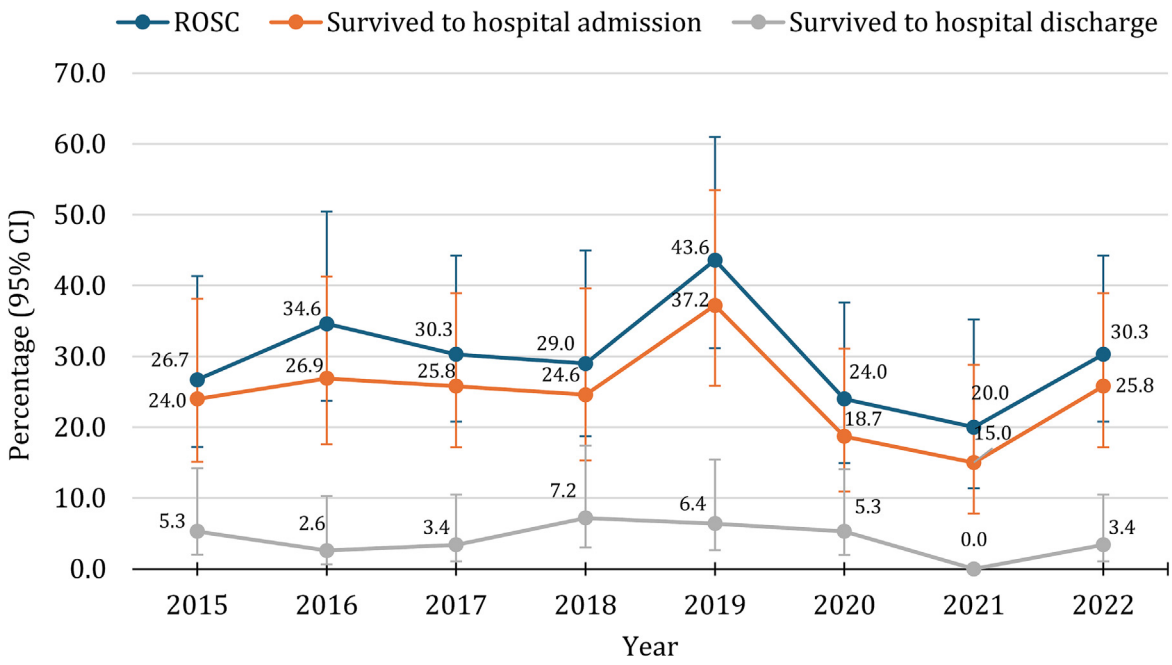


Fig. 2 – Annual rates of clinical outcomes for all events over the study period.

30.3%; $p = 0.011$, respectively) and a higher median of previous visits (6 vs 2, $p = 0.003$, respectively) than those who did not survive to hospital discharge.

Factors associated with survival to hospital discharge among admitted patients

Among admitted patients ($n = 154$), a total of 26 (16.9%) survived to hospital discharge. Table 3 presents the results of the univariable and multivariable logistic regression models. In the multivariable model, increasing age independently reduced the likelihood of survival to hospital discharge (aOR = 0.94; 95% CI: 0.9, 0.99). A history of respiratory disease was associated with lower odds of survival (aOR = 0.11; 95% CI: 0.01, 0.039), whereas a history of stroke was associated with higher odds of survival (aOR = 16.15; 95% CI: 3.08, 84.6). In addition, patients who had a higher number of previous visits to the ED had a higher likelihood of survival (aOR = 1.12; 95%: CI: 1.05, 1.19).

Patients who had OHCA events had a lower chance of survival by 75% (aOR = 0.25; 95% CI: 0.07, 0.99), compared to those who had an arrest while in the ED. Patients with cardiac etiology and those who received defibrillation during resuscitation had over six-fold increase in odds of survival (aOR = 6.31; 95% CI: 1.52, 26.3 and AOR = 6.14; 95% CI: 1.32, 28.54, respectively). While the number of epinephrine doses was associated with lower odds of survival (aOR = 0.29, 95% CI: 0.15, 0.56). Finally, later calendar year independently reduced the odds of survival (aOR = 0.73, 85% CI: 0.54, 0.99), indicating that for each calendar year the odds of survival reduced by 27.0%.

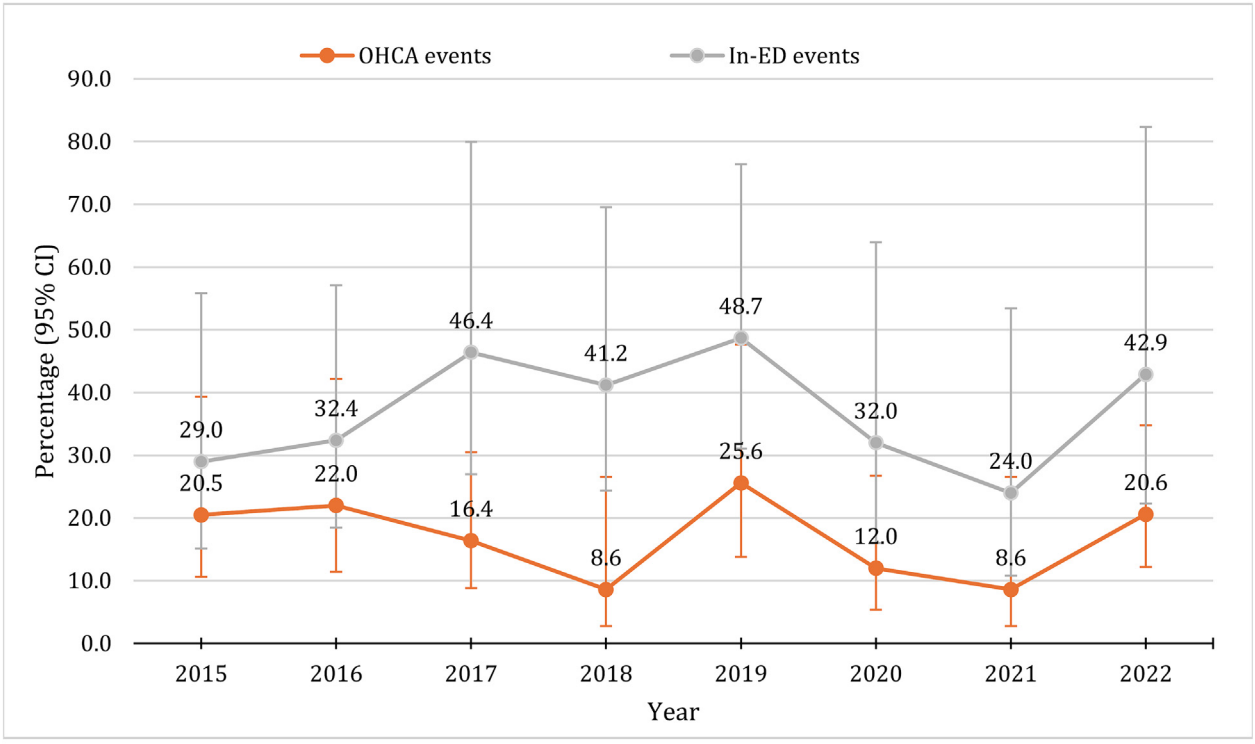
Discussion

This study highlights a concerning incidence and poor clinical outcomes of cardiac arrest in the ED of a tertiary teaching hospital in Jordan, with significant implications for public health and emergency care practices. The incidence rate of ED cardiac arrests was 9.3 per 10,000 visits, with a higher and unchanged incidence rate for OHCA compared to in-ED events. Overall, the clinical outcomes were poor, with only 25.1% of patients sustained ROSC and were admitted to hospital and 4.2% survived to hospital discharge, with notably better clinical outcomes among in-ED events compared to OHCA events. Survival to hospital discharge worsened in later years, particularly during the COVID-19 pandemic. Asystole was the most common initial rhythm in both OHCA and in-ED events that may have a great impact on the poor survival. Other factors independently associated with survival were age, history of stroke and respiratory disease, defibrillation, location of arrest, and the number of epinephrine doses during CPR.

Incidence rate

The incidence rates of ED cardiac arrest reported in the literature show considerable variability. A nationwide Swedish study on in-ED events documented an incidence rate of 1.6 per 10,000 ED visits between 2016 and 2018.[16] This rate is notably lower than what is reported in our study (3.6 in-ED event per 10,000 ED visits). Similarly, a study of IHCA in United States EDs reported an annual incidence rate of 2 events per 10,000 ED visits.[17] Nevertheless, the incidence rate of ED cardiac arrest in our study was lower than what was recently reported by Hsu et al. in a national study from the United States (~ 20 events per 10,000 ED visits) where similarities to our population was noted by including all patients receiving resuscitation including those with OHCA. As well, the incidence rate of OHCA events reported from KAUH may be lower than that at other local hospitals in Jordan, possibly because KAUH is located outside major urban centers. It is also not the primary destination for OHCA patient transport due to the longer travel times from residential areas.

A. Survival to hospital admission



B. Survival to hospital discharge

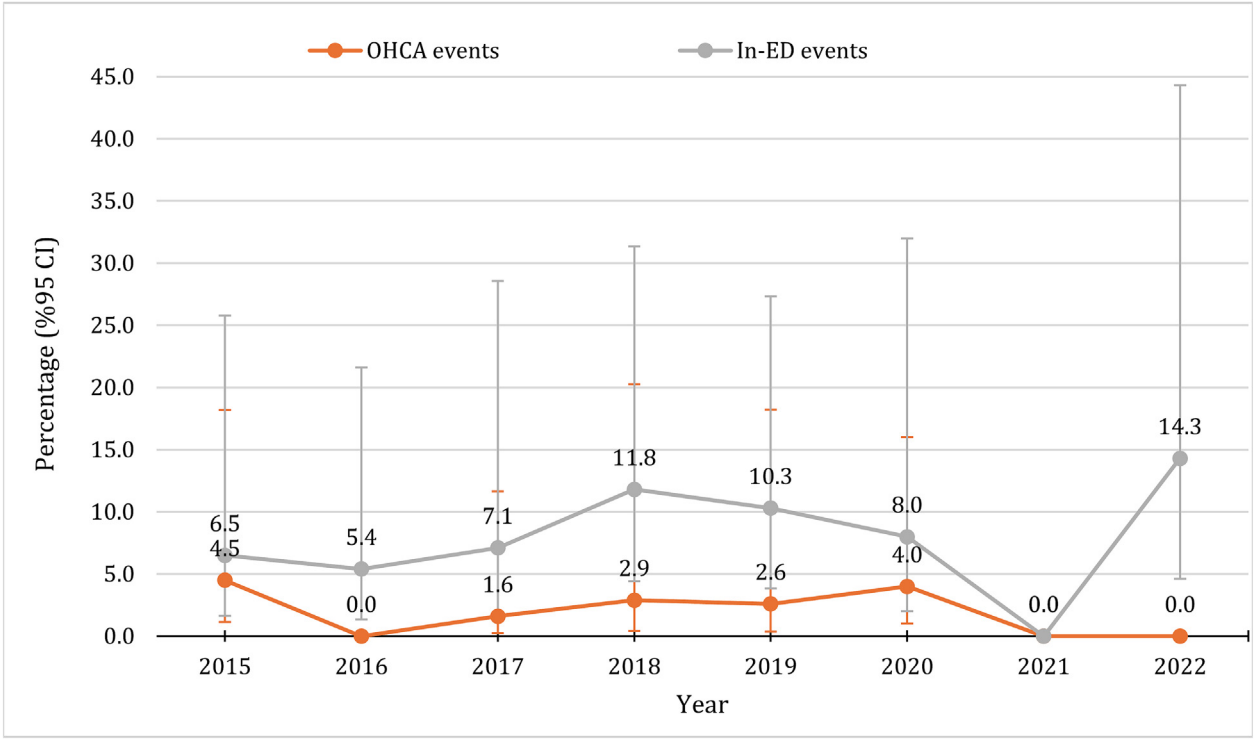


Fig. 3 – The difference in clinical outcomes between OHCA and in-ED events over the study period. A. survival to hospital admission. B. survival to hospital discharge.

Table 2 – Differences in patient and event characteristics across clinical outcomes.

	Survived to hospital admission			Survived to hospital discharge		
	Yes n = 154 (25.1%)	No n = 459 (74.9%)	P-value	Yes n = 26 (4.2%)	No n = 587 (95.8%)	P-value
Age, mean (SD)	61.5 (17.7)	61.3 (19.2)	0.9156	59.4 (13.2)	61.5 (19.0)	0.579
Sex (Male), n (%)	90 (58.4)	286 (62.3)	0.394	19 (73.1)	357 (60.8)	0.209
Comorbidity						
Diabetes	82 (53.3)	87 (19.0)	<0.001	16 (61.5)	153 (26.1)	<0.001
Hypertension	91 (59.1)	112 (24.4)	<0.001	16 (61.5)	187 (31.9)	0.002
Respiratory diseases	28 (18.2)	23 (5.0)	<0.001	3 (11.5)	48 (8.2)	0.544
Ischemic heart diseases	40 (26.0)	50 (10.9)	<0.001	8 (30.8)	82(14.0)	0.018
Cancer	25 (16.2)	44 (9.6)	0.024	2 (7.7)	67 (11.4)	0.557
Stroke	23 (14.9)	20 (4.4)	<0.001	8 (30.8)	35 (6.0)	<0.001
Renal diseases	17 (11.0)	15 (3.3)	<0.001	3 (11.5)	29 (4.9)	0.139
Not reported	0 (0.0)	265 (57.7)	<0.001	0 (0.0)	265 (45.1)	<0.001
OHCA events	64 (41.6)	309 (67.3)	<0.001	7 (26.9)	366 (62.4)	<0.001
In-ED events	90 (58.4)	150 (32.7)	<0.001	19 (73.1)	221 (7.7)	<0.001
Precipitating cause						
Cardiac	56 (36.4)	22 (4.8)	<0.001	15 (57.7)	63 (10.7)	<0.001
Non-cardiac	98 (63.7)	55 (12.0)	<0.001	11 (42.4)	142 (24.2)	<0.001
Medical non-cardiac	82 (53.3)	34 (7.4)	<0.001	10 (38.5)	106 (18.1)	0.009
Trauma	16 (10.4)	21 (4.6)	0.009	1 (3.9)	36 (6.1)	0.632
Not reported	0 (0.0)	382 (83.2)	<0.001	0 (0.0)	382 (65.1)	<0.001
Initial shockable rhythm, n (%)	7 (4.6)	8 (1.7)	0.051	4 (15.4)	11 (1.9)	<0.001
Defibrillated during CPR, n (%)	25 (16.2)	43 (9.4)	0.019	9 (34.6)	59 (10.1)	<0.001
Epinephrine doses, median (IQR)	3 (2–3)	4 (3–5)	<0.001	2 (1–2)	4 (3–5)	<0.001
Duration of CPR, mean (SD)	11.1 (6.5)	17.9 (8.2)	<0.001	8.2 (4.3)	16.5 (8.3)	<0.001
Callender year			0.130			0.493
2015	18 (11.7)	57 (12.4)		4 (15.4)	71 (12.1)	
2016	21 (13.6)	57 (12.4)		2 (7.7)	76 (12.9)	
2017	23 (14.9)	66 (14.4)		3 (11.5)	86 (14.6)	
2018	17 (11.0)	52 (11.3)		5 (19.2)	64 (10.9)	
2019	29 (18.8)	49 (10.7)		5 (19.2)	73 (12.4)	
2020	14 (9.1)	61 (13.3)		4 (15.4)	71 (12.1)	
2021	9 (5.8)	51 (11.1)		0 (0.00)	60 (10.2)	
2022	23 (14.9)	66 (14.4)		3 (11.5)	86 (14.6)	
Weekend (Fridays and Saturdays)	53 (34.4)	139 (30.3)	0.339	14 (53.9)	178 (30.3)	0.011
Nighttime of day	73 (47.4)	195 (42.5)	0.287	15 (57.7)	253 (43.1)	0.142
Number of previous ED visits, median (IQR)	2 (0–10)	2 (0–6)	0.059	6 (2–17)	2 (0–7)	0.003

OHCA, out-of-hospital cardiac arrest; ED, emergency department; CPR, cardiopulmonary resuscitation.

Survival rate

This study alarmingly poor outcomes for ED cardiac arrest in Jordan, where survival rates fall below those reported in the United States (28.7%)[18] and Sweden (35%).[16] The high prevalence of asystole as the first recorded rhythm likely contributes to these outcomes, given its known correlation with worse survival and prolonged time to initial rhythm analysis.[18] Moreover, as a tertiary-care facility, KAUH may treat s more severely ill population with a poorer prognosis, further limiting survival.[19] A nationwide analysis including various healthcare facilities is needed to better understand ED cardiac arrests in Jordan.

Our findings indicate that survival to discharge for OHCA events (1.9%) is markedly lower than global averages (8.8% for OHCA, 17.6% for IHCA).[12,13] Having an OHCA event independently decreased survival chances after hospital admission. However, these results do not reflect the broader OHCA population, as individuals who died before ED arrival or who sustained ROSC prehospital were excluded. Future research should identify poor survival predictors for OHCA in Jordan and examine EMS to guide urgently needed public health initiatives. Reliable data, however, remain scarce, and standardized prehospital data collection using Utstein-Style Templates is still lacking.

Low- and middle-income countries, including Jordan, often lack adequate registries and public health initiatives targeting early recognition of cardiac arrest and timely CPR and defibrillation.[10] While most Jordanian healthcare sectors follow AHA guidelines, we recommend regular monitoring of CPR quality and adherence. The absence of widespread public CPR and AED education initiatives,[20] along with the lack of important legislation, is likely linked to poor clinical outcomes for OHCA in Jordan.[10,21] No national directives govern when to initiate, withhold, or terminate resuscitation, and do-not-

Table 3 – Factors associated with survival to hospital discharge among admitted patients.

	Admitted patients n = 154	Univariable		Multivariable	
		OR (95% CI)	p-value	aOR (95% CI)	p-value
Age in years, mean (SD)	61.5 (17.7)	0.99 (0.97, 1.02)	0.499	0.94 (0.9, 0.99)	0.012
Male sex, n (%)	90 (58.4)	2.18 (0.86, 5.54)	0.102	–	–
Comorbidity, n (%)					
Diabetes	82 (53.3)	1.50 (0.63, 3.60)	0.355	3.99 (0.78, 20.47)	0.097
Hypertension	91 (59.1)	1.13 (0.48, 2.68)	0.781	–	–
Respiratory diseases	28 (18.2)	0.54 (0.15, 1.93)	0.342	0.11 (0.01, 0.90)	0.039
Ischemic heart diseases	40 (26.0)	1.33 (0.53, 3.36)	0.542	–	–
Cancer	25 (16.2)	0.38 (0.08, 1.72)	0.210	–	–
Stroke	23 (14.9)	3.35 (1.24, 9.03)	0.017	16.15 (3.08, 84.60)	0.001
Renal diseases	17 (11.0)	1.06 (0.28, 4.00)	0.929	–	–
None	22 (14.3)	1.11 (0.34, 3.60)	0.861	–	–
Number of previous ED visits, median (IQR)	2 (0–10)	1.02 (0.99, 1.10)	0.141	1.12 (1.05, 1.19)	0.001
OHCA events, n (%)	64 (41.6)	0.46 (0.18, 1.17)	0.102	0.25 (0.07, 0.99)	0.048
In-ED events, n (%)	90 (58.4)	2.18 (0.86, 5.55)	0.102	–	–
Etiology, n (%)					
Cardiac Etiology	56 (36.4)	2.9 (1.22, 6.85)	0.016	6.31 (1.52, 26.30)	0.011
Non-Cardiac etiology	98 (63.6)	0.35 (0.15, 0.82)	0.016	–	–
Medical non-cardiac	82 (53.2)	0.49 (0.20, 1.15)	0.102	–	–
Traumatic	16 (10.4)	0.30 (0.04–2.39)	0.256	–	–
Initial non-shockable Rhythm, n (%)	147 (95.5)	0.13 (0.03, 0.63)	0.011	–	–
Initial shockable rhythm, n (%)	7 (4.6)	7.58 (1.59, 36.2)	0.011	–	–
Defibrillated during CPR, n (%)	25 (16.2)	3.71 (1.41, 9.71)	0.008	6.14 (1.32, 28.54)	0.021
Epinephrine doses, median (IQR)	3 (2–3)	0.54 (0.37, 0.81)	0.003	0.29 (0.15, 0.56)	<0.001
Duration of resuscitation, mean (SD)	11.1 (6.5)	0.89 (0.82, 0.98)	0.012	–	–
Calendar year, median (IQR)	2018 (2016–2020)	0.97 (0.80, 1.17)	0.730	0.73 (0.54, 0.99)	0.046
Weekend, n (%)	53 (34.4)	0.38 (0.16, 0.89)	0.025	2.73 (0.82, 9.09)	0.102
Nighttime of day, n (%)	73 (47.4)	1.65 (0.70, 3.86)	0.252	3.31 (0.91, 11.97)	0.069

OHCA, out-of-hospital cardiac arrest; ED, emergency department; CPR, cardiopulmonary resuscitation; aOR, adjusted odds ratio.

resuscitate protocols are rare. These factors may inflate the number of resuscitated patients and partly explain the low survival rates observed in the current study.

Impact of COVID-19

During 2021 and 2022, our study noted the lowest incidence rates of ED cardiac arrest coinciding with the COVID-19 pandemic. This contrasts with reports of increased cardiac arrest rates elsewhere.[22,23] Pandemic-related OHCA spikes often correlate with local COVID-19 incidence,[24,25] yet our findings may reflect higher ED utilization rather than fewer arrests. Our hospital, serving as Northern Jordan's main COVID-19 center in 2020–2021, received both low- and high-risk patients, potentially diminishing the proportion of ED arrests. The lower 2021 OHCA incidence may also indicate higher community mortality or fewer CPR attempts during peak waves. Further survival declined during these years, with the likelihood of survival decreasing by calendar year.[26] Overcrowding and possible direct effects of COVID-19 may have contributed. Notably, a history of respiratory illness further reduced survival to discharge, suggesting a COVID-19–related impact on outcomes.

Limitations

This study has several limitations. The design of the study leaves it open to the inherent limitations of a retrospective observational study. Additionally, as we focused on patients who received documented CPR in the ED, we did not include patients with OHCA who died or attained ROSC before hospital, or those who presented in a near-arrest state but did not receive CPR. This limited approach may underestimate the broader OHCA burden and restrict the generalizability of our findings, highlighting the need for more comprehensive prehospital data and documentation protocols. Further, the relatively limited sample size of our study may have resulted in insufficient power to detect smaller effect sizes. However, it remains adequate for observing the primary outcomes of the study. Data regarding certain variables such as comorbidity and etiology of cardiac arrest were infrequently recorded and missing in the analysis. However, the main outcomes investigated in the study were well-recorded in the study population. Although several variables were entered into multivariable regression models, certain potential factors may have been missed, particularly for OHCA.

Conclusion

Clinical outcomes following both OHCA and in-ED cardiac arrests in Jordan were relatively poor and have not improved over time. Survival rates are relatively low and likely declining, and the prevalence of asystole as the first recorded rhythm is high. Patients with OHCA had a lower chance of survival relative to those arresting in ED, without any change in their incidence rate over time. More attention should be directed toward improving OHCA survival through robust prehospital initiatives, including evidence-based clinical guidelines,

community-wide bystander CPR training, and increased AED availability. For in-ED and other in-hospital arrests, targeted performance improvement efforts, adherence to guideline-based protocols, and structured post–cardiac arrest care can optimize outcomes. Quality improvement projects for emergency health care services should be conducted more regularly at the national level and focus on guideline-directed performance and documentation.

Author contributions

AA and SR conceived the idea and developed the study design; AA, MAN, SK, and DA contributed to data collection and data manipulation; AA and KAK conducted data analysis and visualization; AA and MAN wrote the first draft of the manuscript; and SR, KAK, SA, MA, AO, LR, and ZN critically reviewed and edited the manuscript and approved the final version.

CRediT authorship contribution statement

Ahmad Alrawashdeh: Writing – original draft, Visualization, Resources, Methodology, Formal analysis, Data curation, Conceptualization. **Mohammed Al-Nusair:** Writing – original draft, Resources, Data curation. **Sukaina Rawashdeh:** Resources, Methodology, Data curation, Conceptualization. **Doaa Abdi:** Resources, Data curation. **Khalid A. Kheirallah:** Writing – review & editing, Validation, Supervision. **Saeed Alqahtani:** Writing – review & editing. **Mahmoud Alwidyan:** Writing – review & editing. **Alaa Oteir:** Writing – review & editing. **Liqaa Raffee:** Writing – review & editing. **Ziad Nehme:** Writing – review & editing.

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Data Availability

The data used in the current study are available from the corresponding author upon reasonable request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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REFERENCES

1. Sasson C, Rogers MAM, Dahl J, Kellermann AL. Predictors of survival from out-of-hospital cardiac arrest a systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes 2010;3:63–81. https://doi.org/10.1161/CIRCOUTCOMES.109.889576. PubMed Central PMCID: PMC20123673.
2. Wissenberg M, Lippert FK, Folke F, et al. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. JAMA 2013;310:1377–84. https://doi.org/10.1001/jama.2013.278483. PubMed Central PMCID: PMC24084923.
3. Martinell L, Nielsen N, Herlitz J, et al. Early predictors of poor outcome after out-of-hospital cardiac arrest. Crit Care 2017;21. https://doi.org/10.1186/s13054-017-1677-2. PubMed Central PMCID: PMC28410590.
4. Myat A, Song KJ, Rea T. Out-of-hospital cardiac arrest: current concepts. Lancet 2018;391:970–9. https://doi.org/10.1016/S0140-6736(18)30472-0. PubMed Central PMCID: PMC29536861.
5. Kempster K, Howell S, Bernard S, et al. Out-of-hospital cardiac arrest outcomes in emergency departments. Resuscitation 2021;166:21–30. https://doi.org/10.1016/j.resuscitation.2021.07.003. PubMed Central PMCID: PMC34271123.
6. Johnson NJ, Salhi RA, Abella BS, Neumar RW, Gaieski DF, Carr BG. Emergency department factors associated with survival after sudden cardiac arrest. Resuscitation 2013;84:292–7. https://doi.org/10.1016/j.resuscitation.2012.10.013. PubMed Central PMCID: PMC23103887.
7. Hsu SH, Sung CW, Lu TC, et al. The incidence, predictors, and causes of cardiac arrest in United States emergency departments. Resuscitation plus 2024;17. https://doi.org/10.1016/j.resplu.2023.100514.
8. Szaruta-Raflesz K, Łopaciński T, Frequency SM. Prognosis, and clinical features of unexpected versus expected cardiac arrest in the emergency department: a retrospective analysis. J Clin Med 2024;13. https://doi.org/10.3390/jcm13092509.
9. Yeung J, Matsuyama T, Bray J, Reynolds J, Skrifvars M. Does care at a cardiac arrest centre improve outcome after out-of-hospital cardiac arrest?—A systematic review. Resuscitation 2019;137:102–15.
10. Grubic N, Hill B, Allan KS, Dainty KN, Johri AM, Brooks SC. Community interventions for out-of-hospital cardiac arrest in resource-limited settings: a scoping review across low, middle, and high-income countries. Prehospital Emerg Care 2023;27:1088–100. https://doi.org/10.1080/10903127.2023.2231559. PubMed Central PMCID: PMC37406163.
11. Raffee LA, Samrah SM, Al Yousef HN, Abeeleh MA, Alawneh KZ. Incidence, characteristics, and survival trend of cardiopulmonary resuscitation following in-hospital compared to out-of-hospital

cardiac arrest in northern Jordan. Indian J Critical Care Med: Peer-Reviewed, off Publ Indian Soc Crit Care Med 2017;21:436.
12. Yan S, Gan Y, Jiang N, et al. The global survival rate among adult out-of-hospital cardiac arrest patients who received cardiopulmonary resuscitation: a systematic review and meta-analysis. Crit Care 2020;24. https://doi.org/10.1186/s13054-020-2773-2. PubMed Central PMCID: PMC32087741.
13. Schluep M, Gravesteijn BY, Stolker RJ, Endeman H, Hoeks SE. One-year survival after in-hospital cardiac arrest: a systematic review and meta-analysis. Resuscitation 2018;132:90–100. https://doi.org/10.1016/j.resuscitation.2018.09.001. PubMed Central PMCID: PMC30213495.
14. Khader Y, Al Nsour M, Abu Khudair S, Saad R, Tarawneh MR, Lami F. Strengthening primary healthcare in Jordan for achieving universal health coverage: a need for family health team approach. Healthcare (Switzerland) 2023;11. https://doi.org/10.3390/healthcare11222993.
15. Hammad EA, Alabbadi I, Taissir F, et al. Hospital unit costs in Jordan: insights from a country facing competing health demands and striving for universal health coverage. Health Econ Rev 2022;12:11. https://doi.org/10.1186/s13561-022-00356-0.
16. Kimblad H, Marklund J, Riva G, Rawshani A, Lauridsen KG, Djärv T. Adult cardiac arrest in the emergency department–A Swedish cohort study. Resuscitation 2022;175:105–12.
17. Sung C-W, Lu T-C, Wang C-H, et al. In-hospital cardiac arrest in United States emergency departments, 2010–2018. Front Cardiovasc Med 2022;9:874461.
18. Høybye M, Stankovic N, Lauridsen KG, Holmberg MJ, Andersen LW, Granfeldt A. Pulseless electrical activity vs. asystole in adult in-hospital cardiac arrest: predictors and outcomes. Resuscitation 2021;165:50–7.
19. Hirlekar G, Jonsson M, Karlsson T, Hollenberg J, Albertsson P, Herlitz J. Comorbidity and survival in out-of-hospital cardiac arrest. Resuscitation 2018;133:118–23.
20. Alwidyan MT, Alkhatib ZI, Alrawashdeh A, et al. Knowledge and willingness of schoolteachers in Jordan to perform CPR: a cross-sectional study. BMJ Open 2023;13:e073080. https://doi.org/10.1136/bmjopen-2023-073080.
21. Li S, Qin C, Zhang H, et al. Survival after out-of-hospital cardiac arrest before and after legislation for bystander CPR. JAMA Netw Open 2024;7:E247909. https://doi.org/10.1001/jamanetworkopen.2024.7909. PubMed Central PMCID: PMC38669021.
22. Sung C-W, Lu T-C, Fang C-C, et al. Impact of COVID-19 pandemic on emergency department services acuity and possible collateral damage. Resuscitation 2020;153:185.
23. Bharmal M, DiGrande K, Patel A, Shavelle DM, Bosson N. Impact of coronavirus disease 2019 pandemic on cardiac arrest and emergency care. Cardiol Clin 2022;40:355–64.
24. Baldi E, Sechi GM, Mare C, et al. COVID-19 kills at home: the close relationship between the epidemic and the increase of out-of-hospital cardiac arrests. Eur Heart J 2020;41:3045–54.
25. Huber BC, Brunner S, Schlichtiger J, Kanz K-G, Bogner-Flatz V. Out-of-hospital cardiac arrest incidence during COVID-19 pandemic in Southern Germany. Resuscitation 2020;157:121–2.
26. Ippolito M, Catalisano G, Marino C, et al. Mortality after in-hospital cardiac arrest in patients with COVID-19: a systematic review and meta-analysis. Resuscitation 2021;164:122–9.