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Clinical paper

Epidemiology and outcomes of out of hospital cardiac arrest in Karachi, Pakistan – A longitudinal study

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ABSTRACT

Background: Out-of-hospital cardiac arrest (OHCA) is a major cause of morbidity and mortality globally, with survival outcomes remaining poor particularly in many low- and middle-income countries. We aimed to establish a pilot OHCA registry in Karachi, Pakistan to provide insights into OHCA patient demographics, pre-hospital and in-hospital care, and outcomes.

Methods: A multicenter longitudinal study was conducted from August 2015-October 2019 across 11 Karachi hospitals, using a standardized Utstein-based survey form. Data was retrospectively obtained from medical records, patients, and next-of-kin interviews at hospitals with accessible medical records, while hospitals without medical records system used on-site data collectors. Demographics, arrest characteristics, prehospital events, and survival outcomes were collected. Survivors underwent follow-up at 1 month, 6 months, 1 year, and 5 years.

Results: In total, 1068 OHCA patients were included. Mean age was 55 years, 61.1 % (n = 653) male. Witnessed arrests accounted for 94.9 % of the cases (n = 1013), whereas 89.4 % of the cases (n = 955) were transported via non-EMS. Bystander CPR was performed in 10.3 % (n = 110) cases whereas pre-hospital defibrillation performed in 0.4 % (n = 4). In-hospital defibrillation was performed in 9.9 % (n = 106) cases despite < 5 % shockable rhythms. Overall survival to discharge was 0.75 % (n = 8). Of these 8 patients, 7 patients survived to 1-year and 2 to 5-years. Neurological outcomes correlated with long-term survival.

Conclusion: OHCA survival rates are extremely low, necessitating public awareness interventions like CPR training, developing robust pre-hospital systems, and improving in-hospital emergency care through standardized training programs. This pilot registry lays the foundation for implementing interventions to improve survival and emergency medical infrastructure.

Introduction

Sudden cardiac arrest (SCA) is a major global health concern, being the leading cause of pre-hospital and in-hospital deaths worldwide. The vast majority of these cardiac arrests occur outside of the hospital setting, known as out-of-hospital cardiac arrests (OHCA), with an approximate annual incidence of 95.9 per 100,000 adults globally.[1] Despite its high incidence, OHCA survival rates remain alarmingly low, under 10 %.[1]

The time taken to initiate cardiopulmonary resuscitation (CPR) is the

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most critical determinant of survival rates for OHCA cases.[1] Prompt bystander CPR significantly improves OHCA survival,[2] with global survival rates increasing over the past 40 years,[2] but varying across regions, being higher in high-income countries.[3]

The estimated OHCA incidence in high-income countries is 50–60 per 100,000 people,[4] with a systematic review showing 29.7 % achieving return of spontaneous circulation (ROSC), 22.0 % surviving to hospital admission, 8.8 % to discharge, 10.7 % at 1-month, and 7.7 % at 1-year follow-up.[2] In contrast, LMICs disproportionately bear a higher OHCA burden and poorer outcomes, e.g., Karachi's annual incidence is 166/100,000.[5] likely an underestimate,[6] with extremely low survival rates of 0 % in traumatic and <2 % in non-traumatic cases[7,8] attributed to lack of bystander CPR knowledge, delayed responses, inadequate EMS-hospital coordination, limited defibrillation access, insufficient public awareness, and socioeconomic inequalities.[4,7,8]

Establishing OHCA registries is a crucial first step towards improving survival, as emphasized by global organizations,[9,10] providing local data on prevalence, predictors, risk factors, interventions, and tracking outcomes over time to identify trends, problems, and delays in care to formulate interventions and evaluate effectiveness.

In this context, we aimed to establish a pilot registry in Karachi, Pakistan, as part of the Pan-Asian Research Outcomes Study (PAROS), a multicenter prospective registry network of OHCA cases across the Asia-Pacific region.[3] Our objective was to lay the groundwork for comprehensive OHCA data collection and surveillance, systematically capturing key metrics, emphasizing quality of life and long-term survival, an aspect that has been largely overlooked in previous efforts. By achieving these objectives, we hope to inform efforts for improving survival and quality of life, and establish a standardized methodology and framework that can facilitate the expansion into an ongoing, city-wide registry, driving advances in emergency care and resuscitation practices. The aim of the study was to determine the characteristics and outcomes of out-of-hospital cardiac arrest (OHCA) patients and to assess the association of key metrics or indicators collected through this pilot registry.

Methods and materials

Study design

A longitudinal study on characteristics and outcomes of OHCA was conducted. An approval was obtained from the Ethical Review Committee of all the hospitals involved, prior to data collection. For sites without such boards, approval was sought from the Medical Administration Offices. A second round of ethical approval was obtained for long-term survivor follow-up which was conducted via phone call by the data collectors. Consent for follow-up was obtained from survivors at discharge.

Study setting

This study was conducted in Karachi, Pakistan's largest city and a major port on the Arabian Sea coast, with a population of approximately 20 million. The city's healthcare system is multi-tiered, comprising primary, secondary, and tertiary facilities, although emergency medical services remain limited.

We selected 11 tertiary care hospitals (3 public, 8 private) through convenient sampling. In Pakistan, tertiary hospitals provide specialized healthcare services, including advanced diagnostics, complex treatments, and often serve as referral centers for secondary hospitals. These facilities typically offer multiple specialties and subspecialties. Nine of the 11 selected hospitals had cardiac intervention (PCI) capabilities.

These hospitals represent key public and private healthcare centers in Karachi, covering a significant portion of the city's population. Serving as major healthcare hubs, they attract patients not only from within Karachi but also from surrounding regions. As the city's premier teaching institutions, these hospitals handle a significant proportion of emergency cases and collectively serve patients from a broad spectrum of socioeconomic backgrounds and ethnic groups. This approach minimized selection bias and allowed us to gather data that closely mirrors the city's demographic makeup and improve the study's generalisability. Notably, these hospitals' reach extends beyond Karachi, serving individuals from surrounding regions as well.

EMS services in Karachi are still in the developing phase, with pre-hospital care and transportation remaining limited. During the study period, AMAN Ambulance was the only standardized EMS provider, offering basic and advanced life support, trained medical staff, life-saving equipment, medical oversight, and quality monitoring. However, due to the limited coverage and low public awareness, most patients are transported to hospitals via private or public vehicles, or by non-standardized ambulance services.

Study population

The study included OHCA patients aged ≥18 years. OHCA was characterized by the absence of pulse, unresponsiveness, and absent breathing upon arrival at the ED. Patients who had a Do Not Resuscitate (DNR) status or were referred from other hospitals were excluded from the study.

Data collection

Data was collected from August 2015 to October 2019, with follow-up for OHCA survivors until 2022. Commencement of data collection at each site varied based on approval timelines, feasibility, and logistics.

Data collection strategy varied depending on the availability of electronic health records. At hospitals (n = 3) with electronic medical records, data was retrospectively obtained from medical records and telephone calls. For hospitals (n = 8) without a functional medical record system, on-site data collectors gathered information prospectively from hospital staff, patients/attendants, and EMS personnel using a standardized Utstein-aligned survey form [S1, 52].[11,12] The Utstein template or standard is a set of guidelines and recommendations for uniform reporting of data on OHCA. It was developed to standardize the reporting and improve the comparability of cardiac arrest studies across different regions and systems. Pre-hospital data sources were family, next-of-kin and/or AMAN ambulance records. Hospital management details came from medical staff/records.

Surviving OHCA patients were followed up at several time points to assess long-term survival and quality of life. Follow-ups were conducted at the 1-month mark using the European Quality of Life-5 Dimensions (EQ-5D) scale, and Cerebral Performance Category (CPC) score. The EQ-5D assesses mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, providing insights into health outcomes[13]. Meanwhile, the CPC scale, which categorizes neurological outcomes into five levels ranging from 1 to 5 (lower number = better neurological function), is utilized to evaluate post-cardiac arrest neurological function.[14] Additional follow-ups took place 6 months, 1 year, and 5 years after the event.

Data management and analysis

De-identified data was entered into the ePAROS electronic data capture system with quality checks. Data analysis was performed using SPSS v21 and Python 3.7.17. For descriptive statistics, means and standard deviations were calculated for continuous variables like age, whereas for categorical variables frequencies and percentages were calculated.

Results

The study included 1068 patients with OHCA. Results are summarized according to the Utstein style template (Fig. 1).

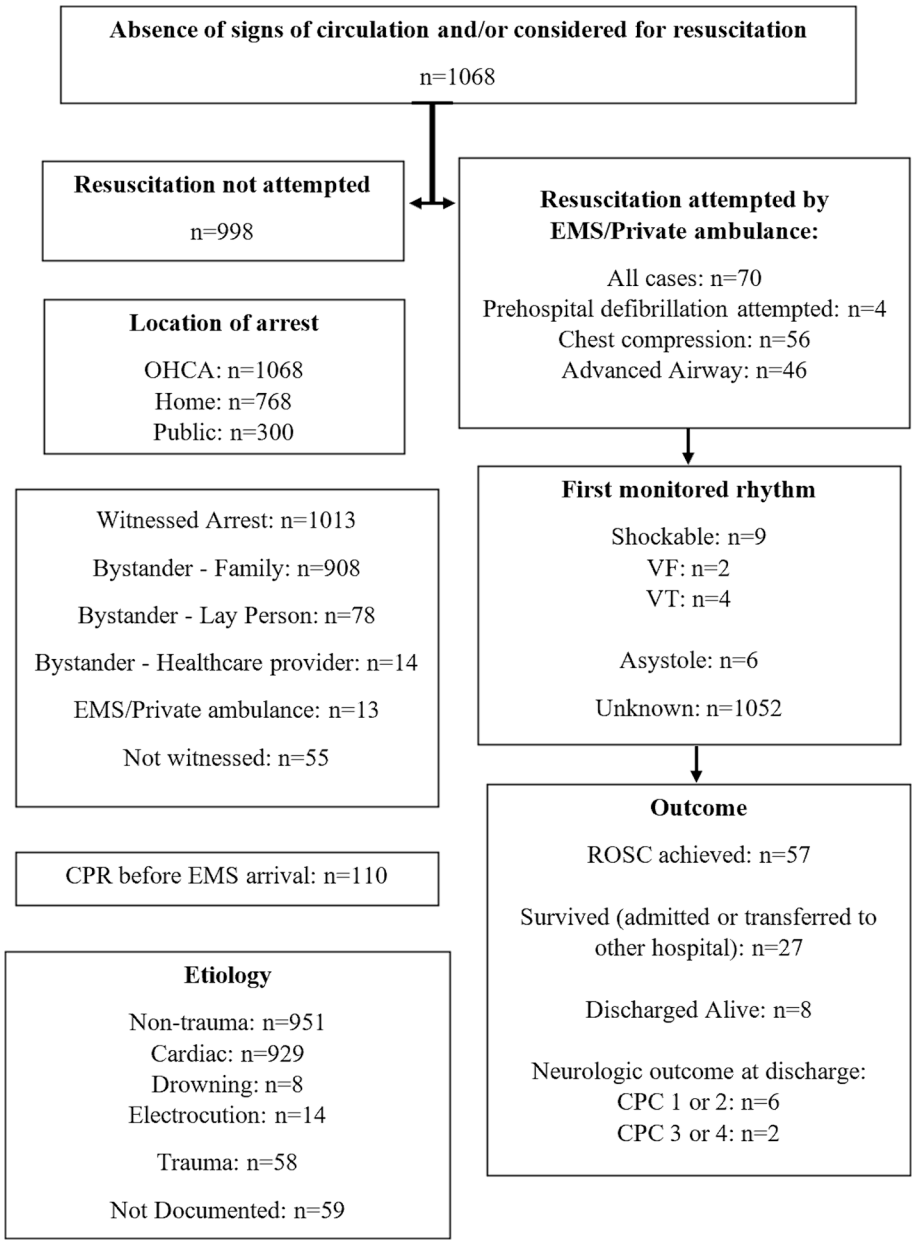

Fig. 1. Utstein template for reporting data on out-of-hospital cardiac arrest.

Table 1 summarizes the study population demographics, pre-hospital cardiac arrest characteristics, and management data. Mean age was 54.94 ± 20.45 years, 61.1 % (n = 653) were male. Witnessed cases made up 94.9 % (n = 1013) of the total cases. Bystander CPR was provided in 10.3 % (n = 110) cases, mostly by family (6.6 %). EMS was utilized by 10.6 % (n = 113) of cases whereas 89.4 % (n = 955) arrived via non-EMS transport. Resuscitation was attempted by EMS/ambulance staff in only 7.5 %. Pre-hospital interventions were rare (7.1 %). Only 3.4 % of cases had shockable rhythm on ED arrival, but defibrillation was performed in 9.9 % cases. Regarding the survivors, all survivors presented with non-shockable rhythms. Despite being witnessed arrests, only 25 % (n = 2) of the survivors received bystander CPR. Most (87.5 %) were transported by non-EMS means.

Table 2 presents the clinical and neurological outcomes following OHCA. ROSC was achieved in 5.4 % of patients (n = 57), with an overall survival rate of 0.7 % (n = 8) at hospital discharge. Notably, half of the survivors demonstrated good neurological function (CPC score 1) at the time of discharge.

Supplementary Fig. S1 shows cases distribution across different areas of Karachi. Majority of the cases occurred primarily in the East (22.87 %), Korangi (22.31 %), and Central (15.37 %) districts.

Table 3 stratifies OHCA survivors by neurological outcome: good (CPC<3, n = 6) and poor (CPC 3–5, n = 2).

Discussion

This study reports preliminary findings from the first centralized cardiac arrest registry in Karachi, Pakistan, filling a critical gap by enabling assessment of current OHCA outcomes, practices and areas needing improvement. Building upon previous work,[7,8] this multicentric registry reflects systematic collection of key indicators which are responsible for the outcomes of patients with OHCA. A key strength is the prospective follow-up, capturing not only initial survival but also neurological outcomes, quality of life, and long-term survival up to 5 years post-discharge – rarely explored in low-resource settings.

The findings highlight the abysmal state of OHCA care and poor

Table 1
Demographics, cardiac arrest characteristics, pre-hospital management and ED management of all OHCA patients (n = 1068) and OHCA survivors (n = 8).

Characteristics	n (%) total patients	n (%) survivors
Total	1068	8
Age (Mean ± SD)	54.9 ± 20.5	64.6 ± 10.0
Gender		
Male	653 (61.1)	5 (62.5)
Female	415 (38.9)	3 (37.5)
Comorbidities		
None	266 (24.9)	0 (0.0)
Unknown	134 (12.5)	0 (0.0)
Diabetes	301 (28.2)	3 (37.5)
Hypertension	299 (28.0)	3 (37.5)
Heart disease	261 (24.4)	4 (50.0)
Respiratory disease	87 (8.1)	1 (12.5)
Cancer	49 (4.6)	0 (0.0)
Renal disease	49 (4.6)	0 (0.0)
Stroke	36 (3.4)	0 (0.0)
Etiology		
Non-traumatic	951 (89.0)	8 (100)
Presumed Cardiac	929 (97.7)	8 (100)
Drowning	8 (0.8)	0 (0.0)
Electrocution	14 (1.5)	0 (0.0)
Traumatic	58 (5.4)	0 (0.0)
Not Documented	59 (5.5)	0 (0.0)
Mode of transport		
Non-EMS	955 (89.4)	7 (87.5)
EMS	113 (10.6)	1 (12.5)
Witnessed Arrest	1013 (94.9)	8 (100.0)
Bystander-Family	908 (89.6)	6 (75.0)
Bystander-Lay Person	78 (7.7)	2 (25.0)
Bystander-Healthcare provider	14 (1.4)	0 (0.0)
EMS/Private ambulance	13 (1.3)	0 (0.0)
Not witnessed	55 (5.1)	0 (0.0)
Bystander CPR		
Yes	110 (10.3)	2 (25.0)
No	958 (89.7)	6 (75.0)
First Pre-hospital CPR initiated by		
No CPR Initiated	902 (84.5)	6 (75.0)
Bystander-Family	70 (6.6)	1(12.5)
Ambulance-Crew	56 (5.2)	0 (0.0)
Bystander-Healthcare provider	25 (2.3)	0 (0.0)
Bystander-Lay Person	15 (1.4)	1 (12.5)
Resuscitation attempted by EMS or Private ambulance		
Yes	80 (7.5)	1 (12.5)
No	529 (49.5)	3 (37.5)
Not documented	459 (43.0)	4 (50.0)
Pre-hospital Intervention		
Not Available	992 (92.9)	7 (87.5)
Advanced airway	46 (4.3)	0 (0.0)
Drug administration	26 (2.4)	1 (12.5)
Defibrillation	4 (0.4)	1 (12.5)
Disposition		
Transferred to Emergency care	1018 (95.3)	8 (100.0)
Pronounced dead at the scene	50 (4.7)	0 (0.0)
Cardiac rhythm on ED arrival		
Unknown	69 (6.5)	0 (0.0)
Shockable	36 (3.4)	0 (0.0)
Non-shockable	960 (89.9)	8 (100.0)
Other	3 (0.3)	0 (0.0)
ED defibrillation performed		
Yes	106 (9.9)	3 (37.5)
No	911 (85.3)	0 (0.0)
Not Documented	51 (4.8)	5 (62.5)

outcomes, with an overall survival rate to hospital discharge of only 0.7 % (8 patients). Bystander CPR rates and EMS utilization were around 10 %, with virtually non-existent prehospital emergency care. Remarkably, among the survivors, half had favourable neurological function at discharge. However, the long-term prognosis was bleak, with a 75 % mortality rate by 5 years. These findings underscore the pressing need to implement comprehensive strategies to improve prehospital and hospital-based resuscitation systems in Karachi.

The low survival rate in our study is consistent with a previous study

Table 2
ROSC Status and Neurological Function in OHCA Patients.

	n (%) total patients	n (%) survivors
ROSC achieved (Prehospital or ED)		
Yes	57 (5.3)	8 (100.0)
No	960 (89.9)	0 (0.0)
Not available	51 (4.8)	0 (0.0)
Status on hospital discharge		
Dead	1060 (99.2)	0 (0.0)
Alive	08 (0.7)	8 (100.0)
Cerebral performance category (CPC) score:		
1		4 (50.0)
2		2 (25.0)
3		2 (25.0)
Overall performance category (OPC) score:		
1		4 (50.0)
2		2 (25.0)
3		2 (25.0)

Table 3
Comparison of OHCA survivors stratified according to CPC score (n = 8).

Characteristics	CPC score	
	Good outcome (CPC score < 3) n = 6	Bad outcome (CPC score 3–5) n = 2
Age: Mean ± SD (range)	67 ± 9.5 (50–75)	57.5 ± 10.6 (50–65)
Gender		
Male	5 (83.3)	0 (0.0)
Female	1 (16.7)	2 (100.0)
Mode of Transport		
Non-EMS	6 (100.0)	1 (50.0)
EMS	0 (0.0)	1 (50.0)
Status at 5-year follow-up		
Alive	2 (33.3)	0 (0.0)
Dead	2 (33.3)	1 (50.0)
Loss to follow-up	2 (33.3)	1 (50.0)

from Karachi by Minaz et al. in 2016 showing <1 % survival at hospital discharge, and 0 % at 2 months post-OHCA[7]. The survival rate in our study is significantly lower than the average 7 % survival to discharge reported among developed countries in North America, Europe, Australia and Asia.[1,15] This disparity can be attributed to gaps in the chain of survival, including delayed recognition of cardiac arrest and CPR initiation, lack of public-access AEDs, inadequate pre-hospital care systems, and variability in in-hospital OHCA management practices.

Bystander CPR was found to be administered in 10.3 % of OHCA cases. While higher than some previous Karachi reports of 0–2.3 %,[7,8] it still represents a concerningly low frequency of bystander resuscitation attempts. The 10.3 % rate is likely an overestimation in our registry given the lack of standardized definitions and potential interpretation differences for what constitutes bystander CPR between reporting sites/persons. The 10.3 % rate is comparable to low rates globally, including 4.4 % in Lebanon,[16] 9.6 % in China,[17] and 9.8 % in India,[18] indicating bystander CPR for OHCAs remains limited across regions and socio-economic settings. Barriers like low socioeconomic status, lack of CPR knowledge, lack of confidence, inadequate public health infrastructure and fear of legal consequences may contribute to low global bystander resuscitation.[19,20] Our study underscores the consistent need to improve rates of early bystander CPR to improve the outcomes of patients with OHCA.

Our results showed only a small proportion of OHCA patients receiving bystander CPR achieved ROSC (5.5 %) or survived to hospital discharge (1.8 %). Additionally, ROSC and survival rates did not significantly differ between those who did and did not receive bystander CPR. The lack of association could relate to the quality of resuscitation provided and lack of publicly available AEDs. Suboptimal bystander CPR may fail to improve outcomes.[21,22] The unavailability of public-

access defibrillators may have negated the potential benefits of bystander CPR, especially for patients whose initial rhythm was shockable. Prehospital care and ED management also have a major impact on OHCA outcomes; therefore, without other chain of survival components, bystander CPR alone may not improve outcomes. Overall, these findings indicate a need to increase bystander CPR rates, ensure proper technique, improve communication and coordination with EMS, and improve post-arrest hospital care.

One concerning finding was the inappropriate delivery of shocks to patients with non-shockable rhythms, contradicting resuscitation guidelines. This could stem from lack of training, failure to initially recognize non-shockable rhythms accurately, and potential cultural or traditional beliefs encouraging defibrillation attempts regardless of rhythm. This highlights the need for enhanced cardiovascular life support training programs and reinforcement of protocols regionally.

Regarding witnessed arrests, the 94.85 % rate in our study is higher than that observed in other global OHCA studies, indicating potential overreporting compared to prior studies.[7,16,17,23] Possible reasons for higher witnessed collapse in our data include bystander overinterpretation of events as cardiac arrests or due to a joint family structure which leads to higher number of occupants per family thereby increasing chances of someone in the family witnessing the event.

The concentration of OHCA cases primarily in the East (22.9 %), Korangi (22.3 %), and Central (15.4 %) districts of Karachi provides valuable insights into the geographic distribution of these incidents. This information can guide the targeted allocation of emergency medical resources and services to areas with the greatest OHCA burden. Additionally, employing geolocation techniques like GPS could precisely identify and target high-burden regions.

It is important to note that the current Utstein template primarily applies to mature EMS systems in high- and middle-income countries. To make data collection more applicable and manageable in low-resource settings, the International Liaison Committee on Resuscitation (ILCOR) has proposed a minimum dataset, which includes variables like date of cardiac arrest, age, sex, location, mode of transport, bystander CPR, witnessed status, first monitored rhythm, presumed etiology, ROSC status on arrival, and survival status.[24]

Karachi's insufficient emergency medical infrastructure significantly impacts OHCA outcomes. The single standardized emergency medical service is inadequate for a city which is home to more than twenty million people. The absence of an organized prehospital system results in low rates of bystander CPR and defibrillation, underutilization of EMS, lack of communication and coordination between community members and EMS leading to prolonged response times, all of which ultimately contribute to the abysmal OHCA survival rates. Implementing systematic surveillance through registries marks an important initial step in recognizing current gaps. These findings highlight the need of public awareness and training programs, focused on recognition of cardiac arrest, activation of emergency response services and initiation of CPR till medical help arrives. In addition, this study also underscores the need for strengthening the emergency response systems and improving in-hospital care of OHCA patients through capacity building and quality improvement by measuring their performance with the help of key indicators. As an initial pilot, sustainability and expansion across Pakistan remains uncertain without continuous funding or stakeholder buy-in. Effective pre-hospital and in-hospital service collaboration is essential but requires coordinated infrastructure and operations, stable budgeting, and adequate human resources. Nonetheless, this pilot registry provides preliminary local evidence to inform policies and interventions for this high OHCA mortality risk population.

Limitations

Limitations of this study include potential inaccuracies from relying on family recall for prehospital data from non-EMS transports, which could be overcome by developing standardized prehospital data collection forms/systems across EMS providers. Absence of continuous on-site data collection at all centers may have resulted in some loss of information, especially regarding EMS details. Selection bias is likely as the study excluded patients brought to non-tertiary care settings and those who did not reach the hospitals. Although statistical analyses were initially planned to determine associations between gender, mode of transport, bystander CPR, ROSC, and survival outcomes, these analyses were ultimately excluded due to the small sample size, which limited the statistical power and reliability of such comparisons. Finally, our study was limited by missing data especially regarding ROSC status and the lack of information on whether resuscitation was attempted by EMS or not. This data was either inconsistently recorded or unavailable. Moving forward, we aim to improve data collection processes to collect these details more comprehensively.

Conclusion

Our pilot cardiac arrest registry marks the first multicentre OHCA surveillance effort in Karachi, Pakistan. Similar to other settings, findings reveal stark survival disparities, with a meagre 0.75 % survival rate at hospital discharge. The study underscores the pressing need for improved emergency infrastructure, as bystander CPR rates, EMS utilization and pre-hospital care remain inadequate. Despite challenges, the registry provides vital insights emphasizing the importance of public awareness, early CPR, public defibrillator access, enhanced prehospital care, and standardized protocols for strategic interventions. This study provides a platform to expand the pilot registry for continuous data collection that can be utilized to design and implement evidence-based best practices, especially for low resource settings that will help improve outcomes of patients with OHCA.

Authorship contribution statement

Marcus Eng Hock Ong and Junaid Razzak conceptualized the study. Uzma Rahim Khan developed the methodology. Uzma Rahim Khan, Noor Baig, Kamlesh M Bhojwani, Ahmed Rahim, and Nadeem Ullah Khan performed the formal analysis. The initial draft was written by Uzma Rahim Khan, Noor Baig, Kamlesh M Bhojwani, Rubaba Khan, Mohammad Ahraz Hussain, Salima Sayani, and Nadeem Ullah Khan. Editing of the manuscript was done by Kamlesh M Bhojwani, Noor Baig, Kanza Shabnum, and Saadia Saajid. The manuscript was reviewed by Uzma Rahim Khan, Marcus Eng Hock Ong, Junaid A Razzak, Fareed Ahmed, and Munawar Khursheed. Data collection was carried out by Ayaz Ilyas. Project administration was handled by Uzma Rahim Khan, Junaid A Razzak, Marcus Eng Hock Ong, Munawar Khursheed, Bashir Hanif, Ghazanfar Saleem, Seemin Jamali, Ali Kashan, Alvia Saad and Nadeem Ullah Khan.

Declaration of AI and AI-assisted technologies in the writing process

In the preparation of this manuscript, Claude AI was utilized for paraphrasing to reduce the word count. AI's role did not extend to ideation, analysis, or interpretations presented in the manuscript. The content generated by Claude AI was thoroughly reviewed, approved and edited by the authors. The authors take full responsibility for the final content of the manuscript.

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CRediT authorship contribution statement

Uzma Rahim Khan: Writing – original draft, Project administration, Methodology, Formal analysis. **Noor Baig:** Writing – review & editing, Writing – original draft, Formal analysis. **Kamlesh M. Bhojwani:** Writing – review & editing, Writing – original draft, Formal analysis. **Ahmed Raheem:** Formal analysis. **Rubaba Khan:** Writing – original draft. **Ayaz Ilyas:** Data curation. **Munawar Khursheed:** Supervision, Project administration. **Mohammad Ahraz Hussain:** Writing – original draft. **Junaid A. Razzak:** Writing – review & editing, Project administration, Conceptualization. **Marcus Eng Hock Ong:** Writing – review & editing, Project administration, Conceptualization. **Fareed Ahmed:** Writing – review & editing. **Bashir Hanif:** Project administration. **Ghazanfar Saleem:** Project administration. **Seemin Jamali:** Project administration. **Ali Kashan:** Project administration. **Alvia Saad:** Project administration. **Salima Kerai:** Writing – original draft. **Syeda Kanza:** Writing – review & editing. **Saadia Sajid:** Writing – review & editing. **Nadeem Ullah Khan:** Writing – original draft, 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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Appendix A. Supplementary data

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