Resuscitation Plus 20 (2024) 100775

Contents lists available at ScienceDirect

Resuscitation Plus

journal homepage: www.elsevier.com/locate/resuscitation-plus

Clinical paper

In-hospital cardiac arrest in middle-income settings: A comprehensive analysis of clinical profiles and outcomes of both adults and pediatrics

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ARTICLE INFO

Keywords:
In-hospital cardiac arrest
Cardiopulmonary resuscitation
Epidemiology
Outcome

ABSTRACT

Background: In hospital cardiac arrest is associated with poor survival despite basic and advanced life support measures. This study aimed to identify the clinical characteristics and outcomes of cardiac arrests occurring during in-hospital admission to the tertiary care center in Pakistan.
Method: A retrospective, cross-sectional study at Aga Khan University Hospital from 2021 to 2023 analyzed 230 cardiac arrest cases. Data included demographics, arrest type, timing, initial rhythm, resuscitation duration, and arrest location. American Heart Association guidelines were adhered to for life support. The main outcomes focused on the return of spontaneous circulation survival to hospital discharge.
Results: During the study, 230 cardiac arrests were observed: 152 in adults (mean age 57.8, 142 shockable cases, ROSC 52.6 %, alive at discharge 28.3 %) and 78 in pediatric patients (mean age 4.99, non-shockable rhythm 85.9 %, ROSC 51.3 %, alive at discharge 17.9 %). Adult Charles comorbidity index: 2.88 (SD±2.08), pediatric index: 0.610 (SD±0.88). Survival rates were lower with a high comorbidity index and code duration > 20 min.
Conclusion: The study provides valuable observational data that challenges global survival rates for in-hospital cardiac arrest. It highlights how factors like being in monitored units and the presence of rapid response teams can lead to higher survival rates. The research underscores the influence of comorbidities, initial rhythms, and the duration of resuscitation efforts on patient outcomes, emphasizing the need for more research, especially in settings with limited resources.

Introduction

In-hospital cardiac arrest (IHCA) stands as a global health concern, significantly contributing to increasing mortality and morbidity globally.[1,2] According to the American Heart Association (AHA), a hospital cardiac arrest (IHCA) is estimated to occur at a rate of 9.7 cases per 1000 hospital admissions, totaling approximately 292,000 cases annually while for the pediatric population, it is 15,200 cases annually[3,4] The incidence in the UK in 2013 was estimated at 1.6 per 1000 hospital admissions.[5] Despite the global impact of IHCA, there is a lack of data in low-middle-income countries. Various evidence-based studies have emphasized the increased hospital burden due to IHCA in developing countries to maintain effective resuscitation systems. Research conducted in Thailand, involving 639 patients across various age groups, indicated a 61.7 % rate of return to spontaneous circulation and a survival rate of 6.9 %. Likewise, Aziz et al. reported an incidence of 11.7 cases of in-hospital cardiac arrest per 1,000 hospital admissions, with a survival rate to discharge of 7.7 %. Similarly, a study conducted in India found a return of spontaneous circulation (ROSC) rate of 16.7 % and a survival to discharge rate of 8.2 %.[6]

In well-resourced medical settings, the response to IHCA has evolved, typically involving the activation of specialized first responder teams, known as medical emergency teams (MET) or rapid response teams (RRT). Comprehensive IHCA registries, including UT Stein-style

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https://doi.org/10.1016/j.resplu.2024.100775
Received 30 May 2024; Received in revised form 22 August 2024; Accepted 6 September 2024

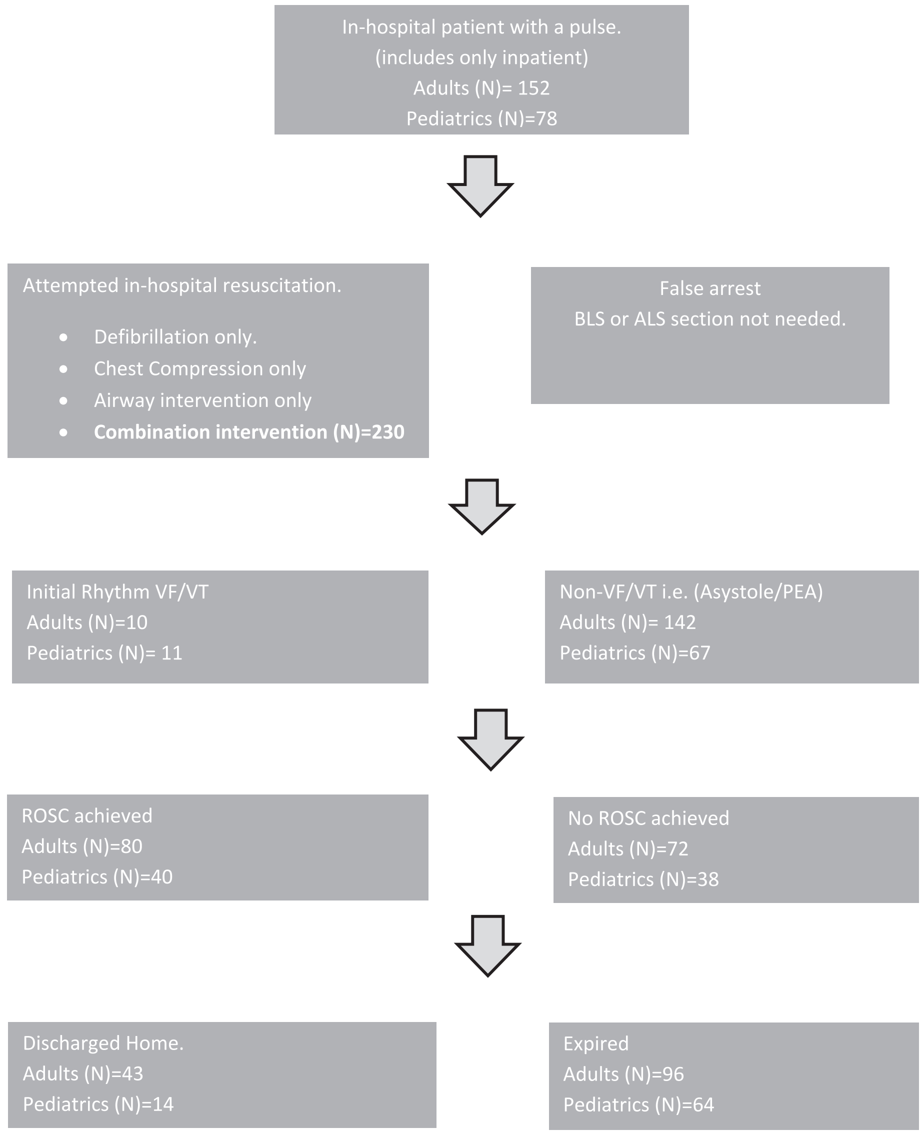

Fig. 1. In-hospital Ut-stein style reporting.

reporting guidelines and the BASeline Investigation of Cardiac Arrest (BASIC)–IHCA, serve as valuable tools for assessing resuscitation strategies and guidelines through observational studies. However, most research on cardiopulmonary resuscitation originates from well-resourced populations and high-resource healthcare environments. Implementing resuscitation guidelines from these studies poses challenges for healthcare systems in LMICs, where limited research indicates a survival rate of only 18.9 % for individuals experiencing cardiac arrest while for pediatrics 80–90 % survive the event but most patients do not survive to hospital discharge.[7,8]

It is unclear whether data from high-resource, well-developed settings can be effectively utilized to guide practices in low- and middle-income countries (LMICs). The main objective of this study is to analyze the demographics, risk factors, and outcomes of patients who experience in-hospital cardiac arrest (IHCA) in tertiary care institutions in Pakistan. By focusing on IHCA in this specific context, the study seeks to address existing knowledge gaps and provide insights into the challenges of managing IHCA in such environments (see Fig. 1).

Methods

This retrospective cross-sectional study examined the clinical characteristics and outcome of patients at Aga Khan University Hospital who experienced cardiac arrest requiring chest compressions, defibrillation, or both, between January 2021 and July 2023. The Institutional Review Board at the University deemed this research exempt from ethical approval with reference number 2024–9258-28229.

The data management adhered to university policy and the principles outlined in the Declaration of Helsinki. The term cardiac arrest is used to describe a critical medical event characterized by the cessation of effective ventilation and perfusion.[1] In the study, all patients above 1 month of age who developed cardiac arrest and received CPR were included. Those who suffered cardiac arrest outside of the hospital and in the emergency, department were excluded from the study.

The Aga Khan University Hospital (AKUH), accredited by the Joint Commission International, has a total capacity of 710 beds and serves a population of over 234.1 million. The facility includes 137 beds for specialized (monitored) care and 28 beds for intensive care units (including medical, surgical, cardiac, and cardiac surgical ICUs) for adults while for pediatrics 90 specialized (monitored) care out of which 8 (high dependency unit) HDU and 12 (pediatric intensive care units) PICU beds are available. AKUH runs a dedicated Rapid Response Team (RRT) that addresses the medical needs of adult and pediatric patients throughout the hospital, excluding those in the Intensive Care Units

Table 1
Population and event characteristics.

Domain	Pediatric Population (n = 78)		Adult Population (n = 152)	
Age	**Age Category**	**N (%)**	**Age Category (years)**	**N (%)**
	1 month −1 year	32 (41.0 %)	**18–24**	8 (5.3 %
	1 year- 3 years	10 (12.8 %)	**25–44**	29 (19.1 %)
	3 years- 6 years	09 (11.5 %)	**45–64**	48 (31.6 %)
	6 years- 12 years	12 (15.4 %)	**>64**	66 (43.4 %)
	12 years- 18 years	14 (17.9 %)		
CCI Score Mean (SD)	0.61 (0.88)		2.88 (2.08)	
Sex	**Male**	46 (59.0 %)	**Male**	98 (64.5 %)
	Female	32 (41.0 %)	**Female**	53 (34.9 %)
Clinical Specialty	**Medicine**	46 (59.0 %)	**Medicine**	129 (84.9 %)
	Surgery	32 (41.0 %)	**Surgery**	23 (15.1 %)
Location of Patient	**PICU**	67 (85.9 %)	**ICU**	102 (67.1 %)
	HDU	9 (11.5 %)	**HDU**	4 (2.6 %)
	Ward	2 (2.6 %)	**Ward**	45 (29.6 %)
Rapid Response Team (RRT) Activation	**≤ 24 Hours**	3 (3.8 %)	**≤ 24 Hours**	52 (34.2 %)
	> 24 Hours	8 (10.3 %)	**> 24 Hours**	100 (65.8 %)
	Not Applicable	67 (85.9 %)	**Not Applicable**	
Initial Rhythm at the Time of Cardiac Arrest	**Shockable**	11 (14.1 %)	**Shockable**	10 (6.6 %)
	Non-shockable	67 (85.9 %)	**Non-shockable**	142 (93.4 %)
Cause of Code Blue	**Cardiac**	47 (60.3 %)	**Cardiac**	104 (68.4 %)
	Respiratory	31 (39.7 %)	**Respiratory**	48 (31.6 %)
Duration of Resuscitation (Median IQR)	12.0 ± 14.0		10.5 ± 18.8	
ROSC Achieved	**Yes**	40 (51.3 %)	**Yes**	80 (52.6 %)
	No	38 (48.7 %)	**No**	72 (47.4 %)
Alive at hospital discharge	**No**	64 (82.1 %)	**No**	96(63.2 %)
	Yes	14 (17.9 %)	**Yes**	43 (28.3 %)

Table 2
Comparison of Return of Spontaneous Circulation (ROSC) across key variables. (Adult).

	Category	NO ROSC	ROSC	OR (univariate)		OR (multivariable)	
				N (%)	p-value	N (%)	p-value
Age (years) (Ref: >64 years)	18–24	5 (62.5)	3 (37.5)	0.60 (0.12–2.65)	0.507	1.19 (0.13–10.99)	0.875
	25–44	12 (41.4)	17 (58.6)	1.42 (0.59–3.48)	0.439	1.04 (0.26–4.18)	0.958
	45–64	22 (45.8)	26 (54.2)	1.18 (0.56–2.50)	0.660	1.02 (0.40–2.62)	0.970
	>64	33 (50.0)	33 (50.0)				
Sex (Ref: Males)	Females	27 (50.9)	26 (49.1)	0.82 (0.42–1.60)	0.555	0.80 (0.36–1.75)	0.576
	Males	45 (45.9)	53 (54.1)				
Clinical speciality (Ref: Surgery)	Medicine	60 (46.5)	69 (53.5)	1.25 (0.51–3.09)	0.617	1.41 (0.52–3.82)	0.494
	Surgery	12 (52.2)	11 (47.8)				
Location (Ref: Ward)	HDU	1 (25.0)	3 (75.0)	4.11 (0.48–86.60)	0.237	4.43 (0.34–130.71)	0.299
	ICU	44 (43.1)	58 (56.9)	1.80 (0.89–3.71)	0.103	1.52 (0.63–3.69)	0.348
	Ward	26 (57.8)	19 (42.2)				
RRT (Ref: >24)	≤ 24 Hours	24 (46.2)	28 (53.8)	1.08 (0.55–2.12)	0.829	1.14 (0.52–2.51)	0.745
	> 24 Hours	48 (48.0)	52 (52.0)				
Initial Rhythm (Ref: Non shockable)	Shockable	4 (40.0)	6 (60.0)	1.38 (0.38–5.59)	0.630	1.97 (0.41–11.83)	0.415
	Non-shockable	68 (47.9)	74 (52.1)				
Cause of Code Blue (Ref: Cardiac Arrest)	Respiratory Arrest	27 (56.2)	21 (43.8)	0.59 (0.30–1.18)	0.138	0.55 (0.23–1.31)	0.177
	Cardiac Arrest	45 (43.3)	59 (56.7)				
CCI Score	Mean (SD)	3.0 (2.3)	2.8 (1.9)	0.95 (0.82–1.11)	0.552	0.96 (0.73–1.26)	0.766
Duration of Resuscitation (min) (Ref: >20)	<=20	45 (37.5)	75 (62.5)	8.67 (3.35–27.07)	<0.001	10.26 (3.78–33.63)	<0.001
	>20	26 (83.9)	5 (16.1)				

(ICUs). The primary goal of the RRT is to respond within a 5-minute timeframe, assess patients using modified early warning signs and pediatric early warning signs, and actively engage in resuscitation efforts. Additionally, a dedicated 24/7 Code Blue Team, comprising Anesthesia, Cardiology, and Internal Medicine teams (with the Pediatric Intensive Care Unit team for pediatric cases), ensures continuous coverage code blue coverage. The Code Blue Team remains involved until the Return of Spontaneous Circulation (ROSC) or the declaration of death. Detailed

Table 3
Comparison of Return of Spontaneous Circulation (ROSC) rates across key variables (Pediatrics).

	Category	NO ROSC	ROSC	p-value
Age	1 M−1Y(Infant)	12 (31.6)	20 (50.0)	0.076
	1Y-3Y(Toddler)	5 (13.2)	5 (12.5)	
	3Y-6Y(Preschool)	2 (5.3)	7 (17.5)	
	6Y-12Y (School-age)	8 (21.1)	4 (10.0)	
	12Y-18Y(Adolescent)	10 (26.3)	4 (10.0)	
Sex	Female	13 (34.2)	19 (47.5)	0.258
	Male	25 (65.8)	21 (52.5)	
Clinical Specialty	Medicine	26 (68.4)	33 (82.5)	0.190
	Surgery	12 (31.6)	7 (17.5)	
Location of patient	PICU	33 (86.8)	34 (85.0)	>0.900
	HDU	4 (10.5)	5 (12.5)	
	WARD	1 (2.6)	1 (2.5)	
RRT	≤ 24 Hours	4 (10.5)	4 (10.0)	>0.900
	> 24 Hours	1 (2.6)	2 (5.0)	
	Not applicable	33 (86.8)	34 (85.0)	
Initial rhythm	Non-shockable	33 (86.8)	34 (85.0)	>0.900
	Shockable	5 (13.2)	6 (15.0)	
Cause of code blue	Cardiac	26 (68.4)	21 (52.5)	0.172
	Respiratory	12 (31.6)	19 (47.5)	
Resuscitation time (minutes)	≤ 20	16 (42.1)	37 (92.5)	<0.001
	>20	22 (57.9)	3 (7.5)	
Alive at Hospital Discharge	No	38 (100)	26 (65.0)	<0.001
	Yes	0 (0)	14 (35.0)	

documentation of each Code Blue event occurs through a specialized Cardiopulmonary Resuscitation Record Form (CPR), capturing patient demographics, existing medical conditions, recent RRT utilization, and the timeline for Code Blue Team arrival within a 5-minute.

The study population's demographic information, including age and gender, was recorded, along with additional variables sourced from the Health Information Management System (HIMS) and the CPR database. These variables include the initial cardiac rhythm, categorized as either shockable (ventricular fibrillation and ventricular tachycardia) or non-shockable (pulseless electrical activity and asystole), CPR duration in minutes, the achievement of Return of Spontaneous Circulation (ROSC) within 20 min, the Charlson Comorbidity Index (CCI) score,[24] and survival to hospital discharge. Cardiac arrests were classified as either primary cardiac or non-cardiac in origin, with respiratory issues being the most common cause in the non-cardiac category. Respiratory causes of cardiac arrest primarily involve severe hypoxia, tension pneumothorax, and other respiratory complications.

Statistical analysis was conducted using RStudio (version 4.1.2; Boston, USA). For numerical variables, we calculated the mean (SD), while for categorical variables, we determined the frequency (proportion). Stratification analyses were carried out using the following variables: ROSC (Yes/No), Survival to discharge (Yes/No), and Code time (≤20/>20). To assess statistical associations, we utilized an independent *t*-test for quantitative data and Chi-square or Fisher's exact tests for qualitative data. Furthermore, univariate and multivariable binary logistic regression models were employed to identify potential factors associated with ROSC, survival to discharge, and code time. Statistical significance was defined as a p-value of less than 5 %.

Results

The study recorded Code Blue incidents at rates of 3, 5, and 5 per 1,000 patient days for 2021, 2022, and 2023, respectively. Among the 230 participants, 152 were adults (66.1 %), with a mean age of 57.8 years (SD±17.9), and 78 were pediatric patients (33.9 %), with a mean age of 4.99 years (SD±5.66). The majority were male in both groups (64.5 % adults, 59.0 % pediatrics). Most cardiac arrests occurred in the Department of Medicine (84.9 % adults, 59.0 % pediatrics), predominantly in the ICU (67.1 % adults, 85.9 % pediatrics). The Rapid Response Team was activated for 34.2 % of adults and 3.8 % of pediatric patients within the first 24 h of arrest (Table 1).

Cardiac arrests mostly involved non-shockable rhythms (93.4 % adults, 85.9 % pediatrics) and were largely due to cardiac causes (68.4 % adults, 60.3 % pediatrics). Return of spontaneous circulation (ROSC) was achieved in 52.6 % of adults and 51.3 % of pediatric patients, but 28.3 % of adults and 17.9 % of pediatric patients were discharged alive (Table 1). The study evaluated the likelihood of achieving ROSC, duration of code time, and survival outcomes in relation to demographic and clinical characteristics.

In the adult cohort, a duration of resuscitation of less than or equal to 20 min, was associated with a higher likelihood of achieving ROSC (AOR:10.26, 95 % CI: 3.78–33.63, $p < 0.001$). Age did not significantly affect ROSC outcomes, with similar rates across all age groups. Sex also showed no significant differences in ROSC rates (AOR: 0.80, 95 % CI: 0.36–1.75, $p = 0.576$). The highest ROSC rates were observed in the ICU (AOR: 1.52, 95 % CI: 0.63–3.69, $p = 0.348$) (Table 2).

In the pediatric cohort, ROSC rates were higher among infants (1 month-1 year) and children aged 3–6 years, though this was not statistically significant ($p = 0.076$). Most of the pediatric patients who

Table 4
Comparison of Code time in minutes (Adult) across key variables.

	Category	>20	<=20	OR (univariate)		OR (multivariable)	
				N (%)	p-value	N (%)	p-value
Age (years) (Ref: >64 years)	18–24	3 (37.5)	5 (62.5)	0.46 (0.10–2.45)	0.322	0.14 (0.01–1.43)	0.100
	25–44	6 (20.7)	23 (79.3)	1.05 (0.37–3.28)	0.926	0.70 (0.13–3.72)	0.669
	45–64	8 (16.7)	40 (83.3)	1.37 (0.53–3.74)	0.519	0.95 (0.27–3.34)	0.936
	>64	14 (21.5)	51 (78.5)				
Sex (Ref: Males)	Females	12 (23.1)	40 (76.9)	0.80 (0.36–1.85)	0.596	0.87 (0.32–2.45)	0.794
	Males	19 (19.4)	79 (80.6)				
Clinical specialty (Ref: Surgery)	Medicine	26 (20.3)	102 (79.7)	1.09 (0.34–3.03)	0.876	0.92 (0.23–3.27)	0.902
	Surgery	5 (21.7)	18 (78.3)				
Location (Ref: Ward)	HDU	1 (25.0)	3 (75.0)	0.77 (0.09–16.62)	0.831	0.33 (0.01–11.75)	0.500
	ICU	21 (20.6)	81 (79.4)	0.99 (0.40–2.33)	0.985	1.06 (0.34–3.21)	0.924
	Ward	9 (20.5)	35 (79.5)				
RRT (Ref: >24)	≤ 24 Hours	10 (19.6)	41 (80.4)	1.09 (0.48–2.62)	0.841	1.05 (0.38–2.99)	0.918
	> 24 Hours	21 (21.0)	79 (79.0)				
Initial Rhythm (Ref: Nonshockable)	Shockable	2 (20.0)	8 (80.0)	1.04 (0.24–7.11)	0.966	0.58 (0.08–5.14)	0.587
	Non-shockable	29 (20.6)	112 (79.4)				
Cause of Code Blue (Ref: Cardiac Arrest)	Respiratory Arrest	7 (14.9)	40 (85.1)	1.71 (0.71–4.61)	0.253	2.80 (0.90–9.94)	0.089
	Cardiac Arrest	24 (23.1)	80 (76.9)				
CCI Score	Mean (SD)	3.1 (2.6)	2.8 (1.9)	0.95 (0.79–1.15)	0.593	0.97 (0.72–1.31)	0.819
	No	28 (28.6)	70 (71.4)	0.12 (0.02–0.44)	0.005	0.36 (0.03–3.81)	0.376
Alive at hospital discharge (Ref: Discharged)	Yes	2 (4.7)	41 (95.3)				

achieved ROSC were resuscitated within 20 min (92.5 %, p < 0.001) although 35 % of ROSC patients were alive at discharge (p < 0.001). Additionally, no significant differences were observed regarding sex (p = 0.258), PICU location (86.8 % no ROSC vs. 85.0 % ROSC, p > 0.900), initial rhythm (p > 0.900), and cause of the code (cardiac vs. respiratory, p = 0.172) (Table 3).

In the adult cohort, younger age (18–24 years) had lower odds of having a code time under 20 min compared to those over 64 years, though insignificant (AOR: 0.14, p = 0.100). Respiratory arrest had higher odds of having a code time under 20 min as compared to those with cardiac arrest (AOR:2.80, 95 %CI: 0.90–9.94, p = 0.089). There were no significant differences based on sex (p = 0.794), clinical specialty (p = 0.902), location (p = 0.500,0.924), RRT activation (p = 0.918), initial rhythm (p = 0.587), survival to discharge (p = 0.376), or CCI score (p = 0.819) (Table 4).

In the pediatric cohort, infants (1 month to 1 year) had a significantly higher proportion of code time > 20 min compared to ≤ 20 min (47.2 % vs. 28.0 %, p = 0.046) while children aged 6–12 years had a higher proportion of code time <=20 min (32.0 % vs. 7.5 %, p = 0.046). There were no significant differences based on sex, although males were more prevalent in both groups (p = 0.141). The clinical specialty, location of the patient, RRT timing, initial rhythm, and cause of Code Blue did not show significant associations with code time. However, return of spontaneous circulation (ROSC) was significantly associated, where 88.0 % of patients did not achieving ROSC when code time was under 20 min compared to 30.2 % when code time was greater than 20 min (p < 0.001). While not statistically significant, a higher percentage of patients in the ≤ 20 group were not alive at hospital discharge compared to the > 20 group (92.0 % vs. 77.4 %, p = 0.204) (Table 5).

In the adult cohort, patients aged 25–44 had a lower likelihood of survival compared to those over 64, with an AOR of 0.41 (95 % CI: 0.08–2.18, p = 0.293), though insignificant. No significant differences in survival were observed based on sex (AOR: 1.35, p = 0.528). Medicine specialty patients had a lower odd of survival than those in surgery (AOR: 0.26, p = 0.048). Similar trends were observed for HDU patients compared to the ward patients (AOR:0.01, p = 0.010). Additionally, the involvement of the RRT within 24 h significantly improved survival outcomes (AOR: 3.83, p = 0.013), indicating the importance of timely intervention. Duration of resuscitation of less than 20 min significantly decreased survival outcomes (AOR: 0.06, p = 0.001) (Table 6).

In the pediatric cohort, most of the cardiac patients expired (68.8 %), whereas most of the respiratory patients survived (78.6 %) (p = 0.002). 100 % of the patients who achieved ROSC in under 24 h were alive at discharge (p < 0.001). Survival rates did not significantly differ across age groups (p = 0.417) or sex (p > 0.900). Clinical specialty and location also showed no significant impact on survival outcomes (p = 0.735 and p = 0.120, respectively). The initial rhythm and rapid response team activation were not significantly associated with survival (p = 0.678 and p = 0.151, respectively). (See Table 7).

Discussion

This study analyzed all patients who went into cardiac arrest at Aga Khan University Hospital over 3 years, from 2021 to 2023. The incidence was 3,5 and 5 per 1000 patients in the years 2021–2022 and 2023 respectively. This has been found to vary between institutions and countries being 1.6–6 per 1000 patients in Australia and New Zealand While the United States reported it to be 9–10 per 1000 patients for adults. Published results for the incidence of pediatric in-hospital cardiopulmonary arrest (IHCA) range from 1.1/1000 to 21/1000.[9,10] Potential reasons for such variation in IHCA survival may include differences in IHCA preparedness e.g. availability and allocation of resources for preventing and managing IHCA, rapid response or code team, dedicated nursing staff, routine resuscitation simulation, quality

Table 5
Comparison of Code time in minutes (Pediatrics) across key variables.

	Category	>20	<=20	p-value
Age	1 M−1Y(Infant)	25 (47.2)	7 (28.0)	0.046
	1Y-3Y(Toddler)	7 (13.2)	3 (12.0)	
	3Y-6Y(Preschool)	8 (15.1)	1 (4.0)	
	6Y-12Y (School-age)	4 (7.5)	8 (32.0)	
	12Y-18Y(Adolescent)	9 (17.0)	5 (20.0)	
Sex	Female	25 (47.2)	7 (28.0)	0.141
	Male	28 (52.8)	18 (72.0)	
Clinical specialty	Medicine	42 (79.2)	17 (68.0)	0.397
	Surgery	11 (20.8)	8 (32.0)	
Location of patient	PICU	46 (86.8)	21 (84.0)	0.867
	HDU	6 (11.3)	3 (12.0)	
	Ward	1 (1.9)	1 (4.0)	
RRT	≤ 24 Hours	5 (9.4)	3 (12.0)	0.867
	> 24 Hours	2 (3.8)	1 (4.0)	
	Not applicable	46 (86.8)	21 (84.0)	
Initial rhythm	Non– shockable	47 (88.7)	20 (80.0)	0.316
	Shockable	6 (11.3)	5 (20.0)	
Cause of code blue	Cardiac	29 (54.7)	18 (72.0)	0.215
	Respiratory	24 (45.3)	7 (28.0)	
ROSC	No	16 (30.2)	22 (88.0)	<0.001
	Yes	37 (69.8)	3 (12.0)	
Alive at hospital discharge	No	41 (77.4)	23 (92.0)	0.204
	Yes	12 (22.6)	2 (8.0)	

Table 6
Survival Outcomes in Relation to Key Variables (Adult).

	Category	NO ROSC	ROSC	OR (univariate)		OR (multivariable)	
				N (%)	p-value	N (%)	p-value
Age (years) (Ref: >64 years)	18–24	3 (42.9)	4 (57.1)	0.41 (0.08–2.31)	0.285	0.48 (0.04–5.59)	0.558
	25–44	13 (48.1)	14 (51.9)	0.34 (0.13–0.88)	0.026	0.41 (0.08–2.18)	0.293
	45–64	13 (28.9)	32 (71.1)	0.77 (0.32–1.86)	0.553	1.26 (0.41–4.07)	0.686
	>64	14 (23.7)	45 (76.3)				
Sex (Ref: Males)	Females	16 (32.7)	33 (67.3)	0.88 (0.42–1.89)	0.747	1.35 (0.54–3.57)	0.528
	Males	27 (30.0)	63 (70.0)				
Clinical speciality (Ref: Surgery)	Medicine	39 (33.6)	77 (66.4)	0.42 (0.11–1.20)	0.133	0.26 (0.06–0.91)	0.048
	Surgery	4 (17.4)	19 (82.6)				
Location (Ref: Ward)	HDU	3 (75.0)	1 (25.0)	0.07 (0.00–0.64)	0.031	0.01 (0.00–0.25)	0.010
	ICU	32 (35.6)	58 (64.4)	0.39 (0.15–0.91)	0.036	0.42 (0.13–1.23)	0.121
	Ward	8 (17.8)	37 (82.2)				
RRT (Ref: >24)	≤ 24 Hours	9 (18.8)	39 (81.2)	2.58 (1.15–6.28)	0.027	3.83 (1.40–11.94)	0.013
	> 24 Hours	34 (37.4)	57 (62.6)				
Initial Rhythm (Ref: Non shockable)	Shockable	5 (55.6)	4 (44.4)	0.33 (0.08–1.31)	0.113	0.31 (0.05–1.71)	0.184
	Non-shockable	38 (29.2)	92 (70.8)				
Cause of Code Blue (Ref: Cardiac Arrest)	Respiratory Arrest	12 (25.5)	35 (74.5)	1.48 (0.69–3.34)	0.326	1.04 (0.36–2.99)	0.946
	Cardiac Arrest	31 (33.7)	61 (66.3)				
CCI Score	Mean (SD)	2.3 (1.9)	3.2 (2.1)	1.22 (1.02–1.48)	0.036	1.12 (0.80–1.60)	0.533
Duration of Resuscitation (min) (Ref: >20)	<=20	41 (38.0)	67 (62.0)	0.12 (0.02–0.42)	0.005	0.06 (0.01–0.27)	0.001
	>20	2 (6.7)	28 (93.3)				

Table 7
Survival Outcomes in Relation to Key Variables (Pediatric).

	Category	Alive	Expired	p-value
Age	1 M−1Y(Infant)	9 (64.3)	23 (35.9)	0.417
	1Y-3Y(Toddler)	1 (7.1)	9 (14.1)	
	3Y-6Y(Preschool)	2 (14.3)	7 (10.9)	
	6Y-12Y (School-age)	1 (7.1)	11 (17.2)	
	12Y-18Y(Adolescent)	1 (7.1)	13 (20.3)	
Sex	Female	6 (42.9)	26 (40.6)	>0.900
	Male	8 (57.1)	38 (59.4)	
Clinical specialty	Medicine	10 (71.4)	49 (76.6)	0.735
	Surgery	4 (28.6)	15 (23.4)	
Location of patient	PICU	10 (71.4)	57 (89.1)	0.120
	HDU	3 (21.4)	6 (9.4)	
	Ward	1 (7.1)	1 (1.6)	
RRT	No	3 (21.4)	5 (7.8)	0.151
	Yes	1 (7.1)	2 (3.1)	
	Not applicable	10 (71.4)	57 (89.1)	
Initial rhythm	Non-shockable	13 (92.9)	54 (84.4)	0.678
	Shockable	1 (7.1)	10 (15.6)	
Cause of code blue	Cardiac	3 (21.4)	44 (68.8)	0.002
	Respiratory	11 (78.6)	20 (31.3)	
Resuscitation time In minutes	≤20	12 (85.7)	41 (64.1)	0.204
	>20	2 (14.3)	23 (35.9)	
ROSC	≤ 24 Hours	14 (100)	26 (40.6)	<0.001
	> 24 Hours	0 (0)	38 (59.4)	

of CPR, and regulatory requirements.

The proportion of patients discharged alive was higher in our cohort for both adults and pediatric patients as compared to other studies.[5,11–14] In our study, most in-hospital cardiac arrests (IHCA) occurred in the ICU, with 67.1 % of adult cases and 85.9 % of pediatric cases. Previous research suggests that the location of a patient significantly affects their outcomes, with monitored settings leading to better results.[2] The reasons for improved outcomes in monitored environments like the ICU are likely multifaceted, including the immediate availability of advanced life support, the witnessed and monitored nature of cardiac arrests and a higher nurse-to-patient ratio. Additionally, our study included all patients who were full code, as well as those for whom resuscitation efforts were halted by family decision.

Pre-arrest comorbid diseases (e.g. cancer, cardiac diseases, and sepsis) are associated with a low survival rate. The CCI score is a widely utilized tool to assess the severity of comorbidities.[13] As published in an article, emphasizing patients with higher age-adjusted CCI scores had a higher likelihood of dying during hospitalization.[15–18] In our study the cardiac arrest patients with known co-morbid, the CCI score was found to be 2.88 with an SD of (2.08) for adults and 0.61 with an SD of (0.88) for pediatrics showing that the low CCI score contributed to the high survival rates.

Recent studies have postulated that survival from adult and pediatric in-hospital cardiac arrest was superior after a first documented shockable rhythm of ventricular fibrillation or ventricular tachycardia compared with a first documented non-shockable rhythm of PEA or asystole.[19–20] This was well established in our cohort too. The survival rate of patients where the initial rhythm was shockable was recorded to be 55.6 % and 17.5 % in contrast to patients experiencing non-shockable as the initial rhythm.

We found a graded association between lower survival and code time. Patients having a code time of < 20 had a survival rate of 41.7 % and 85.7 % while those above 20 min were estimated to be 16.7 % and 14.3 % for adults and pediatrics respectively. This observation reinforces the rationale for shortening the code time as much as possible to maximize the effectiveness of resuscitation. A study published in 2021 established that patients who had cardiac arrest for less than 20 min had a better survival rate than those who were arrested for more than 20 min.[21] The proportion of patients discharged alive was significantly lower for those who experienced cardiac arrest lasting more than 20 min., compared to patients who were arrested for less than 20 min (3.1 % vs. 41.3 %, p = <0.0001).[22] Similarly, pediatric patients' mortality increased with longer CPR durations.[23]

There is a growing acknowledgment of the significant role Rapid Response Teams (RRT) play in managing In-Hospital Cardiac Arrest (IHCA).[20] Previous research has indicated a 19 % decrease in the incidence of IHCA following the implementation of RRT in adults. In 1999, Goldhill et al. reported a 26 % reduction in cardiac arrests occurring before patients were transferred to the intensive care unit (ICU) after the introduction of an RRT. Our study revealed that only 34.2 % of patients received treatment from the rapid response team. This lower percentage could be attributed to delayed recognition of arrests, an increasing number of patients in our cohort aged 64 years and older, and potential discrepancies in retrospective data, which may have influenced this finding.

Limitation

While the study results provide valuable insights into the resuscitation and survival outcomes of in-hospital cardiac arrests in the context of Pakistan, certain limitations should be acknowledged. These include the study's reliance on a single center, exclusion of cardiac arrest cases admitted in the ER, a relatively small sample size, a short observation period of three years, and not analyzing the CPC score.

Conclusion

The present study provides important observational data regarding in-hospital cardiac arrest outcomes challenging global survival averages. Factors like monitored units and rapid response teams contribute to higher survival rates. The study underscores the influence of comorbidities, rhythms, and code duration on outcomes, emphasizing the need for continued research in this context.

CRediT authorship contribution statement

Muhammad Faisal Khan: . **Omer Shafiq:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Methodology, Investigation, Formal analysis. **Sana Hirani:** Writing – original draft, Resources, Data curation. **Amber Sabeen:** Writing – review & editing, Validation, Methodology, Formal analysis. **Sijal Akhtar Sheikh:** Writing – review & editing, Formal analysis. **Qalab Abbas:** Writing – review & editing, Resources, Data curation. **Tahir Munir:** Software, Formal analysis, Data curation. **Huba Atiq:** Supervision, Project administration, Formal analysis, Conceptualization. **Yasmin Hashwani:** Writing – review & editing, Resources, Data curation. **Asad Latif:** Writing – review & editing, Supervision, Project administration.

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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